Proceedings of the 25th International Conference and 50th Anniversary Celebration

July 29 – August 2, 2007
Boston, Massachusetts, USA

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Massachusetts Institute of Technology
Sloan School of Management
Cambridge, Massachusetts, USA

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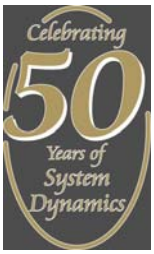

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Table of Contents

Welcome

Dear Colleagues,

Welcome to the 25th International Conference of the System Dynamics Society. This year we return to the birthplace of System Dynamics in order to celebrate 50 years of work in the field. The growth in interest, applications and activity over that time has been tremendous and rewarding, but it does mean that we don't fit comfortably in the hotels closest to MIT. We hope you will enjoy the Seaport and nearby Boston Harbor.

This year once again the program is a testament to the breadth of applicability of the work done 50 years ago that lead to the publication of "Industrial Dynamics: A Major Breakthrough for Decision Makers" in the *Harvard Business Review*. Conference participants come from over 45 different countries. Over the next four days you will have a chance to present, listen to and discuss system dynamics work presented by academics and practitioners from around the world.

There are a number of activities that will mark the 50th anniversary. Some are in the schedule, and some will be surprises. Many generations of system dynamicists will be in attendance. The conference is a wonderful opportunity to meet an amazing collection of people. We encourage you to walk up and say hello to everyone – generally we are a pretty friendly bunch.

To further increase your enjoyment of the conference we have also scheduled a variety of social events including an informal gathering during registration, a "Neighborhoods of Boston" buffet on Monday evening, and the Conference Banquet and System Dynamics Talent Show on Tuesday. We welcome those who may be accompanying conference participants but not attending the formal sessions. We hope that you will take part in the special events and enjoy the attractions of Boston and New England. There will be organized activities including a Freedom Trail walking tour and a guided tour of the MIT campus, where system dynamics and so many other vital inventions began.

This year 424 volunteer reviewers screened and commented on a record number of submissions. In addition, many dozens of volunteers worked many hours to ensure a successful conference. Without their commitment our conference would be impossible. A special thanks goes to all who helped.

In addition to all our other sponsors and our conference host, the System Dynamics Group at the MIT Sloan School of Management, we are also very fortunate this year to have two conference partners, PA Consulting Group and Kolbenschmidt Pierburg. We sincerely appreciate the enthusiasm and support of all our sponsors.

We hope that you find the conference stimulating and rewarding. We ask that you bring to our attention anything that may help us to ensure the success of the current conference, as well as future ones. Thank you for attending, and, once more, welcome!

Best wishes from the conference organizing committee,
Bob Eberlein, Rogelio Oliva, John Sterman, Jack Homer and Roberta Spencer

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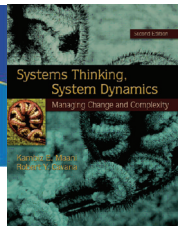

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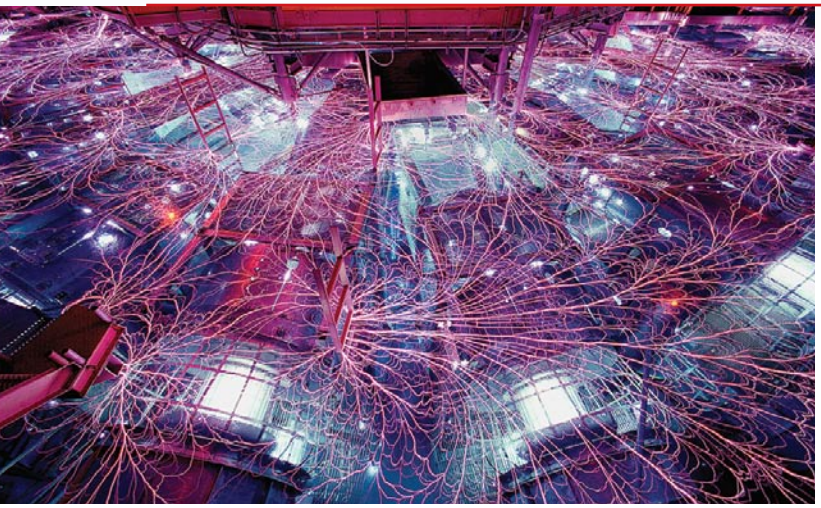

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System Dynamics at Sandia

Sandia has been active in system dynamics since 1975. Today Sandia is highly vested in SD-based studies of critical infrastructure protection, energy economics, and water resources management. Efforts to understand the dynamics of coupled infrastructures, examine alternative energy sources, and highlight short- versus long-term trade-offs in strategy and decision making are currently funded at the level of millions of dollars annually.

Modeling for Water & Energy Decision Support

System Dynamics modeling for water and energy decision support has focused on the issue of sustainability. An international effort to build a high-level model of water resources in China, and a local initiative to model household water conservation in the Rio Grande Basin of New Mexico, have spun off many other water resource management studies, both domestically and abroad. The energy models have been used to contrast alternative, renewable energy sources against petroleum-based fuels.

A Global Energy Futures Model simulates key aspects of nuclear and non-nuclear energy, nuclear materials storage and disposition, global nuclear-materials management, and nuclear-proliferation risk, along with oil, gas, coal, greenhouse gas emissions, and other measures of environmental impact. The model has been used by government officials to simulate future energy trends and has created interest in bio-fuel and renewable fuel studies, as well as integrated water, energy, and food modeling projects.

These multi disciplinary projects have been client based and stakeholder-driven. The assumptions embedded in the models have been scrutinized by a gamut of scientists and experts. A groundbreaking effort is under way to integrate system dynamics, border gradients models, and spatially explicit modeling environments, such as GIS.

Modeling for Critical Infrastructure Protection

Today's open and technologically complex society includes a wide array of critical infrastructures. Many have historically been physically and logically separate systems that had little interdependence. As a result of advances in information technology and the necessity of improved efficiency, however, these infrastructures have become increasingly automated and interlinked. These same advances have created new and possibly cascading vulnerabilities.

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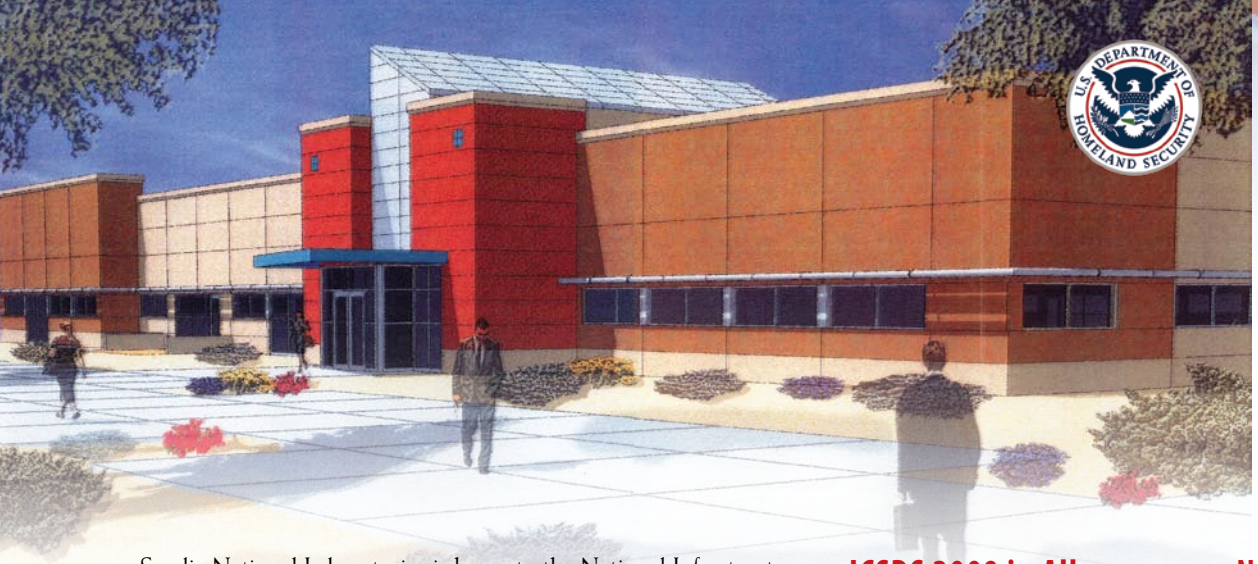

Sandia National Laboratories is home to the National Infrastructure Simulation and Analysis Center (NISAC)

Sandia National Laboratories is home to the National Infrastructure Simulation and Analysis Center (NISAC), established to integrate the national laboratories' expertise in modeling and simulating complex systems. System dynamics is an important modeling capability used to quantify and evaluate the effects of infrastructures and their interdependencies on supply and demand under different conditions.

Given a specific threat or vulnerability scenario, the model-based analyses estimate the potential magnitude, location, and timing of disruptions. Further, the analyses establish propagations throughout infrastructures and national regions, examine limiting factors, capacities, and redundancies and quantify overall consequences. The models incorporate the feedbacks created by the interdependencies and their net effects on supply and demand balances. They also aim to identify unintended consequences of policy responses.

Critical infrastructure protection studies using system dynamics modeling include, among others:

- Port security and long-term economic viability
- Loss of multiple telecommunication assets
- Social and economic effects of animal and plant diseases
- Physical disruptions due to natural disasters

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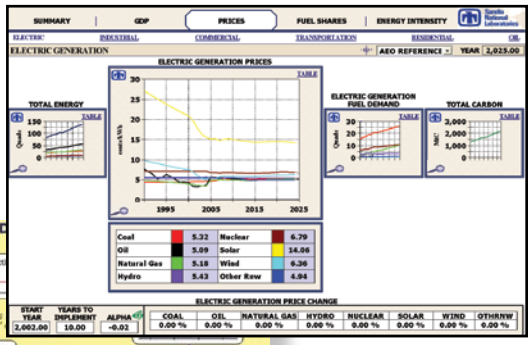

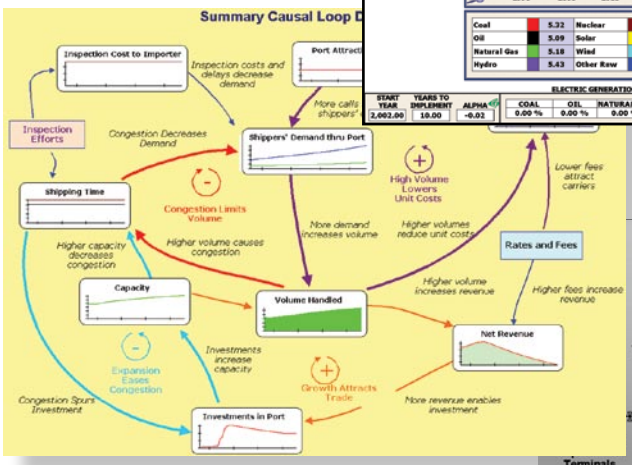

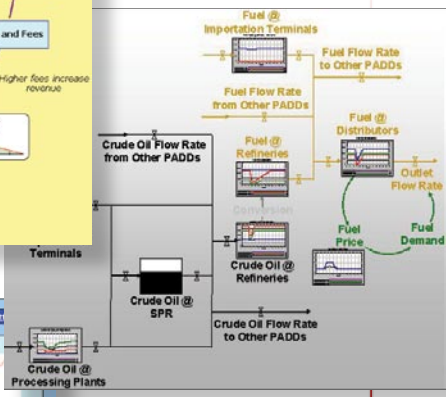

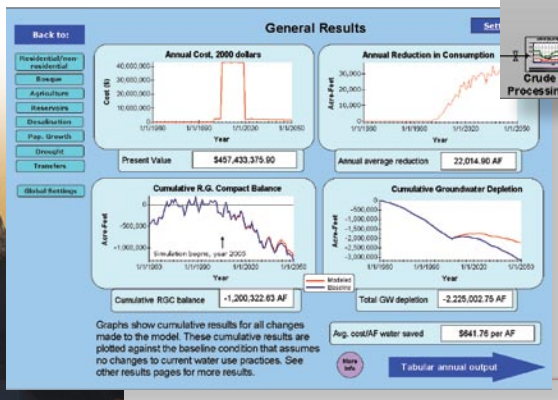

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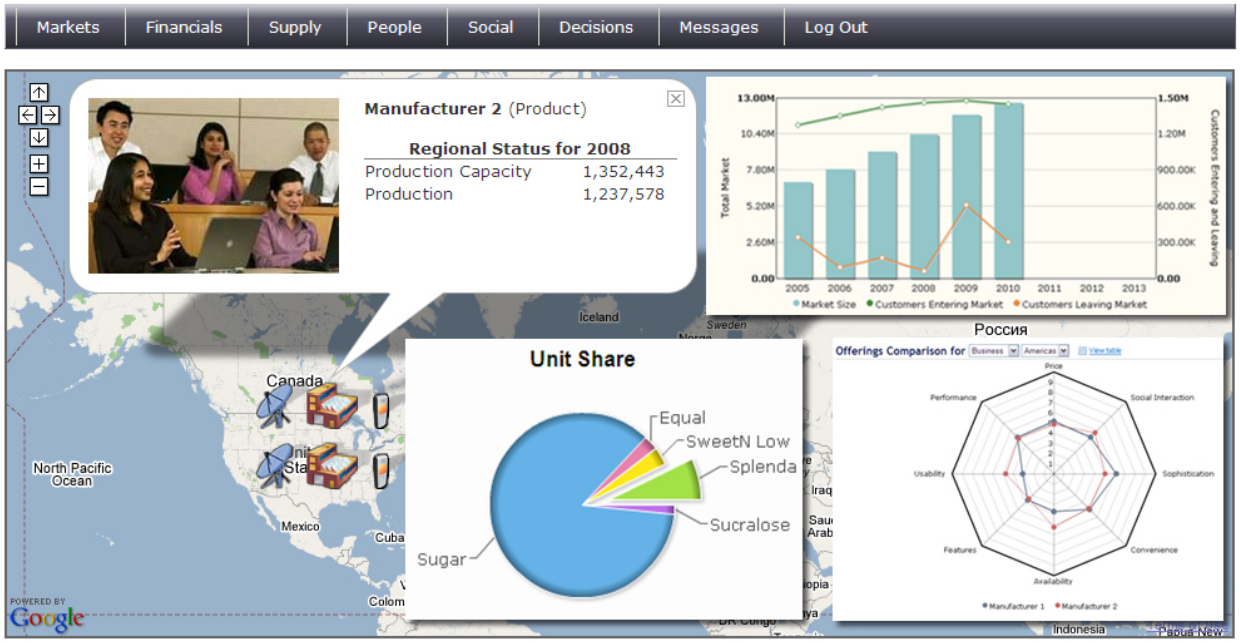

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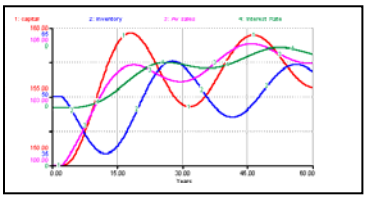

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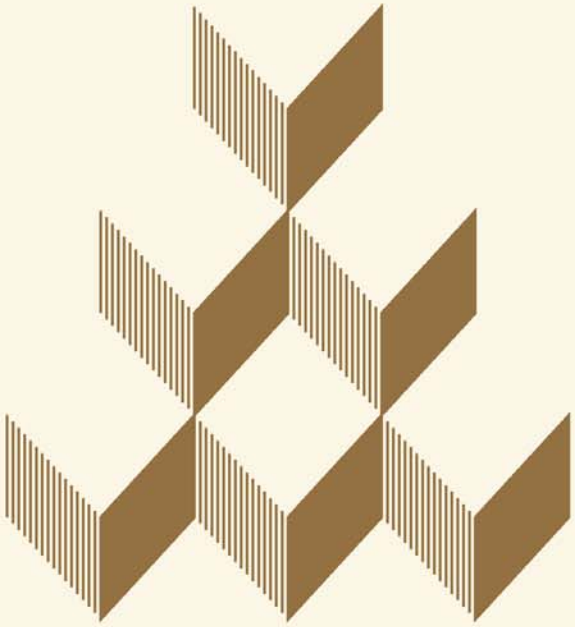

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IT HAS BEEN OUR PLEASURE to help fund the Dana Meadows Student Paper Prize, given annually for the best student paper presented at the International System Dynamics Conference. Thanks to all who helped establish the fund to permanently endow this valuable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

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

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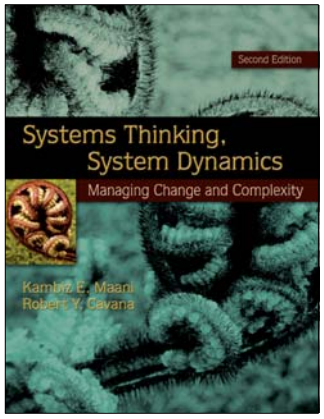

Systems Thinking, System Dynamics

Managing Change and Complexity

Kambiz E. Maani & Robert Y. Cavana

Pearson Education New Zealand, Auckland. © 2007

www.pearsoned.co.nz/vbd/systemsthinking

ISBN: 978 1 877371 03 5 288pp

This revised edition, re-titled **Systems Thinking, System Dynamics**, offers readers a comprehensive introduction to the growing field connecting systems thinking and system dynamics, and its applications. The book provides a self-contained and unique blend of qualitative and quantitative tools, step-by-step methodology, numerous examples and mini-cases, as well as extensive real-life case studies. The content mix and presentation style make the otherwise technical tools of systems thinking and system dynamics accessible to a wide range of people.

Systems Thinking, System Dynamics includes additional material on theory as well as several new cases. The book comes with a **CD-ROM** that includes the models presented in the book as well as the installation package for a save-disabled version of the *iThink* software and the installation program for Vensim PLE (Personal Learning Edition) which allows users to create their own models.

New edition also available from **Pegasus Communications Inc.** **www.pegasuscom.com**

The International Society for the Systems Sciences

51st Annual Meeting, Tokyo Institute of Technology, Tokyo, Japan

August 5-10, 2007

The International Society for the Systems Sciences (ISSS) is entering its second half-century of interdisciplinary collaboration and synthesis of systems sciences. Based on fifty years of tremendous interdisciplinary research from the scientific study of complex systems to interactive approaches in management and community development, the next conference in Tokyo, Japan, the 51st annual meeting, will take the theme "Integrated Systems Sciences: Systems Thinking, Modeling and Practice". The conference will attempt to promote systems sciences as an approach to complexity in a broad sense, identified in organizations, communities and societies, and their environments, in such a holistic and integrated way that we draw on all of systems sciences from systems thinking and systems modeling to systems practice.

Planning is also underway for the 52nd meeting to be held at the University of Wisconsin, Madison, WI, 13-18 July 2008. The theme of this conference will be: "Systems that make a difference" and ideas for plenaries, paper sessions, workshops or other discussions are welcome at this time.

For further information about this year's meeting or the meeting in 2008, please consult the ISSS website: http://www.isss.org/conferences/tokyo2007/ or contact the ISSS office at isssoffice@dsl.pipex.com

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THE *SYSTEM DYNAMICS CAREER LINK*

What is it? The *SD Career Link*, in its ***eighth*** year of operation, is hosted by the System Dynamics Society at the University at Albany. It includes on-line information and links to organizations that employ candidates with system dynamics and systems thinking backgrounds. The *SD Career Link* provides a valuable forum for the 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 SD Career Link web page of the Society web site has two subsections: (1) company/university profiles, and (2) specific job listings. In the profiles section, company and university employers provide general yet descriptive information about how system dynamics fits into their organization, typical jobs, career paths, and other aspects of employment. This subsection allows employers to provide information about system dynamics opportunities within their organizations to supplement the more general information contained on their corporate or academic websites. Such career information is valuable to current as well as future system dynamics students, academics, and practitioners, and we urge companies and universities to describe the use of system dynamics expertise in their organization even if they do not have job openings at the present time. In the job listings section of the bulletin board, employers advertise their current openings. These are for any level of required expertise located in any geographical region.

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.

The Diagram Slam

A System Dynamics Conceptualization Contest

This is a contest for teams of people (1-5) to create the most interesting, funny, innovative, or beautiful causal-loop and/or stock-flow diagram on a topic that appeared in the news.

Qualifying Round Submissions

Diagrams must be based on material from an article in a newspaper or magazine (any country, any language) that was printed after July 23, 2007. The diagram may include factors not addressed in the article.

The diagram must fit completely on an 8.5 x 11 piece of paper or paper napkin. Multiple colors may be used. The diagram can include notes, behavior-over-time graphs, pictures, anything you choose. Please attach the article from the paper that prompted the diagram. Do not write names of contestants on the submission. Contestants will be given a number to identify the diagram.

An arbitrary group of judges will pick the top five diagrams for the finals.

Final Round

Five finalist teams will be invited to compete for the championship via a live presentation after the Beer Game. Each team can have as many presenters as they like. They will have:

- No more than four minutes.
- An overhead projector and projection screen.
- Five blank transparency sheets.
- A packet of multi-color pens.
- An adoring crowd.

Schedule

- Diagrams must be submitted by 5pm on Tuesday, July 31.
- Five finalists will be announced in the August 1, Wednesday morning plenary session. They will receive their blank transparencies and pens soon after.
- The five finalists will compete for the championship on Wednesday evening, August 1 immediately following the Beer Game, at around 9pm.

Announcing the Twenty-sixth International System Dynamics Conference Athens, Greece July 20 - 24, 2008

Conference Contacts

Conference Co-Chairs:
Emmanuel Adamides
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Fordham University Business Schools, New York, USA

Local Co-host Institutions:
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Panteion University
The Hellenic Chapter of SDS

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The venue for the 2008 conference of the System Dynamics Society will be the Athenaeum Intercontinental Hotel in Athens, Greece. Athens is an historic, cosmopolitan and cultured city with many nearby attractions. Visiting historic sites and museums, attending cultural events, sightseeing and shopping are very convenient thanks to Athens's modern transportation infrastructure.

The Athenaeum Intercontinental Hotel is situated in Athens's main business district and features elegant guest rooms. It is just a short distance from Syntagma Square, the Plaka district, the Acropolis and other historic sites. Many restaurants, shops and museums are very close. The hotel is a short ride from Eleftherios Venizelos Airport.

Of most importance to the conference attendees, the Athenaeum Intercontinental Hotel conference facilities are excellent! This will provide a wonderful venue for all programs and sessions. For detailed information about the Athenaeum Intercontinental Hotel, visit http://www.intercontinental.com

For announcements and details visit our website: http://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. Papers are listed alphabetically by the last name of the primary author.

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

Some of these files are plain text files 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, .vpa, .vpm, .mdl	Vensim

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

STELLA/iThink by isee systems:
http://www.iseesystems.com/player

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/SDConference2007/sdconference.asp

Powersim Studio 7 Express is a free and fully-functional 60-day trial version of Powersim Studio 7 Enterprise edition, our SAP-certified platform for building, analyzing and sharing business simulations in a corporate environment. Studio 7 contains an array of new and exciting features, including calendar-independent simulations, new functions for prioritization and resource allocation, etc., improved dataset and SAP BI connectivity, scatter graphs, updated wizards and tutorials and more. Note that a Studio 7 installation will automatically replace any previous version of Studio.

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

Parallel and Poster Sessions

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Path dependence and transients in random and adaptive walks on strategy fitness landscapes

Over the last decade complexity theory in general, and Kaufmann's NK fitness landscape model in particular, have been very popular means of promoting evolutionary and prosessualistic approaches to strategic management. However, either in pure conceptual, or in more formal forms, these models assume rather naïve, "memoryless" and unrestricted by past choice strategy processes (organisational structure and decision making), i.e. they ignore the internal dynamics of the strategy-formulation system. In this paper, we demonstrate how system dynamics modelling can enrich the NK fitness landscape model so that these drawbacks are overcome, especially with respect to the way the fitness landscape is searched/walked. The resulting modelling framework becomes particularly useful for understanding strategic behaviours and assessing strategic flexibility under the assumption of resource-based competition as it allows the explicit modelling of the dynamics of assets accumulation and the complementarity and substitution effects among strategic decisions and actions towards resource and capability development for achieving higher fitness. We demonstrate our approach in the modelling of operations strategy as an emergent process of distributed decision making for capabilities development.

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An Investigation into the Diffusion Process of a Social Norm by a System Dynamics Approach

The way in which a behavior becomes normal in a society and how we adopt it as a norm are interesting processes to study. Many sociologists believe that these processes depend mainly on the acceptability of a behavior (according to the culture of the society), the impact of the innovator of that behavior on the society, and the tendency of the people in the society to conform to each other. A system dynamics approach was used in this study and a model was developed to simulate these processes - especially for a society under the impact of a traditional culture like Iran. The results were obtained by running the model for different values of its parameters (corresponding to different social situations). Comparison between these results and the reality proved that our model simulates the situations with reasonable accuracy. This shows that system dynamics approach can have vast applications in social sciences. Also, the results of the simulations would be of great help to any government, organization, etc. that intends to diffuse a norm among the people of its country.

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Secondary Data Analysis in System Dynamics Modeling

The importance of qualitative data is appreciated in the System Dynamics field since its early days. In his description of information content, Forrester (1980) categorized information into three main databases; Mental, written and numerical. Most of the information available to modeler is qualitative in nature. Forrester (1991) discusses that despite qualitative information's importance, management and social scientists have long been neglected this "far richer and more informative body of information that exist in the knowledge and experience of those in the active, working world." Luna-Reyes and Andersen (2003) indicate the lack of well defined protocols to incorporate qualitative information during the modeling process. In their paper, they discuss the suitability of several qualitative data collection methods in the different stages of the modeling process. In their conclusion, they indicate the need for the development and testing formal protocols involving qualitative social research techniques to support the modeling process. This paper is indented to respond such need by developing and testing a formal protocol to support the test of a generic dynamic theory by using qualitative data analysis techniques. These techniques will be used to do secondary data analysis of previously done interviews by other researchers.

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From Mopping the Floor to Fixing the Plumbing: How KPN Telecom Uses SD to Improve Ramp-ups In its Service Supply Network

Paper describes an ongoing applied research project at KPN Telecom, the leading mobile and fixed telephony operator in the Netherlands. The project describes is aimed at developing a collaborative sales & operations planning business process at KPN that will support the ramp-up of new IP-based service offerings through KPN's service supply network. Paper discusses root causes for why coordinating capacity and sales ramp-ups in the various stages of the chain is far more difficult in service than in manufacturing. Introduces workload as a key organising concept in collaborative supply chain coordination during ramp-ups. Describes project findings so far, which are still limited to conceptual simulation model development through group model-building workshops. Subsequent project results will be incorporated in the paper as these become available.

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Beyond Rounding Up the Usual Suspects: Towards Effective Quality Management Policies for Production Ramp-ups in Supply Chains

This study investigates the issue of managing quality during production ramp-ups in high-tech supply chains. It combines an in-depth case study of one particular high-tech supply chain setting with insights from the recently-emerging literature on behavioral operations and synthesizes these two into a

system dynamics simulation model. Model analysis suggests that isolated and intuitively appealing quality management policies are likely to lead to suboptimal or even detrimental results. Of crucial importance is finding the balance between ramping up production rates sufficiently fast to capture short-lived market demand and avoiding to increasing production starts so high that workload levels in the supply chain move beyond the tipping point. This means that when workloads become too high, the entire supply chain can get bogged down in a vicious cycle of high workloads leading to low quality levels, which lead to high rework levels and hence to even higher workloads. Especially promising policies to be used in combination are, firstly, moderate production ramp-up rates that turn out to generate more timely output than overly aggressive production ramp-ups. Secondly, policies that leverage the expertise that can be gained from analyzing defective units that cannot be repaired easily downstream, as these may yield knowledge regarding hidden quality issues upstream.

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A Qualitative Analysis of Periodic Maintenance of Roads

Many transportation agencies are experimenting with innovative contractual arrangements for the procurement of construction, maintenance and operation of roads. They are changing from traditional contracts that prescribe the kind of work that need to be done in a specific section of the network, to more flexible contracts, increasing the contractors freedom to its maximum level, where the contractor itself decide which section, when and what kind of work he will perform, with the only condition of keeping a certain level of performance for a whole road network. Advanced computer models have been developed that estimate what would be the resulting road condition for given investment decisions and maintenance actions. Nevertheless it remains uncertain if contractors are given the freedom: What trade-offs would they make? Will road quality decrease? Will road agencies be able to monitor or control contractors? Before all these choices and freedom are transferred to the private sector, it is urgent to develop a clear view of the most important trade-offs that are now already made by the public authority. In order to contribute to the building of this understanding this paper explores the issue of road condition and some of the most the relevant and conflicting aspects of it.

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Modeling Dynamics of Workforce Absenteeism and Effectiveness of Mitigation Actions During Pandemics

A pandemic is likely to occur in the near future, and it could cause significant disruptions in society creating deaths, despair, fear, and monetary cost, among other losses. Firms would also be negatively affected by a pandemic through loss of revenue, profit, employees, and even through a reduction in the value of the business itself. Especially for service-intensive businesses, employee absenteeism is a key factor that impacts firms when a pandemic occurs, hampering various business operations. In this paper, we describe a system dynamics model that describes dynamics of workforce absenteeism resulting from a pandemic, and also effectiveness of corporate mitigation actions.

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How the System Dynamics Society Came to Be: A Collective Memoir

In this paper several of the early workers in the field of system dynamics tell both a consensus story of how the System Dynamics Society came into being over 25 years ago and some of the early history of the Society itself. Several slightly different versions of this story have been told over the past several years and we thought it would be fun to involve a broader group in this kind of modified oral history project. The paper is based on a series of separate recollections that have been posted in full on the web at http://www.systemdynamics.org/history/oral_history.htm
Keywords: System Dynamics Society, history, founding, volunteering, Dynamica, constitution, early conferences.

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Two Group Model Building Scripts that Integrate Systems Thinking into Strategy Workshops Facilitated with Group Explore

Vennix (1996), Andersen et al (1997), Richardson and Andersen (1995), and Andersen and Richardson (1997) have called for a greater sharing of knowledge and experience in group model building (GMB) projects to disseminate innovative practices and to increase the effectiveness of products being delivered to our clients. This poster responds to that call by describing two scripts based on system dynamics group model-building practices that have been used in strategy workshops using Group Explorer. Eden and Ackermann (1998) have developed a workshop-based approach for the rapid development of strategic options working directly with client teams. In its most recent manifestation, this approach uses the Group Explorer software to facilitate rapid mapping, modeling, and analysis of issues, goals, and distinctive competencies into well-integrated business plans, livelihood schemes, and statements of strategic intent (Ackermann and Eden, 2005) Recently, Howick et al (2006) demonstrated how scenarios maps developed in this tradition of strategic analysis and modeling could be usefully integrated with system dynamics models to improve overall impact and value being delivered to client groups. Andersen et al (2006) have presented a curriculum for co-teaching Eden and Ackermann's (1998) approach to strategy linked to Bryson's (2004) approach to leadership and strategy development as well as key elements of system dynamics and systems thinking.

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Accumulations of Legitimacy: Exploring Insurgency and Counter-Insurgency Dynamics

We explore the dynamics of regime-changing insurgencies by examining elements of traditional insurgency studies (e.g., Beckett 2001; O'Neill 2005)

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in light of Bourdieu's (1990) theory of practice. In particular, we examine the insurgent and counterinsurgent activities as a contest for creating accumulations of legitimacy through which incumbent state organizations—and insurgent organizations that seek to become state organizations—shape the very categories of thought that people use to recognize and interpret "state" organizations and their activities. We use system dynamics causal-loop and stock-flow mapping to conceptualize the accumulations of social capital and the activities that generate and deteriorate these accumulations according to the cause-and-effect relations asserted by political-science and military-history studies of insurgency and counterinsurgency. We lay out an agenda for formalizing and simulating the conceptualized structures to check for internal consistency with the historical dynamics as well as for consistency with, or contradiction of, organizational studies of legitimacy. Through this research, we offer to integrate historical insights with insights from organization theory. We hope to contribute to understanding of points of leverage in diffusing and addressing insurgent and counterinsurgent activities. We also hope to inform and extend understanding of the organizational-infrastructure construct of legitimacy and how it is created and undermined by examining these critical contests for leadership and governance.

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Improving the Software Development Process: A Dynamic Model Using the Capacity Maturity Model

Regardless of their size, software firms search for better methods to improve the delivery of their projects. The SEI Capability Maturity Model (CMM) is one available framework employed to assist in improving this process. The challenge of identifying the benefits associated with implementation of CMM Level 2 practices for the smaller software development firm is the main focus of this research. The objective is to evaluate the impact of each key process area of CMM 2 on productivity, product quality and ability to meet deadlines. A simulation model is designed to help researchers in software development, and management teams in SMEs, understand the impact of alternative management policies and practices according to CMMD. The results indicate that the CMM's software quality assurance process area has a sizeable impact on productivity and that all CMM process areas impact scheduling activities. The process areas associated with project management (software project planning and software project tracking) have very little impact on product quality as opposed to the other process areas with impacts more substantial on this performance measure. The analysis of scenarios indicates that the adoption of CMM2 practices based on requirements management yields more positive results than policies based on project management.

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Using System Dynamics-based Learning Environments to Enhance System Thinking

System dynamics is a suitable method in education for problem-oriented learning and for improving overall system thinking skills. It is proposed that integrated learning environments consisting of system dynamics models and

additional didactical material have positive learning effects. This is exemplified by the illustration and validation of a learning sequence concerning market processes.

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The dynamics of nutrient reduction trading: a simulation-based search for effective poicy design

This paper describes a system dynamics model developed to facilitate design of nutrient reduction trading (NRT) programs. NRT is a form of cap-and-trade policy that has been strongly promoted in recent years to address diffuse source nutrient pollution. Despite its wide appeal and the enthusiasm of its proponents, very few trades have occurred to date. We propose that impediments to learning encountered in real-world pilot studies have contributed to lack of consensus in design and implementation of NRT. The model we offer is intended as a demonstration of how the design process in this instance can benefit from system dynamics modeling.

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Modeling the Dynamics of the Egyptian Stock Market

The Egyptian stock market has been experiencing a set of fluctuations over the past two years. This was caused by several factors that include the behavior of the Egyptian Economy, as well as the performance of the other Middle Eastern stock markets. In this paper we use System Dynamics as a tool for mapping the performance of the CASE 30, Egyptian Stock market index, to identify the various interacting feedback loops that triggered such performance. These loops are then incorporated in a system dynamics model that is used to understand the causes of such performance as well as developing several scenarios for managing the various factors affecting the Egyptian stock market.

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Landscape Dynamics of El Farol attendees

Paradigm of the El Farol bar for modeling bounded rationality is undertaken. The memory horizon available to the agents and the selection criteria they utilize for the prediction algorithm are the two essential variables for agent strategies. The latter is enriched by including various rewarding schemes during decision making. Playing with the essential variables, one can maneuver the overall outcome between the comfort level and the endogenously identified limiting state. The distribution of algorithm clusters varies considerably for short memory. This affects the long-term aggregated dynamics of attendances. A transition occurs in the attendance distribution at the critical memory where the correlations of the attendance deviations take longer time to decay. A larger part of the crowd becomes more comfortable while the rest of the bar-goers still feel congestion for long memories. Introducing direct local interactions within the attendees by forming different

types of networks, we create extremes in the attendance distributions. Delayed feeding of the data to the agents or their inclination of to absorb failure by insisting on unsuccessful algorithms introduces significant correlations, hence predictability of attendances. We additionally explore the extent of agents' manipulation, achieved by modulating the threshold in accordance with the correlations in the data.

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System Dynamics Highlights the Effect of Maintenance on Hemodialysis Performance

there are conflicting reports regarding the relationship between dose of dialysis or patient outcome, and machine maintenance. In this article, we will discuss the impact of hemodialysis machine maintenance on dialysis adequacy Kt/V and session performance by building a system dynamics model to evaluate the effect of machine maintenance on session performance.

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Developing and fine-tuning dynamic intuition. Experimental evidence.

Considerable evidence shows that repeated trials and more elaborate analytic training help little to mitigate problematic subject performance in dynamic decision making. The paper uses a cognitive processing theory to account for poor learning. Consistent with recent reviews of intuition in decision making, the theory suggests that there are two classes of cognitive processing called high and low roads to learning respectively. The theory calls for massive decision training instead of analytic training for short and medium length training programs. An experiment with 25 professionals randomly assigned to high and low road training programs cannot disconfirm the theory.

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A Comprehensive Model of Goal Dynamics in Organizations: Setting, Evaluation and Revision

Goals play significant role in decision making. Most organizations can be assumed to set and then pursue certain goals either stated explicitly or assumed implicitly. In realistic models, the goal is not a constant but a variable: it can erode due to persistent failure or it can evolve further as a result of confidence caused by success With respect to many different types of goal dynamics, there exist some models of limited and linear goal erosion dynamics in the literature. We extend the existing models to obtain a comprehensive model of goal dynamics, by including organizational capacity limits on performance improvement rate, performance decay when there is no effort, time constraints and pressures, motivation and frustration effects. The

model constitutes a general theory of goal dynamics in organizations. Our model also demonstrates some strategies to avoid the undesirable goal and performance erosion in various unfavorable, risky goal seeking environments.

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Structure and Behavior Testing Software Demonstration: SiS and BTS II*

System dynamics validity consists of two very different types: structural and behavioral. A unique property of system dynamics method is that structure validity must precede behavior validity; the latter has no value without the former. We thus present structural tests and behavior pattern tests in this order and separately. Structure tests are further classified into direct and indirect structure tests. We place special emphasis on indirect structure tests. These are strong (special) behavior tests that can provide information on potential structural flaws. Since they combine the strength of structural orientation with the advantage of being quantifiable, indirect structure tests seem to be the most promising direction for research on model validation. We demonstrate two different validity testing software designed at Bogazici University to assist with indirect structure testing (SiS) and behavior pattern testing (BTS II). SiS software does automatic dynamic pattern recognition, indirect structure testing and pattern=oriented model calibration. Our behavior pattern testing (BTS II) software is also pattern-oriented. It estimates and compares the major dynamic pattern components that exist in the simulated and actual dynamic behaviors. *Supported by Bogazici University Rereacrh Fund no. 06HA305.

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Modeling of Real Estate Price Oscillations in Istanbul

The purpose of this study is to develop an understanding of the dynamics of the real estate market in Istanbul. As a result of the unavoidable delays in perception of the real estate condition and construction of new buildings, the market variables are strongly oscillatory. A system dynamics model is constructed to understand the reasons of oscillations in real estate prices in Istanbul from the perspective of a construction company. The model includes the factors effecting the speed and size of the construction side (supply) and sales (demand). The model focuses on the balance/imbalance between housing supply and demand as a result of fundamental material and information delays, rather than costs and interest rates. Different scenarios are tested to improve the current oscillatory behavior. This model can serve as a simulation basis for predicting the reaction of the market to changes in the decisions of internal players and external inputs.

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Threshold 21 (T21) USA: Behavior Description

This paper provides an overview of the projections simulated by the base case of the Threshold 21 (T21) model customized to the United States of America. The present study highlights the main results of the simulation of the model for the three spheres, society, economy and environment and shows more in detail the behavior of the energy sector.

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Planning for Adaptability in Healthcare Infrastructure

As part of an integrated system, healthcare infrastructure should be planned and evaluated in conjunction with the services it supports. However, this is challenging because of uncertainty about future requirements due to technological, demographic, medical and policy change. Long lasting infrastructure needs to support healthcare processes that change rapidly. In the UK public private partnership models provide additional challenges for the National Heath Service. Contractual agreements between public sector providers of care services and the organisations responsible for the provision and maintenance of the built infrastructure typically last 30 years or more. Over this period both the demands for care services and the technologies used to deliver them are likely to change considerably. Infrastructure needs to be able to adapt to these changes, and planning tools need to recognise the interdependencies within the care service and care infrastructure system. System dynamics modelling offers the potential to plan for these challenges. It can help to guide the planning process of new healthcare infrastructure under conditions of uncertainty, so that the services it enables can meet present and future needs. The stylised model presented considers care service delivery over time depending on infrastructure flexibility options (e.g. to increase capacity) under different scenarios.

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Participatory Modeling for Adaptive Management: Reports from the Field II

As the natural world has become dominated by human influences the need for the public involvement in natural resource management decisions has become vital. In addition, scientists are now viewing nature as a dynamic rather than "in balance". To accommodate these paradigms, natural resource managers have been encouraged to look holistically at the problems they manage through the lens of adaptive management. Current adaptive management theory incorporates variability, uncertainty, the relationship of impacts with respect to potential temporal and spatial disconnects, and social concerns. Add the obvious need for modeling and the stage is set for participatory system dynamics modeling. Participatory SD modeling is a process that can integrate science and local knowledge with policy, and open the lines of communication between potentially different world views. We will use case studies to highlight three characteristics of participatory

environmental modeling to illustrate the flexibility of process and the effectiveness of a broad range of interventions. 1) Interventions may take place anywhere on the "problem identification to solution producing" continuum. 2) Stakeholder involvement in the actual building of the model varies; the "hands on" continuum. 3) The type of data required varies on the "qualitative to quantitative" continuum.

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Modeling the Wetland Mitigation Process: A New Dynamic Vision of No Net Loss Policy

Over the last two hundred years, the United States has experienced dramatic losses in wetland coverage and quality. In 1987, the National Wetlands Policy Forum recommended that U.S. wetlands policy should achieve overall "no net loss" of the country's remaining wetland acreage and function. Since then, regulations requiring compensatory mitigation for wetland losses, often through wetland creation or restoration, have become an essential component of federal wetland protection efforts. Recent reports have concluded that no net loss policy has been successful, citing the virtual elimination of wetland losses experienced in certain areas. However, these reports have not assessed the temporal nature of wetland loss and restoration. Delays in initiating and completing restoration activities mean that frequent temporary wetland losses can contribute to a consistent net loss over time. This paper analyzes wetland loss and compensation as dynamic processes that include temporal lags endemic to various mitigation techniques. Here, a system dynamics model of the mitigation process is used to explore wetland alteration and mitigation data collected between 1993 and 2004 for the Chicago, IL region. By analyzing wetland change dynamically, it becomes possible to adjust wetland mitigation methods to more effectively eliminate temporal net loss of wetlands.

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Evolving System Dynamics Models, Model Identification by Means of Evolutionary Computing

The formulation of a System Dynamics Simulation Model is a bottom up process which is based on a deep understanding of the causal structure of the underlying system. In this paper an initial study of a different approach to modelling is presented. Starting with the output of an unknown model structure, candidate System Dynamics Models are generated automatically by means of an evolutionary computation algorithm. This top down approach could be useful for the selection of model boundaries as well as for the validation of models in general.

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Opportunities and pitfalls in Public policies for SME districts: A dynamic resource-based-view

Industrial districts (IDs) are considered as a powerful source of wealth for different categories of 'actors' operating in the areas hosting them. Although business clustering has since always been a spontaneous – rather than planned – phenomenon, in order to promote local economies, in the last 15 years public institutions have been inclined to establish formal policies to

foster the start-up or development of IDs. What is it possible to learn from Italian successful cases of business clustering? What are the main factors positively affecting and tackling small business networking? What are those affecting the crisis of a cluster? What are the opportunities and pitfalls that clustering implies for small business management? What are different categories of actors who may play an active role in promoting and managing a business cluster? In particular, what role can public agencies and governance bodies (e.g. District Committees) play in ID governance? A Dynamic Resource-Based-View is suggested in this paper, to foster learning and build consensus among different actors in a district. This approach is claimed to: (a) identify synergies between alternative policies; (b) affect sustainable ID growth; (c) detect weak signals of crisis; (d) assess ID performance and affect it.

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A Classroom Simulation of a Tradable Green Certificate Market and Implications for Model Development

Tradable green certificate (TGC) markets are economically driven policy instruments that can be used to increase investment in renewable electricity generating capacity. This type of policy increases revenue for renewable electricity generation units, making the units more cost effective in comparison to conventional electricity generation. An educational classroom game was created to simulate a TGC market, and was played twice with university students. Outcomes of the game varied substantially between the simulations. Strategies for playing the game were discussed with participants, and students were encouraged to analyze how these strategies affected the outcomes of the game. Players' strategies were also used to extend each simulation past the number of simulation periods actually played, and to suggest ways to improve decision rules in system dynamics models of TGC markets.

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Exploring the Underground Economy through System Dynamics to support Public Decision Makers: a preliminary qualitative analysis

To estimate and analyse the underground economy phenomenon, different methods and approaches have been provided in literature. However, such approaches are very often based on static and linear equilibrium models and seldom adopt simulation tools. This paper results from a research project conducted in the Sicily Region (Italy) aimed at investigating – through the System Dynamics methodology – main causes-and-effects relationships underlying the phenomenon of the "hidden workers" at both firm and self-employment level. By combining micro and macro-analysis, the authors present a preliminary causal loop diagram of the investigated phenomenon. Such feedback structure has been built through the support of managers and representatives of private and public organisations.

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Exploring Intellectual Capital Investments Policies in a Call Center through A 'System Dynamics' Resource Based View

This paper examines alternative Intellectual Capital (IC) investment policies in a dynamically complex system for explaining differences in firm performance. Such analysis is supported through the use of a System Dynamics (SD) simulation model. This paper is based on the hypothesis that to explain superior performance is not sufficient to look at the endowment of strategic resources, but it also requires an analysis of the dynamics of resources accumulation and depletion processes resulting from management policies. To assess IC impact on company performance, a conceptual framework and a SD simulation model have been built. Finally, alternative scenarios results are commented.

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Behavioral Causes of the Bullwhip Effect in a Single Echelon

Two laboratory experiments on a single-echelon inventory task show that inventory durability interacts with transit lags to create order volatility that exceeds demand volatility (the bullwhip effect). Durability creates bullwhip effects because players adjust orders insufficiently to reflect current inventory and backlogs, much as they adjust orders insufficiently to reflect holding and backlog costs in newsvendor studies (e.g., Schweitzer and Cachon 2000). Transit lags exacerbate bullwhip-like effects by interfering with players' ability to correct prior errors. Our results suggest that bullwhip effects can be driven by characteristics of inventory and supply chains, even in the absence of the inter-echelon coordination problems studied by Sterman (1989a, 1989b) and Croson, Donohue, Katok and Sterman (2005).

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Developing a diffusion model of competing alternative drive-train technologies (cadt-model)

Strategic measures for global ecology and security of energy supply particularly affect road traffic, as a main originator of greenhouse gas emissions by use of fossil energy. The introduction of several alternative, eco-friendly drive-train technologies in the automotitve fleet leads to a competition with the existing petrol and diesel engines as well as with each other. A system dynamics model is developed to understand the fundamental competing forces driving the market penetration of the new technologies, and to derive policy implications and strategies potentially contributing to their successful introduction. A conceptual model is presented to examine different diffusion patterns between competing technologies. First results show, that reaching a critical market share in time is a decisive factor. This is demonstrated for the case of Switzerland, that represents a demand driven market without an autonomous automotive industry.

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Advertising effectiveness and spillover: simulating strategic interaction using advertising

This paper examines the strategic interaction between two firms competing using advertising. The simulation is based on the Cournot analytical duopoly model. The paper discusses the analytical model and then discusses the simulation model. The paper discusses the ways in which the simulation model is different, usually for pragmatic reasons, to the analytical model. The paper shows results of the model for a number of competitive scenarios. These scenarios demonstrate that small changes in model parameters lead to large differences in firm and industry behavior. The paper demonstrates that positive spillover (cooperation) reduces the impact of advertising and negative spillover (predation) increases the impact of advertising.

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The Dynamics of the Eroding Goals Archetype

Various attempts have been made to construct dynamic simulation models of the system archetypes. This paper examines the eroding goals archetype and hypothesizes that achieving classical archetypal behavior over time requires the inclusion of structures that are technically outside the common description/definition of the archetype. Four dimensions of managerial decision-making sensitivity are introduced into the model in order to achieve the expected dynamic behaviors described in the literature.

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Self-organizing Markets

This paper develops a model to understand self-organizing markets. This kind of markets is characterized by a highly skewed distribution of firms' size, so a way to explain them is by introducing increasing returns to the growth of the firm. In this paper, besides, I show how urn theory can be used to formalize the model suggested in this paper.

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A macroeconomic systemic model for the Brazilian economy

The purpose of this paper is to show that a simple systemic model is able to "imitate" the behavior of a complex economy as the Brazilian one.The main identified features of the Brazilian economy are:1) the short term growth rate is influenced in an important way by the effective demand; in the medium term, however, the growth is restricted by real factors such as the capital stock and the capacity to import ; 2) attempts of growing above the rate allowed by those restrictions accelerate the inflation rate or provoke unbalance in the balance of payments; 3) in both cases, the government is forced, earlier or later, to adopt restrictive monetary policies to reduce the final demand growth rate, reducing the domestic absorption of resources; 4) an important leverage point to reach a sustainable growth path is to create conditions for a consistent increase of the exports. 5) the growth of exports in the medium term, however, requires significant investments in competitiveness acquisition, without which the country will be limited to sell products in international markets already saturated such as the one of commodities and, therefore, with limited growth potential.

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Dynamics of a Democracy Deeply in Debt: Simulation Studies of Federal Revenue and the Capacity of the U.S. to Service its Debt

The issue of the growing federal debt and whether it will be serviceable in the years to come is addressed. Can the U.S. federal government continue to expect its tax revenues to rise to the occasion? Will the retirement of seventy-seven million baby boomers result in diminished federal revenue after the year 2010? Will the changing tax structure reduce federal revenues? Will these circumstances lead in-turn to an incapacity of our federal government to service its burgeoning national debt, now nine trillion dollars? Are there probable disaster scenarios that policymakers must navigate using judicious policy choices? Is it time to start drastically cutting the federal budget? These are the questions that get addressed by the simulation models we will present.

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Organizational Growth and Population Dynamics: Strategies for Success

Abstract This paper examines the impact of population decline on an organization serving youth, to determine its impact on membership over a sixty year period. A double population chain model is used to identify population dynamics at the city and organization level. The model shows that membership would be greatly affected and that the response could either be downsizing or restructuring of activities. A multi-attribute model is then used to identify the preferences in all age groups of scouting to identify the criteria that they value in a after school activity and which activities compete with scouting.

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Dynamic Stochasticity in the control of liquidity in Asset and Liability Management (ALM) for pension funds

System dynamics may enhance Asset and Liability Management (ALM) capability to be risk oriented. Many integrated ALM problem for pension funds has been modeled to address, among others, liquidity control. The purpose is to provide long-term liquidity control prognoses for investment decisions as a way to forecast long-term scenarios and to develop an integrated policy for assets and liabilities.

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Non-Equilibrium Industry Dynamics with Knowledge-Based Competition: An Agent-Based Computational Model

An agent-based computational model is developed to explore the evolutionary dynamics of an industry which is subject to knowledge-based competition with entry and exit. It views the production process as a system of inter-dependent activities and the firm as an adaptive entity whose survival depends on its ability to perform various activities with greater efficiency than its rivals. The model is capable of generating many empirical regularities, including those on firm turnovers, evolving market structure, and the intra-industry technological diversity. Comparative dynamics analyses are performed to investigate how these regularities are affected by various industry-specific factors such as the attributes of the market environment, search propensities and the nature of the technology space in which individual firm's learning takes place.

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SMILE and XMILE: A Common Language and Interchange Format for System Dynamics

Proposed four years ago, SMILE has made minimal progress toward a full-fledged specification that System Dynamics software vendors can use to interchange models. This paper attempts to move the development of the standard one step further with a draft specification of both the language that needs to be interchanged (SMILE) and an XML format for that language (XMILE). Central to the success of this standard is the idea of three increasing levels of compliance, only the lowest level (interchange of equations) being required of all vendors.

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Modeling Agile Development: When is it Effective?

It is very difficult to deliver high-quality software (i.e., with very few bugs) in a reasonable time period. Indeed, it is not unusual on medium to large projects to spend as much time fixing bugs as delivering new features. One of the most challenging issues in software development is keeping pace with changing customer requirements. Agile development was born from the idea that software development needs to be quick on its feet, responding to changing customer requirements without compromising delivery schedules or quality. It was founded on the principle of embracing change rather than fighting it. Some of the fundamental principles of Agile development include frequent customer interaction, frequent releases, writing tests before code, nightly builds with automated testing, and not implementing more than you know the customer needs. Yet there is a surging debate about whether Agile works and when it works. This paper investigates when Agile development methods may work and the relative advantages of different parts of the methodology.

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Scenario Analysis using System Dynamics Modelling:The case of Production Portfolio Change in the Dutch Paper and Board Industry

A scenario analysis on plausible futures served to explore the Dutch Paper and Board – P&B – Industry's resilience towards competition in the form of an aggressive investment from outside the current industry. A System Dynamics model helped to visualize the effects on the Dutch industry's production portfolio. A scenario-space was constructed by combining three mega trends – Demand-shift for P&B products, Social awareness of recycling and Dutch business environment – and five alternative set-ups of a new facility by the prospective competitor. The model output reveals the dominance of the Demand-shift for P&B products, reinforced by the Social

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awareness of recycling, for a good performance of the Dutch P&B Industry, regardless of the new facility type. The Dutch business environment offers limited scope to counterbalance the decreasing sales of P&B products. Interestingly, this industry retains growing sales and profits patterns even in the worst-case scenario. The case study confirmed that the combination of scenario analysis and System Dynamics could support the analysis and visualization of the effects of major, competitive investments on a mature industry.

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The effect of Family Inertia on the Value Creation Process in Family Firms: New Insights from a Simulation Study

The present research can be viewed as a contribution to the literature on the simulation of first-order models of theory testing and on the simulation of second-order models of theory building. It sets out through computer simulations the positive dynamic interconnections studied by Koiranen&Chirico(2006) between knowledge, capabilities, dynamic capabilities, entrepreneurial performance and trans-generational value in family business. Interesting results and new insights emerge introducing family inertia in the model(as a function of paternalism) which influences the creation of capabilities and dynamic capabilities negatively, with some exceptions. We conclude that although a paternalistic behaviour can be positive in guiding and training offspring at the beginning of the activity, it may become less crucial if it persists over time preventing change even when it is needed. Family firms should be able to understand the long-term effects and results of actual events, decisions and behaviours, and, at the same time, prevent their negative consequences.

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A Generic Pattern for Modeling Manufacturing Companies

The insights presented in this paper were gained during the early phase of an ongoing master's thesis, analyzing the supply chain of one particular branch of manufacturing industry. Prior to the investigation of the supply chain as a whole, several models needed to be assembled to facilitate the analyses of the separate stages. Each stage usually consists of numerous companies which can - due to their commonalities - be aggregated and examined as one single company. For this purpose, a generic approach was designed to assist in constructing comprehensive models of companies from the manufacturing industry. This approach is introduced in the paper by identifying all sectors that compose the business of a manufacturing company and by pointing out the interdependencies among those sectors. Subsequently, a model case demonstrates one potential way of transforming the generic pattern of causalities into a simulation model, including an exemplary set of model equations. Eventually, an analysis of one simulation run and its implications is conducted, and ideas for advancements of the approach are discussed.

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Using System Dynamics to Model and Better Understand State Stability

The world can be complex and dangerous - the loss of state stability of countries is of increasing concern. Although every case is unique, there are important common processes. We have developed a system dynamics model of state stability based on an extensive review of the literature and debriefings of subject matter experts. We represent the nature and dynamics of the 'loads' generated by insurgency activities, on the one hand, and the core features of state resilience and its 'capacity' to withstand these 'loads,' on the other. The challenge is to determine when threats to stability override the resilience of the state and, more important, to anticipate propensities for 'tipping points,' that is, the conditions under which small additional changes in anti-regime activity can generate major disruptions. With these insights, we can identify appropriate and actionable mitigation factors to decrease the likelihood of 'tipping' and enhance prospects for stability.

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Achieving Competitive Advantage in a High Turnover, Dynamic Market: A Causal Model Approach

This paper uses a dynamic systems perspective to establish a causal model of how organizations can achieve and maintain competitive advantage in highly competitive situations where unique resources do not exist. The study is grounded in the resource based theory of the firm, and the model is developed from research surrounding this theory and from an extensive fifteen month in-depth examination of an organization in this type of market. Results suggest that keys to achieving a competitive advantage in this situation arise from the ability to establish a strong competitive culture, detailed execution of organizational processes, rapid assimilation of high caliber talent into the organization, and establishment of a constant sense of urgency in preparation and execution of plans. This is expressed as an integrated theory of competitive behavior in a causal model that illustrates the complex feedback nature of organizations in highly competitive, high turnover situations.

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Social structure and health: preliminary work on a system dynamics 'concept model'

Health 'disparity' is a current public policy issue. This creates possibilities for public discussion of dynamics that stratify population health status. A short review of current discussion in public health and sociology is used to create a conceptual framework for factors that influence disparities, namely dominance, disorder and isolation. The framework provides the basis for a system dynamics 'concept model'. Work in progress on the model is outlined. The model is to be used when discussing ways in which local civic action can reduce health disparities.

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Understanding Family Businesses as Value Creating Systems through System Dynamics

In this article family businesses are viewed as value generator systems, where the value is created across generations, accumulated inside the firms and/or distributed to the families' members in accordance to the ownership structure (degree of fragmentation). The value is accumulated through the innovations implemented and it is eroded due to the innovation obsolescence. This process is affected by two variables: the psychological ownership shown by the shareholders and the dynamic capabilities generated by the knowledge-related human capital and by the social capital. The aim of the present research is to explore, extend and test the dynamics of the FITS model through computer simulations in system dynamics and provide new insights about the family business evolution across generations (90 year simulation - 3 genrations - are provided). Family governance and family ownership play a crucial role for the creation of value in family business. The two variables will be analysed and simulated in order to capture their effect on our model as a whole.

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Natural gas demand and supply in Italy

The article explores the dynamics between natural gas demand and supply in Italy. The strong increase in natural gas demand since the beginning of the 70s represents a deep transformation of Italy's energy system which gives rise to security problems. In order to supply Italy with increasing volumes of natural gas, some new pipelines and regasification plants are expected in the next future, but their implementation is uncertain. Thus, there is possibility of natural gas shortage in the future. On the other hand, if all the expected projects will be implemented, situations of oversupply cannot be excluded. In order to study such a problem, a system dynamics model has been built. The

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model core consists of a stock representing the transport network, with the total natural gas supply acting as inflows, and the total natural gas demand as an outflow. A key role in the model is played by the gas storage system and its capacity to inject or extract natural gas from the network, in order to match supply and demand. The model allows to explore future scenarios, make sensitivity analysis and verify under which conditions a balance between demand and supply exists.

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Introducing System Dynamics Modeling to Health Care in Alberta

Alberta, Canada is going through a period of unprecedented demand for health services, driven by the Province's growth. Problems arising from population growth have led to a gradual realization among health region planners that better tools are needed to help make policy decisions. We discuss our progress to date in introducing systems thinking and system dynamics modeling as tools for evaluating alternative health policy decisions. To date, we have held a workshop to introduce Calgary Health Region opinion leaders to what system dynamics can and cannot do, and have begun model development work in two areas. The first is in emergency care services and the second is in colorectal cancer screening. In this paper we describe the problems being tackled and the preliminary (qualitative) models that have been developed.

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Forecasting the Diffusion of Innovations by Analogies: Examples of the Mobile Telecommunication Market

For successful business planning it is essential for a company to quantify its products' future sales volumes. In this article we present first results on forecasting the diffusion of products in the telecommunication market. The method used is applicable to established products with sales histories as well as to new products prior to their launch. Building on a System Dynamics formulation of the Bass model, Thomas's framework for forecasting by analogies, i.e. existing products with a high degree of similarity to an

innovation, is extended. We illustrate the applicability of the forecasting method by simulating future sales of mobile communication devices and inflight mobile phone usage.

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Evaluating System Dynamics as a Tool for Teaching History

History has been traditionally taught as a presentation of isolated facts which fill students' minds with a great volume of dates, actors and events. However, students are seldom encouraged to relate what they learn with changes over time. Thus, they present a lack of understanding of what history has to do with them. Therefore, there is a strong need of placing the understanding of this subject into a structured pattern that leads students to the understanding not only of the past, but also of the present and the future. In this paper, SD is evaluated as a tool to enhance students' understanding of history. Experiments with high school students were run, in which SD and the conventional method of teaching history were tested with groups of students with either no previous experimental experience with the teaching method or without previous experimental experiences on them. The results present the SD teaching method as a better tool to teach history with students who used SD before. however, the conventional method reveals to be persistent in student's minds when they do not posses any previous experience with SD. Important outcomes are documented for future replications of the experiment.

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Analysis Model for State Intervention in the Local Socioeconomic Development

The state role in economy has been a controversial subject matter in the last decades. Insufficient public resources and increased demand require the State to be more judicious and efficient. In such context, this article aims at assessing economic impact of the socioeconomic development urban equipment. Taking into consideration the state intervention in economy, we developed a dynamic model involving public resource management, population growth, income increase and individual well-being. Based on the premise that urban equipment provides some kind of services for a certain parcel of population, the higher is the State investing capacity, the lower is the deficit concerning the population not provided with such services. Services are provided at a given cost that determines the individual well-being increment when compared to the service value. The aforementioned model allowed us to carry out the analysis of service cost variation versus family average income in a community of 20 thousand people for a 20-year period. The analysis considered taxation and expenditures as being the main current public variables. We observed that the State participation, through new urban equipment, has a positive impact when it is considered an element of local development process.

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The Dynamics of Technological Substitutions

Technological substitution is the process by which disruptive technologies replace the dominant ones in an industry. Such paradigmatic shifts have a great effect on the strategic planning. The formulations of classical models of diffusion and substitution impose simplification constraints to reach analytical solvability. We use the System Dynamics methodology to build upon existing models by integrating dynamic aspects derived from a broad theoretical framework and to explore the links between social dynamics, technological developments and substitution patterns. Our simulation model generates a substitutive drop in the life cycle: a "Sydney opera" shape which is not replicated by classical models but which is substantiated by empirical data from the successive generations of DRAM. The generic structure can generate the dynamics of a sailing ship effect and account for the non-uniformity of interpersonal communications. The more general theory embodied in the model allows to better understand the underlying dynamics of technological substitutions.

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Exploring U.S. Flood Mitigation Policies: A Feedback View of System Behavior

Despite the availability of policy tools to mitigate property damage, relief costs for disasters continue to rise. This paper presents a framework for analyzing flood mitigation policies and policy design challenges in the United States. The system dynamics model prepared for this research was developed from qualitative data collected from over 300 sources, including the extant literature on natural disasters, statements made by disaster experts, government documents, policy analyses, and federal disaster mitigation policies. The generic structure developed for this research, the flood-1 model, explains the dynamics of major pressures in any flood-prone community. Eleven policies were analyzed against three scenarios to show the benefits and burdens of several types of mitigation policies. The policies selected in this analysis reflect the incentives established in the federal government's Community Rating System (CRS). In this paper, I show how the system dynamics model was used as a theoretical framework and policy analysis tool to explain the policy design challenges in every flood-prone community.

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Modelling the role of Intellectual Property Management for the development of the agricultural sector in developing countries -

The project is based on the activities of the West African Seed Alliance and generates insights into the development process of the agricultural sector in general and the seed market in specific by developing a system dynamics model of these sectors. Using the model, the impact of Intellectual Property Management as a policy parameter that could level the power relations between dominant actors of the international private sector and local actors that want to enter and succeed in the seed market will be illustrated.

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What Our Mental Models Retain and What They Don't: An Experimental Follow-up of System Dynamics Intervention

System dynamics tools claim to enhance our mental models by enabling us to understand the elements of dynamic complexity thereby improving performance in dynamic decision-making tasks. However to date these claims have not been subject to rigorous experimental testing. The main purpose of this study is to experimentally assess the long-term efficacy of system dynamics interventions in understanding complex dynamic. This is done by evaluating the effectiveness of system dynamics intervention that was provided five months prior to the current examination. The results demonstrate if (and which) elements of dynamic complexity are retained even when people are not actively involved in using system dynamics. The follow-up tests reveal that system dynamics intervention does make long-term, fundamental changes in the way people think about complex systems. Specifically, the ability to understand stocks and flows and recognize feedback loop is retained.

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Qualitative, Quantitative or both?: An Experimental Investigation

System dynamics tools are used extensively to assist in understanding complex feedback systems and design high leverage policies. These tools, both qualitative and quantitative, claim to enhance our mental models by enabling us to understand the elements of dynamic complexity, thereby improving performance in dynamic decision-making tasks. However to date these claims have not been subject to rigorous experimental testing. Furthermore, the relationship between qualitative and quantitative system dynamics with respect to their application and their respective usefulness in dynamic decision making tasks has been somewhat controversial The main purpose of this study is to experimentally evaluate the relative efficacy of qualitative system dynamics, quantitative system dynamics and a combination of the two in understanding complex dynamic systems. The results demonstrate if, how and when these methodologies influence our understanding of dynamic situations. Our findings suggest that mere qualitative system dynamics tools are helpful only in tackling simple situations. However, mere quantitative system dynamics tools aid in much more complex problems. Furthermore, the combination of the two tools is aid in the understanding and subsequent performance in tasks involving dynamic complexity.

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Incorporating System Dynamics Modeling into Goal-oriented Adaptive Requirements Engineering

Adaptive requirements are system requirements that change either internally, or externally in the environment, where environment includes the users and other systems interacting with the subject system. Modeling and analyzing

adaptive requirements are important because change is a ubiquitous phenomenon in social-technical systems. Engineering adaptive requirements is also difficult because many contextual factors need to be taken account of, and some of these factors (e.g., human intentional changes) are hard to quantify. This paper investigates an approach to modeling adaptive requirements by integrating system dynamics modeling into i* goal-oriented modeling. We illustrate that each modeling method has its advantages that are difficult or impossible to achieve using the other method, and each has its limitations that can be overcome using the other method. We then propose a goal-oriented adaptive requirements engineering (GARE) approach that integrates desirable features of system dynamics into i*, taking advantage of the goal-oriented modeling initiatives in i* and the built-in constructs in system dynamics for modeling time-based system evolution and adaptation.

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The Equity Supply Chain: Is it the Cause of So Few Women in Management and Leadership Positions?

Women have comprised over half of US university students since the 1980s. Women make up 45% of the US workforce. However women are poorly represented in senior and leadership positions both in industry and on university faculties. Only 16% of corporate officers and only 2% of CEOs at major companies are women. If increasing numbers of women have been in the pipeline for over 25 years should more have emerged at the other end as leaders? A simple model indicates that the pipeline delay hypothesis is not sufficient to explain the relatively small numbers of women in senior and leadership roles.

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A Simulator for Continuous Agent-Based Modelling

This paper describes a simulation environment that can be used to integrate population-level dynamics with those occurring at an individual, or agent-based, level. The benefit of this approach is that individual agent behaviour may be mapped at a detailed level, using differential equations, and aggregated over the entire population in order to determine population-level dynamics. Furthermore, individual agents can interact with one another, in terms of a social network structure. The environment is firmly grounded in the system dynamics approach, and, unlike conventional agent-based simulation environments, programming is not required in order to specify agent interactions and behaviours. The approach is validated by using a case study based on market dynamics. The overall benefits of the approach are summarised, and future work discussed.

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Sustainability Model for the Valsequillo Lake in Puebla, Mexico: Combining System Dynamics and Sustainable Urban Development

This paper reports on an on-going project on urban sustainability of the Valsequillo Lake in Puebla, Mexico and the Puerto Aura to be developed in this region. The purpose of the study is to build a simulation model to explore the dynamic interaction of the dimensions inherent in sustainable urban development. After a systematic review of Sustainable Urban Development (SUD) frameworks and tools used in various part of the world, the paper designs a model that considers the variables that intervene in SUD and proposes a System Dynamics model to simulate the dimensions that intervene in a sustainable development of this type and to anticipate the consequences of the decision making process. The structure and inter-relationships of the model sectors are described, the sustainability indicators in each sector explained; preliminary conclusions are drawn stating that a complete run of the model simulating a 20 years horizon in monthly periods is expected when the full data from the Puerto Aura master plan becomes available. Keywords: Sustainable development; urban planning; environmental assessment methods; system dynamics; simulation; multi-methodology.

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Slope of Inflow Impacts Dynamic Decision Making

In this paper, we show how participants learn to control a simple dynamic stocks and flows task with repeated inflow and outflow decisions. We present the effect that environmental inflow functions of different slopes (positive and negative) have on our ability to control the simple dynamic system. We investigate this slope effect in two experiments with two kinds of functions (linear and non-linear), and we formalize the decision-making process through a System Dynamics model. A process of human and model data fitting common in the Cognitive Sciences helped explain the reasons for the differences found in a system in which the slope of the inflow function is positive in contrast to one in which the slope inflow function is negative (although the total system net flow is the same).

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Assessing the effect of a group model building interevention: A comparative case study approach

This paper discusses the assessment of a group model building intervention using a comparative approach. The relative degrees of collaboration and consensus achieved by two stakeholder teams with similar task and group constructs are measured and compared. Both groups were 'professionally' facilitated, one using a system dynamics group model building approach, and the other a non-modeling approach. The results support the hypothesis that the group model building results in a greater degree of collaboration and consensus in problem solving groups than traditional facilitation methods. Analysis of more than 2,700 member comments made during meetings

suggests that the discussion that occurs in a traditionally facilitated process is dominated by alternative generation, virtually ignores what causes the problem, and fails to separate the stages in the problem-solving process. The analysis of group model building team comments shows a distinct 'wave' action that flows through the problem-solving stages.

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Can a Reliability Charge Secure Electricity Supply? An SD-based assessment of the Colombian power market

he deregulation of the Colombian electricity market took place in 1994 and the pool started operation in 1995. The Colombian market adopted a capacity charge mechanism to increase incentives for investment in new capacity. The capacity charge proved to be weak in terms of transparency and incentives, causing negative effects on investment. Nowadays, the application of the capacity charge is over and a new mechanism is in place. The new mechanism, the reliability charge, intends to provide reliability to the system. We have previously used a non-standard system dynamics approach to evaluate alternative regulation schemes for the Colombian Electricity Market. In this paper, we have updated the system dynamic model, formerly built, to evaluate alternatives to the capacity charge mechanism. We have also assessed the effect that the reliability charge mechanism may have over the market and found that the proposed scheme may actually overcome some of the drawbacks of the previous scheme; however, simulations indicate that this may not have the desirable effects prompt enough to avoid blackouts.

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Is A Natural Gas Strategic Reserve for the US Necessary? A System Dynamics-Based Approach

The large volume of shut-in natural gas production in the US Gulf of Mexico following the 2005 hurricane season led some US policymakers to consider whether creating a Natural Gas Strategic Reserve (NGSR) might be beneficial. This paper uses a system dynamics-based approach to analyze whether a NGSR is needed, and what having one would mean for the US natural gas infrastructure. Analysis shows that the infrastructure is likely resilient in the face of a more stringent test than the 2005 hurricane season provided. Moreover, as the infrastructure is essentially a closed system, any replenishment of the NGSR would compete for gas with other users, and depending on the rate of replenishment could cause a disruption as large as that it was created to prevent.

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A Generic Dynamic Model for Managing Channel Conflict in the Egyptian Lubricants Distribution Channels

It becomes very difficult to achieve needed coordination among channel members, as one would expect, conflict in marketing channels could also be caused by differences in the domain definition among channel members. The

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intensity of channel conflicts can range from minor flare-ups that are easily forgotten to major disagreements resulting in terminations or lawsuits.Using the system dynamics as a tool to analyze and understand the cause and effect of all significant variables and relationships affecting the rate of overlap in the wholesale channel, the research brings to close that, pressures exerted by producers on channel members, through incentives, intense number of channel members, less focus from producers on long term objectives and investing in strengthening brands, are the major elements of channel such a channel conflict. As the main research objective is to develop a generic model for managing channel conflict in the lubricants distribution channels in Egypt, to simulate future possibilities with different focus scenarios, a model was developed, tested and validated with respect to the Egyptian market, and the research is recommending the generic model to be tested and used for different industries using marketing channels.

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Modeling the Dynamics of Avian Influenza Epidemics and Possible Pandemics

Avian influenza, or "bird flu", is a contagious disease of animals caused by viruses that normally infect only birds; however there exist a dramatic number of infected human cases. This research aims to understand the dynamics of avian influenza epidemics in a closed, finite area by using system dynamics methodology. The model is a network that links wild bird, duck, poultry and human population sectors which are formed by several classical SIR-model building blocks. The dynamics of recent outbreak is analyzed with a base model; additionally some scenario and policy analyses are done with modified models. The simulation experiments show that a highly pathogenic avian influenza outbreak is highly dependant on the density of poultry population in the region. Growing duck and poultry populations pose a great risk. A policy involving the recognition and quarantining of low pathogenic virus infected birds is suggested at the end as a tentative one.

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Pandemic Influenza Mitigation Strategies and their Economic Impacts

The current avian influenza in Asia, Africa, and Europe has sparked discussions of a new human pandemic influenza perhaps hitting the world. While the current influenza is not spread by human-to-human contact—a necessary characteristic for a human pandemic—there is a potential that it may become so. Since the pandemic does not currently exist, it is not known what characteristics—such as infectiousness and death rate—the disease will exhibit. The study conducted by the Critical Infrastructure Protection Decision Support System (CIPDSS) explores the possible mitigation strategies and their effect on the US economy. Results show that while many people may be infected, the economic costs for the US are relatively low compared to past economic perturbations.

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A Proactive Approach for Particulate Matter Air Pollution Management

This paper analyzes the reactive management approach used in the Las Vegas Valley to manage particulate matter (PM) pollution, demonstrates that system dynamics concepts can improve the current strategy, and proposes a more proactive approach to management. Two decision support systems (DSS) were compared for this analysis: the current, linear proportional rollback model and a system dynamics model attempting to capture the essential feedback structure causing the problem. A retroactive policy analysis, beginning in 1960, was performed to analyze the benefits and tradeoffs of a more proactive management strategy. The analysis showed that including a system dynamics perspective does improve the validity of the model and the usefulness of the DSS for policy analysis. Preliminary analysis shows that a proactive approach to management may lead to more effective policy options and greater flexibility in managing this problem but may have prohibitively high initial and/or sustained costs in some cases.

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A Simple Model of Collaboration

This paper details a system dynamics model that represents several processes of collaboration. The model functions as a test bed for the design of a table-top game of collaboration for management. The model allows for the testing of game structure, dynamics and decision rules prior to human play testing. It's main purpose is to ensure that the game represented collaboration processes with sufficient fidelity to provide a useful learning experience. The model is structured as a zero-sum-game competition for fixed exogenous resources among any number of players. The players future resource allocation is dependent on the players current level of success. The players decide what fraction of resources to allocate to a local or community production queues. Production is represented by a material aging chain. The dynamics were tested using a simple set of decision rules to represent the actions of human players. Using these decision rules the model output produced many behaviours demonstrated in models of collaboration in System Dynamics, Game Theory and Agent Based Models.

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Global Warming and System Dynamics

Global warming has emerged as the dominant environmental problem of our time. The next fifty years will be a period of growing accumulation of greenhouse gasses (GHG) in the atmosphere and rising temperatures. It could also be a period in which the nations of the world adopt more stringent policies to control the emissions of carbon dioxide (CO2) and other GHG. If emissions are cut sufficiently, it is possible to stabilize GHG within the first half of the century. The risks of global warming could be reduced, but not eliminated. This paper describes recent applications of system dynamics to improve our understanding of climate change, and it looks ahead to the potential contributions in the future.

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Maya Apocalypse: Warfare-Punctuated Equilibrium at the Limit of Growth

This paper explores the dynamics of population levels in Mayan lands from the Late Preclassic to First Contact, roughly 500 BC - 1500 AD. It starts with a simplified version of the Limits to Growth model and adds the effects of warfare on available production. Drawing also from the 1976 MIT paper "A Case Study of the Classic Maya Collapse (D-2429), this paper explores how humans can politically intensify resource shortages into universal disaster.

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How Price Fluctuations is Influenced by the Response of Intermediaries to Different Sales Methods:Case Study in Automotive Ind.

IranKhodro Co. (IKCO) is the largest automaker in Middle East. Although this company has a particular interest in international markets, still domestic market is its main market. Because of government regulations, rivalry is not aggressive in domestic market, but real prices for various types of cars have depreciated in recent years. Another problem this company encounters is the instability of its market. Price fluctuations provide a good opportunity for speculators to benefit from buying automobiles in low prices and selling them in “higher” prices. On the other hand, presence of speculators in the market aggravates the uncertainty because the manufacturer perceives a demand different from the demand of end users and this leads to an unbalanced demand-supply in market. In this paper we discuss how sales policies of the company leads to above trends in prices and exacerbates its financial problems. Using system dynamics modeling, we are going to answer questions like: What has been the effect of different sales methods on price fluctuations? And what is the effect of different sales methods in long term?

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Choice of utility functions in integrated assessment: how subjective well-being can influence policy analysis

To help inform public policy benefit-cost analysis, modelers calculate the change in expected utility of a society. This utility calculation often is a function of GDP per capita or economic consumption. Less widely used are

subjective well-being utility functions that include relative consumption levels as well as absolute levels of consumption. This paper explores how utility function formulation can change the outcome of a benefit-cost analysis. The choice of functional form is vital to realistically projecting the utility impacts of a public policy and making the correct policy decision. Using climate change policy as an example, the study shows that a simplified subjective well-being utility function would encourage policy makers to enact mitigation policy to prevent a large decrease in society's long-term utility, while a typical GDP/capita utility calculation would encourage policymakers not to enact mitigation policy. This example highlights the practical significance of choosing an appropriate utility measure. The study concludes that the choice of utility function could change the results of cost-benefit analyses and integrated assessment models.

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Fifty Years of Table Functions

Table or lookup functions, TF, are part of System Dynamics models since the very beginning fifty years ago. TF formulation, dynamics and multidimensionality are analyzed and suggestions for their improvement are presented. TF spread nonlinear dynamics to other variables involved and simplify structure, allowing the concentration on problems. Relationships between nonlinear varying eigenvalues and TF' patterns are established, which open the door for SD' software improvements and further research. A general shape, synthesizing typical TF' patterns, plots a normal curve that the Central Limit Theorem of statistics proves as the distribution of any accumulation (level) of random variables. The random face of SD, uncovered by Agent Base Simulation, converges into this normal curve, which gives statistical grounds to lookup relationships and improves policy design by fine-tuning estimation.

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Individual Learning Style and Systems Tool Preferences

Abstract: Research was carried out in order to determine if a relationship existed between the use of specific system thinking tools and Kolb learning styles. Subjects were university students who played the B & B Enterprise game, took the Kolb Learning Styles Inventory and responded to a questionnaire. These questions related to both the frequency and preferences of use of specified system thinking tools and learning styles. The results revealed that for some of the learning style orientations a significant relationship with use and preferences of system thinking tools existed. These results indicate that further study is needed to clarify any differences in relationships between groups and between frequency and preferences. It is thought that if a set of relationships can be identified, such knowledge could facilitate the introduction of systems thinking and system dynamics to selected groups within an organization. Keywords [Systems thinking, system dynamics, Kolb Learning Styles].

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The Dynamics of ERP Success

Enterprise resource planning (ERP) commercial software packages exploded into the market during the 1990s as a popular way by which companies attempted to integrate their financial, human resource, operation, and customer information. Although ERP systems are capable of providing significant returns on investment, they can also cause havoc in an organization if not managed correctly. Research consistently reports that implementation failure or success is people-related (Peterson, 2003; Tapp, et al. 2003). It is often easier to blame the technology than to explore these deeper complex issues but in the end they are the controlling factors. It is important for managers to understand the non-technical dynamic complexities if information system (IS) implementation success before embarking on a new ERP project. The original IS Success Model (DeLone and McLean, 2003) was developed prior to the enormous growth of ERP implementations. It appears that current models do not include enough feedback behavior between the constructs. Although the IS Success Model is causal and does contain some feedback, there are additional causal relationships not identified in the existing models that should be explored and validated. This research will explore an extension of IS Success models using system dynamics tools to explain ERP success.

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Agent-Based Modeling as a Tool for Manpower and Personnel Management

This paper describes the development of a generalized agent-based simulation tool for modeling, analysis and policy de-sign for complex organizational behaviors and interactions of NAVY Shipboard Manpower & Personnel (M&P) processes. Behavior of such a complex system is typically associated with a hierarchical structure in which the lowest level agents are characterized by continuous and discrete event-variable dynamics and the highest level agents by a heuristic based decision-making mechanisms. The interaction of these different levels, with their different types of information, leads to the hybrid representation of system behavioral dynamics by combined discrete/continuous modeling and simulation methodology (e.g. system dynamics approach) on one hand and its dynamic simulation by Agent-Based techniques on the other hand. The sys-tem dynamics approach is used to develop a model that describes the dynamics of a sailor's behavior while he or she is enlisted with US Navy. Agent-based techniques are used to handle heterogeneity in behaviors and domain descriptions asso-ciated with Shipboard Manpower & Personnel Behaviors. Complex relationships between individual sailor's stress, motiva-tion and performance emerge from model structure and interactions which allows us to perform analysis on two levels: an aggregate level and one lower level on which individual sailors can be dynamically modeled.

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Co-opetition for the Diffusion of Resistant Innovations: A Case Study in the Global Wine Industry using an Agent-based Model

This study explores whether and how competitive cooperation, also known as co-opetition, can be utilized to speed the rate of diffusion of resistant innovations, which are defined as products that consumers are reluctant to adopt. We investigate a specific innovation, screwcaps on fine wines, as a case study. We explore the extent to which wineries embrace co-opetition strategies through a coordinated marketing campaign. We model both demand-side and supply-side diffusion within the context of a conjoint simulation. In this ABM simulation, each agent is modeled as either a utility-maximizing (consumers) or profit-maximizing (firms) agent. Both consumers and firms interact, share information, and/or react to decisions by other agents. The underlying data consist of international surveys of over 2,800 consumers, including conjoint analyses, in Australia, New Zealand, and the US coupled with over 20 in-depth interviews of wine producers in the US. In particular, we endow a sample of consumers with preferences based on the conjoint analyses and allow them to interact with one another and with wine producers. Wine producers are rational profit-maximizing agents who decide whether or not to produce wines with Stelvins based on the amount they can sell at (endogenously) chosen characteristics, price, and advertising levels.

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Testing the Effects of a System Dynamics Decision Aid on Mental Model Accuracy and Performance on Dynamic Decision Making Tasks

Previous studies have suggested that decision aid support can positively affect performance on dynamic decision making tasks. However, few studies have examined the effects of decision aid support on the cognitive mechanisms underpinning performance. This study tested the relationships between decision aid support (in the form of causal loop diagrams), task complexity, cognitive load, mental model accuracy and performance, using a product lifecycle management simulation. Results indicate that task complexity and decision aid support are significant predictors of mental model accuracy, and that decision aid support moderates the relationship between task complexity and mental model accuracy. In addition, task complexity and mental model accuracy are significant predictors of performance. Our findings regarding the beneficial impact of decision aid support on mental model accuracy and on incremental gains in learning and performance highlight the importance of understanding the underlying cognitive mechanisms at work. Designing more effective decision aids to enhance the development of accurate mental models is one path with a great deal of potential to improve performance in dynamic decision making environments.

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System Dynamics and Strategy: Accomplishments and Future Opportunities

Do the concepts, methods, and resulting insights that constitute the field of system dynamics have much to offer for research in strategy? While we believe the answer is yes, it is easy to conclude otherwise. Insights about equilibrium conditions arising from economics and sociology serve as the primary theoretical underpinnings for most researchers and teachers of strategy. Unsurprisingly, therefore, formal models in strategy generally derive equilibrium states based on the assumption that actors optimize under various constraints and most empirical work in strategy looks for evidence of contingencies affecting presumed equilibrium outcomes. Over the last several decades, strategy academics have produced and imported a huge stock of such comparative-statics insights and evidence. This stock overshadows the much smaller stock of research on dynamics and behavioural decision making in the system dynamics tradition.

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Untangling the Origins of Strategic Innovation. A System Dynamics Approach

Innovation in strategic positioning enables companies to redefine the way to do business delivering more value to customers and achieving superior competitive performances. We present a System Dynamics simulation model in which the firm's ability to generate and implement innovation in strategic positioning is determined by three factors. Firstly it is related to the ability to govern the technical innovation process. Secondly strategic innovation processes occur in firms characterised by a certain degree of entrepreneurial orientation. Entrepreneurial orientation is deeply influenced by the introduction of organisational innovations that allow the release of the entrepreneurial energy embedded in the organisational structure. Thirdly, technical innovations become strategic innovations only if top managers are able to manage a process of integration through which they integrate new technical initiatives into the company's strategy. Simulations showed that the effectiveness of innovation processes is influenced by top managers' ability to balance the entrepreneurial orientation of middle-level managers with a high degree of discipline. It is essential for top managers to control the quality of innovations rather than to stimulate a relevant flow of innovations. Only by controlling the quality at different stages and during the integration phase can top managers assure a successful strategic renewal process.

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Theory of Stable Dynamical Systems

During development of a dynamical model to simulate the central T-cell subsystem of the human immune system, its extraordinary stability lead to the assumption that it might be deduced solely from stability considerations.

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We demonstrate that linear stability conditions together with additional general requirements indeed define a low number (of the order of 10) of dynamical systems from about 1.E10 possibilities for systems with up to four components. At least two of the most simple ten linearly stable systems play central roles in biology, indicating that stable dynamical subsystems resulting from evolutionary processes might be understood on a mathematical basis. We expect that our ten dynamical subsystems are generic and will be found as basic building blocks in biological, social or technical systems.

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How a System Backfires: From a Redundancy Solution to Redundancy Problems in Security

Increasing attention is being paid to reliability, safety, and security issues in social systems. Scott Sagan (2004) examined why more security forces (a redundancy solution) may produce less security (redundancy problems). In that paper, he discussed how the system could cause backfire in three major ways (i.e. "common mode error", "social shirking", and "overcompensation"). Using Sagan's hypotheses, I simulate and analyze a simplified and generic security system as more guards are added. Simulation results support two of the hypotheses, showing "common mode error" makes the system backfire, and "social shirking" creates inefficiency in the system as well as exacerbating the common mode error's effect. Simulation results show "overcompensation" has no effect on backfiring, but leads the system to a critical situation, in which it could easily be affected by "common mode error." The structure of the model and simulation results give some insights into developing appropriate security policies.

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Economic Transition Management in Iranian Cement Industry

Last decade, a lot of countries implemented a transition policy from centrally planned command economies to market economies, while experiencing different socio-economic side effects. After these years, it is still an important issue in the countries which are not completely adjusted to market economy style, to manage the transition process in order to experience less wild fluctuations in prices. This paper represents recommended policies for Iranian Cement Industry which will deal with economic transition in near future. Using a System Dynamics approach, this paper gives some insights into analyzing similar economic policy problems.

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Evaluating Iran's Progress in the ICT Sector Using the e-Readiness Index, a System Dynamics Approach

In the modern era, the advancement of information technology requires improvement in other fields such as communication technologies, management of human resources, business environments, legal backgrounds,

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and so on. Indicators that measure the growth of ICTs in different societies have also pointed out this importance. National legislators are always seeking means to improve ICTs and use them as an enabler of industry in their countries. a number of developing countries have devoted a considerable effort but have not achieved the results they were expecting. In recent years, Iran, like many other of the developing countries, has made a desperate attempt to get engaged in similar activities, but nothing in particular has been achieved. In this paper, we will take a system dynamics approach to model changes in the progress of information technology in Iran. Sources of many of the problems showed up After the simulation of the model. We have also outlined the policies required for reaching a steady growth in the future.

Improving Hospital Operations Using Bar-Code Capture Data and System Dynamics Modeling Techniques

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To better understand the factors that support or inhibit process improvement in a hospital setting, we conducted a study of one hospital's attempt to implement a health information system (HIS) to reduce errors in medical treatment and manage material flows. We propose a dynamic model capturing the evolution of the interactions among the "physics" underling hospital operations, information technology (IT), and staff behavior. We show that early success in one phase of process improvement can create unintended feedback in a later phase. We use a system dynamics model to examine losses in performance in these later phases. We then recommend management improvements in both materials and staff utilization and estimate the resultant cost-saving. As part of this analysis we explore opportunities to merge real-time operational data with feedback modeling to provide dynamic tools for hospital administration, risk management, and education and training. We believe that the major gains in HIS use will accompany new information gathering capabilities, as these capabilities result in collections of data that can be used to greatly improve patient safety, hospital operations, and medical decision support.

Returns in the Corn Supply Chain

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Hybrid seed suppliers experience excessive and costly rates of seed returns from dealers, who order in advance of grower demand realization and may return unsold seeds at the end of the season. Here we develop a formal dynamic model of the interaction of sales effort allocation and dealer hoarding behavior leading to high corn seed returns through a model-based field study. Sales representatives know they should carefully gather information on grower demand for seed types and quantities to improve their demand forecast (positioning effort). However, they abandon time-consuming seed positioning late in the sales cycle to push out dealers' inflated orders and quickly meet revenue quotas. Such push effort leads to excessive returns in the next period, generating more inflated orders by dealers and increasing the total sales that agents must achieve to meet their quota, requiring them to push still more seed. While returns can have several causes, this work describes how sales resource availability and biased sales effort allocation can generate a self-perpetuating stream of returns.

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Energy equipment diffusion & touristic competitiveness: Building an SD model for the Greek islands

The real-world problem the research aims to address is the continuing highly seasonal, exponential electricity demand growth in the Greek islands that are unconnected to the national electricity grid over the past decades. This paper presents only part of the on-going research. It specifically tests an early draft of the sub-model concerned with the interplay of an island's tourism volume & attractiveness, local technological learning-by-using effects and the dynamics of demand-side equipment diffusion. The general assumption is that a tourist chooses a basket of services received at the place visited, one of which is cooling comfort. Cooling-comfort eventually translates to installed cooling capacity and in effect electricity consumption. This paper examines the sub-model which, based on a figure of cooling comfort per person, constructs an indicator of competitiveness to similar destinations and relates the flow of tourists to it. Similarly, a cost comparison incorporating a learning curve between a conventional and an efficient variant of cooling equipment drives the installation stocks at any time and effectively alters the efficiency of the overall service across the island. The sub-model is run for a number of structural and behavioural tests and also assessed for its potential use in policy making.

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The Structure and Dynamics of the Residential Building: Which Mechanisms Determine the Development of the Building Stock?

The residential building environment and the belonging values creation network consisting of several in-terdependent actors has not obtained much attention from the field of science. Even though much litera-ture exists about the diffusion of innovations (e.g., Rogers 1995), the diffusion process of innovations in the residential building system is not fully understood. Hence, the enormous potential to reduce CO2-emmsions can not be utilized. In Switzerland, a research project tries to elaborate the different processes in the building environment in order to provide policy interventions based on a system dynamics model. Based on this research project, we present the interconnections between the different actors in the system. Thereby, we want to depict the inner life of each important actor group via a details simulation model. In the current version of the paper, only some details about the individual building owners can be provided. For the other actors, empirical survey research is in the process of being executed, after the completion of which dedicated models can be presented, different policies tested and implications discussed.

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Decisions in the Construction Process of the Residential Building Environment: Development of a Static and Dynamic Model

The residential building environment accounts to a large extent for the emission of greenhouse gases. In Switzerland, 27% of the carbon dioxide emissions are generated by heating houses and providing warm water and electricity. The employment of existing state of the art energy efficient technologies can reduce these emissions significantly. Why are the technologies not applied on a regular basis? In this paper, we focus on the decisions the individual building owner has to make during the house planning process. The paper's contribution is multifold: systematization of important decisions during the planning process, development of a static theory of decision making based on psychological action theories, enrichment of the static theory by empirical research, and development of a dynamic theory. From a superior content point of view, the paper sheds light on the decisions during the building planning process. From a methodological perspective, the paper adds to more traceability during the model conceptualization phase. In other words, the art of modeling is partially substituted by a rigorous, scientific research process. This paper is still under development; especially the formulation of the system dynamics model and the subsequent discussion will be developed further in following versions of the paper.

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Tell me 'why' or 'how' – A Heuristic to Choose between Quantitative and Qualitative Systems Analysis

The paper deals with one of the oldest and still most pressing issue in system dynamics: "when to map and when to model". We propose a heuristic to be used in system dynamics projects to give an indication whether one should aim at quantitative modeling (i.e., the classical system dynamics approach) or whether qualitative treatment will be sufficient: (1) If the problem definition phrase starts with the word "why", often causal explanations for the development of variables should be the result of the project; in this case, the exploration of dynamic behaviour needs the application of quantitative simulation models because of the difficulties people have with inferring dynamics from complex models; (2) If the problem definition phrase starts with the word "how", the structure of a system is asked for; then, the result of the project is usually a graphical representation of the shared understanding of team members about the structure of a system, which can be achieved by using qualitative modelling techniques like causal-loop diagrams, hexagons, or policy structure diagrams.

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Inductive and Deductive System Dynamics Modeling

The paper presents and discusses the distinction between inductive and deductive System Dynamics modeling. Findings are that the distinction between inductive and deductive modeling is helpful in appropriately setting up, conducting, and evaluating System Dynamics projects. The discussion is based on a literature review, conceptual considerations, and the insights gained from case studies, both within business and academia. Implications are different processes, different potential outcomes, and different possibilities for implementation for the two modeling approaches. The value of the paper lies in a new perspective on the most relevant question, why some System Dynamics projects thrive while others fail.

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Validation of System Dynamics Models: A Taguchi Methods-based Approach

This paper presents the development of an effective and practical method to complement the methodology for validating system dynamics models. The method is based on an analogy drawn between the system dynamics model development process and the quality design and manufacturing product development process of an industrial context. Employing this metaphor the revolutionary Taguchi principles of Robust Design can be utilized in the validation process of system dynamics models. The proposed Taguchi-based approach is applied and tested in case of a system dynamics corporate model. The results show that with relatively few steps at the beginning of the validation process and in the sub-category of reference behavior tests, the modeler can significantly contribute to successfully reaching the desirable state of "consensus validity of model use", consistent with the relativist/holistic philosophy of science.

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From Hospital Plans to Computer Simulation: A Case Study of the Alfred Centre.

This paper is a preliminary examination of findings that have arisen from a System Dynamics model that has been derived from the initial plan for the Alfred Centre. The Alfred Centre was designed as a stand-alone short stay day procedural centre integrated within the Alfred, one of Melbourne's major hospitals. The model is a patient flow model that links the surgical procedures, medical interventions, and endoscopy interventions to the outpatient capacity.

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Integrating Dynamic Simulation and Risk Analysis in Geographic Information Systems (GIS)

This paper explains how risk analysis has been added to a Geographic Information System (GIS) by integrating dynamic simulation models. The GIS application provides geographic information from an area in the map, which is selected by the user, and retrieves the results of the simulation in return. These dynamic results may be displayed on the map, possibly in combination with relevant static information from other data sources available to the GIS system, for instance, population density and area development plans. The solution is a result of a commercial collaboration between the two Norwegian software vendor companies, Norkart AS and Powersim Software AS. Norkart is responsible for the GIS part of the solution through their GIS application GIS/LINE. Powersim Software provides the simulation capabilities through their simulation software Studio 7. Based on requests from Norkart's customers for risk analyses, two models were developed; 1. The first model simulates the movement of water through soil to identify the risk of landslide. 2. The second model simulates the diffusion and movement of poisonous gases, based on gas types, wind force and wind direction. The solution can easily be extended to cover other problem areas, like flooding and oil spill.

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System Dynamics Modeling of Benefit Realization When Adopting New Software

During the late to mid 1990s, many companies chose to implement Enterprise Resource Planning (ERP) systems, often in the slipstream of the 'information revolution' or as a 'quick' fix for the upcoming Y2K problem. A paradox currently facing both business as scientific analysts is that, as the potential benefits of these systems are almost self explicatory, only few seem to be able to transform this potential into value. The combination of the rush into complex technology and the large impact that ERP systems have on organizations, provides a fertile soil for complicated problems. System dynamics problems often deal with the interaction of technology and organizations; embedding this project in the research context of system dynamics makes a good fit.

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A methodology for Integrating and Synchronizing the System Dynamics and Discrete Event Simulation Paradigms

With the adoption of integration and system perspectives in managing the manufacturing systems and the pressure imposed by the increased competition and rapidly changing business environment, the need has arisen for new approaches for simulating the manufacturing enterprise. We have proposed SDDES; a hybrid System Dynamics Discrete Event Simulation

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approach to simulating the integrated manufacturing enterprise. SDDES offers comprehensive simulation models that encompass all management levels and recognize the differences between them in terms of scope and frequency of decision making as well as the levels of details preferred and used at each level. SDDES maintains the integrity of the two simulation paradigms and can use existing/legacy simulation models without requiring learning new simulation skills. In this paper we describe the modular structure of SDDES, our method to synchronize and coordinate SD and DES, and the functional model of the SDDES controller, which manages the integration of the two simulation methodologies.

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Simulation and Analysis of Taichung Urban Ecosystem

In Taichung there is considerable concern about urban problems, such as the deterioration of living conditions, overcrowding and empty dwellings, the congestion of traffic, the shortage of open space and many other aspects of the urban social, economic and environmental situations. Most of the existing planning methods in this context addressed only one or two of the three aspects. The purpose of this study is therefore to develop an integrated framework for establishing an urban ecological system to maintain a balanced relationship between human needs and urban ecology. A dynamic simulation model, combining urban ecological theory with the techniques of system dynamic, is suggested so that the multiple objectives of urban development can be pursued sustainably to achieve a better quality of life for every citizen, now and for generation to come.

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Chronic Illness in a Complex Health Economy: The Perils and Promises of Downstream and Upstream Reforms

Chronic illness is the largest cause of death and source of health care costs in developed countries and has become a significant problem in developing countries as well. This paper begins with a review of past work in System Dynamics concerning populations with chronic illness. It then presents a generic model of illness in a population and its treatment and prevention, applied to the U.S. population. The model explains the rising prevalence of illness as well as responses to it, responses which include the treatment of complications as well as disease management activities designed to reduce the occurrence of future complications. The model shows how progress in complications treatment and disease management has slowed since 1980 in the U.S., largely due to a behavioral tug-of-war between health care payers and providers that has resulted in price inflation and an unstable climate for health care investments. The model is also used to demonstrate the impact of moving "upstream" by managing known risk factors to prevent illness onset, and moving even further upstream by addressing adverse behaviors and living conditions linked to the development of these risk factors in the first place.

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Women Arrested for Domestic Violence: Unintended Consequences of Pro and Mandatory Arrest Policies

Domestic violence is a major social problem worldwide. In the United States, the failure of communities and police departments to intervene resulted in a push to adopt and implement pro and mandatory arrest policies for domestic violence. These policies have led to an unexpected increase in the number of arrests of women. Competing explanations have been offered. This paper describes the development of a system dynamics model of women arrested for domestic violence. Results suggest that these policies may have created or strengthened a crossover mechanism that shifts the risk of arrests in domestic violence cases from men to women. Model analysis demonstrates how the changing role of cooperation between advocates and police can help explain the trends in women arrests. Implications for research and policy are discussed.

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Dynamics of Innovation Implementation and Organizational Performance in Mental Health Services

While organizational variables play an important role in the adoption and implementation of evidence based practices in mental health, most researchers have assumed that successful implementation leads to improving organizational performance. Yet existing organizational theory suggests that implementation differs by organizational characteristics, and certain configurations can lower organizational performance. This paper shows how implementation of evidence based practice impacts organizational performance. Specifically, we present a system dynamics simulation model of implementation and organizational performance based on existing theory, system dynamics research, and key informant interviews. By varying organizational characteristics we learn how implementation affects organizational performance, and then explain these effects through subsequent behavioral analysis. These analyses lead to a simplification of the theory and model. The theory implies that benefits from evidence-based practice depend on how fast managers can implement the innovation relative to the quality improvement process.

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Broadband adoption: the case of rural and remote Scotland

Broadband has been described as a transforming technology and is now widely available in many developed countries. However, broadband availability is not the same as broadband adoption. If the socio-economic benefits of broadband are to be realised, then adoption needs to be both understood and encouraged. This is particularly important in rural and remote areas. This paper explores the factors that drive broadband adoption in one particular rural and remote area; rural and remote Scotland. A causal model and a quantitative simulation model are developed indicating how the various drivers of adoption interact with one another. Both models show that past policy initiatives have impacted on the rate of adoption. However, the greatest impact could be achieved if future policy initiatives target those people who show no interest in adopting broadband. The paper concludes by suggesting that this work has implications for rural and remote areas all around the world.

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An experimental study on the construction of electricity power stations in China

The history of electricity industry in China can be generalized as cycles of electricity shortage and surplus. It's widely believed that lack of accurate information about future electricity demand is the main cause to this problematic phenomenon. However, there are still few people who believe long time of power station construction so that the investors ignore the stations under construction is the main effect, rather than the information about electricity demand. In this paper, an experiment is carried out to test whether these hypotheses are right or not. Factorial designs with 2 treatments, information about stations under construction and information of future electricity demand, are used to test which of these two factors is the main effect. Statistical analysis indicates that awareness of how many stations are under construction will greatly improve the performance of subjects, while information about the future electricity demand, although assumed accurate, has no significant effect on the performance of the subjects.

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The bullwhip effect in the closed loop supply chain

A simple system dynamics model of a traditional/closed loop supply chain system is investigated. Particularly, the effect of remanufacture, remanufacturing lead-time and the return rate on the inventory variance and bullwhip effect were studied. Our results clearly showed that the bullwhip in the closed loop supply chain is bigger than one in the traditional supply chain and foreign to the collection rate, and the inventory variance in every stage decrease when the remanufacture is introduced into the traditional supply chain. Furthermore, we found that the bullwhip effect in the closed loop

supply chain will increase when the short term lead time of remanufacture cycle time increase and is independent of the long term lead time of remanufacture, and inventory variance will increase in first two stages but will decrease for the producer stage.

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A Dynamic Simulation Model for Long-Term Hypertension Progression

Dynamics of blood pressure over the life span of a human being demonstrates a growth path. The most significant theories which try to explain dynamics of blood pressure adopt a kidney-dependent approach. Structural reductions in the size of renal arterioles (vascular remodeling) and loss of nephrons are considered to be primarily responsible for the progressive increase in blood pressure. A dynamic simulation model is constructed to realistically reproduce the long-term progression of blood pressure in healthy and in hypertensive people. It focuses on systemic interactions that result in vascular remodeling of renal arterioles and in loss of nephrons. These hypertensive mechanisms are integrated with fluid volume and blood pressure control mechanisms which are aimed to achieve homeostatis. This study suggests that progression of blood pressure can suitably be modeled by conceptualizing the problem as a long-term control of fluid excretion capacity. The reference behaviors for normal and hypertensive people underline alternative pathways in blood pressure progression. Experiments with the model demonstrate that management of the number of remodeled arterioles over time should be an essential task in long-term blood pressure progression control. Scenario runs with the simulation model help distinguish successful policies from the ineffective interventions.

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Development of radiation risk assessment simulator using system dynamics

The potential magnitude of radionuclide releases under severe accident loadings and offsite consequences as well as the overall risk are calculated. System dynamics methodology useful for complex systems such as a nuclear power plant has been applied for representing the time-dependent and uncertain behavior of complex physical system. Dynamic variation of radioactivities were simulated by considering several effects such as deposition, weathering, washout, resuspension, root uptake, translocation, leaching, senescence, intake and excretion of soil by animals, intake and excretion of feedstuffs by animals. The input data to the model include the time of the year when the deposition occurs. The time-dependent radioecological model has been developed in order to assess the radiological consequences following the short-term deposition of radionuclides during severe accidents nuclear power plant. The ingestion food model may be run deterministically to yield single estimates or stochastically to provide distributional output that reflects uncertainty of parameter and model uncertainties. The values of the input parameters to the dynamic ingestion pathway model were selected to represent the site-specific The results of this study may contribute to identifying the relative importance of various parameters occurred in consequence analysis, as well as to assessing risk reduction and accident management strategies.

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From Continuous Improvement to Centralized Information: The Life and Times of a Systems Thinking Intervention

This mixed-method retrospective case study examines the implementation of a systems thinking intervention – The Manufacturing Game™ – as part of a comprehensive approach to "Proactive Manufacturing" and workforce involvement in continuous improvement at an American oil refinery. Notable gains in local reliability metrics such as Mean Time Between Failure were achieved as a result of these efforts, which contributed to financial, safety, and environmental performance. At the same time, the overall impact of the program on the refinery's performance is ambiguous, confounded by simultaneous investments in the physical capital and capacity of the plant that generated significant value. This ambiguity created interpretive flexibility for employees of the plant, who were able to both interpret and shape the continuous improvement activities based on prior political divisions, mental models, and interpretive biases. A structurational perspective is employed to understand these emergent and unintended consequences. From this perspective, a speculative model of relational conflict that undermines workforce participation in continuous improvement is developed.

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System Dynamics Modeling for Overtime Management Strategy of Software Project

Schedule overrun is a major problem that disturbed software project team. How to solve this problem? For most software project managers, the first reaction is to work overtime. There is no doubt overtime can alleviate this problem to some extend, but is it an effective way all the time? If not, when shall we give up overtime and change to other ways? This paper analyzed those problems in detail and gave some conclusions in the end. That is for a software project team which has reached its overtime limit, further overtime can only result in much longer completion date. Thus the best overtime policy is to first set a proper scheduled completion date, then try to find the minimums project completion time. The overtime range related to this minimums project completion time will be the critical point to stop further overtime.

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System Dynamics Modeling for Medicine Price Policy in China

There is a strange phenomenon in medicine market of china: abuse of a lot of expensive medicine such as antibiotic, while the low price medicine disappearing in market, and the medicine price is going higher and higher to

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pay for by patient. This is indeed a disaster in health care system of China. In this paper, we set up a system dynamics model to demonstrate the deep mechanism: this is mainly due to medicine price policy; afterwards, a serials policy is proposed to handle this disaster.

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A system dynamics analysis of intensive pig farming eco-energy system based on the rate variable fundamental in-tree model

Intensive pig farming in Centre China leads to the centralization of excreta .Chinese government has allocated lots of funds to construct biogas engineering for resource utilization of bio-energy in recent years. But investigation shows most of farms in rural areas discharge the residual product of anaerobic digestion directly due to the lack of consumers and funds, which has caused severe environmental pollution, and also endangered the development of farms themselves. In this paper, we have constructed a practical pig farming excreta recycle treatment model via a case study of the Lanpo intensive pig farming ecology system, and have conducted simulations with the corresponding dominant archetype. The results show that policies of encouraging more farmers to utilize biofuel, separating anaerobic digester effluent from irrigating water, developing the winter fallow cropland and the hilly land and governments' fund and technology supporting may help shift the system toward sustainability.

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Dynamics of Project Screening in a Product Development Pipeline

Management of a product development pipeline involves starting and steering several promising projects through a sequence of screens known as stages/gates. Only projects with payoffs above a predetermined threshold survive each screen. We model a two-stage product development pipeline as an aging chain with a co-flow. The co-flow structure tracks the number of projects and the corresponding net present value (NPV) of payoff. Managers at each stage must decide on capacity utilization, subject to a trade-off between throughput and value creation rate. Our simulation study mimics a range of relevant decision scenarios by varying the number of starts, screen thresholds, and managerial biases while adjusting utilization. Results illustrate that screening can eliminate the backlog bullwhip effect in the pipeline. Allied statistical analysis indicates a non-linear relationship between the number of starts and the value created at end of the pipeline. An increase in the screening threshold, in either stage, increases the average value of the

projects but reduces the total value created. We also show that a managerial bias towards reducing backlog, instead of improving utilization, affects the average NPV negatively but does not affect the total value created at the end of the pipeline.

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The Economics of Biomass-to-Liquids Fuels

To combat the climate change and for reasons of the security of supply the European Union and its member states have adopted a strategy to increase the use of energy from renewable resources until 2020 and beyond. One long run sub-target of this strategy is to increase the proportion of renewable energy for fuelling purposes to 20 percent. It is hardly possible to reach this ambitious objective by using current technology of bio-fuel production. The paper discusses alternative forms of fuels from renewable energy sources. This discussion identifies biomass-to-liquid (BtL) fuels as the most promising way to accomplish the EU target. The evaluation of the future role of BtL is difficult due to complex and uncertain interdependencies between several factors of influence. The paper develops the basic structure of a SD-model to capture the numerous effects and their dynamic feedbacks.

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Moving from Insights to Action with the CDC Diabetes System Model

Since 2003, the Division of Diabetes Translation of the US Centers for Disease Control and Prevention (CDC) has provided ongoing support for an SD model that addresses how best to balance interventions to reduce the present and future health burden of diabetes. The structure and behavior of this model have evolved, but its results and insights have not changed fundamentally since we first reported on the model three years ago at ISDC 2004. Yet, considerable effort has gone into various activities these past three years that are gradually widening the model's circle of impact. These activities include trimming model scope, challenging and helping to revise a key national objective, facing our model critics, doing more extensive sensitivity tests, conducting an external model review, training model communicators, calibrating the model for various states within the US, and piloting model-based learning laboratories. In this poster, we will describe these activities and reflect on how and why they have (or, perhaps, in some cases have not) helped move decision-makers toward tangible actions based on model insights. We will also reflect on how our experiences may inform other efforts to move from insights to action in the arena of public health, where the gap between science and policy is often a challenging one to cross.

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Mental Models in an Emerging Industry: The Photovoltaic Industry in Massachusetts

This paper reports on an ongoing model-based field study attempting to answer the following research questions: What are the mental models of participants in the photovoltaic industry? How widely are mental models shared among participants? The mental models of system participants are important because participants are the people with the greatest knowledge

about the system, because in any policy solution they are the critical actors, and because it is their decisions and actions from which the behavior of the system emerges. Fifteen experts have so far been interviewed. The knowledge they conveyed was expressed as a set system dynamics models; these models were characterized and compared. The informants all expressed dynamic growth as a result of reinforcing feedback processes, but few perceived of any balancing feedback. Their beliefs indicate successful policies will have to recognize the difference between global and local market effects

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Engineering Change Orders influencing manufacturing start-ups

Many companies, especially in high tech industries, are facing shrinking product lifecycles and increasingly complex production and product technologies. These market dynamics pressure production facilities to begin full scale operations at a point when the underlying process technology is still poorly understood. Consequently companies suffer from substantial yield losses which can dramatically affect the economics of the product, the 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', however they cannot evaluate the effects on the 'time-to-volume' When production is started at a point of low series production readiness a lot of engineering changes are likely to be detected during the ramp-up phase. This paper will compare two policies for the management of changes during production ramp-up.

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Formalisation of the South African Automotive Incentives Using a System Dynamics Approach

We present the formalisation of the South African fiscal automotive incentives – the Productive Asset Allowance (PAA) and the Import-Export Complementation (IEC). We estimate model rates of change using 10 year historical data. Model simulations reveal that while the IEC has a significant effect on industry trade balance, the role of the PAA is trivial. Further still, the IEC incentive cannot be maintained in its current form in the long term as the value of imports it enables to enter the country free of duty tend to total domestic market size.

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Modelling and Analysis of Production System of A Steel Plant- A System Dynamics Approach

Modeling and Analysis of Production System of A Steel Plant- A System Dynamics Approach K.R.Divakar Roy Department of Mechanical Engineering, A.U.College of Engineering (Autonomous) Visakapatnam-530 003 Mail Id: divakarroy@rediff.com, krdroy@hotmail.com Abstract In the fast changing economic scenario world over, the economic strength of any

company depends on the management's ability in improving quality, cutting production costs and providing better customer services to compete effectively in the global market. Even though every management aims at improving the productivity, there is a limitation on the part of various production facilities located in any plant as they cannot be stretched beyond a point. However, management can exploit the existing facilities to the maximum extent possible by introducing the latest state of art technology. Against this backdrop, present production scenario of a local integrated steel plant is described. The key variables considered for the simulation of steel plant production activities are: production of hot metal, liquid steel, prime blooms, bar mill products and wire rod products over a period of 20 years from 1994 to2013. The results obtained from the SD modeling are validated. Further, the model is utilized to explore alternative policies, which have been compared for their relative effectiveness.

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Analytical methods for structural dominance analysis in system dynamics: An assessment of the current state of affairs

We provide a review of different approaches to linking model structure to observed behavior with a particular view towards using models for theory building. We identify four such approaches, namely the "classical" approach, the "pathway participation" approach, the "eigenvalue elasticity" approach, and the "eigenvector" approach, respectively. We outline our assessment of the strengths and weaknesses of each approach and point to some main challenges and tasks ahead. We find that the eigenvalue and eigenvector approaches carry the largest potential but that a more solid theoretical foundation of the method is required. Once such a foundation is developed, it will be important to develop intuitive analytical tools that can be of use to a wider system dynamics audience. Since a "grand unified theory" will never be possible, all tools will be based on approximations and it is only in their practical use that we can discover their real value.

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Development of radiation risk assessment simulator using system dynamics methodology

The potential magnitude of radionuclide releases under severe accident loadings and offsite consequences as well as the overall risk (the product of accident frequencies and consequences) are calculated in this paper. System dynamics methodology useful for complex systems such as a nuclear power plant has been applied for representing the time-dependent behavior (feedback and dependency, etc) and uncertain behavior of complex physical system. System dynamic model is used to construct the transfer mechanism of time dependent radioactivity concentration. The time-dependent radioecological model applicable to Korean environment has been developed in order to assess the radiological consequences following the short-term deposition of radionuclides during severe accidents nuclear power plant. The results of this study may contribute to identifying the relative importance of various parameters occurred in consequence analysis, as well as to assessing risk reduction and accident management strategies.

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Happiness - Cracking the Equilibrium State of People's Well-Being

Understanding the mechanisms producing happiness is not only crucial for individuals and psychological research but also for management science and political economy. In this paper, we develop a System Dynamics model to analyze mechanism creating happiness. It allows a better understanding of the formerly vaguely proposed connections between external life events and individual well-being. We propose that it can make a qualitative estimation of a person's happiness over time as a function of external events. It is widely accepted in positive psychology that good and bad events temporarily affect happiness. Yet, individuals quickly adapt back to hedonic neutrality. This is known as the hedonic treadmill (Brickman and Campbell, 1971), the dynamic equilibrium theory, or set point theory (Headey, 2005). We model a hedonic treadmill by assuming that people's expectations and aspiration levels adapt to the actual stock levels of happiness drivers, such as income, health, and social networks. Policy-designers learn how well-intended policies to increase happiness only succeed short-term.

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Open source software development: A systems dynamics model

Evidence suggests that only a small percentage of open source development (OSSD) projects are active, have significant participation, or have delivered operational software. We develop a system dynamics based simulation model to analyze the dynamics of open source project participation process and software development process. We show that the complex interaction between participation and development processes affects crucially success or failure.

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Telecommunications Operations Resiliency: Labor Shortages and the Voice Network

Models of the voice telecommunications infrastructure have focused on the availability of the network during a disruption without accounting for the workforce necessary to provide repair and recovery functions for that network. This paper describes a system dynamics model of the maintenance operations of the voice telecommunications infrastructure and explores the effects of large and prolonged worker absence on the ability to keep the infrastructure operating. Analysis shows that the voice telecommunications infrastructure is highly resilient to the loss of a large portion of its workforce.

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Mapping Standard HIV Disease Surrogate Markers to Alternatives ones: A System Dynamics Approach

Use of systems dynamics methodology in modelling HIV/AIDS disease progression is not very new, however use of a triangulation of methodologies in form of the Dynamic Synthesis Methodology (DSM) to model the relationship between surrogate markers for monitoring HIV/AIDS disease progression is entirely new. A triangulation of methodologies called DSM combining System Dynamics and Case study methodologies was used to establish the relationships of HIV/AIDS surrogate markers so as to arrive at an appropriate model for monitoring the HIV/AIDS disease progression for a resource limited setting. The problem was initially analysed in its natural form to arrive at appropriate reference modes followed by simulation experiments that were used to map values of Plasma CD4 cell count onto those of Total Lymphocyte count and Heamoglobin, and HIV viral load onto CD8CD38 density representing the same disease state. The paper makes useful contributions in revealing salient insights that can be used to develop tools using alternative HIV/AIDS surrogate markers for cheaply monitoring HIV/AIDS disease progression in a resource limited setting.

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In Search of a Mental-Model-Like Concept for Group Level Modeling

In system dynamics, we use the term “mental model” to describe one’s perceived structure of system. We care about mental model, because it is what we attempt to describe, understand, and improve using computer simulation models. But if we are developing our simulation models from a group of individuals, can we still call what we are trying to study a mental model? This paper attempts to define the concept parallel to mental model that can be applied to group environment. In order to discover a group-level mental-model-like concept that is grounded in the established literature, this study surveys various terminologies and definitions used in the literature to describe the similar concepts. The survey reveals that there are subtle differences among the concepts discussed, and the conceptual differences are highlighted by using location and form of the processor as criteria. This finding leads to an insight that what system dynamics modelers try to understand, represent, and improve in group intervention processes is not one single concept. Depending on data collection and integration methods, the concept can vary in terms of location and form.

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The Effects of the New Capacity Investment Behavior in the Korea Wholesale Electricity Market

Generation facilities in Korea have been allocated to six firms as a part of restructuring and there is a competitive bidding in the wholesale market, albeit strictly on a cost basis. And Korean government has developed "Basic

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Plan of Long Term Electricity Supply & Demand" in order to secure resource adequacy. Addition of new generation capacities has controlled by this plan. However, if the restructuring will be complete done, generation companies have no obligation to invest if their profitability is not guaranteed. Many experts are arguing that government intervention is still necessary to avoid the price spike in the wholesale market. In this study, simulations for two scenarios were conducted to see whether competition market can help to stabilize the wholesale price in Korean market. The simulation results show that government intervention can prevent the price spike. However, the wholesale price in the competition market turns out to be lower than that in the regulated market due to the more new investment. However, this model has many limitations. First of all, this model assumed that only gas power plants can respond the market price.

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When Cognitive Institution Collapses: A Case of "Master Kim" through a System Dynamics Model on the Action-Driven Process

This study illustrates how minor social norms, which have even negative meaning in organizations, might be able to be dominant by the action-driven sensemaking process. Based on the Weick(1995)'s argument of the action-driven sensemaking process, a system dynamics model is constructed. To examine the properties of the sensemaking process, the system dynamics model built is applied to the case of a Korean maverick named "Master Kim" on cyber pornography. The analytical application shows that the strange epiphany involved in the case of Master Kim can be explained by the dynamic relationship between dominant social norms and deviate social norms. It means that norms, beliefs, and traditions can be collapsed by other cognitive institutions through as social interactions, such as the action-driven sensemaking process, particularly exchanging feedback comments on the hot issues on internet. Moreover, we have to notice that the evolution of cognitive institution could not be emerged unless the formal institution which facilitates the sensemaking process, such as the service of news comments on internet were established. Therefore, this study can be furthered in investigating not only practical implications to strategically make desired breakthroughs in our organizations, but also theoretical insights in the perspective of new institutionalism.

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A Model of Group Learning Supported by Simulation Experiment

This paper addresses the influence of individual and group information feedback on a decision process supported by the application of system dynamics model. For this purpose we have conducted the four-group Solomon experiment under following conditions: a1) determination of

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strategy with application of the system dynamics (SD) model without group interaction with pretest, a2) determination of strategy with application of the SD model and group information feedback with pretest, a3) determination of strategy with application of SD model without pretest, and a4) strategy determination with application of SD model and group information feedback without pretest. The observed variables were the criteria function values and frequency of simulation runs. The hypothesis that simulation model application and group feedback information positively influence the convergence of the decision process and contribute to faster decision-making was confirmed. A model of learning during the decision-making process was developed.

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Firm Behavior Optimal Control on Mobile Service Market

Paper present a system dynamics approach for modeling mobile service competitive market and forecasting market development. The model includes dynamic competition between operators. 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 sales is described. The method for the saturation level identification is considered and the optimal control problem is formulated and solved. Actual data from several regions of Russia are used in this paper.

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Bayesian Analysis of Stochastic System Dynamics

The paper deals with the system dynamics modeling of a stochastic behavior. The starting point is replacing the traditional system dynamics model with a discrete-time stochastic dynamic model in which state variables are measured indirectly, through noisy and incomplete measurements. The state variables and possible unknown parameters in such a model can be systematically estimated from the available measurements using the Bayesian paradigm. Closed-form solutions exist only for few special cases, such as a linear normal model with known parameters, otherwise numerical approximations are required. The paper suggests a particle filter algorithm as a particularly appealing approximation that preserves much of the intuitive workings of system dynamics. A practical example illustrates both the stochastic modeling process and the approximate Bayesian analysis.

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To Cluster or Not to Cluster: A Simulation Study of Managerial Practices for Innovating in SMEs

During the last two decades a strong line of research has emerged in management research and policymakers' agenda: the relationship between firms and clusters. One of the several reasons explaining the increased interest in clusters is the positive association between networks within geographical boundaries and knowledge diffusion. However, there is a strong assumption in this reasoning: clustered firms have enough capabilities to transform local interaction, which has to be also rich in information, into valuable knowledge to improve its performance. What will happen if firms in the cluster lack of skills to absorb information? What will happen if clustered firms do not have rich interactions? This paper aims to show the benefits and trade-offs existing for a Small and Medium Enterprises when at the moment of start an internationalization process managers need to decide either to emphasize the interfim interactions generated inside a cluster or to follow a standalone process without clustering.

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Modeling Brand Equity in International Nonprofit Organizations: A System Dynamics Approach

While nonprofit organizations and their brands are growing in importance and stature, these organizations display surprisingly limited brand management activities. This is partly due to the fact that no explicit brand equity models exist specifically for nonprofit organizations. The aim of this research is to build a formal model of brand equity for international nonprofit organizations engaged in development, advocacy and relief work, using a combination of a system dynamics approach and grounded theory development. In doing so, we hope to contribute to the system dynamics literature by illustrating the step-by-step process of building a model from actual case studies rather than the traditional approach of literature review. Based on in-depth field work in three organizations (Care, Oxfam, and World Vision), two waves of focus groups with 18 brand managers led to the derivation and validation of a formal brand equity model. At the heart of this model are four core variables (Consistency, Focus, Trust, and Partnerships) and their associated causal loops. As such, this research constitutes a significant attempt to advance our understanding of brand equity in nonprofits through modeling, and to demonstrate the effective use of system dynamics in areas of marketing that have traditionally not considered this methodological approach.

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Formal Theory Building for the Avalanche Game: Explaining surprising behaviour using geometrical & human behavioural effects

In 'Avalanche' a rod is lowered to the ground, team members staying in contact throughout. Normally the task is easy. However, with larger group sizes counter-intuitive behaviours appear, including the object's ascending. A

formal theory for the geometric element and other human behaviour effects gives insight into the behaviours. Each player has two balancing loops, one involved in lowering the object, the other ensuring contact. For more players these loops interact and these can allow intermittent dominance by reinforcing loops, causing the system to chase upwards towards an ever increasing goal. Analysis indicates that there is only a narrow region in which the system is able to move downwards. An analogy is drawn between the co-operative behaviour required in this system and Prisoners' Dilemma situations. Sensitivity analysis gives further insight into the system's modes and their causes. Reflections on the benefits of formal theory building close the paper.

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An evolvable model of organizations: A bistable or quantum approach

A nonlinear approach to game theory has been designed to resolve two of its major problems: The arbitrariness of valuing cooperation greater than competition in determining social welfare; and the lack of interdependent uncertainty. The approach is to develop quantum or bistable agents and relationships. The quantum approach means that agents in relationships are more likely to be found in bistable states that correspond to their observation-action or energy-time levels; e.g., the more complex, competitive, or conflictual the state, the greater the energy required but also the less time available to enact an action. In our view, games are initialized, evolved to a state that solves a target problem, then measured, consequently creating a measurement problem. In past research, we have resolved the measurement problem. The measurement problem led to the development of metrics that have been applied to organizations in the field (we briefly illustrate an application to military Medical Department Research Centers). In this paper, we focus on modeling control in bistable close and market relationships to produce evolvable systems.

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System Dynamics modelling for highly active antiretroviral therapy (HAART) and multi drug resistant tuberculosis (MDRTB) treatm

The aim of this study is to quantify the impact of coverage with highly active antiretroviral therapy (HAART) and multi drug resistant tuberculosis cure rates in settings of explosive human immunodeficiency virus (HIV) epidemics and high MDRTB levels. A System Dynamics model was built and simulated over a 10-year period and scenarios regarding different levels of HAART coverage and MDRTB cure rates were tested. The results indicate that increasing HAART coverage reduces cumulative deaths for all levels of MDRTB cure rate. Increasing MDRTB cure rates is likely to result in only a reduction in cumulative deaths from tuberculosis of between 1% and 13% depending on levels of HAART coverage. HAART coverage in the order of 75% or higher is required to substantially reduce deaths from tuberculosis. If high coverage with HAART is allied to high MDRTB cure rates this may result in a reduction of approximately 60% of cumulative deaths.

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A Prototype Simulator for Infrastructure Protection: An Application to Decision Support for Controlling Disease Outbreaks

The Critical Infrastructure Protection Decision Support System (CIPDSS) project has developed a risk-informed decision support system that provides insights for making critical infrastructure protection decisions by considering many critical infrastructures and their interdependencies. Since program inception the project has demonstrated how the CIPDSS can assist decision makers in making informed choices by functionally representing key critical infrastructures with their interdependencies, and computing human health & safety and economic impacts. The method of delivery to date has involved the conduct of analysis by the project developers and delivery of the results in the form of reports, often supplemented with face to face interactions with sponsors and decisions makers. This approach benefits from having the analysis conducted by the developers who best understand the underlying models and their limitations. However, this mode of delivery can be said to live more distant from those who might best benefit from being exposed to the analysis and the inherent trade-offs therein. This paper describes the development of a desktop simulation designed to help bridge this gap between the CIPDSS analysis and decisions makers. To illustrate the utility of this approach, an application focused on controlling infectious disease outbreaks, such as Pandemic Influenza, has been implemented.

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NIMBY Dynamics: Location Policy of Crematory Facilities in Korea

The purpose of this study is to find what factors are directly related to the location of a NIMBY (Not in my backyard) facilities. Using causal loops and stock-flow models derived from System Dynamics (SD) approaches, it focuses on Cheongju crematory location project in Korea. After a series of simulation works, the research finds that the unilateral tactics handled by the public unit have aggravated the public project delay as the negative externalities originated from the adjacent location of NIMBY facilities have exerted significant influence on the dynamic perceptions of major stake-holders. We observe that the proposed alternative negotiation-based models produce higher level of planning performance than the existing approaches in relatively a shorter period. Even though the former may require more human and material resources from the very beginning stage, as they have to deal

with diverse grievances raised by neighboring residents, most of them would be geared toward strengthening reinforcing loops within the complex conflict structure. These results imply that the proposed negotiation approach to deal with public location projects would enhance mutual agreement among major stake-holders, upgrading the overall quality of public project management.

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Using Systems Thinking to Improve Organizational Learning in the Public Sector : Perspective of Public Officials

This study examines how public officials who have completed a one semester two-credit systems thinking graduate course consider how systems thinking training affect their way of thinking and daily administration behavior. Additionally, this study also focuses on how these public officials perceive the barriers to adopting systems thinking for the improvement of organizational learning in the public sector. This study employs a self-evaluated survey as the research method. The research results demonstrate that, after finishing the systems thinking course, questionnaire respondents request more from leaders to clarify organizational goals and to provide incentives for members to bring up innovative ideas. Meanwhile, respondents believed that they considered communication and teamwork important more than before taking the course. However, respondents appeared not to highly value their own role in achieving organizational goals, and to doubt their own willingness to incorporate new ideas into daily routines. Additionally, public officials believe that organizational leaders lack concepts and practice of systems thinking, and public organizational inertia, thus leading to the failure of systems thinking practice to improve organizational learning. This study provides suggestions for systems thinking course design based on the survey results.

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Crisis as the Touchstone of Trust: The Story between the Enterprise and Banks

Much current work in social sciences seeks to understand the role and development of trust in the network of modern society. However, the development process of the trust remains unclear. To explore the dynamic process of crisis and trust, this paper primarily examines on the role that trust plays in the financial manager's network relation, and the influence of its interaction with the banks. This study focuses on a state-owned enterprise in Taiwan that suffered from financial crisis and downsizing. Systems thinking combined with narrative inquiry are adopted to investigate the dynamic change of relationship between the enterprise and banks before and after crisis. The findings show that trust becomes considerably important when an organization suffers from a financial crisis, and the relation between the organization and banks tends to change after the crisis. Finally, an integrative model for crisis and trust is proposed to improve Webb's model and contributes to interpret the dynamic relation of crisis and trust. Keyword: Social Network, Trust, Crisis, Narrative Inquiry, Systems Thinking.

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Pitfalls in Decision-Making in Complex Systems

Experiential research, as well as three decades of working with managers across diverse cultures has revealed an unmistakable pattern of counterproductive decision-making by managers. In general, managers exhibit a tendency to "over-intervene" in the systems they are responsible for. This indicates an inadequate appreciation and understanding of complexity and dynamics, generating unnecessary fluctuations and instability in their organizations. Sterman (1989, 2000) and Maani et al (2004) have studied these phenomena in simulated and experimental environments respectively. Research results, as well as causal observations, highlight a number of mental models and behaviours undertaken by managers in dealing with complex issues. The key research question of this study: "Why managerial interventions in complex organizations often produce counterintuitive failures?" has led to seven propositions investigated in this research. Empirical results from 224 experiments, using two pre-tested microworlds, inform and support our propositions. Research subjects comprise practicing managers, MBA and other graduate students. The findings show congruence with related research, including the multi-year longitudinal study by Collins (2001). The findings have important implications for complex decision-making, leadership and organizational interventions and transformation.

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A System Dynamics Model of Bilateral Intellectual Property Negotiations

Copyright piracy and other intellectual property right (IPR) infringements in developing countries have become serious problems for many developed countries. Intellectual property (IP)-oriented industries in developed countries fear that piracy will impact their revenues. In the U.S., the IP industry usually lobbies the government to pressure countries with serious piracy problems to protect IP. Though the US trade representative takes an aggressive negotiating stance in this area, the U.S. IP industry and government never seem satisfied with the results. This paper builds a system dynamics model to gain insight into the interactions involving the IPR issue between the U.S. government, the U.S. IP industry, China's government, and China's local governments. Through this model, the historical behaviors between the U.S. and China will be examined to show that U.S. pressures do improve China's IP protection while other factors weaken China's effort to protect IP.

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Private-Public Cycle: Testing Hirschman's Theory of Shifting Involvements with a Formal Model

Why do societies oscillate, on a roughly twenty-year cycle, between modes of private acquisitiveness and public spiritedness? Albert O. Hirschman argues that disappointment is the main cause explaining why societies never

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stop shifting from an ideology promoting private interests to another philosophy which endorses public action and vice versa. The aims of this paper are to reconstruct Hirschman's reasoning using a System Dynamics approach and to build a simulation model reproducing the oscillations societies experiment between private and public interests. Our simulation results reproduce the behaviour implied by Hirschman, therefore showing evidence of the dynamic consistency of his argumentation. Furthermore, an example taken for a novel and empirical data, which represents the evolution of turn-out in the US, have been used to gain deeper support of our findings. Further research using this model is promising.

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Turnover-induced Forgetting

A firm's productivity may fall despite continued accumulation of output. We show such productivity decline by means of an in-depth case study with detailed longitudinal data. Hiring of inexperienced labor disrupts the firm's knowledge stock by bringing in workers with less than average experience. Thus, the firm's knowledge becomes diluted through labor-turnover induced organizational forgetting.

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Episode-of-Care Analysis and Tobacco Treatment in Primary Care Settings

Economists and health services researchers have long been faced with the problem of how to effectively unitize and assess cost and quality of health care delivery across diverse practice settings. One such approach is episode-of-care analysis, first theorized and applied by Hornbrook and his colleagues in the mid-1980s. A health care episode is defined as a series of health-related events with a beginning, an end, and a course, all related to a given health problem that exists over a specific time period (i.e., time horizon). The concept of a health care episode lends itself to system dynamics analysis of the processes as well as the outcomes of evidence-based medical care. In our research we have adapted an episode-of-care framework to the topic of treating tobacco use and dependence. In particular, we have defined four types of episodes, namely smoking episodes, quitting episodes, illness episodes, and treatment episodes, which we are studying in relationship to two general goals: Motivating patients who currently use tobacco to quit and, for those who quit, preventing their relapse. We review the literature on episode-of-care analysis and discuss alternative ways to model the dynamics of tobacco treatment at the level of the primary care practice.

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Towards a Theory of Interorganizational Collaboration: Generic Structures of Cross-Boundary Requirements Analysis

In this paper, we present a series of causal maps that constitute an initial effort in the creation of a generic theory of interorganizational cross-boundary requirements analysis. Such causal structures are the result of a

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simulation-based study in which we explored the interactions and social processes associated with the development of trust and knowledge sharing in the development of an interorganizational information system in New York State: the Homeless Information Management System (HIMS). The paper includes the main theoretical and practical implications of the modeling and simulation work, as well as discussion of some paths to continue the exploration of collaboration in this specific context. The causal maps are organized around three themes that emerged during the modeling process. The first theme is related to trust development, and its recursive interactions with knowledge sharing and learning. The second theme is related to the importance of achieving stakeholder engagement by establishing a trusting environment as opposed to the use of authority or coercive mechanisms. The last theme is associated with the understanding of requirement definition as a social process of learning and knowledge transfer.

Building the World: System Dynamics and Macroengineering

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Humans are builders -- we make structures to span rivers, to craft canals, to establish cities. Throughout history, civilizations have created iconic monuments of such immense scale, requiring tremendous resources, that they might have been thought impossible. From the Taj Mahal to the Suez Canal, from Solomon's Temple to the Channel Tunnel, these feats of macroengineering are a testament to the creativity and foresight of architects, engineers, governmental leaders, lawyers, bankers, and diplomats. The macroengineering projects in this presentation can be analyzed through the methodology of system dynamics. In this PowerPoint Poster, Frank P. Davidson and Kathleen Lusk Brooke will present an overview of their book, "Building the World: An Encyclopedia of the Great Engineering Projects in History" regarded by Dr. Jay W. Forrester as "amazing and impressive" and by Dr. David H. Marks, Director of MIT's Laboratory for Energy and the Environment, as "a tribute to the role of large-scale infrastructure in the evolution of the world's societies." This Poster Presentation will announce a "Building the World Prize" for the best system dynamics essay on plausible approaches to help improve the world's future. For more information, please visit: www.buildingtheworld.com.

A Dynamic Balanced Scorecard for Managing Health Systems Performance

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Health system performance management is a dynamically complex problem, affected by a large number of factors which interact to produce health outcomes over time. A brief review of current health system performance assessment instruments, including the balanced scorecard, demonstrates only a limited ability to deal with the dynamic complexity of this problem. These are limitations that can be overcome with the incorporation of system dynamics methods. We propose a dynamic balanced scorecard for managing regional health system performance in New South Wales, Australia. Central to this scorecard will be an understanding of the dynamic interactions of cost, quality and access and how these affect population health.

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Two Loops, Three Loops, Four Loops: Pedagogic Issues in Explaining Epidemic Dynamics

How many feedback loops, and of what type, control the behavior of an epidemic? This seemingly simple question arose on trying to relate the behavior of the epidemic model widely used in K-12 system dynamics to its three-loop feedback structure. A search of the literature discovered two-, three-, and four-loop versions of the basic epidemic model in introductory system dynamics materials. How can the same behavior be explained with such different feedback structures? Can they all be right? This paper will analyze the three basic model structures and discuss implications for system dynamics pedagogy.

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Extending the Industry Evolution Management Flight Simulators: Golf and Solar Industries

The Industry Evolution Management Flight Simulator (MFS) was developed at the MIT Sloan School of Management for use in the MBA Strategic Management curriculum. As described in the proceedings of the 2006 System Dynamics Conference, this MFS includes a generic firm and industry structure that is then adapted to various industries that each emphasize different strategic environments. Earlier applications include the Salt industry and the Video Game console industry. Here, we summarize this work and present two new applications, both tested in a spring 2007 MBA elective course. The first is a MFS of the premium golf club industry. This simulator allows students to experience typical boom and bust dynamics following the introduction of a new consumer durable and experiment with strategies related to price, R&D and marketing. The second new application is a MFS of the Solar Panel industry. In addition to exposing students to the potential of this emerging and important industry, this MFS gives students the opportunity to experience learning curve dynamics for a new technology and understand the importance of knowledge spillovers towards their choice of strategy.

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Criminal Justice Simulation Model (CJSIM): Technology and the Flow of Criminals in the Criminal Justice Syste

This paper examines what would happen in the New York's criminal justice system if two primary changes were made. Those changes are an exogenous doubling of the number of new criminals entering the system (new people becoming criminals) and a doubling of the productivity of police officers. These inputs were selected because they represent changes on the front or upstream end of the criminal justice system, and the effects of these changes on the whole system could be observed. Changes in police capacity, number of people in prison and the total number of active criminals are examined to understand the implications that technological improvements that increase police productivity may have on other parts of the criminal justice system.

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Understanding Carbon Sequestration: A Systems Analysis Tool

A team of collaborators within the Southwest Regional Partnership (SWP) on Carbon Sequestration developed an interactive software tool to help facilitate discussions involving the science, engineering, economic and policy considerations for a carbon sequestration pilot project. This paper demonstrates the Integrated Assessment model, and highlights the 'String of Pearls' network algorithm used to develop a potential carbon dioxide (CO2) transportation network in sequence with existing infrastructure and speaks to the use of system dynamics in a government setting. The 'String of Pearls' model framework can assess geological sink choices according to their distance from the point source (e.g., power plants), relative size (to maintain a useful fill lifetime for a project under consideration), relative distance from existing CO2 transportation infrastructure such as pipelines, and other salient project attributes. The results indicate that the cost to capture CO2 at point sources is the largest component of the overall CO2 capture, transportation and storage system's initial cost estimate. The 'String of Pearls' Integrated Assessment model can help planners assess these issues using an integrated, systems view when deciding where to develop future carbon sequestration pilot projects. The modeling process and the model itself are described in this analysis.

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Design for a Multi-Layer Model of Financial Stability: Exploring the Integration of System Dynamics and Agent-based Models

Modeling for enhanced understanding of complex systems with policy-oriented implications sometimes requires that several different levels of aggregation be considered and formally included. In the system dynamics tradition, different levels of aggregation are not normally combined, leaving certain classes of problems outside of the traditional use of system dynamics models. Agent-based models can capture a very fine-grained level of detail of the system under study but lack the ability to parsimoniously and clearly link behavior to structure. This paper presents a domain in which a combined approach seems to be adequate. Additionally, two alternatives to dealing with the problem of integrating data from different levels of aggregation using system dynamics and agent-based models are discussed.

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Modeling Aviation Security Processes: A Group Model Building Approach

The U.S. Transportation Security Administration (TSA) is collaborating with a team of system dynamics modelers from the national laboratories to build a model of their security checkpoint operations at US commercial airports for the purpose of proactively identifying high-leverage opportunities for investment to improve system performance. To elicit a broad range of expertise and opinions to develop our understanding of the systemic issues facing TSA as they strive to improve their security checkpoint operations, we conducted more than 30 interviews with headquarters and field-operations staff and hosted a 2-day group model building exercise. In this paper, we use both causal-loop diagrams together with a description of the results of the group model building exercise to present a rich articulation of the issues facing TSA in managing their security checkpoints. We also show how the complex interrelationships among various factors ultimately impact the effectiveness and efficiency of the aviation security checkpoint.

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A System Dynamics Model of Asthma Care

Abstract Although our understanding of asthma and its treatment has grown far beyond what was known during the 19th century, both the morbidity and mortality rate from asthma is much higher now than then. In the medical community this is known as the great asthma paradox. In this paper we present a system dynamics model to investigate the causes of this paradox. The model shows how the short-treatments that were not available in the past cause much of the problem behavior of asthma care today. We show the system mechanisms that cause short-term treatments to begat more treatments; that invite those with asthma to become addicted to short-term treatment; and that show how side effects of short-term treatments deteriorate asthma conditions. We then introduce the long-term treatment concepts into the model and examine their impact on asthma care. Through model simulations we show how a proper combination of the long-term and short-term treatments can create optimal results. The results from our model are compatible with clinical results observed by physicians experienced in the care of people with asthma.

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System Dynamics Learning Environment in Teaching Supply Demand Interactions

The market mechanism works through the interaction between supply and demand. In economics, this interaction is taught through comparative static analysis which does not really capture the dynamics involved in the market place. In this paper, we have developed a series of system dynamics models

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to represent the dynamics of such interactions. We start with a simple model which is dynamically richer than the model presented to the students in classical economics text books. Then we identify the simplified assumptions made in the simple model and then gradually relax them one by one in the next models to make the models more realistic. As the assumptions are relaxed, the dynamic complexity increases and students can gradually get deeper and richer understanding of the dynamics of interactions between supply and demand in the market place. We put the whole sequence of the models on a micro-world to make a learning environment that teaches the concepts to students through using the environment on a computer in an interactive ways. We then run some experiences to examine the effectiveness of the learning environment to develop the capabilities of users to understand and explain the dynamics of supply and demand in some real world situations. The experiences show that our learning environment is very effective.

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The Effect of Network Topology in Social Diffusion: A System Dynamics Approach

Several classical system dynamics models, such as models of disease spread, and technology adoption, are built under assumption of a homogeneous population. These assumptions have been recently challenged by recent results showing that the degree distributions of many social and natural networks, such as the so-called scale-free networks, exhibit long-tailed degree distributions. This paper adopts a system dynamics approach to replicate preferential attachment, one of the network dynamics mechanisms known to produce power-scale distributions. We then study the diffusion processes on these networks, e.g. epidemics, product adoptions. We consider a basic compartment model (Susceptible- Infected) and apply scale free network topology in place of the random network topology that is traditionally assumed. The resulting model is used to assess the effect of the topology on the diffusion of attributes throughout the network.

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Jurisdictional Control of Conservative Spine Care: Chiropractic versus Medicine

This investigation explores inter-professional conflict for jurisdictional control and market share advantage. A System Dynamics model, informed by theory of inter-professional competition, was created, focusing on a profession classified as “major” and competitor profession classified as “minor”. Medicine was chosen as the major player, since efforts to manage healthcare expenditures have fostered attitudes that support substituting lower cost alternatives. Chiropractic was chosen as the competitor, due to its independent status, and its prominence in the CAM field. The jurisdiction of interest was neck and/or back pain. It was posited that an increase in academic abstract knowledge or an increase in professional association membership would benefit the minor player. In addition, it was hypothesized that an increase in supply of the dominant profession would adversely affect chiropractic, as would pressure on medicine from external sources such as health management. Simulation results suggested that increasing the

academic abstract knowledge of the minor profession had only a minimal impact, after an extended delay. No differences were seen by increasing association membership. Negative effects on the minor profession's market share were observed when supply of the dominant player was increased and when external pressure was intensified. In general, simulation results favored medicine's monopoly.

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The use of SD methodology to develop services for the assessment and treatment of high risk serious offenders in England&Wales

In England and Wales, national government has introduced a range of policies for dealing with the most dangerous offenders. These include new sentencing arrangements, new treatment programmes, and enhanced supervision of those released on licence. Policy makers needed to estimate the impact of this policy on the prison population and to consider how much treatment and community supervision capacity would be needed over time. They worked with a small SD consultancy to develop and build a model using ithink software, to enable a variety of scenarios to be tested, adopting a group model building approach. A number of staff received training in SD, including model building. The paper outlines the policy background, model structure and examples of scenarios. As well as being a practical application of SD to a sensitive area of public policy, the project is an example of what can be achieved within a relatively short intervention.

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Dynamics of Growth in the New Hampshire Prison Population

Although statistics suggest that serious crimes are infrequent and probably decreasing, the population of inprisioned people in New Hampshire is growing exponentially. This model shows the dominant loops responsible for this paradox. From the model we learn that the processes of judgement and incarceration have reversed the process we normally associate with the prison system - society creates prisioners in order to fill new prisons rather than constructing new prisons in order to house the criminal.

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Uncovering Complex Relationships in System Dynamics Modeling: Exploring the Use of CHAID and CART

One of the premises of system dynamics is that the modeler would make assumptions about variable relationships with enough precision to make the model useful. A common validation method is to consult with field 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. High turnover rates at companies paired with large amounts of data have reduced the number of "experts." Without experts, companies are data rich but not necessarily knowledge rich. 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). We present an application of Classification and Regression Trees (CART), Chi-Square Automatic Interaction Detection (CHAID) which are known nonparametric predictive methodologies to uncover/confirm significant variable relationships and build the equations to feed the model. An illustrative example of CHAID/SEM to explore restructuring decisions in a large service organization will be briefly discussed.

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Understanding the Dynamics of Causal Factors related to Excessive Speeding Behavior of the Drivers

Excessive speeding behavior of the drivers is one of the challenges in the area of transportation around the world. Excessive speeding is defined as driving faster than the posted speed limit or driving too fast for the prevailing traffic and environment conditions. This paper provides a modeling framework that integrates the dynamic interaction between causal factors responsible for motivating drivers to adopt excessive speeding behavior. This modeling framework is developed based on information gathered through extensive literature review on speed choice behavior of the drivers, interviews of officials from police department, and interviews of a group of drivers. The modeling framework has been translated into a formal simulation model. The development of simulation model includes heuristic relationships that need refinements based on empirical evidence. It is expected that end product of this research would be a fully integrated decision-support tool that would help in understanding the resistance to achieving a sustainable reduction in the number of excessive speeding drivers.

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Application of System Dynamics to Human Resource Management of Canadian Naval Reserves

The mission of the Canadian Naval Reserves (NAVRES) is to provide trained reservists to meet various challenges of its combat and support elements to enable Canada to meet its objectives in time of peace, crisis or war. In order to sustain effectively and economically NAVRES has to manage an optimal number of the trained reservists in meeting their demands. The responsibilities and tasks of meeting the growing demands of the trained reservists can be daunting, risky, and costly without the proper knowledge and tools for evaluating the nature, structure, and potential behavior of the different components of the NAVRES as they relate to the mission of the organization. This paper describes a model that assists management of the NAVRES to deal with the challenges organization is faced with; as well as plan, manage and drive the future and strategic focus of the organization in its desired direction. The model estimates the requirements of the trained reservists at different levels under various scenarios as well as provides a laboratory environment for the decision makers to test virtually unlimited number of strategies that would accelerate their learning and help them in designing robust and effective strategies to successfully manage their resources strategically.

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New Venture Commercialization of Clean Energy Technologies

Clean energy technologies lower harmful emissions associated with the generation and use of power and many of these technologies have been shown to be cost effective and to provide significant benefits to adopters. This paper examines why new ventures founded to commercialize these technologies have failed to achieve widespread adoption. Based on interviews with clean energy entrepreneurs and other stakeholders and on case studies of clean energy technology ventures, a new venture simulation model was developed that models the cash flow, labor force, market, competition, and product development for a prototypical clean energy technology venture. When the model is parameterized to correspond to a venture that starts with superior technology at an attractive price its behavior corresponds to the experience of many of the companies interviewed. The modeled venture takes many years to achieve profitability due to long sales cycles, limits to market growth, and the time needed to gain experience producing and selling its products, and therefore has a high probability of failure. Analysis of the model results in a set of guidelines for what these ventures, investors, and policy makers should do to increase their odds of success.

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Improving the Naval Construction Process Through Lean Implementation

This study uses systems dynamics modeling to analyze the United States Navy's current construction administration process from design to implementation in order to recommend process improvements, which will prevent cost overruns, delays, and ultimately a waste of tax payers' resources. This study specifically examines the impact of upstream design implementations on the entire system, and incorporates a number of lean thinking ideas. It demonstrates the positive effects of increased constructability efforts and design sharing among engineers, and indicates that when limited resources exist it is best to focus constructability and design sharing efforts as early as possible during the upstream process. Finally, this paper concludes with a number of recommendations for how the United States Navy's Civil Engineer Corps and possibly Seabee Construction Battalions can best implement these ideas.

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Network Centric Operations and the Brigade Unit of Action

The U.S. Army is currently transforming to a more agile and deployable organization, which is centered largely on the integration of new information technologies. While most Army leaders report that many of these new information "tools" such as the Army Battle Command System (ABCS) give them an unprecedented level of situational awareness, others report that the integration of this new digital technology comes with some unintended consequences that in some cases actually slows information flow. We studied the "Brigade Unit of Action" concept with specific emphasis on the Brigade's ability to disseminate and process information within and between command posts, using System Dynamics as a modeling tool to help better understand the impact of various policy decisions. Our study concluded with five heuristics that Army leaders should consider when developing the future command and control architecture for the Brigade Unit of Action.

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Responsiveness and Efficiency of Pull-Based and Push-Based Planning Systems in the High-Tech Electronics Industry

Planning systems for supply chain management can be designed in different ways in order to achieve the multiple objectives of supply chain management. Two of these objectives are responsiveness and efficiency of the system. In this paper, a System Dynamics simulation model is used to assess the performance of planning approaches for supply chains in the high-tech electronics industry on the dimensions of responsiveness and efficiency. Supply chains in this industry are subject to a number of challenges that complicate the achievement of these two objectives. The findings suggest that pull-based planning approaches can be used to achieve high efficiency and responsiveness, at the expense of higher fluctuations in capacity utilization upstream in the supply chain.

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Do the Parallel Lines Meet? A Comparison between Pathway Participation Metrics and Eigenvalue Analysis

The search for tools and techniques aimed at model analysis has gained momentum in the system dynamics community during the last decade. A variety of approaches have been developed, modified and applied to replace or enhance the traditional intuitive-based schemes for understanding the behavior of dynamic models according to its feedback structure. Despite the diversity of the methods developed for model analysis, recent studies suggest that there is considerable convergence in the results they produce. The objective of this paper is to explore some of the similarities and differences between pathway participation metrics and eigenvalue elasticity analysis that can potentially explain the reasons for the convergence and divergence in analysis. In the first part of the paper, we lay out some of the theoretical differences and similarities in approaches between aspects of pathway participation metrics and eigenvalue elasticity analysis in order to explain how they, despite the significant differences in the process of model analysis, can produce similar and comparable results under certain conditions. The second part of the paper presents application of pathway participation metrics in three simple models that have been previously analyzed using the eigenvalue elasticity approach. The case studies highlight some of the similarities and differences between the two approaches.

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Transaction Costs and Outsourcing Dynamics: A System Dynamics Approach

Increasingly, firms are outsourcing their processes. Outsourcing regards not only peripheral activities but portions of key activities as well. Outsourcing is a pervasive phenomenon that often overlaps, and interferes with, the strategic decision to define a firm's boundaries. By outsourcing phases of R&D processes, for example, firms may lose their know-how concerning the production of core products. The outsourcing of processes may interact with a firm's organizational learning, thereby influencing the definition of the boundary that includes the core activity of the firm. Thus, managing outsourcing requires regulating the flow of knowledge that leaves the organization. Such a calibration produces transaction costs, which, in the long term, may decrease the desirability of outsourcing. To address the dynamic interplay among forces at work in outsourcing processes we built a system dynamics model. Specifically, the model represents the different components of software production. One of the main industries on which outsourcing has had a big impact in the last few years is software development. Our model attempts to include the main dynamics of a software-house company that is considering the possibility of outsourcing its production. We used the model to generate a number of hypotheses to study long term consequences of outsourcing policies.

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The Dynamic Balanced Scorecard as Third Generation of Performance Measurement Systems

In the last decades, traditional PMS, exclusively based on financial indicators, have been criticized since they give no information about companies' ability to achieve long-term survival and growth. For this reason, since the '90s scholars have been proposing several PMS oriented to evaluate company results according to the different dimensions of firms' success. Among them, the Balanced Scorecard (BSC) still represents the most diffuse multi-dimensional PMS both in literature and practice. Since its introduction, the BSC has been subjected to a rapid evolution process that has led some scholars to identify three different generations. By analyzing the BC evolution process, we will try to underline the main requisites of the third generation models to understand whether the Dynamic Balanced Scorecard (DBSC) presents such characteristics. With this purpose, we will also examine the advantages deriving from the adoption of the DBSC by an analysis of its application to a health care organization.

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An Experience Using System Dynamics to Facilitate an Insider Threat Workshop

CERT has been investigating the use of system dynamics to better understand the threat to an organization's information technology (IT) systems posed by malicious employees or contractors of that organization. At the 2006 International System Dynamics Conference we published a system dynamics model that was originally intended to be used as an interactive simulation in a workshop on insider threat. We believed that the model and simulation would effectively communicate the risks and mitigations involved in the insider threat problem. Through several pilots of the model-based workshop we learned how to better use system dynamics modeling as the basis for communicating complex concepts within the insider threat domain to an audience of business and IT managers not familiar with, or interested in becoming familiar with, system dynamics modeling. This paper describes the MERIT model and the development and evolution of the insider threat workshop based on this model.

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An Investigation of the Innovation Performance in the Capital Goods Sector in Colombia: Using the System Dynamics Approach

The innovation performance of a firm is addressed using the System Dynamics method. The problem that motivated this study is the lack of a

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comprehensive theory that explains both the poor innovation performance of the Colombian industry and its scarce level of the technological capabilities. Although there are a number of attempts to explain the problem, their causal structures are not fully specified and their results have not been evaluated with regard to whether they altogether constitute a coherent and consistent theory of the underlying causes explaining the observed dynamics. Robledo's (1997) research on the innovation process of the Colombian capital goods industry is examined in detail. We tested that the dynamics that Robledo describes can be produced by the causal factors he postulates. In Colombia, industrialists, academics and policy-makers need to do both acknowledge innovation as a learning process and estimate the intangible benefits of R&D.

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Fish and Ships – Fishery Dynamics with Bounded Rationality

The long-term sustainability of fisheries depends on maintaining the appropriate balance of fish and ships (or more precisely the fishing effort of the fleet). It sounds simple, but most of the world's fisheries are overexploited and in danger of collapse within 40 years. In this poster session I explore the paradox of fisheries management with a small system dynamics model of a harvested fishery inspired by the well-known Fish Banks gaming-simulator. The model represents the interaction of the fish stock, regeneration, ships at sea, investment and harvesting. I illustrate bounded rationality and myopia in fleet investment and the resulting formulations for an endogenous investment policy. Simulations show the tendency of fish catch to grow and then collapse. The model is extended to include regulatory policy whose fundamental purpose is to ensure that scientific information about the state of the fishery influences fleet deployment in such as way as to limit fishing effort. Further simulations examine whether, and under what circumstances, regulation can bring about sustainable and economically viable futures for fisheries.

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Egress toward a New Paradigm for the Social Sciences and the Role of System Dynamics in It

Historians of science have identified a number of notable changes that took place in science in the twentieth century. Among them was an increasing emphasis on relationships and systems, on looking at things as wholes in which every part has to be understood in relationship to the whole. Russell Ackoff has taken the idea a step further, maintaining that this shift to a systems perspective characterizes a transition in worldview. Viewing the social sciences as a single paradigm currently dominated by the ideal of the randomized experiment, this paper takes a comparative look at that transition from the standpoint of the development of approaches to causal inference. From the standpoint of an example drawn from educational research, changing methods of analysis are examined that indicate a progression away from the restrictions imposed by the experimental model toward a process-oriented approach. It is argued that those developments are creating an increasingly favorable environment for a process-based paradigm and a more prominent role for system dynamics.

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Insights from Modeling the Dynamics of Process Improvement

Process improvement takes place in the context of ongoing work, so people usually face the dual pressure to produce output and to build capability. Repenning and Sterman's (2002) study of two process improvement initiatives developed a causal loop diagram characterizing first-order improvements which boost output from existing processes and second-order improvements which enhance the capability of underlying processes, but the study stopped short of building a simulating model. This paper starts from the feedback structure they present and constructs a system dynamics model that formalizes the critical interaction between first- and second-order improvements as options for governing production. Analytical results characterize the optimal tradeoff between working harder and working smarter. However, practitioners generally must manage this tradeoff lacking adequate knowledge of the parameter space to find the optimum. Results demonstrate tipping points in the dynamics of process improvement, identify perverse behaviors that are likely to thwart the good intentions of practitioners, and show how the feedback structure of process improvement presents challenges to agents facing the dual pressures to produce and improve. By moving from causal loops to a simulating model, the paper also provides an example of how formal modeling yields more nuanced understanding.

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Modeling the Dynamics of Time-pressured Diagnostic Sensemaking

Problem solving in urgent situations challenges decision makers to make sense of their environment and take action quickly. This paper draws on novel data from an in-depth study of clinical problem solving in operating room crises to develop a grounded theoretical model of diagnostic decision making under time pressure. We develop a system dynamics model that represents the interactions among acting, interpreting cues, and cultivating new diagnoses. The model replicates four dynamic patterns of diagnostic sensemaking observed in the source data: stalling, fixating, vagabonding, and adapting. We show that self-fulfilling interpretation gives rise to fixating, but paradoxically is also crucial to adaptive sensemaking. By exploring the critical interactions among acting, interpreting cues, and cultivating new diagnoses, we find that generating new diagnoses quickly may be a liability and that, in diagnostic problem solving, acting quickly can mitigate the effects of slow interpretation. Driven by powerful reinforcing dynamics, the effectiveness of time-pressured decision making depends on the interplay among these processes. We discuss model-based strategies for mitigating the failure modes observed in the source data.

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The unavoidable a priori, revisited, or deriving the principles of SD

Over the years, representatives of other schools of quantitative analysis have at times critisized the System Dynamics methodology. To investigate the basis for such criticism, I take two advanced forms of quantitative analysis as my starting point: optimisation under uncertainty and Bayesian statistics. These methods can be seen as shared ideals for simplified optimisation and estimation techniques. It turns out that for an important class of dynamic problems, System Dynamics can be seen as consistent with the advance methods, and as an economical way to perform advanced policy analysis.

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Green tax, trucker actions, media coverage, misperception and political reversal

During the winter of 2000, truckers blocked the main roads in and out of the Norwegian capital Oslo. The main cause was low profitability in the business, and the reason for that was claimed to be a steady increase in the environmental tax on diesel oil the preceding five years. As a consequence, the politicians removed the tax. When doing so, some politicians neglected the philosophical ground of being for their parties, and a majority of them ignored Kyoto Treaty obligations and stated preferences for green taxes. In this paper, I claim that all this happened because: Voters, media and policy makers do not quantify their arguments. Their focus is on actions rather than causes. Adam Smith's invisible hand is still 'invisible'. There seems to be no institution readily available to correct misperceptions.

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System dynamics continuous modelling of endangered systems

Although large developed System dynamics model can be applied on different ecological system in this paper it is applied on Kastela region in Croatia. The Computer Simulation Submodel of The Ecological Regional Subsystem of the "KASTELA BAY" is an extra relevant submodel of The System Dynamics Computer Simulation Model of the "KASTELA BAY" which has been developed with the help of System Dynamics. It is, in its essence, a continuous model because it is presented as a system of non-linear differential equations. At the same time, it is a discrete model, because it is presented as a system of linear differential equations (System Dynamics DYNAMO - software package). Its DT (length of intervening time = computation interval) is chopped in full accordance with the Sampling Theorem (Shannon and Koteljnikov). The System Dynamics Computer Simulation Model of the "Kastela Bay" also employs certain experience gathered by experts who had worked on the preparation of projects: "Blue Plan" and "The Meth-odological Basis for the Scenario of the Management of Natural Resources of the "Kastela Bay"" (1991).

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Organization's Changes Through its Lifecycle; A System Dynamics Approach

Many scholars have used organizational life cycle theory to explain development in organizations. Each has considered stages of organizational development from a specific perspective by unique sets of organizational characteristics. For example, Queen (1983) focused on changes in organizational structure or Mintzberg (1984) emphasized on Power perspective. So in most of the models, only some attributes are discussed to be able to cope with the complexity of change. As a result, the relationship between these attributes is not vividly discussed. In this paper, we tried to extract some of the key attributes of organizations which cause the change from the literature and concentrated on the relationship between them. Resting on this approach, we were able to look at organizational change as a continuous process which is caused by the mutual relationship between different attributes.After recognizing the feedback loops that shape the behavior of organizations through their life cycle, we simulated it with system dynamics tools. Since in different situations and presumption organizations may encounter different barriers to growth, which are referred as crises, we developed our model for different scenarios. This way, it is possible to view the dynamics of organization's changes in its lifecycle.

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Rise of a New Player in the Competitive Telecommunication Market: Case study of Iran

Mobile communication is one of the most important market segments in the telecommunication market. This rapidly growing market is going to have 2,776 million subscribers by the end of the first quarter of 2007. Iran plans to expand the mobile communication network. One of the key steps was to share the monopolized market with a "Second Operator". This will be start of a competition era in the Iranian mobile market. This paper provides a system dynamics model to predict the interactions and competition of the two main mobile service providers. Equilibrium is possible in which the older provider can only survive if the market grows fast enough and the cost decreases. The model is an example of emerge of a new player into the environment.

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Towards a System Dynamics Model of De Soto's Theory on Informal Economy

This paper presents the first phase of a work in progress which aims at building a System Dynamics simulation model of the theory of the Peruvian economist Hernando De Soto. This theory proposes that the explanation for the fail of capitalism in Latin America should be looked in the informal sector of the region. The complete project will develop a full model for testing and complementing such a claim. This first phase presented here builds the platform for this endeavor; it briefly introduces the theory of De Soto and underlines its relevance and suitability for a System Dynamics approach; the article also connects the claims of the theory with the modeling

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language of System Dynamics, presenting the main structures of the simulation model and a further link with path dependence patterns. Finally, from this discussion, the article delineates the next steps to be taken.

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High Level Internet Modeling

This paper presents a hierarchical internet model suitable for simulating the impact of a localized physical disaster on the Internet within a typical metropolitan area. This first order model reports internet availability as the ratio of offered to car-ried traffic. We compute the carried traffic by examining the fraction of offered network traffic which flows through potentially impaired network entities. The impact of a physical disruption on a network entity reduces the carried traffic by the fraction of traffic which passes through that entity. The model is fully parameterized with respect to application properties (locality, latency, bandwidth, etc.) and connections to other infrastructure models (electric, phone, etc.). We also present a simplified system dynamics representation of this model using Vensim.

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Lightening the Performance Burden of Individual-Based Models through Dimensional Analysis and Scale Modeling

While individual-based models are attractive for addressing certain types of modeling problems, such models impose (frequently dramatically) higher performance costs for larger populations. Lengthy simulation times inhibit interactive learning, and – given limited modeler time – can impose higher opportunity costs by limiting model comprehension, refinement and user interaction. This paper proposes the novel use of dimensional analysis and scale modeling – which have long played an important role in understanding physical systems – to lessen the performance barriers associated with simulation of individual-based models. Given a dimensionally homogeneous ("full-scale") simulation model with a large population, we propose a precise, rigorous, systematic and general-purpose technique to formulate a "reduced-scale" individual-based model that simulates a smaller population. Measurements made of particular output parameters of such reduced-scale models can then be precisely transformed (in accordance with model scaling laws) to yield comparable results for a full-scale model – without the need to run the full-scale model. While discretization effects limit the degree of scaling that can be achieved, these techniques are notable in relying only upon dimensional homogeneity of the full-scale model, and on not the specifics of model behavior or use of a particular mathematical framework.

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Using Traditional and Agent-Based Toolsets for System Dynamics:

In its first 50 years, System Dynamics has evolved a rich set of modeling and analysis tools providing support for declarative, graphical specification of state equation models, with many features for analysis, calibration, and visualization. Many System Dynamicists are now using Agent Based modeling packages, which offer very different feature sets from traditional System Dynamics tools. The many differences between these two tool traditions have made many modelers uncertain about which toolset is most appropriate for their needs. This paper analyzes differences between existing traditional System Dynamics and Agent Based tools, and discusses their impact on model quality attributes such as transparency, performance, and accuracy. Our analysis finds that there is room for each tool tradition to benefit by adopting features of the other. Looking forward, we argue that both traditions are likely to converge on support for features presently supported by just one tradition, including hybrid discrete/continuous time and states, declarative mathematical specification, modular composition, metadata and dimensional reasoning, and exploratory longitudinal visualization. We believe that there will remain excellent reasons use a wide spectrum of model granularities, and argue competitive modeling packages will provide rich support for everything from extremely individual-level to aggregate models and multi-scale hybrids.

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Management of RhD-negative Pregnancies: Do New Technologies Make a Difference?

In this work we are modelling the management process of RhD negative pregnancies. The current practice is based on the use of anti-D as a prophylactic measure to prevent sensitisations (development of antibodies by the mother against fetal blood type). RhD NIPD is a diagnostic test designed to improve management of RhD negative pregnancies and to make the usage of anti-D prophylaxis more efficient. Despite the latter benefit, the need for the RhD NIPD technology introduction into clinical practice at the population level is questionable. This test is a technology-push product rather than a market-driven development and is characterised by high implementation costs and no clinical impact on the decrease of sensitisations and HDFN (haemolytic disease of fetus and newborn) cases in countries where antenatal anti-D is implemented. However, scientists argue the importance of this test in clinical practice. We employ systems thinking and simulation modelling to assess the potential and the impact of this test. This work describes the development of a game simulator for clinicians and policymakers. We hope it will serve as a useful decision-making tool for evaluation of RhD NIPD adoption scenarios.

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Structural Interventions in Electronic Networks of Practice: A Dynamic Grid/Group Model of Growth and Decline.

Electronic networks of practice can help an organizations discover and share knowledge more effectively by facilitating learning both from within the organization as well as from entities outside the organization. In those instances where firms have linkages with outside organizations, however, the acquisition and sharing of knowledge takes place free from the constraints of hierarchy and local rules. These networks can be characterized as loosely structured, and generally self-organizing, which are made up of individuals who voluntarily participate in the creation and sharing of knowledge. Building networks without formal boundaries is a challenging task for any organization. This is because those responsible for building them must not only have to encourage the use of the new tools, but also refrain from intervening too often. The objective of this paper is to conceptualize a simulation model, with which we can test the effects of structural interventions in electronic network of practice. Simulation results indicate that: (a) too much structure (rules, regulations, and group commitment) can result in a decline of network attractiveness; (b) lack of structural interventions can lead to a network that only attracts those people who prefer an environment without any form of control.

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Agricultural Production and Income Dynamics in Latvia

In this study we use system dynamics to evaluate possible development scenarios of agricultural sector in Latvia. Growth and balancing forces of agricultural economic are investigated along with dynamics of capital, land and labor allocation. Resource stocks are considered from two perspectives: a) breakdown between crop and livestock farming activities b) allocation between commercial and self-subsistence farms. Total production output and per-capita income of the population employed in the sector are chosen as key development indicators. Impact and efficiency of public support policies for agriculture are discussed.

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Effects of Causal Loop Diagrams on Escalating Commitment

Previous research suggests that decision makers have the tendency to keep on investing in losing courses of action. The present study focuses on de-escalation and proposes causal loop diagrams as a technique to decrease escalating commitment in a failing action. The effectiveness of causal loop

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diagrams is also contrasted with the effect of receiving a list of important factors. Causal loop diagrams were found to decrease commitment as compared to having no decision aid. However, no significant difference was found between causal loop diagrams and a list of important factors as a de-escalation technique.

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Investment Incentives in the Korean Electricity Market

This paper develops a model-based analysis of the effects of various capacity incentive systems on new investment in the Korean electricity market. The restructuring process in Korea allocated power generation to six firms, competing within a wholesale market, albeit strictly on a cost basis. Because of this cost-based pool, capacity payments were also introduced to encourage new investment. However, it is an open question whether the current fixed capacity payment scheme is enough to secure resource adequacy and consideration is being given to alternative mechanisms such as the use of LOLP. Using a detailed market simulation model, based on system dynamics, we compare these approaches in terms of how they may influence the investors' decisions and thereby determine the system reserve margin. The simulation results suggest that there may be serious problems is staying with the current fixed capacity payments in order to achieve resource adequacy. In contrast an LOLP based capacity mechanism may, in the longer term, increase the reserve margin compared to a fixed capacity payment. More generally, this paper indicates how crucial the effective modeling of the investment behavior of the independent power producers is for adequate policy support, even if they only constitute a fringe in a substantially centrally influenced market.

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Modeling for Sensitivity Analysis in Endangered Fish Species Management

Managing endangered species populations is a complex task demanding integration of knowledge across many disciplines, spatial and temporal scales, and ranges of human impacts. Computer simulation models can be useful in these efforts. We describe an ecosystem-level model for simulating population dynamics of the Rio Grande Silvery Minnow (RGSM; Hybognathus amarus) in the Rio Grande of central New Mexico. The model includes numerous variables which can be set by the user for different and in many cases uncertain minnow life history traits, impacts on mortality, and environmental conditions. Sensitivity analyses were conducted on the model's output as a way of testing the robustness of the model, gaining insights into RGSM population dynamics, and identifying important data

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gaps. The model returned biologically reasonable results consistent with currently limited understanding of RGSM population dynamics. Some results were completely predictable (e.g., good fertility and mortality data are the most important variables for understanding population dynamics), and some offered useful insights (e.g., current captive release programs may have little impact on long term population dynamics, but may prevent short term extinction).

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Investments in Operational Attributes and Impact on Outcomes in Training Services

The service industry has grown considerably in the last century and investments in operational improvements have increased. Operational investments decisions have a huge impact on the profitability of the organization not only at present but also in the future affecting the sustainability of the organization. The service-profit chain is a framework that brings together several components in the service delivery process. Evaluations of service operations based on the service-profit chain and others have taken a static approach without any consideration to the feedback structure. We develop a system dynamics model to evaluate the impact of number of courses offered on profitability of training services. This is accomplished by incorporating an optimization structure using the hill-climbing algorithm. The results from the simulation are then discussed along with validation of the model.

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A Communication Model with Limited Information-Processing Capacity of Recipients

This paper offers a computational model of profit-driven communication, when information-processing capacity of recipients is limited. Even though the model was inspired by the present situation in the direct online marketing industry, it has a wide applicability. In the model, profit-seeking communication firms exploit freely-available attention of recipients, while recipients allocate their limited cognitive capacity between competing tasks. We run numerical experiments to test various technical, market and regulatory proposals that aim at improving the social outcome. The paper makes a theoretical contribution to the economic literature and it also elucidates the current public policy debate about direct online marketing industry.

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Threshold21 Mali: System Dynamics-based national development planning in Mali

This paper describes how the Threshold21 Model developed for the Government of Mali has been used to support the preparation of the five-year strategic plan for the country. The model proven useful at different levels in the planning process: (1) it enabled testing the coherence of data collected; (2) provided insights into the future development of current issues and the emergence of new challenges in the Business-As-Usual scenario; (3)

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supported the discussion of alternative policies and development paths; and (4) provided a basis for monitoring and evaluation of implemented policies. This paper reports of the use of the model at levels (2) and (3), describing how it enabled an open discussion on the critical assumptions for economic growth to be used in the strategic plan, and on the delays involved in the country's growth process. Results from the model have been eventually incorporated in the national strategic plan.

Blending planning and learning for national development

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National development planning is a decision process at the central government level that defines the strategic plan for a country's long-term development. The System Dynamics Group at the University of Bergen in collaboration with Millennium Institute and the University of Iowa is developing an interactive learning environment for national development planning. BLEND is the acronym for Bergen Learning Environment for National Development. BLEND is a networked computer learning environment that constitutes a microcosm for real planning settings where policy makers play roles in a simulated government. The simulation model underlying BLEND is based on Millennium Institute's Threshold 21 model (T21) which has so far been applied in over 20 countries. T21 is a rather large model with a high level of detail. There is, however, ample evidence that learning environments are more effective when the models are simplified. The purpose of this paper is therefore to identify the key learning goals that BLEND has to address. Based on these we develop a simplified version of T21 that exhibits a lower level of detail and eliminates non-fundamental structural components.

Nemak: A look in to the future using a Dynamic Balanced Scorecard

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Nemak, a Mexican enterprise devoted to the production of engine cylinder heads and blocks a market leader on the industry, tries to identify critical external factors to gain competitive advantage as well as to understand their influence on its overall performance in order to face the challenges of the global economy. This paper presents the use of Balanced Scorecard based on a System Dynamics model that intends to be a decision-making tool for the company. The model is able to generate behavior trends on several different scenarios.

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Achievements teaching Systems Thinking and Systems Dynamics to Graduate students through e-learning

This paper shows a course design and its knowledge transfer process when teaching the changing paradigm of systems thinking, systems dynamics and simulation, through e-learning. The course uses the methodology for changing the analytical approach to the Systems dynamics thinking paradigm -in three months-; and was designed under the "thought on-line" approach. Action research method is used to observe the course evolution and to evaluate: new knowledge, skills developed by students and student's improvements on the changing paradigm. This is an on-going research; we present preliminary results about the achievements up-to-date. Even that ST, SD and simulation are difficult topics, they can be successfully taught on the right e-learning environment. We can state that, teaching this kind of topics can result in a good learning experience for students. These results can contribute to broadcast the e-learning experience to other related topics.

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The Logistic Game®

Abstract The aim of this paper is to describe an innovative Logistic Game® developed by the authors. It creates a competition between different teams in terms of strategic decisions in logistic and production problems in a real production system. The game is innovative in three ways. The first is the type of game. It is a game representing a production and logistic system, with the dynamic problems of a real system where, with finite resources, decisions have a relevant impact on performance. The second is the application of a simulation package to create the real scenario in which the competition develops, with the possibility to consider all factors (WIP, down times, line balancing, skills of person, etc). The third is its possible applications, since the game can be used not only as an educative facility, but also as a tool to assess the management skills of a future/present manager to face real and dynamic logistic problems.

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Visualising the Effects of Non-linearity by Creating Dynamic Causal Diagrams

Even though non-linearity is said to drive the behaviour of system dynamics models, modellers do not have access to techniques that show this happening. The tools at their disposal to present model structure are powerful, but, by

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nature, static. Formal model analysis methods has made significant progress in explaining how structure drives behaviour, but the connection to standard model conceptualisation techniques have generally not yet been made. This paper presents work that links the results of recent formal model analysis techniques to traditional conceptual diagramming techniques. A prototype visualisation tool is used to create dynamic causal diagrams that display the changing influences of the elements of model structure over a simulation run; it shows the waxing and waning of the influence of different sets of loops.

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Mitigating the Bullwhip Effect in Supply Chains using Grammatical Evolution

This research introduces a relatively new evolutionary algorithm in computer science; Grammatical Evolution (GE), to the field of supply chain dynamics and bullwhip mitigation. As a proof of concept several experiments are conducted to derive optimal ordering policies for agents in a multi-tier supply chain. These results are compared with existing research using Genetic Algorithms (GA) to derive optimal ordering policies using similar simulations. This paper shows that GE can consistently discover the optimal ordering policies similar to the GA approach, and that in several experiments GE outperforms GA.

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Is Layered Disaster Response Effective: An Analysis of Communications Problems during Natural Disaster

This paper specifically focuses on the impact of communications failures and information delays on timely decision-making during the initial Response Phase to a natural disaster. A comparison of the initial response efforts to Hurricanes Andrew (August 1992) and Katrina (August 2005), using both systems dynamics and systems thinking approaches was conducted in an attempt to better understand communications and organizational decision-making in crisis situations. All work on this paper was done by a group of doctoral students at University of Maryland University College between September 12th and November 18th, 2005. Since that time, several of the recommendations identified in this paper have become points of discussion in the ongoing national debate on how to improve response to disasters such as Hurricane Katrina. No updating of this paper has been done to reflect emergent concerns as analysis of the response to Katrina continues within the federal government.

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Modeling Decision Making Biases in the Context of a Market

The effects of two behavioral decision making biases are evaluated within the context of a system dynamics model of a market for a commodity, overconfidence and availability. Overconfidence is modeled as an increase in the percent of a trader's capital they are willing to commit to any trade and is

found to have the effect of increasing profits for traders with good information relative to traders with poor information, as well as increasing the volatility of the returns for traders with good information more than for traders with poor information. The Availability Bias is modeled as a overweighting of information easily available to a trader and is found to have the effect of increasing the returns of traders with good information easily available to them and decreasing the returns of traders with poor information easily available.

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E pluribus unum: Using group model building with many interdependent organizations to create integrated health care networks

This paper reports on an action research case study of integrated obstetric care in the Netherlands. Efficient and patient-friendly patient flows through integrated care networks are of major societal importance. How to design and develop such inter-organizational patient flows is still a nascent research area. We have shown that a modification of an existing method to support inter-organizational collaboration by system dynamics based group model building (the Renga method (Akkermans 2001)) may be effective in achieving such collaboration. At the time writing, the action research project that this paper reports upon is still ongoing, but so far, perceived results are promising.

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The EU-25 Power Sector: a System Dynamics Model of Competing Electricity Generation Technologies

The main goal of this paper is to explore -using a system dynamics model of the EU-25 electricity generation sector- the transition of the EU-25 electricity generation system towards a more sustainable system characterised by much lower CO2 emissions. The system dynamics model and the resulting dynamics are explored by means of base case simulations, policy simulations, scenario analyses and (univariate and multivariate) sensitivity analyses. Finally, some conclusions, ex-post criticisms and directions for future research are discussed.

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Combining System Dynamics and Ethics: Towards More Science?

In this paper, ethics is discussed in relation to system dynamics. The domain of ethics is very broad which is why we will first of all demarcate what is meant by ethics here. Then, we will discuss the importance of ethics for the domain of system dynamics and where it could come into play. Calls for,

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mentions of, and applications of ethics in the system dynamics literature will then be reviewed, followed by a discussion of possible contributions of the explicit consideration of ethics to the domain of system dynamics and of system dynamics to the domain of ethics. Two examples will be discussed: 'responsibility' and 'sustainable development'. Then, some advantages and disadvantages of combining ethics and system dynamics will be discussed. And finally, possible ways to deal with ethics in system dynamics will furthermore be proposed in the concluding section.

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Dealing with Uncertainty? Combining System Dynamics with Multicriteria Decision Analysis or with Exploratory Modelling

This paper discusses how system dynamics allows to deal with uncertainty, risk, robustness, resilience and flexibility, and how this could be improved. Two venues for improving the capacity of system dynamics to deal with uncertainty, risk, robustness, resilience and flexibility are provided, in both cases by matching system dynamics with other method(ologie)s, more precisely with discontinuous multiple criteria decision analysis and with exploratory modelling.

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System Dynamics Modelling of Competing UK Construction Firms

Although competitiveness is a widely used word in the construction industry, with past papers modelling competitive behaviour (Drew, 1997; Katsanis, 1995), there is considerable variance in both the definition and context of this term. As part of a 3-year multi-institutional research project, referred to as 'The Big Ideas', Salford University is using the System Dynamics (SD) methodology to model the competitiveness of construction firms. The competitiveness of a firm is represented in a 'competitive index' (CI), which is an amalgamation of elements that impact upon a firms perceived competitiveness. By incorporating the CI into a SD model firms will be able to increase their understanding of the possible impact their possible actions may have on their competitiveness. This paper examines competitiveness definitions, when used as a business idiom, and how this is related to a firm's capabilities. The SD methodology has then been used to quantify and model firms' competitiveness.

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System Dynamics Modeling of Public Expenditure and Human Development - A Case of Pakistan

This study develops a system dynamics model to estimate population, primary education rate and access to basic health care given exogenous gross domestic product (GDP) and public spending on education and health to

examine the impact of public expenditure on human development in Pakistan. It predicts development path of population, primary education and access to basic health care. The results show that high economic growth may not result into better human development indicators. On the contrary, high spending on education and health will improve human development indicators even if the economy grows at a relatively lower rate. It suggests a threshold of 3% of sustained economic growth rate as a pre-requisite to plan for human development in Pakistan. With that in place this paper suggests anchoring of public policy to human development by allocating more public funds for human development. Key Words: Human Development, Public Policy, Public Expenditure, System Dynamics.

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System Dynamics Modeling of Sustainable Food Security in Pakistan

This study develops a system dynamics based simulation model to understand dynamics of food security of Pakistan assuming exogenous GDP. The management of sustainable food security in Pakistan is based on the available agricultural land, size of its population and productivity of the factors of production. The natural endowment of agricultural land in use will decrease over time limiting food supply in Pakistan. Increased productivity of land and labor through education and technology may help improve situation. On the other hand, the sheer size of the population will worsen the food security situation. The simulation results suggest that economic growth rate of 4.75% or more coupled with high public spending on human development, higher than current levels of 2% on education and 1% on health, is a must for sustainable food security in Pakistan. Such an economic growth rate and commitment to human development will not only improve human development indicators but will also ensure sustainable food security. However, one critical finding is that Pakistan may not be able to provide the threshold calories to its population required for a healthy living. This clearly suggests persistent prevalence of malnutrition even though it may reduce over time.

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A Preliminary Model of the Vulnerability Black Market

The emergence of vulnerability black markets enhances the opportunities for malicious actors to launch exploits toward computer networks, to commit cyber-crime and to perform other unlawful activities. Asymmetric information, inadequate software testing, lack of incentive to improve quality of the software are presumed to be the most important grounds of the software vulnerability problems. This work is a preliminary model to build a structure that may explain the factors influencing the emergence of vulnerability black market and to simulate undesired consequences from desired effect to eliminate software vulnerabilities. The purpose of the research is to provide better understanding for information security community about the dynamic features of the software vulnerability and the vulnerability black market problems.

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In Defense of System Dynamics: A Response to Professor Hayden

In a 2006 paper in the Journal of Economic Issues, Professor Gregory Hayden argued that system dynamics is an inadequate tool for explaining the institutional systems principles of hierarchy, feedback and openness. The purpose of this paper is to show that Professor Hayden's claims are, for the most part, misguided and, in some instances, patently incorrect. Moreover, we will reinforce the view that combining system dynamics with institutional economics can be a very powerful approach to heterodox economic analysis.

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Reductionism, Holism and System Dynamics

The objective of this paper is to examine the concepts of holism and reductionism as they relate to System Dynamics (SD) and to a lesser extent Systems Thinking (ST) then to relate the findings of that examination to some of the disillusionment with SD and the resultant lack of commercial take up. This paper looks at the concepts of Reductionism and Holism as applied throughout the literature in a broad range of academic areas from medicine and philosophy to physics and looks at different definitions of holism, and reductionism. Practical applications of Reductionist and Holistic principles are examined. From this analysis the fundamental nature of SD as a Holistic/Reductionist methodology is deduced and differentiated from the more generally holistic nature of ST. From this basis the conclusion that SD is a reductionist methodology in practice, though not necessarily described as such by practitioners, is postulated. The paper recommends that there be further work carried out in the field of theoretical and practical holism and greater awareness of these issues within the practitioner community. Within the conclusions there is a pointer for some further fundamental areas of work.

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Disease Modeling with Application to Parasite-borne Diseases

System Dynamics provides a suitable framework for modeling diseases that can bring together biological, epidemiological, clinical, and public health issues in a manageable way. In this paper, we discuss models for the development and transmission of parasite-borne diseases which involve a primary host (e.g. a human), a vector(e.g. a mosquito), and a parasite . The models discussed here are being applied to different diseases; this paper will refer primarily to results for filaria. We first examine models for the biology of the disease in a vector and in a host, and for disease transmission between two humans through a vector. We then discuss a model for disease transmission in a population of vectors interacting with a population of hosts. We examine the effect of different control strategies, including preventive measures as well as treatment, and also possible effects of changes in the environment. We point out some of the complexities inherent in the biological processes, and the variability resulting from change in the values of the parameters in the system.

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Forecasting Turning Points in Shipping Freight Rates – Lessons from 30 Years of Practical Effort

We argue that it is possible to explain much of the history of the world's shipping markets since 1950 as the interaction of two balancing feedback loops: a capacity adjustment loop which creates a "20-year" wave, and a capacity utilization adjustment loop which generates a "4-year" cycle. We show how this insight has been used rather successfully since the early 1980s for practical forecasting of turning points in the shipping market 1 - 4 years ahead of time. The basic mechanisms in the shipping system create a strong "deterministic backbone" which is visible through the exogenous noise, and hence predictable with useful precision. Our experience leads to a number of questions concerning system dynamics best practice, for future research.

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IT Project Management, Concept Modeling, and Blind Dates

This paper describes a recent activity where scholars from two disciplines met to consider possible systemic causes of repeating failure during a three-decade long IT modernization project in the US government. From the system dynamics perspective, the problem appears to be related to a dynamic and repeating management failure with an embedded project management model. We decided to use a simple project model to develop this perspective. Our initial attempt shows some of the anticipated dynamics of project escalation. More important, though, was the discussion of the problem itself that was launched by the use of a formal model. We believe that this approach has provided insight into how to approach a more focused and grounded analysis of the problem domain.

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A system dynamics perspective on a global fishing enterprise: the case of tuna ranching industry in Mexico

Tuna ranching is a value-added economic activity along the coast of Baja California in Mexico involving the live capture and transport of migrating juvenile bluefin tuna to pens located near shore, where they are fed for a period of months then harvested and shipped fresh for the high-end sushi market, which is centered in Japan but expanding elsewhere. Ranching is nested within the entire global tuna fishing and processing business. Little is known outside the industry about the functioning of Mexican tuna ranching, which differs in important ways compared to its Australian and Mediterranean counterparts, and does not involve the harvest of reproducing age animals. Our analysis and exploratory modeling exercise identify several factors and issues that merit closer examination. A feedback perspective can shed light on whether Mexican ranching activities have the potential to become sustainable.

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Computational and Dynamic Complexity in Economics

This paper examines the rising competition between computational and dynamic conceptualizations of complexity in economics. While computable economics views complexity as something rigorously defined based on concepts from probability, information, and computability criteria, dynamic complexity is based on whether a system endogenously and deterministically generates erratically dynamic behavior of certain kinds. One such behavior is the phenomenon of emergence, the appearance of new formes or structures at higher levels of a system from processes occurring at lower levels. While the two concepts can overlap, they represent substantially different perspectives. A competition of sorts between them my become more important as new, computerized market systems emerge and evolve to higher levels of complexity of both kinds.

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Supply network design and collaboration: a preliminary study

This paper is aimed at formalizing and testing a model for explaining the relations among supply chain design decisions (i.e. sourcing strategies, number of network stages, nodes' capacity and localization) and the need for collaboration between the nodes of pull-based supply chain. As a consequence, a causal diagram which depicts such relations is built and its validation is performed by means of simulation techniques and statistical analyses (ANOVA and linear regression). In particular, since the magnitude of the relations is out of the scope of the paper, the validation is done in relative terms. The results obtained by running the simulation model of the supply chain which represents the 'base case' are compared with the outputs of the models which simulates the original logistic network modified according to the above mentioned supply chain design elements. The statistical analyses allow the majority of the relations of the proposed causal diagram to be actually validated.

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Modeling crime control in the Netherlands: insights on process

This paper is about a group model building project at the Ministry of Justice in the Netherlands. The aim of the model is to gain insight into the combined effects of an increase in the case load and investments in different phases of

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criminal justice administration and contextual developments such as increased complexity of cases. A group of representatives from the police force, public prosecution, courts and sentence execution participated in constructing the model from January to August 2004. In this paper we report on reasons for starting the modeling effort and the process of model construction. We then compare the procedure followed to 'scripts' – small parts of modeling process that have been tested out in practice and serve as standard building blocks for a group model building project. Scripts specify a technique, the situations for which it is suited and the expected results, enabling a modeler to choose from the wide variety of available modeling techniques. By describing the process followed in this case and consistently relating it to well-established practices we hope to further clarify the modeling process, by contributing to the existing body of modeling techniques and the dissemination of process insights.

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Is Immunization Demand Equal to Immunization Coverage? A Case Study on Uganda Healthcare Provision

Abstract. This paper critically examines the challenges associated with demand for immunization, including the interplay of political, social, economic and technology forces that influence the level of immunization coverage. In an earlier paper by the same authors, system dynamics modeling and case study research methods are used to capture the complex and dynamic nature of the immunization process. This paper suggests a framework to capture the complex and dynamic nature of the immunization process and tests its effectiveness using a case study on Uganda healthcare provision. The results indicate in cases of developing nations, immunization demand outstrips immunization coverage. The paper suggests that the model and results could be used for theory building in immunization policy evaluation in developing countries.

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Application of Resilience Analysis in Production Systems – Bombardier Transportation Case Study

This article presents the results of ongoing research on resilience in production systems. It refers to the term resilience as a way of dealing with uncertainty and disturbances. The proposed resilience analysis method, based on dynamic models, supports analysis of the production system in order to determine which structures and processes should be improved or reduced, and what resources preserved, in order to manage resilience. The application of the method is presented using results of the research project in Bombardier Transportation manufacturing plant in Poland. For the purpose of the analysis highly detailed discrete-event model and System Dynamics model were built. Both area of interest of both models complemented one another. In this paper

the main focus is given to the System Dynamics model. In the course of the research project the System Dynamics approach proofed to be very useful for examining the impacts of various disturbances and possible solution policies. As a tool for the resilience analysis results dissemination, the dynamic model based simulator, was prepared.

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Controlling Employment, Profitability and Proved Non-Renewable Reserves in a Theoretical Model of the U.S. Economy

This paper elaborates the original theoretical law of capital accumulation that generates scenarios of macroeconomic evolution. The main variables are relative labour compensation, employment ratio, and gross unit rent, produced capital-output ratio, proved non-renewable reserves-output ratio, desired proved non-renewable reserves-output ratio, and depletion of non-renewable reserves per unit of net output. Worsening profitability and declining employment ratio over the long term characterise an inertia scenario for the U.S. economy over 1991–2107. Excessive depletion of proved non-renewable reserves contributes to these disadvantageous tendencies. A forward-looking investment policy based on proportional and derivative control over proved non-renewable reserves brings about their extension, raises profitability and employment over the long term in the first normative scenario in comparison with the inertia scenario. The initial theoretical law is transformed into control law of capital accumulation. The operational application of this control law to the U.S. economy reveals and explains substantial lasting improvements in profitability, employment ratio, labour productivity and real labour compensation in the second normative scenario compared with the first normative scenario that are achieved together with extending proved non-renewable reserves due to excess income levy. Keywords: Capital accumulation, proved reserves, long wave, closed loop control, excess income levy, the U.S. economy.

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Using multi-scale systems simulation to evaluate health record solutions to improve medication use by the elderly

Elderly patients use more medications given the prevalence of co-morbidities putting them at risk of experiencing medication errors. A highly anticipated strategy is the implementation of health record solutions, namely a mix of shared electronic health records and personal health records. This intervention provides information for all individuals involved in the medication use system (patients, carer, doctors and pharmacists) and enables them to make more informed decisions throughout the medication use process (prescribing, dispensing, administering, monitoring of medications). However, it is difficult to direct the design of such an integrated health record solution that takes into consideration contextual factorsand its impact on, existing interventions and society. Traditional methods such as random controlled trials lack the capacity to capture the scale of the problem and are

inadequate in terms of time frames, cost, resources required, and non-applicability of trial settings. Multi-scale simulations can represent the system's different spatial and temporal resolutions providing a logical and consistent framework for dynamic analysis and a means to design and test health record policies to cover a range of possible futures in a risk-free environment.

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Trend Forecasting as Derivative Control

This paper revisits the use of trend forecasting in driving policy in social systems by comparing it with derivative control in classical control theory. While both processes involve use of trend to determine policies for achieving reliable performance, the outcomes of the former have considerable variability while those of the later can create improvement in performance with certainty. The similarities and differences between the two processes are discussed and guidelines suggested for improving the efficacy of trend-forecasting in policy design in social systems.

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The Dynamic Impact of the Cost of Doing Business on SME's in the Economy of Egypt

This research deals with the problems still constraining the private sector in Egypt such as complicated and costly rules and entry regulations. The research concentrates on legal requirements that need to be met before a business can officially start the operation, the official cost of meeting these requirements, and the minimum time it takes to meet them if the authorities do not delay the process. One of the major problems that face SME's is that they take a very long time and pay high fees to get registered and start the business "legally". A recent study published by the World Bank based on few indicators measuring the smoothness of starting a business in 155 countries, placed Egypt in the rank 115. Normal procedures such as registering the company, issuing licenses, paying taxes and even closing the business take, in other parts of the world, much less than what they take in Egypt. All these regulatory "barriers" - so called procedures - allow the creation of "unofficial economy" or the "informal economy". The informal economy has very negative impacts on Egyptian economy. In other words, the Egyptian government loses a substantial share of its income due to this informal sector.

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Tehran Water Resources Management ; Using System Dynamic Approach

1 Abstract: The growing Population and scarcity of fresh and clean water in Tehran is the most important issues facing the Water Resources Management in this city and neighboring region. Despite the growing attention to a chronic

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crisis in Tehran water resources our Ability to correctly assess and predict the trend of demand and the water availability and balance is still quite limited. For better understand and predict the Tehran Supply and Demand condition a System Dynamic model is developed and used to assess the balance of sources and sinks and also the state of water storages and the degree of water supply reliability. It has shown that there is a strong relationship between the reliability of water supply and the following parameters: • Population growth which its main source is immigration. • Demand Management • Supply management The immigrant in Tehran is due to the attractiveness of Tehran. In the demand management side, the average consumption rate in Tehran is about 350 l/d per person which is very high. For the supply management, the water transfer from other basin after observing all criteria as well as optimization of water potential in Tehran water shed should be studied.

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Extending eigenvalue analysis to nonlinear models via incorporating higher order terms of Taylor series expansion

This paper is a concept paper about a suggestion proposed by Nathan Forrester, in the last year conference to extend eigenvalue analysis to nonlinear models. His idea was to consider higher order terms of the Taylor series expansion when approximating nonlinear models. In this paper, we demonstrate the feasibility of Nathan's idea. The main contribution of this paper is to devise a pragmatic approach to solve the resulting equations of Taylor series expansion. This pragmatic approach is based on our novel concept of 'smoothed Jacobian' matrix, which is computed from both the ordinary Jacobian matrix and the set of Hessian matrices. Recall that the elements of the ordinary Jacobian matrix represent slopes of relationships, while the elements of the Hessian matrices represent curvatures of relationships. So by integrating the elements the ordinary Jacobian with the elements of the Hessian matrices, we are actually smoothing the slopes given the knowledge about curvatures. Consequently we are smoothing the time trajectories of eigenvalues and eigenvectors in nonlinear models.

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The Good, the Bad and the Mediocre: Creating Insightful Stories on Process Improvement

Building upon previous work in the field of system dynamics, a generic model of multiple improvement programs is outlined. The model is used to create insightful stories on success and failure in process improvement initiatives. The simulation experiments reveal that plants should strive for implementation patterns that focus on programs exhibiting higher organizational complexity rather than technical complexity. Furthermore, the simulation analyses provide insights in the interplay between organizational learning, program commitment, and process improvement. The value of the conducted approach lies in the explicit investigation of the impact of varying improvement program patterns on plant performance.

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System Dynamics Models for Generation Expansion Planning in a Competitive Framework: Oligopoly and Market Power Representation

This paper proposes several alternative methods to improve system dynamics models used in the literature for generation expansion planning in liberalised electricity markets. Concretely, these methods provide a better representation of oligopoly structures and market power. These improvements focus on market price and productions calculations, future markets modelling and companies' differentiation when deciding new investments. The methods presented in the paper are based on equilibrium approaches and credit risk theory.

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Conceptualization and formulation of a UK health and social care system using System Dynamics

The UK health and social care systems are continuously changing over time. Other authors have previously put a strong case for usage of system dynamics (SD) in this area largely because SD address issues of system complexity and identification of feedback loops, resulting in a greater insight into this problem situation. This paper presents research carried out in two areas of SD, firstly the conceptualizing of a problem and secondly the building of a SD model related to the dynamic problem of ''bed blocking'' in the UK health and social care domain. A case study approach has been applied to a hospital discharge department and elderly wards in a main UK hospital. This paper provides a useful insight into issues that have occurred when conceptualizing and formulating a health and social care SD model. System behavior has been discussed as has the use of causal loop diagrams and stock and flow diagrams. Causal loop diagrams and stocks and flows have shown to play a useful part in overcoming SD difficulties. SD has proved to be a useful method in helping to gain an insight into the dynamics of a health and social care system. This is a preliminary paper, future papers will expand on this to look at policy experiments and sensitivity tests.

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A System Dynamics Approach to Analyzing Violence, Death, and Displacement in Darfur

This paper presents a System Dynamics approach to analyzing the violence and widespread death and displacement in Darfur, Sudan, as observed since 2003. We lay a foundation for using simulation to investigate the underlying

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structure and effects of violence; model analysis indicates that presently the dynamics may be driven by the population at risk more so than aggressor intent. This model can aid in future policy analysis and establishes a foundation for using System Dynamics to understand the structure and pattern of genocide. We present several challenges to analyzing the Darfur crisis including observability, information delays, and the choice of metrics. Finally we discuss modeling results and options for intervention and propose several policy questions and areas for future research.

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Incorporating Delays in the Decision-Making Interface: An Experimental Study

Delays are one specific factor contributing to misperceptions of dynamics. An experimental study was conducted to investigate how different representations of delays in the decision making interfaces (DMIs) may affect people's ability to manage and understand a dynamic system. A simple production-inventory management game was developed with four distinct DMIs, each featuring the production delay in a different way. Subjects were assigned randomly to use one of the four DMIs and a single-subject, think-aloud experimental protocol was deployed to gather data on the decision making process. No vivid impact of the different representations of the delay in the DMI was observed. However, data gathered through the single subject experimental protocol suggest that the subjects do not follow the anchoring and adjustment rule proposed earlier (see Sterman 1989). Rather, they develop a simplified decision rule that is not robust to changes in the task settings but that is successful in the context of the particular experimental task.

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CO2 Abatement and Trade with Economic Growth in the Long Term: Experimental Analysis

So as to stabilize the atmospheric greenhouse gas concentrations at tolerable levels, global emissions should dramatically be reduced soon within this century. To achieve this end, a long term global cooperation and developing country participation is essential. In this paper, we take the "Contraction and Convergence" framework first proposed by the CSE of India as one possible treaty and investigate the long term abatement and trading behavior of countries with economic growth. Dynamic simulation based economic experiments is the method. Seven countries with potential buyers and sellers trade permits in the global market for 25 years. For each simulated year, asks and bids of the countries /regions are collected and permit prices are set at the equilibrium price. In the first treatment, annual national quotas expire each year and the countries cannot save their allowances. In the second treatment, the countries are allowed to transfer quota surplus /deficit up to 30 /20 percent of their annual emissions to the next year. One hypothesis is that, neither the developed nor the developing countries will make sufficient timely reductions and they will create unanticipated costs for their economies as the quota prices increase over the years. An implication of this result is global cooperation being threatened under more stringent reduction requirements and increasing costs of compliance.

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Causality and diagrams for system dynamics

Polarity and causality are important concepts but have not received much attention in the system dynamics literature. The great effort it takes students to properly understand them has motivated this inquiry. In the framework of a conceptual model of interacting with complex systems, several cognitive tasks are proposed. This paper concentrates on one of them that deals with causal links' polarity. An examination of other approaches that deal with causality and use more or less similar diagram languages shows that usually causality is only very broadly defined, and where it is operationally defined, this is done with respect to events rather than behavior. In contrast to these approaches, system dynamics is about behavior rather than events. We then revisit the traditional criticism of causal loop diagrams and show a way out, but add two new criticisms related to the inability of causal loop diagrams to address behavior: in fact it seems that they are closer to the event-related definition of causality. Also, the impossibility to execute them in simulations means that executable concept-models are to be preferred: they express important information a causal loop diagram cannot represent and on top of it they render the behavioral consequences visible (as opposed to the events).

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Educational quality and equality – why are they so hard to reconcile?

Since the '50s, there have been voices that governments should cease to operate schools and limit themselves to financing it via a voucher system and controlling schools' compliance to quality standards. In the early '80s, this has been implemented in Chile. There are three types of schools: private ones freely charge fees, private subsidized that have a limited fee and public. The quality and equality of the school system fall short of expectations. This paper proposes a qualitative model to explain what is going on. Families are assumed to prefer higher performing schools, teachers prefer better labor conditions and schools prefer favored pupils and better teachers. Richer schools attract more favored families that enable improved results due to the favored-pupil effect; additionally their ability to charge higher fees allows them to attract the best teachers, which further enhances their advantage. We find 5 positive feedback loops. The result is a process of concentration of favored pupils and good teachers that increases inequality. It is concluded that there are unequal conditions amongst the types of schools, and as long as they persist, no initiative in favor of more equality will succeed.

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A Spatial-Dynamic Model of Introducing Bioenergy Crops in Illinois

Growing concern about climate change and energy security has led to increasing interest in developing domestically available renewable energy sources for meeting the electricity, heating and fuel needs in the United States. Illinois has significant potential to grow perennial grasses that can provide bioenergy. Recent research on miscanthus has shown that this low-input perennial may have biomass yields that are twice that of switchgrass

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and corn. Land requirements from growing biomass crops compete with existing profitable land uses, which in the case of Illinois, is primarily in row crop agriculture. This study examines the conditions of switching land from row crops to energy crops which are expected to vary across the landscape in Illinois, depending on soil quality and climatic conditions. To find the optimal land allocation among competing uses we will use spatial dynamic modeling tools combined with data from Geographic Information Systems (GIS) on land quality, climate and land use. The Spatial Modeling Environment (SME) allows inclusion of spatially enabled dynamic models to combine system-dynamics and agent-based modeling approaches. Four major crops are compared, including corn, soybeans, miscanthus, and switchgrass.

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Decision Patterns of Inventory Control Based on a Learning Lab with the Supply Net Game

The essay attempts to estimate the value of aggregating a simulation game for inventory control, namely the supply net game, and a systems thinking intervention through the left-hand column (LHC) method. By value it is meant the performance of the subjects in respect with the deterministic task of inventory control. Particularly, people's performance is measured by the mean marginal inventory costs. A novel application of the left-hand column method is reported. The experimental design and methodology showed that a significant difference exists between the mean of every individual team, which had had a mental model elicitation with LHC before it played the simulation game, and that of the quasi-optimal heuristic of anchoring and adjustment. On the basis of these preliminary results, it cannot be inferred that the learning lab affects the performance of the students. However, these outcomes must be verified by further work encompassing qualitative and quantitative enhancements to this experiment. The learning laboratory offers a number of team and individual learning perspectives.

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Intercollegiate Athletic Departments Performance Assessment

Like other organizations, United States intercollegiate athletics departments face the challenge of operating efficiently and effectively. Performance measurement in this environment is made more challenging by the need to be successful both on and off the playing fields. With its focus on structural performance contributions, system dynamics modeling works well with data envelopment analysis, which is focused on input-output relationships, to provide a more complete understanding of performance measurement and assessment. This combined understanding supports policy analysis that contributes to performance improvement opportunities. This research outlines the success achieved by linking these two approaches, even with the system dynamics contribution limited to a qualitative model.

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Modeling Risk Classification Scheme for System Dynamics Modeling

System dynamics modelers face a broad spectrum of risks toward achieving project objectives. As they gain experience, their risk identification and management capabilities increase. By applying classification techniques from taxonomy development, the collective knowledge of previous modelers has been captured in a classification scheme for system dynamics modeling risks. The classification scheme allows modelers to more efficiently and effectively consider modeling risks by reducing the variation in their knowledge levels. The classification structure is focused on the steps of the system dynamics modeling methodology and the achievement of system knowledge and improvement objectives. As part of a broader modeling risk management approach, the risk classification scheme assists modelers in identifying and prioritizing the anticipated sources of modeling risks for a project. With that knowledge, they can more effectively identify the appropriate techniques for managing risks and then efficiently apply those techniques in a timely fashion through the entire project cycle.

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The Complexity Challenge: A Case for Model-based Management

The purpose of this paper is to present a case study which illuminates the role of dy-namic models as enablers of better general management in the face of complexity. That role is usually accounted for either by the logic of the models or by the process of building them, namely in group model-building. Here, the relationship and interaction of the two, model logic with modeling process, is considered. We maintain that the conceptual understanding of managers is the crucial lever for better management. Our focus is on the role of models in improving such understanding. The empirical base and object of reflection is a large case study from an ultra-complex firm, where a model building and training venture was carried out. The main concern which aimed the project was to facilitate the ability of managers to cope with complexity and to enable effective organizational change. The venture enhanced both the systemic view and awareness among participants of the project, and therefore proved to be a good investment in management quality. In essence, it was an impor-tant move toward model-based management. A core group had been captivated by the power of systemic thinking in general and the use of models in particular. A seed had been sown.

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Effects of naïve personnel policy on the value of human capital

Strategic Human Resources Management (HRM) is a crucial factor of companies in which knowledge plays a vital role. But Germany's shrinking and aging population and their effects on the labor force potential within the next 10 to 15 years seem to be ignored by HR managers. Layoffs are still common practice and even early retirement schemes were common a short time ago. Supposably, managers do not have informative tools neither to

evaluate ex ante specific HR strategies nor to forecast the development of stock and age structure of their workforce by simultaneously taking into account the intrasystem complexity and dynamic. This case study in progress elaborates on the underestimated effects of employee fluctuation and different recruiting policies on the value of human capital in conjunction with a detailed aging chain. The author uses the feasible 'Transparent Human Capital Valuation' approach to assess this human capital value and implements the approach as a co-flow within the system dynamics model. The promotion of an applicable and holistic HRM tool is both a contemporary and overdue issue.

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The Climate Bathtub Sim: An Interactive Simulator to Teach Stock-and-Flow Mechanics of Global Warming

Experimental studies have demonstrated that even highly educated people do not understand stock-and-flow dynamics. Such misperceptions are currently having potentially disastrous effects in the area of climate change policy, where very few non-technical experts yet grasp that stabilizing carbon in the atmosphere will take a massive (50-80%) reduction in emissions in the coming decades. In order to correct such misunderstandings and to support a more grounded public discourse on the speed and scale of response needed to the threat of climate change, a diverse team has constructed an interactive, online simulator for the general public that includes an animated bathtub, so that the learner may experiment with different policy approaches to stabilize atmospheric carbon dioxide. Although extremely simple, the aim of fostering broad, intuitive public understanding has been neglected by more complex climate change models. This presentation will briefly demo the "Sim" and explore the learning theory that undergirds it and the planed series of "freeware" climate simulators.

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A Systems Dynamics Model of Fish Populations in Western Lake Superior

Lake Superior's fishery resources have been subject to management control for more than a century. A goal of achieving stability of fish populations has been elusive. Present goals stated by management authorities have been expressed as hopes of achieving "fish- community objectives", some of which may be impossibly exclusive in practice. A system dynamics model of major predator and prey fish populations of Western Lake Superior is discussed and demonstrated. Model simulations of fish population changes

are compared to historical estimates. Model-implied results of alternative management policies are explored. Experiments applying past and alternative management policies indicate that a policy of reducing current high rates of predator stockings together with moderately increasing predator harvestings would contribute to long term population stability among both predator and prey fish populations of Lake Superior.

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Development of a Human Resources Transition Simulation Model in Slovenian Armed Forces

The paper describes development of a continuous and discrete model of human resources transitions in a large organization. The model considers eight different ranks. The calibration of the model was performed where the historical data was used to determine time constants of transitions and fluctuations. Several simulation runs were performed in order to complete predictive validation of the model. Optimization of the model was performed in order to achieve desired structural dynamics. Pattern search algorithm was applied at this stage while considering the key parameters' limitations. By performing the optimization appropriate strategy of the system structural development could be determined. Development and comparison of the continuous and discrete event model was performed. The discrete event model was applied in the validation phase. The hybrid approach to the problem provided higher level of confidence. System dynamics methodology proved to be appropriate as the tool for initial development of the model and structural validation reference.

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A system dynamics model about public corruption: the influence of bribes on economic growth

This paper builds a system dynamics model to study the impact of some activities of public corruption on economic growth. The model is articulated around a generic economy in which a public and a private sector take part. The sectors produce different goods using the same available economic resources. Both use labour and could employ different criteria for remunerating their workers. The difference between the private and public wage allows the model to justify the introduction and the persistence over time of public corrupt activities in the economy. The causal structure collects the decisions and the rules of behaviour of the economic agents. It reflects the

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normal economic activities and the interactions between them and the new causal relationships arising from the corruption activities. The feedback processes totally explains why corruption modifies both the public and private production as well as the wealth of some citizens. After formulating the decision rules of the economic agents, calibrating the values of the parameters and the initial conditions of the levels, a simulation exercise is carried out to characterize the growth attained by the economy under different scenarios taking into account different degrees of corruption and different ways for fighting against it.

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What Constitutes Systems Thinking? A review of practitioner views

As we approach the 50th Anniversary of System Dynamics, researchers and practitioners have yet to reach a consensus on the components of systems thinking or a method for measuring systems thinking in individuals. This paper reviews the state of thinking about systems thinking and researcher reports of efforts to assess systems thinking. As the foundation for developing an assessment framework to be able to determine an individual's level of system thinking, we present a review of the literature and the results of a survey administered to participants at the 2006 Systems Thinking and Dynamic Modeling for K-12 Conference, in Marlboro, Massachusetts.

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The Choice Between Grid and Off-grid Electrification in Kenya and its Impact on System Development

This paper explores the dynamics of the development of grid-based electrification compared to off-grid electrification in Kenya. Consumers in Kenya who can afford to use electricity must choose to be connected to the national grid or to purchase a standalone system (usually diesel or photovoltaic generators). This decision is based not on price alone, but on the relative availability and reliability of the options. Although competition usually spurs growth, in this case it appears that the presence of strong off-grid choices may be hindering the development of the grid. If this is the true, energy planners might need to consider policy options which encourage the grid and off-grid markets to work as complements.

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The Value of System Dynamics in the Wider World: an Outside-In View

System Dynamics is no longer new, but its impact on the wider world is still quite immature. Newer technologies have been taken up much faster and more broadly, bringing about huge societal changes. Is System Dynamics

fundamentally different, and do essential characteristics necessarily restrict it to narrower impacts and a slower rate of diffusion? The answers lie in innovation. This paper describes how innovation by practitioners will profoundly change the practice of System Dynamics and its societal impact.

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A preliminary microworld to gain insights in Belgian fishery fleet dynamics.

The objective of this paper is to develop and evaluate a micro-economical microworld which will allow policy makers to gain more insight in parameters that influence the Belgian fishery fleet structure. In a later stage, this microworld may contribute to the process of developing a long-term strategy for the Belgian fishery sector, serving as a laboratory for ex-ante evaluation of possible strategies. (Keys, Fulmer, and Stumpf 1996; De Geus 1997) By visualizing decisions and strategies (Morecroft 1999), it generates insights about fleet dynamics in response to a changing environment and policy changes.

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Does a Balanced Scorecard Management Cockpit Increase Strategy Implementation Performance?

In various articles and books, Kaplan and Norton maintain that use of a Balanced Scorecard (BSC) will increase an organization's ability to execute its strategy and therefore ultimately improve its performance. They substantiate their hypothesis with numerous cases for which they report "breakthrough performance". Nonetheless, published empirical evidence for the BSC's positive impact on performance is sparse. This article aims to contribute to the empirical research on the BSC's performance impact describing a laboratory experiment. Using a computer-based feedback-rich micro-world, the subjects were placed in a top manager position. Their task was to implement a given strategy as best as they could, which meant to translate strategy into operational decisions over a period of 10 years. The experiment group was equipped with a BSC management cockpit that was carefully tailored to the strategy, while the control group had to rely on traditional reports as information source. The experiment data are used to test

the hypothesis that subjects provided with the BSC cockpit perform better than the control group. Statistical analysis shows that this hypothesis could not be rejected. The BSC cockpit indeed had a positive impact on performance. Some possible explanations for this finding are discussed and issues for further research are outlined.

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From stylized facts to multiple mechanisms: diffusion analysis of past and present alternative fuel introductions

Contrary to S-curve diffusion theory, historical introductions of alternative transportation fuels (ATFs) exhibit a variety of adoption patterns. Analysis of ATF introductions in the market place of natural gas in Argentina and New Zealand and ethanol in Brazil reveals that the aggregate dynamics cannot be traced back to a single dominant mechanism of change. ATF diffusion embodies several coevolutionary processes, including: the development of the vehicle installed base, consumer preferences and driver behavior, the evolution of technology and complementarities, such as a fueling infrastructure, and the transformation of fuel and automotive supply chains. Further, their diffusion is conditioned by institutional contexts. A behavioral dynamic model with a broad system boundary helps understanding failures and successes of ATF diffusion. While successful diffusion, such as promised by the Brazil case, is possible, the analysis reveals complex dynamics, requiring long periods of commitment and coordination across various types of actors. The paper develops initial steps towards a framework for studying the rich dynamics of socio-technical systems change. Central in such a process based framework are the mechanisms within interorganizational fields, capturing decisions and actions from consumers, organizations across industries and policymakers, and including the system-physiological aspects. We discuss implications for policy and strategy.

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System Dynamics in K-12 Education: Lessons Learned

Fifteen years ago, Jay Forrester laid the cornerstones for a more effective kindergarten through 12th grade (K-12) education based on system dynamics. In this paper, teachers and other educators who have been implementing system dynamics and systems thinking in schools across the United States reflect on their progress. Although all of the educators have been encouraged and inspired by student engagement and insight using system dynamics in their classrooms, wider adoption has encountered obstacles. Strategies to overcome them include: improving the quality and quantity of system dynamics curriculum materials and training opportunities for teachers, integrating the use of systems thinking tools with system dynamics simulation to give students the full benefit of both, seeking ways to work within the K-12 institution to effect change, and working together to learn from successes and mistakes.

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Managing the Transition toward Self-Sustaining Alternative Fuel Vehicle Markets: Policy Analysis Using a Dynamic Model

Designing public policy and industry strategy to bolster the transition to alternative fuel vehicles (AFVs) is a formidable challenge as demonstrated by historical failed attempts. The transition occurs within a complex system with many distributed actors, long time delays, several feedback relationships, and multiple tipping points. A broad-boundary, behavioral, dynamic model with explicit spatial structure was previously developed to represent the most important AFV transition barriers. In this work, the integrated model is parameterized for various vehicle platforms. Structural and parametric sensitivity analyses are used to build understanding of system behavior and to identify policy leverage points. The qualitative impacts of policies are tested individually and then in combinations to find synergies. Under plausible assumptions and strong policies, successful AFV diffusion can occur but requires several decades. Findings indicate that some commonly suggested policies provide little leverage and are quite costly. The analysis demonstrates the importance of designing policy cognizant of the system structure underlying its dynamic behavior. To reach a self-sustaining market, coordinated portfolios of policy instruments must simultaneously foster the development of consumer familiarity, well-distributed fueling infrastructure, and vehicle manufacturer knowledge at similar rates and over long enough duration to surpass thresholds in these complementary assets.

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Incident Learning Systems: From Safety to Security

The complexity of modern networked systems has negative consequences in the form of intended and unintended security incidents. Information security is not the first field to grapple with such challenges. In safety, incident learning systems (ILS) have been used to control high risk environments. Many of these systems, such as NASA's Aviation Safety Reporting System, have demonstrated considerable success while others have failed. Prior to implementing ILS in information security, it is prudent to learn from experiences gained in safety. We use System Dynamics to investigate how factors such as management commitment, incentives, recriminations and resources affect a safety incident learning system. We find that the rate of incidents is not a suitable indicator of the state of the system. An increasing or decreasing incident rate may both be caused by either increased or decreased security. Other indicators, such as the severity of incidents, should be used.

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Managing Risk in Alternative Energy Product Development

We will explore how to value using modern financial techniques the development of new alternative energy technologies (AETs) given uncertainty. Uncertainty in developing AETs derives from: (1) the reduction in installation cost of new generation capacity as experience with the technology is gained, i.e. the learning curve (2) oil and natural gas price cycles; and (3) other macroeconomic and geopolitical forces, particularly the behavior of national oil companies (Aramco, PDVSA, PEMEX, etc.). Evaluating a new AET properly requires representing these uncertainties as well as an investment valuation approach that works well under high uncertainty. In particular, we propose to adapt the real options methodology to value the potential return from developing AETs using stochastic system dynamics models representing the uncertainty in both the learning curve and the fossil fuel price cycles.

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Network Bandwidth Estimation: A System Dynamics Approach

In this paper, we propose a new approach to network bandwidth estimation based on System Dynamics modelling. The paper discusses existing approaches to bandwidth estimation and network capacity planning. Limitations of these approaches are presented and the case for using System Dynamics is made. Applicability of the proposed approach is demonstrated through a real world network planning project for a distributed logistics application. A practical computer simulation model was developed to predict bandwidth requirements for the project's network. This model provides system planners with the ability to test different possible scenarios in order to make informed decisions about the system architecture. We show through practical results of the simulation runs and the insights gained during the process that the System Dynamics approach offers an effective solution to the problem of network bandwidth estimation and system planning. The paper concludes with a review of the results and pointers for further research.

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The Dynamics of Software Testing

In the modern information based society, failure of software systems can have significant consequences. It has been argued that increased attention to testing activities during the software development process can mitigate the probabilities of system failure after implementation. However, in order to justify investments in improved testing, the economic impacts of improper testing should be identified. In this paper, we propose a systematic approach to the evaluation of the economic impacts of software testing. The main factors affecting software testing are identified, and a computer simulation model is developed to investigate different testing scenarios. Usefulness of

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the suggested approach is demonstrated through several exploratory simulations. The results prove the utility of the System Dynamics modelling approach in building better understanding of the impact of software testing. Implications for software development practitioners, researchers, customers of software products and software support organisations are also discussed.

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Using Feedback to Conduct Crowd Control

Crowd Control is a function generally associated with the police more than the military. However, the Canadian Forces are occasionally asked to intervene in riot situations either in Canada, in support to Federal, Provincial and Municipal Governments, or overseas, during Coalition operations. Thus, there is a need to understand crowd behaviour and to determine optimal intervention strategies for crowd control. The Canadian Forces have skills and resources that might be called upon if a situation gets out of control and must be prepared to deploy on short notice. A model has been developed that can be used to understand these events in the time dimension both inside the event and from event to event. The model has been developed theoretically and "face validated" using data from two case studies. The model is required to evaluate appropriate tactics such as the employment of non-lethal weapons, and as a training simulator for strategic and tactical commanders.

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Project Controls to Minimize Cost and Schedule Overruns: A Model, Research Agenda, and Initial Results

System dynamics has been successfully applied to the study of projects for many years. While this modeling has clearly defined the structures which create project dynamics, it has been less helpful in providing explicit policy advice to managers. To address this gap, we examine the effectiveness of three common project controls available to project managers to address deviations in project performance; (1) exerting pressure on project staff to work faster, (2) having staff work overtime, and/or (3) hiring additional staff.

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While the three project controls can have short-term benefits for project performance, their long-term impacts can be detrimental. The current work presents preliminary results of the research, focusing on the impacts of the three project controls on project rework and schedule performance. The work describes the development of project control feedback structures, the initial testing and use of a formal system dynamics model of the system, and preliminary results. The work concludes with a description of future project research efforts.

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Model Analysis Using Statistical Screening: Extensions and Example Applications

System dynamics models are often constructed to improve system performance by identifying and modifying feedback mechanisms that drive system behavior. Once identified, these feedback mechanisms can be used to design and test policies for system performance improvement. A preliminary step in developing policies is the identification of high leverage parameters and structures, the influential model sections that drive system behavior. The current work clarifies and extends the use of statistical screening (Ford and Flynn, 2005) as a model analysis tool with a six step process that identifies specific model sections for further analysis and development. The work also presents a method that clarifies the results of model analysis with statistical screening to practicing managers Statistical screening offers system dynamicists a user-friendly tool that can be used to help explain how model structure drives system behavior.

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Chaotic Behavior in a Modified Goodwin's Growth Cycle Model

Goodwin's "A Growth Cycle" [1967] represents a milestone in the non-linear modeling of economic dynamics. In terms of the two variables "wage share" and "employment rate" and on the basis of few simple assumptions, the Goodwin Model (GM) is formulated exactly as the well-known Lotka-Volterra system, with all the limits of such system, in particular the lacking of structural stability. A number of extensions have been proposed with the aim to make the model more robust. We propose a new extension that: a) removes the limiting hypothesis of "Harrod-neutral" technical progress: b) on the line of Lotka-Volterra models with adaptation, introduces the concept of "memory", which certainly plays a relevant role in the dynamics of economic systems. As a consequence an additional equation appears, the validity of the model is substantially extended and a rich phenomenology is obtained, in particular transition to chaotic behavior via period-doubling bifurcations.

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Do school students learn more about the environment from a system dynamics model by themselves or with a partner?

As part of the first author's PhD project, year 9 and 10 students were given a system dynamics model of the impacts of visitors on a National Park. The students were given a pre- and post-test to determine whether their knowledge of the environment changed. Students were randomly assigned to either the individual learning condition (students interrogated the model as individuals) or the collaborative learning condition (students interrogated the model with one other student). There was a significant increase in the environmental knowledge score for those students in the collaborative learning condition, but not in the individual learning condition. The implications of this finding for the use of system dynamics models in educational settings are discussed.

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A Research on Systems Thinking Based on Three Dimensions Thought

Nowadays, the performance measurement system has been well developed. And the relations between these performance measures are playing important roles in management science. However, the effective method to analyze these relations is still underdeveloped and attracts more and more concerns. After reviewing relevant research, by adopting and further extending the essential theories of Systems Thinking, we propose a three-dimensional Systems Thinking to achieve better analysis, control and decision-making. In this paper, the rationality of the three-dimensional thought is proved first, and the modelling method is then provided in theory. Finally, a manufacturing enterprise is illustrated as an example for practical implementation.

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System Dynamics: Publication Metrics (2000-2005)

System Dynamics (SD) would like to increase its influence and promote its professional approach to understanding and solving significant problems. This paper attempts to capture a snapshot of SD research topics, and publications 2000-2005 as a metric of the scope of SD domains and publication venues. The questions addressed by this paper follow: What are the frequently published topics? What may be the emerging topics? Where do SD authors frequently publish? To this end, 35, 920,686 documents were search. Of the total, 935 met the search criteria. After review and analysis of the 935 documents, only 302 qualified as relevant SD material for further analysis.

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The Problem of Delayed Discharge in Labor and Delivery

Enloe Medical Center is a non-profit community hospital in Chico, California. Among the many services they provide is a Labor and Delivery Department. While mothers are routinely admitted from 1:00pm to 1:00am, they are generally discharged between 10:00am and 5:00pm. This results in a generic bell curve behavior pattern for patient occupancy during the daytime. Hospitals are reimbursed for inpatient services in two major ways: either on a per diem basis, or by diagnosis related groups (DRG). Either way, the revenue to the hospital remains the same, regardless if the patient is discharged at 4:00am or 4:00pm. In California, state mandated nurse to patient ratios require hospitals to maintain a minimum level of nurse staffing for inpatient services. Thus, as the patient census rises during the day, so must the number of nurses on staff. This is the problem studied; costs expended for patient discharge delays.

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A System Dynamics Approach to Strategic Assessment of Transportation Demand Management Policies: Tehran Case Study

Transportation Demand Management has proved efficacious where increasing transportation supply seems ineffective or financially infeasible. Demand management comprises a wide range of policies most of which are different in nature. Assessing impact of various strategies in Transportation Demand Management and developing a system dynamic model to compare diverse policies are the main outcome of this study. Investigating impact of TDM strategies in Tehran and their impotence specifically in encouraging private vehicle users to use public transportation is the focus of this paper. Visualizing prospective changes in share of these different modes of transportation and presenting potential strategies towards achieving TDM goals are included to substantiate effectiveness of the approach.

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MARVEL - principles of a method for semi-qualitative system behaviour and policy analysis

Obtaining insight into the effects of policy interventions is often a difficult matter. A new method to obtain a first insight into those effects is presented in this paper. The basis of the method is a Causal Loop Diagram to which information on causal relations and variables is added. Part of the information is expressed in qualitative terms. This Method to Analyse Relations between Variables using Enriched Loops (MARVEL) takes proposed interventions as a starting point. Interventions are interpreted as imposed changes on selected model variables representing intervention points. A new feature is that causal relations are no longer passive but active model elements. They propagate the

changes through the model in a time-dispersed way. MARVEL determines how this causes (other) variables representing the model's performance to change in the desired direction at selected moments in time. MARVEL can be used for policy development, policy analysis and policy evaluation problems.

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An investigation into Electricity Subsidy Dynamics by a System Dynamics Approach

After the Islamic Revolution in 1979, Iran had to face another challenge: the war against Iraq. This challenge forced the government to help people by granting subsidy to essential goods such as bread, drugs and different kinds of energy - especially electric power which is one of the major industries in every country. This policy helped people have an easier life during the war, but as the famous law of supply – demand tells us, the lower the price of any good, the higher demand for that good is predicted and this low price of energy made Iran one of the most and worst energy consumers in the world. This high rate of consumption will cause lots of problems such as lack of electricity and financial pressure on the government. In this paper, a system dynamics model is developed to simulate the situations of Iran's electric power industry since 15 years ago, assuming the effect of people's pressure on the government and the pressure of the government to decrease subsidy. The main model is built on two positive and negative loops and the results are compared with the real statistics. Then, two policies are applied to the model: education and increasing the price.

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System Dynamics and Philosophy. A constructivist and expressivist approach.

Theoretical reflections about System Dynamics (SD) have usually been grounded in the developments of what can be called "general philosophy of science". In our paper, a philosophical approach more sensitive to the peculiarities of SD is proposed that is closely linked to the recent constructivist proposal of John Searle and to the expressivist theses of Robert Brandom. We will focus on three very important conceptual problems –the ontological problem of realism concerning the structures postulated by SD models, the epistemological problem of the explanatory power of SD models, and the methodological charge of merely producing a kind of "patchwork" when building of SD models--, arguing that by combining the constructivist and expressivist philosophical perspectives of those authors in a certain way would offer a better understanding of scientific and technical activities such as SD modelling.

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A System Dynamics Approach to Improving An Advising System for Business School Undergraduates

A School of Business located in the northeast United States annually administers the AACSB/EBI Undergraduate Business Exit Survey to all its graduating seniors. One area that has consistently received low marks has

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been advising. The Associate Dean of the Business School wanted to address the situation and see how the system could be improved. Through interviews with the Associate Dean and the advising staff, a consulting team compiled information about the system and identified the major problem as congestion in the system. Recommendations included changing the criteria for students required to use the system, simplifying the curriculum, better promoting the advising function to students, increasing the use of automated advising tools, expanding the length of the advising period, and adding advising staff or having faculty do advising. So far, the School of Business has adopted only one of these recommendations—curricular simplification—which may improve the situation as time passes. The School is currently examining other options, especially changing the criteria for required advising and having the faculty get involved in advising.

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Leukemia Dynamics: Understanding the Mechanism of Stem Cell Transplant for the Chronic Myelogenous Leukemia (CML) Treatment

Leukemia progresses through certain phases starting with slow progressing phases, following in the stability, than transition to acute phase, where there is no more control on the disease. The types of leukemia are grouped by how quickly the disease develops and gets worse. Leukemia is either chronic (gets worse slowly) or acute (gets worse quickly). Treatment depends on a number of factors, including the type of leukemia, the patient's age, whether leukemia cells are present in the cerebrospinal fluid, and whether the leukemia has been treated before. It also may depend on certain features of the leukemia cells. Depending on the type and extent of the disease, patients may have chemotherapy, biological therapy, radiation therapy, or bone marrow transplantation. The objective of the current research is to address the dynamics of Leukemia's development with the attempts to understand how does the body respond to different type of treatment.

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Leukemia Dynamics:The Role of the Immune System against Chronic Myelogenous Leukemia (CML)

Nowadays, the definite cause of leukemia is still a mystery, certain factors are known to increase the risk of developing the disease like radiations and other factors. There is no way to predict or prevent leukemia. The types of leukemia are grouped by how quickly the disease develops and gets worse. Leukemia is either chronic (gets worse slowly) or acute (gets worse quickly). There is an abundance of evidence that the immune system plays a critical role in the control of (Chronic Myelogenous Leukemia) CML but the exact mechanism of action remains unclear A mathematical model for the human immune system's response to CML in a hypothetical patient will be proposed with the purpose to help identify promising directions for experimental research on treatments for patients with CML.

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Modeling Fishery Regulation & Compliance: A Case Study of the Yellowtail Rockfish

Motivated by declining fish populations and the apparent inability of regulatory agencies to manage important fisheries, this research measures the accuracy of a fishery model that explicitly models the regulatory process and the resulting degree of compliance by fishers. The method involved careful review and enhancement of a prior model with a more limited regulatory sub model,and then measuring, for both models, the mean absolute error of model calculated values for historical spawning biomass, acceptable biological catch, and harvest. The most recent five years of data were held back so that model prediction error could also be computed. Results indicated that although the fitness error for the enhanced model was significantly less than the prior model (23% vs. 38%), predictions were improved only for one of the three measures. The implications for researchers seeking to endogenously model fishery management processes are sobering. Policy makers on the other hand will likely see the results as support for their instinctual skepticism regarding policy models.

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Window of Opportunity to Grow in Internet Economics: Explore the Growth Dynamics of Taiwan's Online Game Industry

In this paper, we use the system dynamics approach to build up a model about the growth dynamics of online game industry in Taiwan. With the system dynamics model, it is found that there once existed a short period time, which is referred to as "the window of opportunity" in this paper, for Taiwan's domestic online game industry to grow. The window of opportunity was shortly open when Taiwan's online game market started to grow. However, insufficient R&D capability and time delays in expanding R&D capacity and game development process led to the waste of the market opportunity. The market as a whole got saturated so quickly that agents, potential industrial entrants, and off-line games providers are no longer interested in developing domestic online games. To system dynamist, the analysis of temporal equilibrium between different sets of forces, instead of analyzing individual loop gain, can be an interesting direction for system re-design and improvement.

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Standard Business Architectures for Engaging Management

System dynamics professionals have sought 'standard' models for tackling business issues. Finding similar structures in different contexts encourages the idea that modelling efficiency would increase if it could start with part-built models. On the other hand, since each situation is unique, modelling should arguably start with an open mind and develop a structure specific to

that situation to avoid the risk of imposing an inappropriate diagnosis and solution. Nevertheless, organisations of similar types consist of similar stocks of resources – e.g. retailers have stores, consumers and products, consulting firms have clients and professional staff. Moreover, those resources often go through recognised stages of development and relate to each other in standard ways. These common resources and structures provide a robust foundation for models, and enable discussion to move on quickly to investigating why resources are being won or lost, discovering feedback effects whose existence is supported by evidence, and solving the real challenges. This has the further advantage of leaving a model of how an organisation functions that can remain valid (with continuous development) into the future. This poster session will illustrate a number of such common business architectures and their use.

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Connecting System Dynamics with Management Disciplines and Methods

System dynamics practitioners see considerably greater scope for the adoption of their method in many fields than has been achieved to date, and regularly debate how faster adoption might be achieved. Successful interventions seem to depend on recognising the frames-of-mind already shared by the target audience and building on those, rather than portraying system dynamics solutions as fundamentally different – and by implication 'better'. These considerations certainly apply in the management field, where system dynamics continues to struggle for recognition amongst academics, consultants and executives alike. Yet strong connections can be made to some of the theoretical foundations in management subjects, to the analytical methods commonly deployed, and to standard problem-solving procedures. Making these connections explicit might allow system dynamics practitioners to 'start from the same place' when engaging with business academics and practitioners, and thus raise the method's profile and adoption.

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Understanding Recent Developments in Growth Theory

The growth theory has, through the so-called 'endogenous' or new growth theory, taken on decisive impulses. This contribution delivers an overview of the various extensions without going into detail about the mathematical observations and the main focus on supply-side orientated approaches. The main goals of the growth theory are to understand the exponential climb of the population's income or also the per‑capita income and to draw conclusions for policy makers. The paper uses stock-flow-graphs to visualize the major loops. Because changes tend to be incremental I adopt standard textbook models first. All models are used in economic teaching with additional simulation and extensions. Later on students learn to modify those models.

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Application of System Dynamics to Corporate Strategy: An Evolution of Issues and Frameworks

This paper discusses five landmark projects which highlighted issues and produced frameworks that became important building blocks in the application of System Dynamics to corporate strategy. The early models were primarily at the level of the firm. The first model described in the paper captures the tension among conflicting performance objectives and shows how the conflicts impact mid-term company performance. The second model represents the behavior of an R&D organization as it responds to changing pressures and direction from corporate management. Over time the focus shifted to market behavior and competition. The third model explains powerful long-term dynamics that lead to "commoditization" of products and services. Recent work analyzed the social dynamics of markets, e.g., as they affect innovation and technology substitution. The fourth model in the paper represents the fundamental dynamics of innovative industries, building on an extensive body of research and publications. The final model focuses on the market impacts of social factors, e.g., trust, fashion, the characteristics of lead users, how trends are perceived and extrapolated, the flow of information, bandwagon effects, and network effects. The most important lessons are about the critical roles of organizational, social, and psychological factors in important business decisions and competitive behaviors.

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Analysis of Investor Behavior in an Artificial Stock Market

Building upon previous work in the field of behavioral finance and artificial stock markets, a model incorporating discrete and continuous interrelations is developed. Three different investor types are modeled as individual agents: fundamental analysts, technical analysts and noise traders. They differ in their intrinsic pricing mechanism and represent trading strategies that are observed in financial markets. The developed structure is able to reproduce the formation of speculative bubbles and other stochastical anomalies that are characteristic for financial time series.

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The Feedback Method of Teaching Macroeconomics: Is it Effective?

The conventional method of teaching macroeconomics to undergraduates relies on static graphs, an approach with documented pedagogical problems. In contrast, the feedback method uses feedback loop diagrams and interactive computer simulation models. This paper describes the feedback method and reports on four experiments designed to test its effectiveness. Two experiments examined student preferences for methods of learning macroeconomics; for example, using static graphs or a feedback loop diagram. The experimental designs were quite different, but the results were the same—a significant majority preferred the feedback method. The most commonly cited reason: feedback loops enable students to visualize an economic process. The third and fourth experiments addressed the

performance question. In the third experiment, students showed more understanding of GDP when they had access to a stock-and-flow feedback diagram of the economy. In the final experiment, students using feedback loop diagrams displayed more understanding of business cycle dynamics than those who had access to a conventional aggregate supply and demand graph. Teaching undergraduates to search for feedback structure in the economy and using computer simulation to connect structure with behavior appears to be a promising method for teaching macroeconomics.

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A Dynamic Analysis of Organized Crime in Jamaica

In March 2006, the Government of Jamaica engaged the Millennium Institute to assist in the development of a modern planning tool with the capability to integrate relevant sectors of the Jamaican society. An important component of the model is the sector for organized crime behaviour in Jamaica. The purpose of this paper is to explain the development of the organized crime sector within the T-21 Jamaica model and demonstrate the possible utility of system dynamics in facilitating discussions on public policy. The organized crime sector examines the conversion of young, unemployed males living in impoverished, urban areas into gang members and some possible outcomes of this behaviour. The validity of the model is tested by its ability to match Jamaica's historical data for gang-related murders and shootings.Possible interventions are explored with the model suggesting that social interventions would have a more immediate impact on reducing crime rates but increased investment in the security forces would eventually lead to an even greater reduction in crime in the long run.

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The Use of System Dynamics Simulation in Integrated Water Resources Management

In this paper we discuss the use of system dynamics as a methodology with which to address dynamically complex problems in water resources management. Problems in regional planning and river basin management, urban water management, flooding and irrigation exhibit important short-term and long-term effects, and are often contentious issues with high potential for conflict. We argue that system dynamics combined with stakeholder involvement provides an appropriate methodology to address these issues effectively. We trace the theoretical and practical evolution of system dynamics in these areas over the past 40 years. From this review of the literature and selected case studies we identify and discuss a number of best practices and common pitfalls in applications of system dynamics.

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Participatory Methods in Environmental System Dynamics Projects

Today there is widespread agreement that participatory methods are useful if not legally required to understand and effectively address environmental management problems. What participatory methods should be used in which situations and particularly how they should be applied are still insufficiently

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addressed questions. There is limited understanding about the interconnections between project purpose, participatory methods and their application. Participation methods are often selected on the basis of familiarity or cost considerations. We argue that these trade-offs may compromise the potential outcomes and effectiveness of a project. To address these shortcomings we summarise current knowledge and understanding in the public participation literature. System dynamics projects can benefit substantially from public participation particularly through participative modelling. Much research effort focuses on group model building. For projects where group model building is not a prudent choice, we suggest and discuss alternatives.

Reallocating Mental Health Resources in the Borough of Lambeth, London, UK

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This paper describes the application of system dynamics to assist decision making in the reallocation of resources within a specialist mental health trust in south London. Mental health service providers are under increasing pressure to both reduce their own costs and to move resources upstream in mental health patient pathways to facilitate treating more people, whilst not compromising service quality. The investigation focuses on the use of the model to examine the case for converting an existing specialist service ward in a mental health hospital into a 'triage' ward, where patients are assessed and prioritised during a short stay for either discharge or onward admission to a normal ward. Various policies for the transition are studied together with the implications for those patients needing post hospital services and relocation within the community. The model suggests that the introduction of a triage ward could meet the strategic requirement of a 10% shift away from institutional care and into community services. The paper includes a number of statements from the management team involved on the benefits of system dynamics to their thinking.

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The contribution of system dynamics to cost benefit analysis

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This paper presents an example of the value that system dynamics can add to conventional cost benefit analysis. A static cost benefit analysis is described for planning the supply of new mental health services across the UK and the development of this analysis into a system dynamics model is explained. By developing a bigger picture of the issue, both upstream to where patients go after treatment and downstream from where patients originate in the labour market, and by simulation of the enhanced vision, the dynamic cost benefit analysis is shown to advance understanding of the issue and plans. It questions the magnitude of the potential benefit, introduces phasing issues, surfaces structural insights, takes account of the dynamics of the labour

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market and forces linkages between the plan and other initiatives. An overall conclusion is that dynamic factors are often left out of cost benefit analysis simply because they cause too much complexity for decision makers, whereas system dynamics allows these factors to be included without masking the clarity of the case. The paper suggests that cost benefit analysis and system dynamics are very complimentary and should be used together in strategic planning.

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The Role of Systemic Effects on Project Performance in Multiproject Environments

While the focus of the project management literature has been on the management of single projects, the management of multiproject environments is largely neglected. In this research I am focusing on mutiproject environments which exist within a single firm (hereafter called Alpha). Through my investigation in this multiproject environment I explored root causes for project inefficiencies which rather than being possible to attribute to source within each single project boundary, are caused by the effects which I term them systemic effects. System effects are dynamics triggered by the complex linear , nonlinear and time delayed interaction of large number of factors. I develop a model which explains the dynamics through which the systemic effects deteriorate the performance of the projects in this organization. The model is useful in creating awareness among the managers about the lack of holistic approach in decision making and the effects of suboptimum decisions in this environment.

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Balance of Payments and Foreign Exchange Dynamics - SD Macroeconomic Modeling (4) -

This paper tries to model a dynamic determination of foreign exchange rate in an open macroeconomy in which goods and services are freely traded and financial capital flows efficiently for highest returns. For this purpose it becomes necessary to employ a new method contrary to standard methods of dealing with a foreign sector as adjunct to macroeconomy; that is, an introduction of another macroeconomy as a foreign sector. Within this new framework of open macroeconomy, transactions among domestic and foreign sectors are handled according to the principle of accounting system dynamics developed by the author, and the balance of payments is attained. For the sake of simplicity of analyzing foreign exchange dynamics, macro variables such as GDP, its price level and interest rate are treated as outside parameters. Then, eight scenarios are produced and examined to see how exchange rate, trade balance and financial investment, etc. respond to such outside parameters. To our surprise, expectations of foreign exchange rate turn out to play a crucial role for destabilizing trade balance and financial investment. The impact of official intervention on foreign exchange and a path to default is also discussed.

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Improving Maintenance Operation through Transformational Outsourcing

Outsourcing maintenance to third-party contractors has become an increasingly popular option for manufacturers to achieve tactical and/or strategic objectives. Though simple in concept, maintenance outsourcing is difficult in execution, especially in a cost-sensitive environment. This project examines the Full Service business under ABB Ltd to understand the key factors that drive the success of an outsourced maintenance operation. We present a qualitative causal loop diagram developed based on the case study of Kinleith Pulp and Paper Mill in New Zealand. The diagram describes the interconnections among various technical, economic, relationship, and humanistic factors and shows how cost-cutting initiatives can frequently undermine labor relationship and tip the plant into the vicious cycle of reactive, expensive work practices. The model also explains how Kinleith achieved a remarkable turnaround under ABB, yielding high performance and significant improvements in labor relations. A case study of Tasman Pulp and Paper Mill provides a contrasting case where success has been more difficult. Results point to the importance of creating sufficient resources ("slack") to implement improvement activities and pace implementation based on pre-existing dynamics on site.

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Modeling Chinese Steel Industry

This paper uses system dynamics to represent the process of steel-making in China on the basis of statistical data and the analysis of the current industry structure. Simulation results include the projections of medium and long term trends of the Chinese steel industry for the next 50 years. In particular, it reveals the current and potential future problems in the Chinese steel industry, including environmental pollution, production structure, and overinvestment on new capital. It is concluded that restructuring production by substituting BOF with EAF technology, increasing the usage rate of steel scrap and Chinese government's macro control on investment on steel industry, are feasible solutions. Unfortunately none of them can solve all the problems in Chinese steel industry. As a consequence, it is necessary for China to consider environmental protection and sustainable development when boosting its economy.

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Investigation of Impacts of Dynamic Concurrence on Development Project Manageability

Shrinking cycle time with concurrent engineering can make projects more difficult to manage. However, the extent, nature and conditions of the causal relationship between concurrence and manageability are not well understood. This study uses Degree of Concurrence and Degree of Concurrence Relationship Curvature as two measurements of dynamic concurrence based on Process Concurrence Relationship, an improved tool for describing and modeling concurrence, and uses the standard deviation of Process Work Queue Acceleration as Manageability Index to model project manageability.

Single-phase development process model is applied as a data collection tool to investigate the causal relationship between concurrence and manageability. Two hypotheses were developed to test the causal relationship separately with the two different experiments - Linear and Nonlinear. The study finds a significant inverse relationship between degree of concurrence and project manageability with linear concurrence relationship. When the concurrence relationship was changed from linear to nonlinear the relationship became quite unexpected. The results improve the understanding of the causal relationship between dynamic concurrence and manageability.

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Analyze word-of-mouth effect in terms of macro-behavior: The herd behavior in Chinese market

Though world-of-mouth (WOM) communications is a pervasive and intriguing phenomenon, little is known on its effect in terms of macro-behavior. The purpose of this study is to investigate the WOM effect on macro-level marketing to explain the herd behavior of Chinese consumers. To achieve our goal, the system dynamics was applied build a simulation model for a popular herd behavior happening in Macao, Hong Kong, and Taiwan, i.e., buying Portuguese custard tarts. Both micro-behavior and macro-behavior were considered in this model and the linkage between micro-behavior and macro-behavior was specially emphasized. The results showed that the market of Portuguese custard tarts would crash quickly under fast distribution of WOM and herd behavior while considering the limitation of capacity.

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Pattern-based System Design/Optimization

Despite its success and growing practitioner base, System Dynamics (SD) still lacks a strong and rich enough support toolbox, i.e. a set of formal mathematical tools that can support the modeler/practitioner in various stages including model identification, calibration, behavior analysis, policy design and sensitivity analysis. The study presented in this paper is an attempt towards developing such a support tool that can be used for pattern-based parameter search, which may be utilized in model identification, validation and policy analysis stages. The tool mainly incorporates a 2D pattern recognition algorithm and an optimization heuristic in order to search values for selected model parameters that yield a model behavior similar to the desired one in terms of pattern characteristics. The proposed tool is implemented, and a series of test experiments are conducted on three sample models in order to reveal the performance of it. Based on these experiments,

the primary assessment about the proposed method is that its performance is quite satisfactory and it stands as a promising automated parameter search tool, which can be utilized even in the cases where data series representing the desired model behavior is missing.

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Strategic Modelling in a Learning Factory

Within an interdisciplinary research project on "Advanced Manufacturing Engineering" we are currently developing a "Learning Factory" at University of Stuttgart. This project is one of our contributions to the European initiative "Manufuture". So far the first version of the "Learning Factory" has been established. One of its core elements focuses on SD-based modelling. Here students can use simulators that deal with specific problems – like unanticipated side effects of programs for efficiency improvement – and allow them to conduct their own tests and policy experiments. The main purposes of our strategic modelling efforts are to better understand the dynamics of advanced manufacturing systems and to design policies for improving the performance of such systems. Special topics under investigation are: - Intra- and inter-supply chain dynamics and unintended cost effects; - Win-loose versus win-win partnerships in vertical relationships; - Co-evolution of transaction costs and competences caused by outsourcing/offshoring activities; - Adaptiveness of manufacturing systems (when designed as internal and external networks). By modelling and simulating the relationships among the different parts of investigated systems we may identify potential problems, avoid strategic pitfalls, and take steps to better design production systems and to improve their performance.

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A Study of Diesel Vehicle Diffusion in Europe: Calibration and Analysis of a Consumer Acceptance and Adoption Model

While large scale diffusion of alternative fuel vehicles (AFVs) is widely anticipated, the mechanisms that determine their success or failure are ill understood. Analysis of an AFV transition model developed at MIT has revealed that AFV diffusion dynamics are particularly sensitive to consumers' decisions as influenced by social exposure to AFVs. While some empirical research in this area exists, uncertainty in these parameters remains high. Following principles of partial model testing in this paper we report on research that examines the social exposure parameters. We focus on empirical accounts of diffusion involving diesel passenger vehicles in Europe using the historical data of diesel vehicle registrations and installed base in six European countries - France, Germany, Italy, Spain, Sweden and United Kingdom. To complete diffusion data sets we generate synthetic data from 1970 to 2005. Confidence interval testing for model parameters is conducted using the bootstrapping method. The results from the calibrations yield parameters that are in line with other marketing studies and help reduce uncertainty in the social exposure parameters. Further, the analysis suggests applicability of this model for alternative fuel vehicle markets and provides further lessons for other AFV technology transition. We discuss challenges and avenues for further research.

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System-Dynamical Analysis of Mutability, Rational and Emotional Commitment for Explaining Failure to Change in Organizations

There exists a large body of literature on organizational change and on the puzzling effect of change failure. This paper adds the often missing element of combining several reasons for change inefficacy. These reasons for failure to change are low systemic mutability (inertia), insufficient political, rational, and emotional commitment (resistance). Participation and discourse are then presented as one solution to the problem, relieving resistance and enhancing employee commitment.

Plenary Sessions

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Cyclical behaviour in electricity markets: an experimental study

This paper describes a laboratory experiment to study cyclical behaviour of electricity prices in deregulated electricity markets. We observe investment decisions in markets with five-producers, linear demand, and constant marginal costs. The experiment has a four year investment lag and the electricity generating capacity has a life time of 16 years. Oscillatory behaviour results in investment activity and prices. The cyclical tendency is stronger than in previous experimental studies with only one and two period investment lags. Average prices are closer to competitive equilibrium than in previous experiments. The results are consistent with bounded rationality theory; a simple heuristic produces fluctuations similar to those observed when applied in a simulation model. Hence, the results corroborate assumptions made in previous simulation studies.

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Using system dynamics to analyse policy options for tobacco control in New Zealand

This paper outlines a system dynamics model that has been developed to assist the Ministry of Health to evaluate the dynamic consequences of tobacco control policies in New Zealand. The model consists of 4 sectors: population; smoking prevalences; second hand smoke; and tobacco attributable deaths. The model is simulated for 20-30 years into the future. The simulation package used is 'iThink', and a user interface is presented for policy analysis. A range of illustrative scenarios are provided, including: business as usual; fiscal strategies involving less affordable cigarettes; harm minimisation strategies involving either less addictive cigarettes or less toxic cigarettes; and combinations of the above policies. The main output variables (performance measures) include current smoking prevalence, tobacco consumption, and tobacco attibutable mortality. Finally some concluding comments are provided and areas for future model enhancement are identified.

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A Hybrid Approach to the Creation of Dynamic Risk Management Models

Traditionally, system dynamics models are created using the "standard method": A problem is identified, a dynamic hypothesis is generated based on causal loop diagramming and reference mode definition, a stock and flow structure is created to test the dynamic hypothesis, and finally, insights and potential high-leverage policies are identified based on the resulting model. In this paper, a hybrid approach for the creation of dynamic risk management models is introduced by combining system dynamics with the STAMP accident model. The new approach relies heavily on system dynamics concepts and retains the essence of the "standard method", but the structure of the models created is linked to the STAMP safety control structure necessary to ensure safety in the entire lifecycle of complex engineering systems. The main steps of the hybrid method are introduced and the similarities and differences with the standard method are emphasized. An example is provided based on a risk management modeling project performed for the NASA Exploration Systems Mission Directorate (ESMD).

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System Dynamics—the Next Fifty Years

The first 50 years of system dynamics established an introduction to the field, and have shown the promise of achieving a better understanding of complex systems in nature and human affairs. Now the field is on a plateau ready to launch the next thrust forward. We can better understand the present status of system dynamics by comparison to professions that developed earlier. We are now at about the same state of advancement that engineering was when MIT first opened its doors in 1865, or that medicine was in the late 1800s when the Johns Hopkins School of Medicine was established. We have yet as much to learn about high-order nonlinear feedback structures around us as those earlier professions have learned about their fields in the last 150 years. Now is time to plan how the next 50 years can start to close this huge knowledge gap. Like the early days in more mature professions, we do not yet have universities devoted to four- and six-year programs. Like them at the beginning, we do not have the equivalent programs of science and biology in grade school education to condition the public to the challenges and opportunities to better understand the dynamic world of nature, management, politics, environmental change, economics, and social stresses. Looking into the next 50 years, we see ….

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System Dynamics Applied to Project Management: A Survey, Assessment, and Directions for Future Research

Some of the most successful applications of system dynamics have been in the area of project management. Measured in terms of number of applications, number of practitioners, academic papers, value of consulting revenues, and value to clients, "project dynamics" stands as a model for success in the field. This presentation reviews the history of system dynamics work in project management, organized into three categories: (1) typical project dynamics and the underlying structures that create those dynamics; (2) applications of system dynamics to project management practice – success stories and policy messages; and (3) directions for future research and writing.

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Four Decades and Five Careers in System Dynamics

Mastery of system dynamics gives one a variety of ways to be useful and earn a living. Since my first course in Industrial Dynamics at MIT in the fall of 1964, I have used SD in five careers: teacher, author, consultant, manager, and investor. These careers require different levels of mastery. They offer different possibilities for impact. And each has its own risks. I will describe each of these roles briefly and indicate the benefits and costs that confront anyone wishing to pursue that career.

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Why myopic policies persist? Impact of growth opportunities and competition

Several case studies have documented myopic allocation of organizational resources among capabilities that payoff in short vs. long-term. We capture a general class of organizational resource allocation problems in a simple model that exhibits the typical worse-before-better dynamics commonly believed to be responsible for persistence of myopic policies. Next we examine the endogeneity of resources and the impact of competitive pressures on the efficiency of allocation policies. Endogenous resources and competition are both shown to significantly shift the optimal allocation towards myopic policies. Short-term policies become beneficial as they strengthen the positive loop between performance, resources, and capabilities. In fact strategic selection of allocation policy in a competitive market can force the firms to allocate all the resources to the short-term capability. These results provide an alternative explanation for the persistence of myopic organizational decision-rules that does not rest on psychological and learning arguments.

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The emergence of Limits to Growth Scenario 2: The pollution crisis

The paper argues that current world developments are starting to resemble the "pollution crisis" scenario in The Limits to Growth book from 1972. Ongoing global warming increasingly demonstrate the reality of two major structural assumptions in the Limits to Growth models: namely 1) long reaction delays from pollution levels to corrective action, and 2) self-reinforcing feedback from the pollution level to pollution absorption time, and back to the pollution level. If left unchecked, these mechanisms could generate a climate crisis in the 21st century. The paper seeks to highlight the strength in high level system dynamics conceptualization.

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System Dynamics Pioneers Panel Discussion

The early days of system dynamics were a time of enormous innovation, enthusiasm and creativity. Several of the first students and research assistants in the field of system dynamics, including Ed Roberts, Jack Pugh, and Dave Packer will reflect on their experiences, the lessons learned, and the enduring impact on their careers. Panelists will make introductory remarks, followed by dialogue among the panelists and with the audience.

Special and Convened Sessions

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Freedom Trail Walk

Jeanette Abad will be leading a walking tour of portions of Freedom Trail. www.cityofboston.gov/freedomtrail. The Trail takes visitors to many of Boston's most famous historical sites. The tour will be starting from the lobby of the Seaport Hotel at 10am and end at Faneuil Hall. Comfortable walking shoes and bottled water are recommended. $2 per person for public transportation on the T is required. For further information contact Jeanette Abad at jeanette.abad@paconsulting.com.

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Military Roundtable

This roundtable is open to anyone with interest in defense, military and related fields. All participants should include a brief (3-4 minutes) presentation of their interest in the field and a list of historical, current and future activities.

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Guided Tour at MIT

Advance sign up is required; please send your sign up request to the Society office noting day and number of people in your party. Available on Sunday, July 29 and Thursday, August 2. The walking tour will start at Kendall Square, near the MIT Sloan School, pass the Barta Building—the founding home of Whirlwind, and end up at the MIT Museum (on Massachusetts Avenue near Central Square). Total walking time is about 1.5 hours, and the distance covered will be about 2 – 3 kilometers. The MIT Museum has limited hours, in July and August: Monday-Friday 10 A.M. - 5:00 P.M Saturday & Sunday: Noon - 5:00 P.M. The MIT Museum has generously waived the entrance fee for tour participants. MIT Museum information: 265 Massachusetts Avenue, Cambridge, MA 02139, (617) 253-4444, http://web.mit.edu/museum/index.html. Your tour guide is Joost Paul Bonsen. Please note: 1. You must sign up for the tour, first-come, first serve. Maximum 40 participants per tour. 2. You will be responsible for any transportation costs to arrive at Kendall Square or return to the Seaport Hotel. The tour is free, and there is no transportation cost associated with the tour itself. 3. There will be stairs to climb; the tour is a “Walking Tour.” Please wear appropriate footwear. 4. The tour will be cancelled if there is bad weather.

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Business Roundtable

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SDS Membership Roundtable

Are you a satisfied member of the System Dynamics Society? Would you like to be? We'd like to hear from you either way. How can our Society best serve you? The Society provides many activities and services for members, including the SD Review, our annual conference, chapters and SIGs, to name just a few. Attend this roundtable and tell us what you value about Society membership, how our activities and services do or do not enhance this value, what we could improve, and what you'd like the Society to offer in the future.

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Environmental Roundtable - Environmental Idea Marketplace

This year the environmental roundtable will be run as an "Idea Marketplace." At the start of the session anyone present will have the opportunity to stand up and in one minute present an idea related to system dynamics and the environment that they would like to discuss with colleagues. After the first 10 minutes or so a number of these ideas will have been collected, and the session will break up into sub-groups to discuss these topics. Each sub-group will quickly outline its interests and goals with an aim toward developing common approaches, and actions, for working the selected issue. Each sub-group will then report back to the whole group with a one page summary of their discussions. Participants are urged to arrive with some key ideas ready for discussion! Time will be limited.

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Energy Roundtable

The celebration of the 50th anniversary of the SD Society could not offer a better set up for launching the first roundtable of the Special Interest Group on Energy. Energy has been a topic of interest within the SD society since the early days. A large number of issues have been addressed: from national energy planning to strategic intents in markets, from gas to power, and from renewable to fossil sources. Applications have been multidirectional, multidisciplinary and across large number of countries worldwide in topics such as transport, industry efficiency and household preferences. The Roundtable will focus on opportunities for SD research and intervention in energy security, energy markets, energy and the environment and energy for the poor and sustainability. This will be a special event for practitioners, consultants and representatives of the academic community to meet and share ideas.

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Introduction to the System Dynamics Society

This event gives newer conference attendees an opportunity to learn more about the Society and to meet a few of the officers. This is a very informal meeting with a web tour of how to best use the Society website. Most of the time will be spent on questions generated by the audience.

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Security Roundtable

The members of the Security SIG come from the information security field, criminology, air traffic security, organizational accidents and safety. The inhomogeneous nature of the SIG has made it difficult to establish a stable forum. Only the subgroup of information security (the Security Dynamics Network) has a record of group-based activities. The strength of the SIG comes from its social network. It has allowed the development of several cooperative projects, the organization of workshops and the co-direction of PhDs. Thus, the objective for the close future should be the consolidation of all these activities and their formalization. To improve the status of the SIG, the focus of the Roundtable shall be on activity. The goals of this Roundtable are to identify and classify by scope and objectives the activities of its individual members, and attempt to sketch a joint strategy (e.g. policy, guidelines) that will allow the SIG to derive and achieve common objectives, followed by examples of typical projects to expect in the future. Participants will be asked to contribute to the Roundtable with facts about their relevant professional activities, regarding the first goal, and with ideas about joint activities at the strategy or project aggregation level, regarding the second goal.

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System Dynamics PhD Colloquium

The PhD Colloquium is a whole day event for Ph.D. students to present and inspiringly discuss their current research about foundations, techniques, tools, and applications in the field of System Dynamics. Junior and senior System Dynamics practitioners meet here every year to exchange ideas about their projects in an international atmosphere. The forthcoming 8th PhD Colloquium will take place on Sunday the 29th July 2007 at the 25th International Conference of the System Dynamics Society in Boston, Massachusetts, USA. Plenary presentations will identify common problems encountered by PhD researchers using System Dynamics. Each presentation

will be followed by an extended discussion session, providing a unique opportunity for learning among all attendants. Combined with a poster session scheduled in the afternoon, we expect the all-day colloquium to be an exciting event. More information is available at www.sdstudentchapter.org.

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Prospective Conference Host Meeting

The annual conference is the most important activity of the Society, and therefore hosting it is a very important contribution to the Society. In addition, being a host for this event can bring fame (sorry, no fortune) to the hosting individuals and organization, and attract local interest in the field. In this meeting we will discuss the timetable and activities involved in preparing a bid to host the conference, the requirements for a successful bid, and the requirements for a successful conference. We will also discuss the Society's schedule for conference site rotation, and the role of SIGs and Chapters in conferences. Please attend this meeting if you have any interest in hosting a future conference.

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Conference Budgeting Workshop for hosting a Society conference

This workshop will show how the Society deals with budgeting for a conference, the budgeting timeline, and what is required financially. This workshop is open to anyone interested in our conferences.

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Beer Game World Championship

Whether you have led the game or never played, be sure to come. Have fun while learning how to facilitate the game. The game will be followed by a workshop debriefing on Thursday.

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Special Convened Session: Simulation-Based Learning Environments

Simulation-Based Learning Environments include Management Flight Simulators, Microworlds, Interactive Learning Environments, and similar approaches. These learning environments have been developed in a number of areas such as business, health care, and education. The focus of this session will be on different ways of supporting learning with SD models by making those models and their lessons more accessible to users. This is typically done by allowing users to manipulate the models themselves through an interface, simulation game, guidance by well-designed didactic materials, or other means. Papers on three very different applications will be presented. One describes how didactic materials are used to guide students through explorations of market dynamics. The second presents an interface that enables health planners to examine different strategies for dealing with outbreaks of contagious diseases. The final paper describes an experiment in which some participants in a computer-based managerial microworld had access to an interface based on a balanced scorecard while other relied on information in traditional report formats. Discussion afterwards will explore common insights from these applications.

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Seventh Annual Modeling Assistance Workshop

Modeling assistance is available at the conference to enable people to receive one-on-one coaching with an experienced system dynamics practitioner. Opportunities include two scheduled sessions, as well as the possibility of assistance at any time during the conference. Assistance is available for modelers at any level of modeling ability, from beginner to advanced, with questions about a specific model, methodology, or software. Questions may address problem identification, dynamic hypothesis development, model formulation, model testing, or policy design and evaluation. Modelers should bring whatever materials they need to describe their modeling question, including pencil and paper, articles, books, or laptop computers. Spectators are welcome to observe, and even contribute their own ideas, during the scheduled modeling assistance sessions.

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Diagram Slam

All conference participants are invited to compete to create the most entertaining, innovative, beautiful and/or outrageous stock-flow/causal-loop diagram. The topic area will be announced on Wednesday morning with entries due later that day. After the evening Beer Game event, five finalists will present their results in front of the conference audience to determine the winner.

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HPSIG: Health Policy Discussion Focused on Chronic Illness and Business Meeting

The Health Policy Special Interest Group will have a wide-ranging discussion about its members' work in the area of chronic illness. Topics will include diabetes, mental illness, cardiovascular disease (CVD)and its risk factors, and health planning as it relates to chronic illness. Members will discuss their experience in applying SD in these areas, new insights developed as a result of using SD and impact that was achieved, and further opportunities they see for SD to help improve thinking and policymaking about chronic illness. The session will conclude with a very brief HPSIG business meeting. All interested ISDC attendees are encouraged to join us!

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Economics Roundtable: Teaching Economics with SD

The Economics Chapter of the System Dynamics Society will host a roundtable discussion on "Teaching Economics with SD." Everyone is invited to attend. The Roundtable will highlight current initiatives that involve substantial application of SD modeling and/or conceptual thinking in economics courses. Those of us in the Chapter are aware of some of those initiatives, but we want to know more. We are particularly interested in (a) the way SD methodology is being implemented as a teaching tool in economics, and (b) assessment efforts to gauge the effectiveness of SD as a tool for teaching economics. There will be brief "highlight" presentations by instructors from both higher education and K-12 who are using SD to teach microeconomics or macroeconomics, followed by questions and discussion. We hereby invite anyone interested in making a presentation to submit a proposal (less than 200 words) via email to David Wheat

(david.wheat@uib.no) for consideration by the selection committee. For planning purposes, it would be helpful to know how many participants to expect. Please email David Wheat (david.wheat@uib.no) if you are considering attendance.

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Peer Review Dialog Meeting

This year's "peer review dialog meeting" will take up what participants have articulated last year and what the Policy Council has undertaken in the meantime. Briefly put: even though the final decision is up to the programme committee, formally deficient papers would be rejected without revision, formally deficient reviews would lead to suspending the reviewer for one year, authors of accepted papers would evaluate the review's usefulness and reviewers would have a discussion forum in order to collaborate. One conference later, we shall ask how the actual process related to the planned one, on the basis of last year's report and the PC's response to it. We'll also assess how it worked this time, indicate what has been achieved and what seems to need improvement. We shall conjointly set up a set of recommendations, too.

Exhibitor Demonstrations

Exhibitor demonstrations will be held during breaks to showcase products and services in practice.

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K-12 Open Discussion

All those interested in system dynamics in K-12 education are encouraged to attend and join in the discussion. We will be discussing three major strategies for increasing the use of system dynamics in K-12: Innovative curriculum development, appropriate training for teachers and students and linkages with other organizations or movements which could be enhanced by the utilization of system dynamics, such as sustainability education and economics. Those planning to attend are urged to contact Lees Stuntz (stuntzln@clexchange.org) before the session so that we can make the most of our time together.

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Special Convened Session: Celebration of System Dynamics in K-12 Education; Honoring Jay Forrester

Jay Forrester, who created the field of system dynamics, turned his attention to K-12 education about 18 years ago. He has put his considerable and positive energy into promoting the use of system dynamics in education for students aged 5 through 18. He mentored the System Dynamics in Education Project at MIT for 13 years, developing Road Maps, a self-guided study program originally designed to help teachers learn system dynamics. He has been active as Trustee of the Creative Learning Exchange, encouraging the writing of curriculum through the Gordon Brown Fund and staying involved with teachers through workshops and conferences. This session is intended to honor Jay, his support for and his commitment to the K-12 students and teachers.

Chapter and SIG Poster Sessions

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Thinking global, acting local: The activities of the Hellenic Chapter of the System Dynamics Society

July 2006 was a milestone for the Hellenic Chapter, as it was announced that the 2008 Conference of the Society would be held in Athens, Greece. The decision of the Policy Council immediately mobilized the core members of the chapter along two directions: First, towards the organization of a conference to be remembered for its quality and excellence, and second towards creating a critical mass of new members that will contribute to the organization and operations of the conference as much as they would be benefited from it. As a consequence, in parallel with the preparations for the 2008 conference (hotel and venue arrangements, sponsor meetings, etc.), the society is organizing in May and June two national events in association with other related societies (The Hellenic Systems Studies Society and the Hellenic Operational Research Society), while an edited volume of contributions from Greek members of the System Dynamics international community is to be published by a leading publisher in Greece.

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Pakistan Chapter Poster Presentation

Pakistan Chapter of Systems Dynamic Society consists of professionals across diverse disciplines, engineers, managers, educators and business men keen to apply systems dynamics in their relevant fields. They are twenty five in number. Pakistan Chapter is trying to include more members and plans to conduct educative seminars in different institutions of higher learning in Pakistan to attract more energetic and keen learners. It has already conducted a workshop on Beer Game last year. Pakistan Chapter also offers diploma and certificate courses in "Systems Thinking and Strategic Planning" and "Modeling Business Dynamics." Three papers have been contributed for Boston 2007 on Pakistan Chapter's behalf. They are: "A SD Approach on Quality Education in Classroom Management at Schools" by Ijaz Yusuf, and Rabia Sajjad; "Aligning the Supply Chains of Educational Institutes with Business Strategy" by Asher Ramish and "Developing Universal Model of Educational Leadership" by Seema Arif. The Pakistan Chapter looks toward support and coaching from international Society members to increase knowledge and awareness about systems thinking, dynamic modeling and strategy planning in Pakistan.

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Business SIG Poster Presentation

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UK Chapter Poster Presentation

The UK Chapter was one of the first regional Chapters to be formed. We have regular meetings in the UK and annually at the international conference venue. This year we held our 9th Annual Gathering at Harrogate, North Yorkshire. The event consists of a Thursday afternoon of talks, presentation of UK Chapter Student prize and a business meeting. A convivial dinner follows in the evening with further sessions on the Friday morning. We expect an attendance in the range 50-60 and a recent survey of the entire membership showed it to be a very worthwhile session at a pleasant venue. In Spring 2006 we inaugurated an evening networking event in London and over 40 people attended. The second was held in December 2006. More of these events are planned for 2007 and beyond. Finally, we have recently updated and re-located our website. Point your browser to www. systemdynamics.org.uk If you are based in the UK and not already on our membership list (membership is free) then please do join us and see what we have to offer. If anyone would like to see a specific type of event taking place then please make your idea known. We look forward to hearing from you.

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Brazil Chapter Poster Presentation

The main activity of the Brazilian Chapter during 2006 was The 1st International Business Dynamics Congress, in Brasília, from October 18th to 21st. Participation was possible either in person or over the Internet. With English / Portuguese simultaneous translation at most of the sessions, the congress brought together researchers, executives from the public and private sectors, consultants and academics from the national and international communities. Around 80 papers were presented, and the main keynote speakers of the event were Juan Martín Garcia (La Salle, Barcelona) and Paulo Gonçalves (Miami University). The objectives of this congress were to: • facilitate the Brazilian public's contact with the System Dynamics' concepts and applications; • contribute to the development of a community of system dynamics' researches and practitioners; • allow the participation of everyone, on-site or off-site, promoting international exchange of ideas and experiences; The videos of event presentations will be available for streaming starting on July 15, 2007 at www.sbds.org.br. The next Congress will be held in Sao Paulo, May 14-16, 2008.

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The Environment Special Interest Group Poster Presentation

The environment special interest group provides a forum for members with interests in many aspects of the environment. The group includes system dynamicists with interests in a wide variety of sub-areas from ecological studies of specific ecosystems, to worldwide concerns about human influences on planet Earth. Domains of interest include: ecological studies of natural systems, management of renewable natural resource systems, water resource systems, management of mineral resources, interactions between humans and the natural environment, specific impacts pollutants and

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products (such as GM crops) on our environment, larger impacts on the global ecosystem (biogeochemical cycles, global warming effects etc) and their mitigation, policy studies, and efforts aimed at ensuring human "progress" including "sustainability", renewable energy etc. and I I The poster will stimulate conversation among system dynamic society members regarding the wide variety of subject areas that are included under the umbrella "environment" and how these different areas complement one another and other activities of society members. The poster will also clarify and help define the role that the environment special interest group could have with regard to overall society activities, such as supporting non-SIG members who may require ideas and suggestions about environmental subjects. Contact: Richard Dudley, Chair: Richard.dudley@attglobal.net.

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Australasia Chapter Overview & Planned Activities

The Australasian Chapter has about 56 members from across the region. This is up from approximately 45 members in 2006. In terms of geographical spread, we have 35 members in Australia, 9 in New Zealand, 3 in Pakistan, 2 in Singapore, 1 in Indonesia, 1 in Malaysia, and 1 in India. In March, the chapter held a one-day workshop in Sydney that attracted 13 attendees from all over Australia. There was a good mix of academics and practitioners in attendance and it was terrific to hear about the interesting work being done by chapter members on a wide range of topics. The chapter has also had several international visitors so far in 2007. Professor Yaman Barlas, from Bogaziçi University, visited in late January and gave seminars at UNSW's Accelerated Learning Lab and Centre for Health Informatics. Professor Erik Larsen visited UNSW at the end of February. Also, Professor Andy Ford visited the University of Queensland in February. The Chapter is currently working on an interactive content management web site. Updates about chapter activities, expertise of chapter members, a discussion forum, seminars, conference announcements, etc. will be posted on the web site soon.

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Security Special Interest Group

The Security SIG has members from very different areas since "security" is a very generic term. Many members come from the information security field. In addition, areas as different as criminology, air traffic security, organizational accidents, safety are also represented. However, traditionally, the SIG leadership has come from the information security area. The inhomogeneous nature of the SIG and the "bias" of the SIG leadership have made it difficult to establish a forum with continuous activities. Only the subgroup related to information security (the Security Dynamics Network) has so far shown a consistent record of group-based activities. The poster illustrates a project originating within the information security area that has is likely to involve aspects in the fields of safety and criminality/terrorism.

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Student Chapter Poster Presentation

The Student Chapter of the System Dynamics Society was established in 1999. We bring together all students who are involved in System Dynamics research and give them the opportunity to raise key questions and to discuss concerns related to their research in a constructive and enjoyable atmosphere. For this purpose, the Chapter manages a website, a list server, and a newsletter, and organizes a yearly PhD Colloquium held during the International Conference of the System Dynamics Society. The objectives of the Chapter are: (1) to extend and unify the knowledge of feedback systems among students all over the world, (2) to promote the development of System Dynamics and the interchange of knowledge and research, (3) to intensify the communication between and form a basis for cooperation amongst the graduate students in their researches, (4) to arouse interest among undergraduate students towards SD, (5) to promote the communication between the students of SD and the practitioners of the field, (6) to form a medium to help SD students to get into contact with field related graduate studies and job opportunities. It is also for these reasons that the Student Chapter organizes the now traditional PhD Colloquium. Check www.sdstudentchapter.org for more information.

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Swiss Chapter Poster Presentation

The Swiss Chapter of the System Dynamics Society consists of researchers, educators, consultants, and practitioners in the corporate and public sectors. Approximately 120 people receive our e-mails and about twenty of them are full members who pay the membership fee. The number of participants in chapter meetings is relatively constant at around ten. Additional activities involve enhancing consulting competences and educational programs. Chapter meetings are organized where we usually combine a presentation about System Dynamics in action with the discussion of organizational, chapter-related issues. In addition, the Swiss Chapter organizes several PhD round tables each year at different locations. At these meetings, PhD students of Switzerland who apply System Dynamics and related disciplines in their research have the opportunity to present and discuss their projects and obtain feedback from senior researchers and peers. With such a structure, we try to maximize the benefits for our chapter members. Our conclusion so far is that there are quite some people in Switzerland who deal with System Dynamics. Everyone in this heterogeneous group is ultimately motivated to reach his individual SD related goals. The value added by the Chapter's activities lies in the provision of networking, learning and exchange opportunities. Visit: www.systemdynamics-swisschapter.ch.

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Health Policy Special Interest Group Poster Presentation

The Health Policy Special Interest Group (HPSIG) has about 150 members representing many countries. It maintains a Wiki (www.hpsig.com) with much useful information about SD applications in health care and relevant

papers that present systemic views of health care problems. The HPSIG also hosts a Sunday afternoon session prior to the beginning of the ISDC on topics such as health reform and why it is so difficult (at the 2005 and 2006 conferences) and SD applications to chronic illness in different countries (coming up at the 2007 conference). This poster session will be an opportunity to meet some of the HPSIG's members, learn more about the group, and join if you are interested.

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The current activities and plans of the SDS Education SIG

This paper describes the current activities and plans of the SDS Education SIG. We continues to pursue our twin interests in publicising and enhancing both the contribution of SD to Education Management and the evolution of the contribution of SD to the curriculum - in both cases the interest spans the whole span of education from K-12 to Higher Education. Plans and activities include: 1. Organising workshops and other events on the utilisation of systems based approaches to Education management. 2. Encouraging education, systems and other graduate students to consider using system dynamics approaches for education policy dissertations. 3. Encouraging graduate students to consider examining enhanced techniques for improving the contribution of SD to the curriculum in their dissertations. 4. Making presentations & publishing articles to introduce members of other education associations to system dynamics approaches to their work. 5. Conducting a survey of all those interested in SD & education so as to form an active network with a database of current and planned system dynamics topics / projects and a taxonomy of publications. 6. Improving our collaboration with other groups conducting K-12 based activities. Your ideas and contributions to any of the above are most welcome!

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Psychology Chapter Poster Presentation

The Psychology Chapter of the International System Dynamics Society was formed about a year and a half ago. In general, the goals of the chapter are to integrate relevant psychological concepts into System Dynamics models and to apply System Dynamics methodology to model individual and social psychological theories, by introducing feedback mechanisms as underlying causes of behavior. The Chapter currently is in its early stages of development. There are plans to survey the System Dynamics literature to find how others in the past have included psychological processes in their models. In addition, a list serve will be established for its members to share ideas about modeling psychological processes and to discuss behavioral principles might be needed to make some System Dynamics models more attuned to the current psychological literature. In the meeting in Boston, we will begin the process of writing the Chapter's bylaws, which eventually should lead to election of officers.

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Japan Chapter Activity Report

System Dynamics history in Japan commenced in 1960s; several textbooks of Industrial Dynamics were published in those days. After that, many researchers used System Dynamics in their own field individually for about 30 years. Thereafter, System Dynamics researchers gathered and founded Japan Chapter of International System Dynamics Society in 1990. Since then, Japan Chapter held The International System Dynamics Conference 1995 hosted by Gakushuin University in Tokyo. The chapter members assembled their best minds and finished it successfully. In 2006, Japan Chapter had over one hundred chapter members. As Research activities, Japan Chapter publishes an annual journal and holds regular research meetings and symposiums. In 2006, we held six research meetings including one public symposium. In particular, public symposiums are the most important events not only for the chapter but also for the public. The recent theme of the public symposium is "Whither Japan SD Education?" The symposium had many participants including public people. We always welcome System Dynamics members or users who visit Japan. Several System Dynamics researchers have already had meetings hosted by Japan Chapter. Contact with our Chapter Liaison is greatly appreciated.

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Russian Chapter Poster Presentation

Last year was very fruitful for SDRus. We increased our membership and improved SD Rus website. In April 2007 the second international business conference "Simulation modeling in strategic and operational business management" was organized by SDRus Vice-president Alexey Gorbunov. Many of SDRus members participated. In Apatity (Kola Peninsula) national scientific conference "Theory and practice of system dynamics" was held. All conference materials are available on our website. SDRus was advertised during both events and it increased our profile as well as attracted new members. Now the SDRus website (www.sdrus.org.ru) is featuring the forum for discussions which helps members exchange ideas, answers their questions and inspires new projects. XJtek continues to support SDRus and helps expand the presence of system dynamics in Russian and International markets. Dennis Meadows visited Moscow in February of 2007 and gave a lecture at the Mendeleev University of Chemical Technology. The lecture "It has to be completely stopped" was dedicating to the discussion of climate change and excessive reliance on natural resources. System dynamics continues to actively develop in a number of centers in Russia. Interest in academic circles is growing along with the numerous projects in the industry.

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Economics Chapter Poster Presentation

Since its inception in 2003, the Economics Chapter has been promoting the use of system dynamics to study and improve economic systems. The chapter maintains a website and a mailing list with over 70 subscribers. Members of the chapter have successfully organized system dynamics threads during economics conferences and coordinated the economics thread during annual meetings of the System Dynamics Society. We encourage anyone interested in Economics to stop by the poster to learn about the activities of the chapter and its members. We also would like to hear about your interests and invite you to join the chapter. A special event this year is a Roundtable discussion on using SD to teach economics, and everyone is invited to attend.

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Latin American Chapter of the System Dynamics Society

The Chapter was founded en 2002. Its first line of activities was to start a Latinamerican conference, from 2003 on - held in Monterrey (Mexico), Talca (Chile), Cartagena (Colombia) and Cancun (Mexico). Since 2004, the chapter has a quarterly on-line newsletter called sisTEMAS (dinamicasistemas.utalca.cl/sisTEMAS/sisTemas.htm). In 2005, appeared the "Revista de Dinámica de Sistemas" which publishes 2 numbers per year (dinamicasistemas.utalca.cl/Revista/RDS_home.htm) and currently he 4th issue is on-line. The chapter has a growing number of members from Colombia, Mexico, Venezuela, Argentina, Peru, Chile and particularly Spain, 23 of whom are formally members of the System Dynamics Society. Currently, the Chapter is represented in the Policy Council by Gloria Pérez from "Instituto Tecnológico de Monterrey" (Mexico) and presided by Martin Schaffernicht from the "Universidad de Talca" (Chile). Priorities are to strengthen the internal structure of the chapter so as to foster collaboration despite the geographical distance between members; since the Cancun conference, collaborative work on an on-line book is under progress. Also, we will strive for the "Revista" to be incorporated into the LATINDEX database. The official web-site is dinamica-sistemas.mty.itesm.mx.

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SYDIC: System Dynamics Italian Chapter Poster Presentation

The final design and development of the System Dynamics Italian Chapter (SYDIC) new website continue to be in progress. At Communication Sciences faculty Rome University "La Sapienza", the SD course has been confirmed and more than 50 students were introduced to System Dynamics methodology and development of simulation modelling. There has been continues academic activities developed by Chapter members (here reported) in the field all over the country. University of Bologna –Faculty of Mathematical, Physical and Natural Sciences – Dynamics of Complex

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Organisations course University of Siena – Department of Social and Business Studies – Governance and Management Control course University of Rome "La Sapienza" – Faculty of Communication Sciences – Advanced degree in Enterprise Communication – System Theory and Dynamic Simulation Modelling course University of Rome "La Sapienza"– Master at Faculty of Statistics Sciences – Department of Data Intelligence and Strategic Decisions – Integrative lessons in SD University of Rome "Tor Vergata" – Faculty of Economics – Department of Enterprise Studies University of Rome "Tor Vergata"– Faculty of Engineering – Department of Enterprise Engineering – Enterprise Production Processes Modelling & Service System Modelling course and Master in Network System Engineering – Integrative lessons in SD ENI Corporate University – Mattei School of Management – Master in Energy and Environmental Economics and Management - Integrative lessons in SD.

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Energy SIG: Overview

The prime objective of the Energy SIG is to further the development of a holistic view on energy policy and energy systems by use of systems thinking and use of system dynamics tools. Areas of interest for this new SIG are the development and application of system dynamics in: • Energy systems technology development and energy market modeling • Technology assessment • Energy impact on sustainable development • Energy economics • Energy-environmental policy design and assessment • … with direct application to systems of direct relevance to the energy sector. The Energy SIG develops and stimulates activities aimed at: • Information exchange; • Stimulate further research; • Organize special sessions during SDS-Conferences or during other events supporting the Energy SIG objectives; • Promote cooperation and joint sessions with other energy-related organizations during SDS-Conferences or during other events; • Stimulate cooperation and exchange with other Special Interest Groups of the SDS; • Contribute with study, research, and activities, to the discussion of sustainable development questions, including the energy role and environmental impacts. The poster will show the objectives and activities undertaken by the Energy SIG. More information on this Energy SIG may be obtained via energy@sigs.systemdynamics.org or from the website http://www.systemdynamics.org/sigs/energy.

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China Chapter Poster Presentation

For information about the China Chapter please visit the website: http://www.systemdynamics.cn.

Workshops

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Methods to Make Your Simulation Run on the World-Wide Web

Simulations that run in web browsers have the advantages of global accessibility, simple distribution, and the ability to monitor simulation usage. However, simulations need to be modified in order to effectively use the online medium. Online simulations need to engage the user, be accessible in multiple formats, be simple to navigate, and correspond to the user's learning objectives. Usability design is critical to create simulations that will be used by a diverse, global audience with limited knowledge of simulation, short attention spans, and unarticulated use objectives.During the workshop, Michael Bean will demonstrate how to create web simulations, discuss commonly occurring web simulation design challenges and potential solutions, and show examples of web simulations that have been used by thousands of users. Michael will also provide a series of guidelines for creating simulations online. Michael will provide handout booklets, sample simulations, and sample HTML pages that can be used to create your own first web simulation.

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Getting Started with AnyLogic Software

AnyLogic is a multi-method simulation software supporting System Dynamics, Discrete Event and Agent Based modeling. AnyLogic modeling language enables you to efficiently capture the complexity and heterogeneity of business, economy and social systems. In this workshop we build a model where interacting objects in the real world having different nature will be modeled using a combination of different approaches. The model will be from Supply Chain or Healthcare domain. We will go through most of new feature of recently release version 6. You may bring your own laptop, install the software (CD will be available) and follow us, or just watch the process of model development.

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Modelling Agent-Based Systems Using System Dynamics

This workshop presents an experimental simulation environment – based on the .NET platform - that can be used to integrate population-level dynamics with those occurring at an individual, or agent-based, level. The benefit of this approach is that individual agent behaviour may be mapped at a detailed level, using differential equations, and aggregated over the entire population in order to determine population-level dynamics. Furthermore, individual

agents can interact with one another, in terms of a grid-based social network structure. The environment is firmly grounded in the system dynamics approach, and, unlike conventional agent-based simulation environments, programming is not required in order to specify agent interactions and behaviours. The workshop describes the approach, and participants will have an opportunity to experiment with a market dynamics model, based on two firms competing for a fixed market population.

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Getting Started with Vensim®

System Dynamics is about understanding complex systems. As Jay Forrester points out human beings are not able to understand the implications of multiple interacting feedback loops. To support us in this endeavor, therefore, we need software. Vensim is one of the available software products that fully supports system dynamics and this workshop is an introduction to using it.

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Getting Started with STELLA and iThink

This workshop will be an introduction to building and communicating system dynamics models using STELLA or iThink software. The workshop is intended for people who are relatively new to the field or do not have experience using STELLA or iThink. The session will be conducted as a hands on workshop and demonstrate basic techniques for building, analyzing and communicating simple simulation models. Participants should bring their own computers with STELLA or iThink Version 9 installed or arrive 15 minutes early to install the software.

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Teaching Your Children System Dynamics/Systems Thinking

Workshop attendees will participate in several lessons designed to teach the principles of system dynamics to elementary, middle and high school students. Participants may share their experiences in teaching system dynamics to children. The workshop will conclude with a brief discussion of the available curriculum resources, strategies, challenges and pitfalls of implementing K-12 system dynamics. A CD containing helpful articles and sample lessons will be made available to each participant (at no cost).

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Modeling Dynamic Systems: Lessons for a First Course (new chapter on delays)

"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. A new chapter dealing with material and information delays will be discussed. 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, supply and demand, and more). Developed over 15 years, the lessons in this book provide an easy-to-use set of teaching materials that are paced gently enough for novice modelers.

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The Career Simulator - Which are the key decisions in Career Planning?

Which are the key Career Planning decisions? I created the Career Simulator to teach last year students the basic systemic structure of career success at ITBA – (Instituto Tecnológico de Buenos Aires), which offers 5-year academic programs in engineering. The Career Simulator model is based on more than 11 years coaching the careers of our graduates and in the study of the careers of successful professionals in Argentina and USA. The model predicts 4 key "hard" career planning decisions. Surprisingly, a great percentage of high talented and qualified engineering professionals ignore them leading some of them to poor career results. The advantages of taking into account this 4 key "hard decisions" when planning your career are very important: more career resources and career options, higher income potential, increased negotiation power. They complement your "soft" career decisions with logical and established criteria for taking your "hard" decisions to enhance your career.

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Getting Started With Forio Broadcast

This workshop will present a step by step approach to building a web-based simulation based on an existing simulation model. Participants will use the web application Forio Broadcast to upload a simulation model and construct a simple web interface. The resulting simulation will be accessible by anyone across the internet using only a standard internet browser. Participants can bring a model (built with popular simulation software packages such as Vensim, Powersim, Ithink, STELLA) or may use one of Forio's pre-built models as an example.

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Getting Started with GoldSim Software

This workshop will be an introduction to building probabilistic system dynamic models using GoldSim. GoldSim differs from traditional system dynamics software in that 1) it puts much greater emphasis on probabilistic simulation techniques to support representation of uncertain and/or stochastic systems; and 2) it relies on more specialized model objects (beyond stocks, flows and converters) in order to make models less abstract (and hence more transparent) and help represent processes and events that cannot easily be represented using a traditional system dynamics approach. In general, this is because GoldSim has traditionally been used for engineering and scientific applications where quantitative probabilistic predictions of future performance have been required (e.g., by regulators) in order to inform and defend policy and design designs. The workshop is intended for people who are already familiar with traditional system dynamics tools, and will focus on how GoldSim models can be used to complement and extend models built using traditional approaches. The session will demonstrate basic GoldSim functionality, how GoldSim can be used to represent uncertain and stochastic systems, and will discuss a number of specialized objects provided by the software. Computers are not required for this short workshop.

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Advanced application design with Powersim Studio

A system dynamics application is the combination of a model and a user interface. A key to building effective applications necessitates spending some time on model layout and the software engineering techniques that ultimately improve model quality and lend models to application development. These include module coupling and cohesion, naming conventions, modeling team interaction, and standards. The ultimate success of an application is measured by use. There are traditional and novel creative ways to make useful applications using the available interface tools. Extending a model and interface beyond the usual system dynamics constructs may lead to more effective applications.

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Multiscale Modeling in Anylogic6 with Health Examples

There is a long history of using disaggregated micro models for assisting with structure and calibration of more highly aggregated SD models. We present a new integrated development environment which combines SD, Agent Based and Discrete Event simulation using the java Eclipse framework, which allows powerful software extensions, including GIS datasets and optimization, and compelling and engaging animations across multiple Mac and PC platforms. This interactive workshop will use mostly

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health examples to illustrate the features, including epidemics, diffusion of innovation, "across the skin" modeling, population dynamics, and chronic illness morbidity and disability, dynamic decision-making and adaptive supply chains.

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Dynamic Experiments for Learning Basic Modeling

Demonstrating the benefits of simulation modeling to new audiences is not an easy task. Models that solve real-world dynamic problems may take weeks, months, or even years to develop. Audiences new to System Dynamics may have a hard time relating model behavior to the real-world problem because of their unfamiliarity with the problem being modeled, or simply because of the separation between their world experience and its representation in the computer. This workshop teaches the basics of modeling using dynamic experiments which are brief, exciting, memorable, and involve workshop participants. The participants act as observers who collect behavioral data "real-time" from the experiment. The participants discuss their observations of the experiment and their understanding of the data. A dynamic hypothesis is drawn out by the workshop moderator as a Causal Loop Diagram based on the outcome of the discussion. A model (built prior) is simulated to reproduce the observed dynamics. From the model behavior, the participants suggest a manageable change to the experiment which is then rerun (using data collection) and the results are compared to the simulation model runs.

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Why Do Different Methods in Model Analysis Produce Similar Results?

This workshop will be useful for people with an interest in understanding the behavior of dynamic systems based on their feedback structure. Recent studies done to contrast the outcome of alternative techniques for identifying loop dominance conclude that a significant overlap may exist in the outcome of various approaches to model analysis. The purpose of the workshop is to explore the similarities and differences among various methods including, but not limited to, pathway participation metrics and eigenvalue analysis. Methods of analysis will be explored in three dimensions: 1) metrics used to

characterize structure and behavior, 2) selection of dominant structure and, 3) interpretation of results. The workshop will provide the opportunity for the participants to share their experience in understanding the connection between dynamic behavior and feedback structure. This workshop will compare the results of analyzing several models by pathway participation metrics (implemented in Digest) with those of eigenvalue analysis and conclude s that the pathway participation metrics and eigenvalue elasticities may converge in the long run behavior of linear systems.

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Strategy Dynamics: Introduction and New Developments

This workshop will demonstrate the use of system dynamics for tackling strategy and other management topics. It will be highly interactive, and seek to demonstrate the approach by working on live management issues from the audience. Although a repeat of successful workshops from previous years, it will add some important extensions, including the live use of software to capture strategy issues and important connections to established frameworks from other management topics.

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Getting Started with MyStrategy Software

This workshop will be an introduction to building system dynamics models using 'MyStrategy'. The workshop is intended for people who are relatively new to the field or do not have experience using MyStrategy. The session will be conducted as a hands-on workshop and will demonstrate basic techniques for mapping the causal structure of business and other challenges, and developing simple simulation models. Participants should bring their own computers with the specific software loaded on them or show up one half hour early to load the software. People without computers are welcome to watch, and they will be paired or in small groups to work together with those who do have computers.

Author Index

D

E

F

G

H

I

J

K

L

M

N

O

P

Q

R

S

T

U

V

W

Y

Z