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Conference Host:
Worcester Polytechnic Institute

Conference Local Co-hosts:
Amber Blocks Ltd. and
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Navigating the Conference Proceedings

For portability and ease of use, the 2003 System Dynamics Conference Proceedings are being distributed in Adobe Acrobat (PDF) version 5.0 format. You can view the files using Adobe Acrobat Reader version 5.0, which you can download for free from <http://www.adobe.com/acrobat/>. For optimum viewing, please download Acrobat version 5.0.

These instructions show you how to:

- Use Acrobat's basic tools to explore the Proceedings
- Navigate the Proceedings using bookmarks and links
- Search for authors, abstracts, and papers, and access supplementary files.

If you are familiar with Acrobat Reader, you will recognize the common navigational features, including bookmarks, links, and menu icons. If you are unfamiliar with Acrobat, you may want to print this page for reference. (For information about printing, see the section "Print a PDF Document" below.)

Using general tools

Page tool

The built-in Page Tool (figure 1) allows easy navigation within multi-page PDF documents.

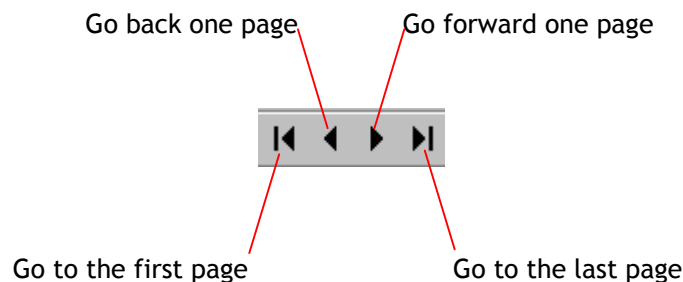


Figure 1. The built-in Page Tool lets you move between and across pages.

Browsing

The built-in Browser Arrows (figure 2) allow you to move through Acrobat in much the same way that an Internet browser allows you to surf the web:

- The back arrow returns you to the page you visited last
- The forward arrow reverses the action of the back arrow

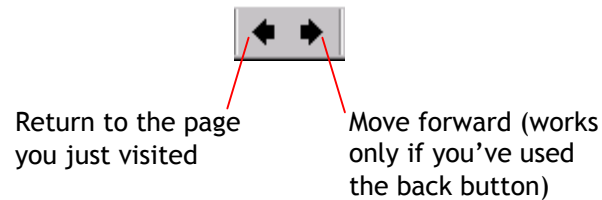



Figure 2. The Browsing Arrows give you greater flexibility to explore the Proceedings.

Printing

You can print a PDF document in two ways:

- Use the Print icon  on the Acrobat tool bar, or:
- Select **File | Print** from the Adobe Acrobat menu bar.

Note: Both of these actions will display the print dialog box with your default printer set to print. You can then set any specific options necessary for printing.

Links, buttons, and icons

Links and buttons allow you to easily search and access the Proceedings. Links take you from the Author Index to a particular abstract, and from an abstract to a particular paper. Any text or image surrounded by a blue rectangle is a link (figure 3):

All links are surrounded by a blue rectangle.

Figure 3. A sample link

Buttons allow you to move quickly between the Author Index, the Abstracts, and individual papers. The “Author Index” button (figure 4) returns you to the top of the Index, and the “Go Back” button (figure 5) returns you from a paper to its abstract. The “Table of Contents” button (figure 6) returns you to the Table of Contents.

Author Index

Figure 4. The Author Index button takes you to the first page of the index.

Go Back

Figure 5. The Go Back button takes you from a paper to its abstract.

Table of Contents

Figure 6. The Table of Contents button returns you to the table of contents.

Using Bookmarks

Bookmarks, which appear in the left pane of the Acrobat Reader (figure 7), display the main sections of the Proceedings document. To display Bookmarks, select **Window | Show Bookmarks**. Clicking on a bookmark will take you to the specified page of the Proceedings.

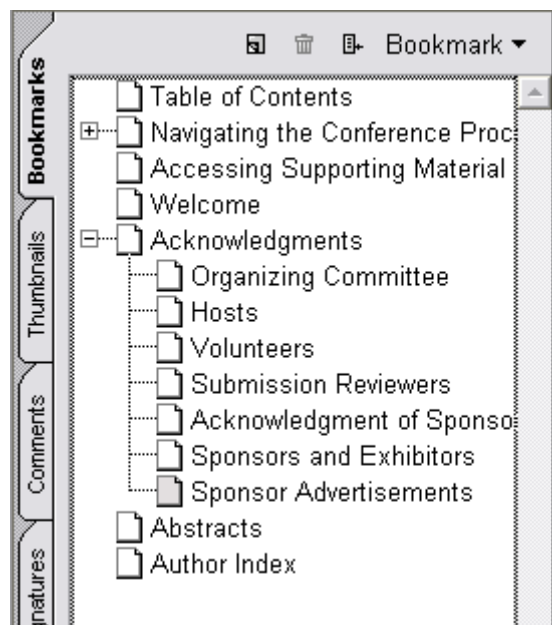



Figure 7. The Bookmarks pane

Finding abstracts

You can locate abstracts in two ways:

1. Locate the author's name in the Author Index
 - a. Click the "Author Index" link in the Bookmarks panel.
 - b. Find the author's name in the Author Index.
 - c. Click a page number after the author's name.


Note: authors may be involved in more than one paper or presentation, which is indicated by multiple page numbers in the index.

2. Use the Acrobat "Find" function
 - a. Click the Find icon .
 - a. Enter the appropriate title, author name, phrase, or keyword in the "Find What" input box.
 - b. Click the Find button. The first instance of the search text will be highlighted if found by the search.
 - c. Repeat step c to find other instances of your search criteria in the current document.

Finding papers

You can locate papers in two ways:

1. Link from an abstract
 - A blue rectangle will surround the title of any abstract with an associated paper. Click inside the rectangle to access the paper.
 - Some abstracts do not have an associated paper.

2. Use the Acrobat "Search" function:
 - a. Click the Search icon .
 - b. Enter the appropriate title, author name, phrase, or keyword in the "Find What" input box.

Note: do not include articles (a, an, the) in the search.

- c. Click the Search button. The title of any documents that include your search criteria will appear in the "Search Results" dialogue box.
- d. Repeat step c to find other instances of your search criteria in the current document.

After accessing a paper from its abstract, click "Go Back" to return to the Abstract or "Table of Contents" to return to the beginning of the proceedings.

Accessing Supporting Material

➤ Identifying Supporting Material:

In the Abstracts Section and at the beginning of some papers, **S** indicates there are Supporting Material for that work. There is also a list of papers, alphabetically by first author, with the associated Supporting Material file names, at the end of these instructions.

➤ Finding the Supporting Material Folder:

1. Using the list on the following pages, identify the supporting material file(s) that you would like to access
2. Explore the System Dynamics 2003 Proceedings CD-ROM using the utility appropriate for your computer (Windows Explorer for Windows, Finder for Mac)
3. Once you have opened the CD-ROM, open the “Supporting Material” folder
4. In the “Supporting Material” folder, locate the Supporting Material file that you identified in step 1
5. Double-click to open or launch the file
6. You may need to download software to open some files. Below, there is a list of the different websites where you can download the necessary software.

➤ Viewing/Opening/Reading the Supporting Material:

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

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

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

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

STELLA/ithink by High Performance Systems:

<http://dynamic.hps-inc.com/community/downloads/software demos.aspx>

This link will navigate you to STELLA and ithink Demo Kits. Each kit includes a free save-disabled version of the respective software which you may use to run STELLA and ithink models. The kits

also contain many additional models that you may find interesting, as well as several Flash-based tutorials that will walk you through how to use the software.

Powersim Studio by Powersim Solutions:

<http://www.powersimsolutions.com/sdconference2003/sdconference.asp>

Powersim Studio Express is a 90-day trial version of Powersim Studio 2003. Note that this installation will automatically replace any previous version of Studio 2000 or 2001 that is installed on the computer. Studio 2003 can open Studio 2001 files, but Studio 2001 cannot open a file that has been updated or created in Studio 2003. Integrated risk assessment, model hierarchy and improved connectivity towards external data sources are among the new features available in this release.

Vensim by Ventana Systems:

<http://www.vensim.com/reader.html>

The Vensim Model Reader is free software which allows you to publish models constructed with Vensim and distribute them to other people. Your model and the Vensim model reader can be copied and passed to as many people as you want, giving people access to your model without their needing to purchase Vensim.

➤ **Papers and the Associated Supporting Material**, *alphabetically by first author*:

Author Name and Paper Title	Supporting Material
Abdel-Hamid, Tarek, "The Obesity Problem: Is It a State In Mind?"	919_sup.pdf
Arenas, Fernando, "A Financial Approach to the Sustainability of Public Debt: The Case of Colombia"	370_sup.mdl
Bourguet-Diaz, Rafael, "On Mathematical Structures for Systems Archetypes"	361_sup.zip
Braje, Santiago, "Loan Portfolio Dynamics"	295_sup.mdl
Caramia, Massimiliano, "Service Quality and Customer Abandonment: A System Dynamics Approach to Call Center Management"	316_sup.zip
Chen, Yueping, "Economic Dynamics in Mobile Service Industry of China"	426_sup.zip
Chung, Ik Jae, "An Application of a System Dynamics Model to Evaluate Information and System Performance"	925_sup.stm
Dudley, Richard, "A Basis for Understanding Fishery Management Complexities"	118_sup.zip
Dudley, Richard, "Are International Development Projects Unfair to Local Staff?: Dynamics of the Dual Salary Scale Question"	211_sup.mdl
Gonzalez, Jose, "The Role of Learning and Risk Perception in Compliance"	350_sup.zip
Kapmeier, Florian, "Dynamics of Common Learning in Learning Alliances"	342_sup.mdl
Kubanek, Gordon, "Pilot Project to Map the Causal Relationships of the Conduct-Operations-Capability Program within Defense's Performance Management Framework"	158_sup.pdf
Kubanek, Gordon, "Dynamic Modeling of Three 'Personnel' Case Studies for the Department of National Defense and the Canadian Forces"	157_sup.pdf

Author Name and Paper Title	Supporting Material
Levine, Ralph, “Models of Attitude and Belief Change from the Perspective of System Dynamics”	177_sup.zip
Luna-Reyes, Luis, “The Digital Divide: An Integrated Approach”	246_sup.mdl
Mendez Acosta, Carlos, “Modelling the Grazing System: Grazing System Model”	349_sup.itm
Mora Luna, Ana María, “Wind Energy in Colombia: An Approach from the Real Options”	356_sup.zip
Newton, Paul, “System Dynamics Adoption at Enterprise Locations”	359_sup.mdl
Petrides, Lazaros, “Financing Retirement: A Basic Economic Analysis of the Pay-As-You-Go (PAYG) System and the Expected Consequences from a Transition to a Fully-Funded (FF) Scheme”	393_sup.txt
Pushnoi, Grigorii, “Dynamics of a System as a Process of Realization of its 'Potential'”	205_sup.pdf
Radianti, Jaziar, “A Dynamic Model of Spatial Planning in Metropolitan Areas”	226_sup.sim
Sawicka, Agata, “Choice under Risk in IT Environments According to Cumulative Prospect Theory”	345_sup.sim
Shiryaev, Vladimir, “Manufacturing Supply Chain Adaptive Management under Changing Demand Conditions”	304_sup.zip
Soto-Torres, M. Dolores, “Modeling Reforms and Growth of the Economy: A System Dynamics Approach”	101_sup.sim
Stave, Krystyna, “A Model to Understand Population Decline of the Devil's Hole Pupfish (<i>Cyprinodon diabolis</i>) and Support Habitat Management Decisions”	360_sup.mdl
Trailer, Jeff, “On the Theory of Rent and the Dynamics of Profitability”	371_sup.mdl
Tu, Yi Ming, “A Study of Connected Dynamic Data Sources to Improve Simulation Techniques for System Dynamics”	310_sup.zip
Ulli-Ber, Silvia, “Dynamic Interactions between Citizen Choice and Preferences and Public Policy Initiatives: A System Dynamics Model of Recycling Dynamics in a Typical Swiss Locality”	401_sup.mdl
Voronin, Anatoly, “Stability and Bifurcation of a Model of the Price Mechanism of Export-Import Transactions”	242_sup.pdf
Wakeland, Wayne, “A System Dynamics Model of the Pacific Coast Rockfish Fishery”	182_sup.stm
Zagonel, Aldo, “Using Group Model Building to Inform Welfare Reform Policy-Making in New York State: A Critical Look”	351_sup.zip
Zaraza, Ronald, “Using System Dynamics as a Core Tool for Content Teaching: A Mature Use of System Dynamics in the Pre-College Environment”	384_sup.pdf

Welcome

Dear Conference Participants:

Welcome to the 21st International Conference of the System Dynamics Society in the Big Apple! New York City has been a focal point for world events throughout its short history, even more so in recent years. The idea to hold the conference in New York City was first put forward in 1997 at the Istanbul conference, discussed in Wellington in 1999, then again in Bergen in 2000, and finalized in 2001 at the Atlanta conference.

A great deal has happened since then. Having this substantial group of people gather here is a testament to our belief in the importance of system dynamics, the significance of sharing our work, and the value we place on our relationships in this strong and active community. Thanks for coming!

As you can see from the presentation titles listed in our program, the field of system dynamics is thriving. Your fellow attendees come from about 40 countries and many different institutional settings. We hope that you will enjoy the program, learn and share, make new acquaintances, and renew ties with old friends.

Over the next four days you will have a chance to sample system dynamics work by leading practitioners from a variety of application areas. Well over 250 scheduled presentations are broken down into an exciting variety of parallel and convened sessions, interesting poster sessions, skill-building workshops, and a fascinating array of plenary and special sessions. We have grouped the presentations by topic to help you identify sessions you most wish to attend.

The conference theme is “economic dynamics” and several of the sessions are devoted to examining the ways in which system dynamics can be used for economic analysis. In particular, there will be a variety of presentations from “heterodox economists,” who object to traditional economics and see system dynamics as a tool that can add value to their work.

To increase your enjoyment of the conference, we have scheduled several on-site special events including an Informal Gathering, a Welcome Reception, and the Conference Banquet.

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, feel at home at the Roosevelt Hotel, and enjoy the attractions of New York City - a city beyond comparison!

This year over 275 volunteer reviewers, twenty five percent more than last year, screened and commented on submissions. In addition, 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 having our conference host Worcester Polytechnic, we are also very fortunate this year to have not one, but two local hosts: Fordham University Schools of Business and Amber Blocks Ltd. We sincerely appreciate the enthusiasm of all, especially Nicholas Georgantzas and Allen Boorstein.

We hope you find the conference rewarding and the facilities accommodating, and ask that you bring to our attention anything that may help us to both ensure the success of this, and future, conferences. Thank you for joining us.

Best wishes from the Conference Organizing Committee,

Bob Eberlein, Mike Radzicki, Roberta Spencer and Vedat Diker

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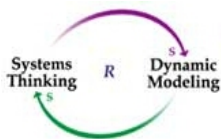
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Our strong focus on best practice is illustrated by the development of a methodology for the verification and validation of System Dynamics based models. This includes validation with mental models, ensuring that the problem has been well understood with a suitable boundary; verification of the simulation model to be certain that the influence diagram has been correctly translated into a quantitative simulation model; and finally, tests designed to validate the simulation model, comparing the model's behaviour with that of the real world.

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Our focus on the defence sector means that we bring unparalleled knowledge of the market place and the issues that face our clients to all our assignments. As part of our professional development programme, our consultants receive training in these issues from retired senior civil servants to ensure that we continue to provide solutions focused on our clients' precise needs.

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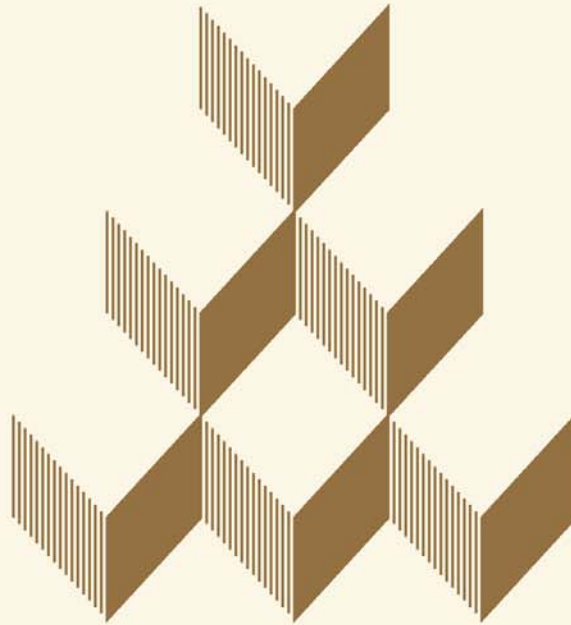
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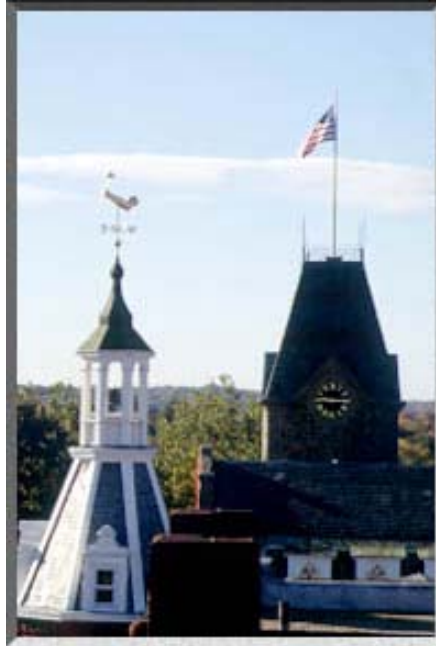
Overall Dynamics

The following diagrams show the relationships between various business metrics:

- Technology Availability leads to Product Investment and Product Attractiveness.
- Product Attractiveness leads to Price and Revenue.
- Price leads to Revenue.
- Revenue leads to COGS Reduction Investment and R&D Spending.
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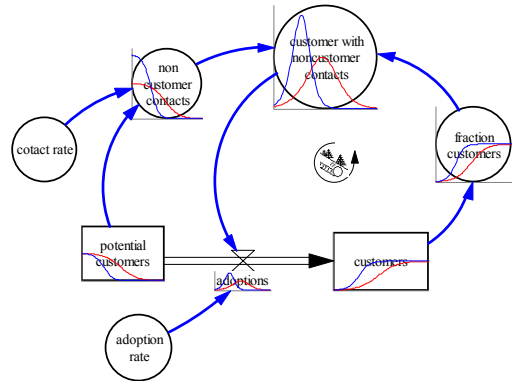
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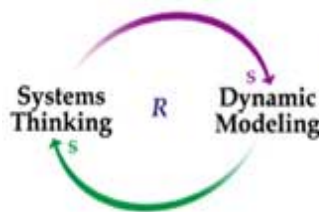
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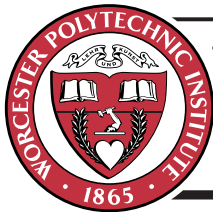
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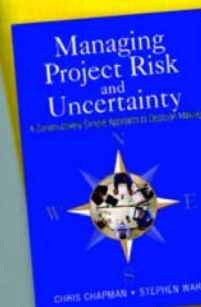
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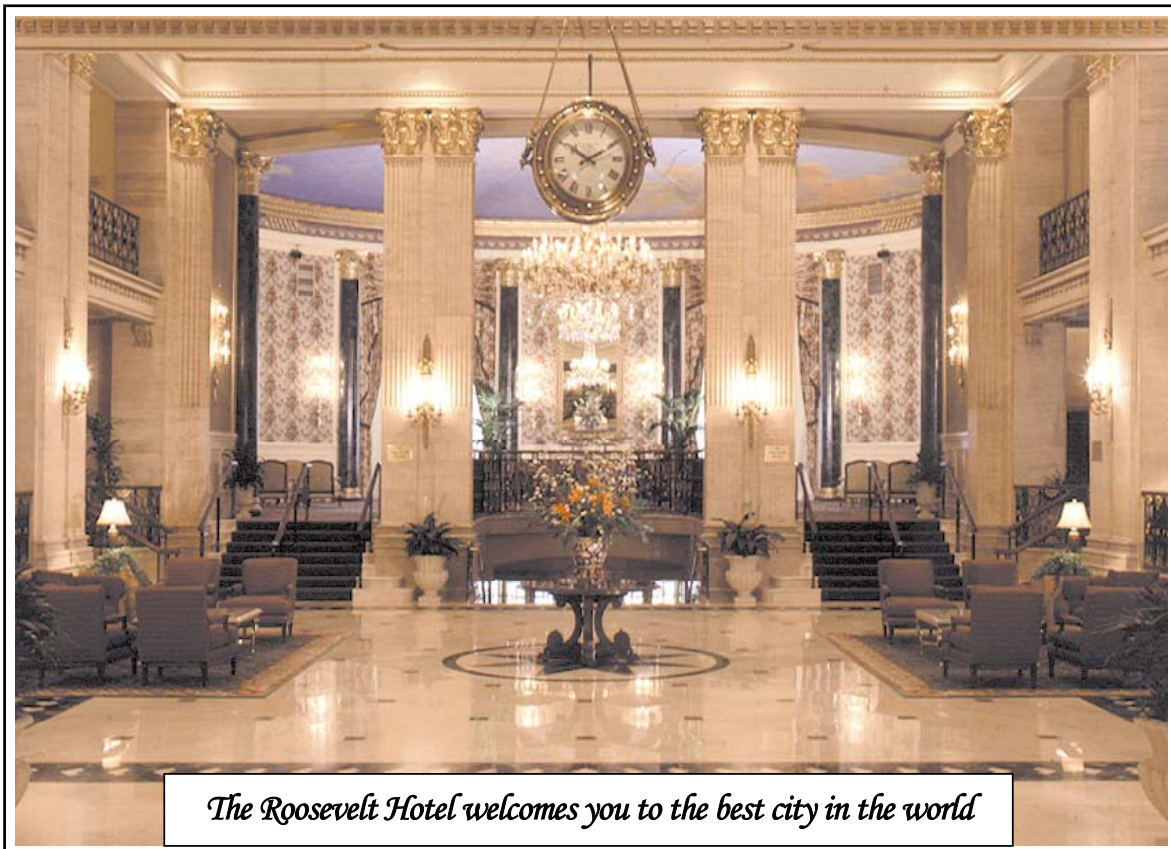
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THE SYSTEM DYNAMICS CAREER LINK

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

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

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

System Dynamics Oxford 2004



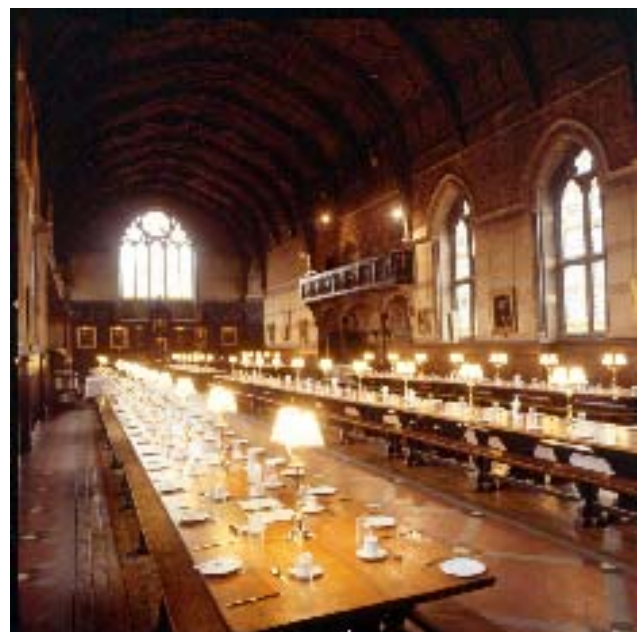
The 2004 conference of the System Dynamics Society will be held at Keble College, Oxford. This will provide a unique opportunity for delegates to experience an Oxford college whilst enjoying the benefits of a state of the art conference facility. Oxford's central location makes it readily accessible from London's major airport, Heathrow, and provides an ideal base for visiting many of the UK's major attractions. The historic atmosphere of an Oxford college should make for a truly unique conference and facilitate the exchange of ideas in our field.

The benefits of this conference will be:

- A unique opportunity to experience Oxford and Keble College with its heritage of academic excellence;
- With everything on one site and in close proximity, there will be unprecedented opportunity to network with international friends, colleagues and clients:
- Access to state of the art conference facilities; and
- Conference proceedings will be seamlessly organised in purpose built venues designed for maximum benefits and minimum hassle

The package

The conference will be available at an all inclusive package of accommodation and all food. This should enable delegates to plan their budgets with greater precision.



21st International Conference of the System Dynamics Society, July 20 – 24, 2003, New York City, USA

Papers

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The Obesity Problem: Is It a State In Mind?

The growing obesity problem is addressed from a decision-theoretic perspective. In managing their health (and their bodies), people are viewed as decision makers who are managing a truly complex and dynamic system – the human body. The question is how effective the mental models that people rely on are for such a task? Specifically, our objective is twofold. First, to demonstrate the deficiencies in people's mental models and the impacts they have on the treatment and prevention of obesity. Second, to demonstrate the utility of System Dynamics modeling tools to address these deficiencies through learning and decision support. A holistic system dynamics computer model is presented that integrates the processes of human metabolism, hormonal regulation, body composition, nutrition, and physical activity. The model serves as a laboratory tool for controlled experimentation to gain insight into the dynamics of body weight regulation. Three simulation experiments are conducted.

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System Dynamics at the Design-Science Interface: Past, Present and Future

This paper argues that system dynamics is about design science. Design activities are aimed at changing the world, not just analyzing it. As such, design science is a research perspective that has been second nature to the engineering and medical disciplines but has been problematic for the social sciences. This is because a design focus leads one to look for major real-world problems, where real-world relevance is high but academic rigor problematic. System dynamics seeks to improve the world based upon rigorous analysis of that world. Its design orientation has led to significant business relevance, but has long hampered its academic respectability. These days, both goals appear to have been achieved. However, the academic success of SD has been largely accomplished by positioning SD as part of mainstream science. In the future, this positioning might lead to a reduced design orientation of academic SD researchers and split the field into a practitioners and academics part.

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Health Care Supply Chain Dynamics: Systems Design of an American Health Care Provider

Health care organizations supply chains are more problematic to manage compared to its industrial counterparts. Moreover, health care organizations have very little control over the demand of supplies. In this paper we propose an integrated system dynamics framework for analyzing and modeling health care logistics chain. An American health care provider is used as an example to demonstrate the implementation of various stages of our framework. Based on the systems analyses, causal relationships were developed and an EOQ based computer simulation model was built and tested. The analyses of the results revealed that the existing “push” type inventory control policies are not suitable for the type of demand that is usually experienced by the health care systems. The authors further suggest that in the health care sector, inventory management should be based on ranking items in terms of “value” and “criticality” rather “frequency of use” to develop appropriate stocking policy.

A Dynamic Approach to Bank Credit in Light of Economic Development

It is really difficult that the managers can make in front of the necessity of investment of their companies appealing so alone to the own funds, that is to say, to the self-financing. The global competitiveness doesn't wait, neither gives truce, it is so they have to appeal to some financing form, either through a bank credit or an emission of holding and values in the stock exchange. The present investigation tries to explain the dynamic behavior between the productive sector and the financial sector, it presents the dynamic form as it is that multiple variables are interrelated, such as the benefits of the companies, the bank deposits, private saving, the interest rate, the retirement of savings, so that through the bank credit they contribute in the economic development of a country like Peru.

The Impact of E-Learning on the Quality of Education in Egyptian Universities

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Healthcare Performance Management Model: A System Dynamics Approach

Healthcare centers all over the world, and especially in the Middle East, face a situation of increasing revenues at a decreasing rate, while margins of profit are decreasing markedly. In an attempt to control expenses, hospital managements have tended to respond to this situation by introducing across-the-board cost-cutting policies on the side of the hospital's employees. In addition, management has had a tendency to over-use 'punishment of employees' and increased 'work-pressure' as their primary response to performance short-falls. In this study, the resultant drop in employee motivation and its negative effect on 'profit levels' will be shown. This study is trial to articulate, the 'Dynamics' between management policies, employee motivation, patient satisfaction, and revenues and expenses (profits). It is a modeling of the inter-relationships between these variables, as they exist today, in most Egyptian hospital environments.

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A Financial Approach to the Sustainability of Public Debt: The Case of Colombia

The public debt in developing countries, its management and sustainability, is a topic that, especially in the recent years, has been a main concern and a source of controversy among economists, academics and government policy makers. This article shows a system dynamics model that approaches the topic from a financial point of view, in order to contribute to the analysis of which are the policies and variables that present the higher degree of leverage for getting a sustainable level of the debt. The model has been developed considering the case of Colombia, as representative of the performance of public debt in several developing countries, where variables such as debt composition (foreign and local), inflation, devaluation, exchange rate, government expenditure structure and specifically military expenditure, are of major importance. The paper presents a preliminary univariate analysis whose results serve as a basis for a multivariate analysis where some high leverage policies and variables are suggested.

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Creating a Smart Growth Strategy for New Hampshire: Balancing Economy, Environment, Transportation, and Housing

New Hampshire is the fastest-growing state in New England; in fact, it ranked in the top 10 nationally in population growth percentage. Population growth has been accompanied by increasing sprawl, reduction in open space, greater traffic congestion, and conversion of what was previously green space into developments. New Hampshire is a politically fractious state, with large numbers of Republicans, Democrats, and Independents. It is also a state with relatively little in the way of zoning regulations or state government influence on growth and a state with a strong tradition of popular support for limiting the power of government. As a result of the way New Hampshire has grown and of its political fragmentation, the conflict over growth has often involved heated emotions and, sometimes, lawsuits. Our project has brought together business, civic, environmental, and other leaders to address these issues and balance their diverse concerns.

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Profiting from Environmental Improvement

Situation Businesses have tremendous influence on the environment, both through their production and business processes and through the choices their products offer consumers. To the extent businesses become more environmentally friendly, the environment benefits tremendously. Complication Many companies would like to make their business practices more environmentally friendly, but believe that to do so would harm profits. Given the current market environment, they feel they cannot do anything that would reduce profitability. Questions - Can environmental improvements be prevented from reducing profitability? - Can environmental improvements even increase profits? - What techniques can companies use to improve their environmental records while maintaining or improving profitability? Session Approach We will address these questions by examining simple structures, techniques, and results drawn from many different industries.

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Boom and Bust Shrimp Aquaculture: A Feebate Policy for Sustainability

Well intentioned policies which fail to perceive environmental feedback often exacerbate over-exploitation of renewable natural

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resources, especially when the resource exploitation is driven by powerful market forces. The purpose of this paper is to consider such a situation, the world shrimp aquaculture industry, and to explore one localized case where a policy intervention of “feebate” may offer a potential balancing effect.

An Explanatory Model for Restoring Manufacturing Competitive Advantage in Egypt

In this paper, we present an explanatory model for gaining competitive advantage in the manufacturing sector. First a conceptual model of manufacturing strategy, with a view to give competitive advantage in the market, is developed and concepts such as competitive priority, product and process profile and its implication on competitive advantage are explained. Then once the model is fully developed we map it into a meta-model based on business dynamics methodology. This process will help us understand the policy that government and managers must follow to achieve the ultimate goal of being competitive in the global market.

Common Ground for Institutional Economics and Systems Dynamics

Institutional economics traces its roots to the works, beginning in the late nineteenth century, of Thorstein Veblen, John R. Commons and Wesley C. Mitchell. They believed that orthodox economic theory, based on deduction from axioms, was not a proper foundation to study the economy. They attempted to establish relations between economic actors as defined by important economic institutions. Classical theory, on the other hand, is based on natural law rather than human organization. Natural law provided a fixed structure, and this reduced uncertainty in economic theory. Change was within the structure but the structure was always stable. Institutional economists examine institutions that provide economic order, and they study the endogenous forces that cause these institutions to evolve. I believe these are some of the same elements that describe Systems Dynamics.

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Estimation of Bi-fuel Vehicular Emission with a System Dynamics Approach

This work have done on Chassis dynamometer to identify fuel consumption's, power output, and exhaust emission. The chassis dynamometer testing result, and the number of CO, HC and CO2 and CNG sales data in the 1997-2000 will be use for simulation to determine the condition of some parameter as mentioned above. The objectives of the study is to carry out a trial to know the change of CO, HC, and CO2 pollutant from CNG vehicles using gasoline versus CNG by simulation. The result shown the amount of CO in the year of 2008 will reduce to 593,271.5 ton (77.41%), HC will be reduce to 169,916.67 ton (91.66%), and CO2 will reduce to 9,680,384 ton (17.36%) (Scenario 1). Scenario 2: the amount of CO in the year of 2008 will reduce to 1,039,825.67 ton (60.41%). HC will be reduce to 169,682.13 ton (91.67%), and CO2 will be reduce to 9,702,197 ton (17.18%).

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**Misperception of Dynamics in Military Planning:
Exploring the Counter-Intuitive Behaviour of the
Logistics Chain**

Knowing from the system dynamics (SD) literature that human decision makers generally have problems when making intuitive judgements in situations involving accumulations, time lags, feedback and non-linearities, we suspect that the problems will be no less for planners of military operations. Since most conventional military operations involve the movement of forces from base or camp into an area of operations, one should expect that commanders, planning staff and analysts possess at least a basic understanding of logistics dynamics. However (and consistent with our initial suspicion), in a simplified experimental task framed as a "Peace Support Operation (PSO)", we find that even highly educated defence analysts are consistently over-optimistic as well as demonstrate only a partial understanding of the dynamics generated by the logistics chain structure. In addition to reporting these preliminary findings, the paper makes suggestions on how to build and improve mental models of decision makers in situations of conflict, crisis and war.

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Models for National Planning

Standards for national planning models are changing. The World Bank (WB), UN Development Programme (UNDP), the International Monetary Fund (IMF), and many bi-lateral funders have adopted Comprehensive Development Framework (CDF) and Poverty Reduction Strategy Paper (PRSP). The CDF, PRSP, and the Millennium Development Goals (MDGs) make new demands for transparency, comprehensiveness, and user-friendliness in national models. While the WB's Revised Minimum Standard Model-Extended (RMSM-X) and the IMF's Financial Planning Framework (FPF) model continue to dominate, they are outdated and do not meet the new standards. A review of currently available national planning models was funded by Conservation International and published by the University of Bergen; the review ranks highest a System Dynamics model called Threshold 21 (T21). This paper summarizes the review, presents an overview of the T21 model and some of its recent national applications, and describes emerging partnerships using T21.

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Simulating Health and Social Care Delivery

In this presentation we discuss the use of system dynamics to understand the delivery of health and social care. We report on the development of a simulation model to address the issues of elderly care in a local health care system in the South East of England. We explore the appropriate level of aggregation for a model to address the policy challenges faced by local care organisations. While we recognise the value of a highly aggregated systems dynamics approach and the danger of inappropriate disaggregation, we argue in the presentation that features of the care system (such as the recurrence of admissions to the hospital) make it desirable to include some aspects of patient history in a flow model of patient path ways. We examine the feasibility of a more disaggregated approach and the influence of this choice for the understanding of the system and the development of beneficial policy options.

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A Sustainability Assessment of the Urban Rehabilitation Project of the Medina of Fez, Morocco

The old city of Fez, Morocco, classified as Heritage of Humankind by the UNESCO, is subject to an integrated rehabilitation plan

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running over 15 years. The plan aims at restoring and preserving the economy, cultural value, and social heritage of the old city. The study follows a system dynamics approach to describe and analyze the rehabilitation plan in order to identify the strengths and defects of the plan. This study shows that while the plan is giving relatively satisfying results over the short and medium terms, it is unlikely to attain long term sustainability.

Not with a Bang, but with a Whimper: Understanding Delays in Semiconductor Supply Chain Dynamics

The semiconductor industry is characterized by high volatility. Therefore, one would expect its supply chains to be very fast in adjusting to demand. However, it appears that delays in adjusting to the latest downturn of the market in 2001 have been considerable. Generally, these delays and the dynamics that are causing them are not well understood within the industry. This paper presents research that explains these delays by means of a system dynamics simulation model capturing semiconductor supply chain structure, decision-making processes and associated supply chain. The model is based upon the existing literature but has been tailored, calibrated and validated with company representatives and quantitative time series data from a major European IC manufacturer. With this model, several SCM policies are explored that are effective in improving both sales and supply chain performance, such as more aggressive capacity build-up, lower capacity utilization targets and higher end product buffer stocks.

Managing Intellectual Capital through Interactive Learning Environments Based on System Dynamics and Accounting Models: The Dynamic Intellectual Capital Scorecard

This paper shows the potential impact of Interactive Learning Environments (ILEs) embodying System Dynamics (SD) and accounting models to support top management decisions in allocating

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business resources in a planning setting for Intellectual Capital (IC) management. Human resource training and organisational expenditures are often budgeted as discretionary costs and quite seldom their impact on business performance over time is properly investigated. The above issue provides the basis for an ILE portraying a “scorecard” including a qualitative framework for IC monetary and non-monetary assessment. In the first section of the paper, an overview of the conceptual foundations of IC and different methods for its assessment is given. Main assumptions, strengths and weaknesses are remarked. A qualitative evaluation approach for IC management is then proposed by the authors, and justification for applying the SD methodology is given.

Applying System Dynamics to a Municipal Firm: The Case of a Small Municipality's Education Policies

As consequence of EU addresses to introduce efficacy and efficiency principles into public administration management, municipality administrators must adopt new and more effective tools and techniques for strategy analysis and decision support. This paper describes the results of applying System Dynamics to a small municipality. Together with municipality administrators and managers, the authors developed a simple SD model to analyze a portion of the managing system, i.e. the Education Service. First, information and data have been collected through interviews and report analysis. Then, the model was gradually developed through an iterative process that constantly involved municipally actors. Within this process, missing knowledge was hypothesized and, hence, tested with the support of field managers. Key-levers were stated in details. As a final point, the effects caused by lever manipulation was described and discussed. The authors conclude with remarks on further project's developments.

Identification of Carrying Capacity of the Cellular Communication Market and Synthesis of a Company Price Strategy

The purpose of the work is to develop the optimum price strategy for the cellular communications services company. This is achieved by establishing a new price structure based on the identification of the capacity of the market segment for the sale of cellular communication services.

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On Mathematical Structures for Systems Archetypes

A proposal on mathematical structures for systems archetypes is presented. The mathematical structures are based on systems of differential equations and the concept of state variable representation. Vensim is used to construct block diagrams and execute simulations. Finally, benefits are discussed by using both representations as conventional System Dynamics models and as differential equation systems.

The Use of System Dynamics in Management: Reasons and Applications

This paper discusses the benefits of SD in management. The first part raises questions why SD is not used widely and, based on underlying feedback structures in management decisions, gives arguments why it should be more present; like spreadsheet software. The second part exemplarily describes two specific areas of application that may be relevant for most corporations, namely Knowledge Management and derivation of the balance sheet. We will focus on specific problems in these fields as well as typical questions and approaches how to answer them by introducing SD. User interfaces will briefly be discussed as well as input control using rule bases. The paper concludes with an outlook and critical evaluation.

Loan Portfolio Dynamics

This paper presents an approach to credit risk modeling that builds on standard techniques to develop a system dynamics model. To this author's knowledge, this is the first attempt to analyze a loan portfolio using transition matrices within a system dynamics framework. The paper shows how a simple model considering the stock and flow structure of a loan portfolio can give valuable information about the performance of the portfolio over time and analyzes the steady state equilibrium. The simulation results of a more detailed model indicate that misperception of the dynamic structure and the use of decision heuristics to determine growth

strategies and pricing may generate significant oscillations. This is true even in this simplified framework, in which a single and isolated bank is modeled in an environment of fixed funding rate, and the response to a single discrete change in parameters is considered.

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Emergency Management Simulations: An Approach to the Assessment of Decision-Making Processes in Complex Dynamic Crisis Environments

Crisis Management has been a topic for training activities within the field of emergency management for a long time already. These approaches target at different objectives.

First, there are conventional crisis management exercises for the development of procedural skills considered to be necessary for efficient responses to events. The use of the relevant skills is monitored. Participants receive feedback on the level of skill they can demonstrate.

Second, there are computer-based simulations for the training of decision making processes both in a procedural as well as in a problem-solving approach. Such scenarios allow participants to run through practise exercises in 'virtual' environments. That can cover processes and situations which go beyond exercises which can be experienced in real settings. Participants receive feedback on their performance from experts and are given respective advice. The simulation techniques used can be model- respectively event-driven. In both approaches models mostly remain to be 'block-boxes'.

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Using Simulation to Produce a Data Fusion Decision Support Tool for the Assessment of Manmade and Natural Disasters

Abstract: Effective performance in complex, dynamic command and control environments depends on high quality awareness. In such situations, an Emergency Command Center's (ECC) ability to deal with multiple disparate sources of information is complicated by the volume of information available from human experts and automated decision support tools. In the event of a natural disaster, large amounts of information, both accurate and inaccurate, must be assessed by the ECC. The data to be analyzed is reported to the ECC by field agents, or sensors. These sensors are disbursed throughout the disaster area and vary from trained professionals to civilians. The correct assessment of the information reported by these sensors is necessary to support a variety of authoritative decisions made by the

ECC. This paper focuses on the creation of the intelligent agent based reporting simulation that produces the ground truth and field reports necessary for data fusion to analyze.

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Inflationary Stabilization and External Vulnerability of the Brazilian Economy in the Second Half of the 1990's: A Systemic Approach

The current boom of economic studies using the systemic approach has not yet produced effects in Brazil. For instance, there are no macroeconomics studies published in the principal Brazilian economic journals which use this approach. The present study seeks to begin to fill this gap, building and simulating a very preliminary systemic model for the Brazilian economy. The purpose of the paper is to try to understand why the stabilization plan launched in 1994 – The Real Plan – endogenously generated unexpected effects that ended for threatening to reverse the victory in the battle for economic stabilization reached in the first years. It will be argued that one of the reasons the plan was not as successful as it could have been was the disregard for the systemic effects of the adoption of an appreciated exchange rate as an anchor for the new currency. The most important of those effects was the Brazilian economy's progressive vulnerability to external shocks, which culminated by bringing the country to the edge of insolvency in the beginning of 1999.

Service Quality and Customer Abandonment: A System Dynamics Approach to Call Center Management

The ability to profitably manage the level of resources in a service system can be considered a strategic skill in all those organizations, including no-profit ones and Public Administrations, that aim at providing an added value service to customers as well as balancing the level of service (in terms of quality) with costs. In this paper we will focus on a typical service system inside of which, in every moment, management struggles in order to reach that balance, because of the extremely dynamic behavior of the entire system: a Call Center. Our aim is to show that an efficient management of the customers abandonment and the quality of service offered to customers, can positively impact on a correct resource leveling in the system, which may otherwise be found by means of typical Operations Research or Queuing Theory methods. In particular, we want to show that this can be more easily inferred and understood by resorting to simulation.

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**Twelve-Year-Olds Learning Mathematics with
System Dynamics: A Case Study from a Rural
Locality of Northeastern Portugal**

System Dynamics is been used experimentally in the teaching of Mathematics to young adolescents, taking advantage of its capacity to facilitate the visualisation of abstract entities. The objective of the experiment is to compare the scholarly progress between the students learning with SD versus the others learning with conventional mathematics methodology and media. The particular experiment is conducted in rural North-eastern Portugal, where the students historically have exhibited a low interest and aptitude for mathematics. In addition, due to socio-economic conditions, they have little or no familiarity with modern information technology and equipment, which makes an experiment of this sort especially interesting. Overall, the results of the experiment are encouraging and System Dynamics appears as a promising instrument for certain topics of mathematics, possibly looking into a formal curricular introduction.

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**The Actors' Behavior Improving in the 'Mobisim'
Model**

The simulation model, named MobiSim, was elaborated on the demand of the French Ministry of Transport (the model was presented during XX International Conference of the System Dynamics Society in Palermo). The objectives were to create the tool for a relevant assistance in strategic decision-making on the transportation system development in the relationships (interconnections) with the territory development in the metropolitan area. Two model realisations: TourSim and MobiSimII and the interface allowing to establish scenarios, visualize and analyze the output results, were create with the Vensim simulation software. They were applied for the exploration of the person's displacement evolution scenarios in the French agglomerations of a different size. The model's applications output correct and logical results in there large lines. Nevertheless, the model modifications concerning the behaviour of the different actors must be made, which will allow improving the relevancy of the simulation results.

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A System Dynamics Pilot Study to Demonstrate the Impact of Border Intervention on Tobacco Related Activities in New Zealand

This paper summarises the collaborative work undertaken by a group from Victoria University, the NZ Customs Service (NZCS) and the NZ Ministry of Health. It shows how the system dynamics methodology was used to demonstrate the value of the relationship of Customs outputs to desired Government outcomes in relation to the collection of tobacco excise duties and cigarette smoking in New Zealand. Group model building workshops addressed the organising question: “What are the affects of price on tobacco consumption in New Zealand?”. A demonstration system dynamics simulation model using the ithink dynamic simulation software was developed, consisting of 7 sectors: NZCS Air & Marine sector; duty paid cigarette imports; duty free cigarettes; NZ tobacco manufacturing sector; NZCS duty collection; NZ tobacco products market; and a health sector. The model variables are simulated on an annual basis from 2000 to 2010. Policy experiments with the model include examining the effects of changes in tobacco excise duties.

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Economic Dynamics in Mobile Service Industry of China

The current mobile service in China displays a highly dynamic competition between two major operators, China Mobile and China Unicom. Their market share concerning the number of subscriber is influenced by the subscriber base, service quality, pricing policy, etc. Current researches and analyses are mostly direct comparisons of the relative advantage of the two operators, in which weights of every item being compared are chosen almost arbitrarily and the dynamic relationships between these items are usually ignored. This research stands from the view of China Mobile, the bigger and earlier operator, to explore the reason of its shrinking market share after SMS (Short Message Service) becomes popular in China. The dynamics between the service quality, exchange capacity, price in the mobile service are highlighted to show how these factors influence the growth of the total mobile market and the relative advantage in the duopoly as well.

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A System Dynamics-Based Study on Elderly Non-Acute Service in Norway

Modern non-acute service sector for old people is a highly dynamic and complex system. Currently in Norway, it includes nursing home service, community house service and home-based service. Patient flow between different service sectors is influenced by various factors like population composition, waiting time and relative satisfaction. Traditional analyses and comparisons between these services ignore the dynamics and complexity underlying the patient flow and fail to properly represent the structure of non-acute service sector for old people. Other researches on the flow in public health service system, although from a dynamic view, usually take the non-acute care system as a supplement to acute care system. Thus they do not differentiate the non-acute services and make comparisons for the investment decision-support purpose in non-acute sector. This research uses the system dynamics methodology to map the dynamic patient flow in elderly non-acute caring system in Norway.

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Dynamics of Government-Nonprofit Interdependencies

This paper examines the dynamic partnerships between government and service nonprofits, focusing on fundamental causes and consequences of interdependence between those sectors. We collected data from national, state, and local level cross-sectional studies done by various researchers at different points in time from 1960 to 2000, constructed a trend chart using the results to reveal the patterns of the government-nonprofit relationship. Causal loop diagrams were drawn to help explain the dynamic interdependence between government and nonprofits for service delivery. The results show that government funding has helped lead to nonprofits' dysfunctional consequences. This study demonstrates that system dynamics modeling is not only a powerful way to understand dynamic processes, but also a useful way to explore the consequences of policy adjustments to offset future dysfunctional consequences and proactively guide organizations toward viable futures.

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**An Application of a System Dynamics Model to Evaluate Information and System Performance**

As more organizational resources are expanded in designing information system, it becomes increasingly important to assess benefits actually derived from the system. Information provided by system is resource available to organizations or decision-makers. The introduction of information system should be justified on a cost-saving ground like other resources. However, it is not easy to measure the benefit and the value of information system. Although several approaches for evaluating information system have been suggested, they show significant difficulties in applying to complex and dynamic environments. This study applies system dynamics model to evaluate information and system performance. A system dynamics model is used as a laboratory setting to evaluate information by examining the relative merits of information attributes in terms of its impact on the overall system performance. System performance is discussed with three different aspects; expansion, stability, and efficiency.

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Teaming Up: An Educational Experiment

Ford Motor Company teamed with the University of Michigan to offer six MBA students the opportunity to learn Systems Thinking and apply it to a real business issue ("Shadow IT") in a short 8-week period. This paper explores the experiences of the students learning a new and different analysis tool juxtaposed against the standard set of business analysis tools offered by their MBA curriculum. The effect on the students of the "forced marriage" of Systems Thinking to the standard action learning program at Michigan is revealed. Finally, we will also discuss the highly successful results of this project and how it has affected the application of Systems Thinking at the Ford Motor Company.

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A Distributed System Dynamics-Based Framework for Modeling Virtual Organizations

With advances in distributed computing technology, the idea of a virtual organisation – a network of collaborators whose purpose it is to execute a business model – is now a reality. A core need of any business that conducts operations over a computer network is the availability of systems and tools to support their business process. Many excellent modeling products exist, however these have mostly

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been tailored to suit co-located planning activities, where group members typically build models within the same “four walls”. The aim of this research is to leverage significant developments in distributed computing – XML and .NET in particular – to provide a “plug and play” vendor-neutral distributed framework, which can support dispersed actors in a virtual organisation. The problem used to focus the development efforts is the well-known “beer game”. This paper presents the background to our approach, the overall system architecture is also shown, and future work is described.

How Do We Increase Port Security Without Imperiling Maritime Commerce?: Using Flight Simulators and Workshops to Begin the Discussion

Port security is an area of increasing national concern. Various security measures have been proposed to reduce security threats. These measures have the potential to significantly increase shipping cost and time. To help explore the tradeoffs between security and commerce, we have used system dynamics models to engage diverse representatives of business and government. We have developed models of port performance on two relevant time scales. A short-term port operations model simulates the effects of a variety of security measures on port operations, under both normal conditions and when subject to several disruptions in supporting infrastructures. A long-term port economics model simulates the possible consequences in of port performance changes caused by security measures on the long-term competitiveness of the port. In workshops designed around these models, we have engaged government and business representatives in discussions about the ramifications of security policies.

Learning from Incidents

Many disasters have occurred because organizations have ignored the warning signs of pre-cursor incidents or have failed to learn from the lessons of the past. Risk is inherent in many high technology systems, but society views the benefits of continuing to operate these systems as outweighing the cost of the occasional disaster. Must we continue to live with disasters? Normal accident theory sees accidents as the unwanted but inevitable output of complex systems,

while high reliability theory sees accidents as preventable by certain characteristics of the organization. This paper proposes that an incident learning system can provide a bridge between these two theories. By learning from the incidents that inevitably occur in a complex system, an organization can reduce risk and minimize loss. Thus, an organization with an effective incident learning system sustains a process of continuous improvement that allows it to become a high reliability organization over time.

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**Are you vMad to Go for Surgery? Risk
Assessment for Transmission of vCJD via Surgical
Instruments: The Contribution of System
Dynamics**

This paper describes the application of system dynamics to assess the risk of transmission of vCJD (a human form of “Mad Cow Disease”) via surgical instruments. This was undertaken on behalf of the UK Department of Health and contributed to officially published reports by the UK government. System dynamics modelling helped simulate potential transmission rates and the impact of mitigation policies on the general population. A wide-ranging review group (medical and modelling experts) undertook a very detailed verification and validation exercise on models used in the study. The paper reviews the modelling process, and illustrates how system dynamics can be effectively used in conjunction with static spreadsheet models.

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**Extreme Event Agenda Setting and Decision
Making**

Extreme events are “potential” focusing events that can cause severe damage and potential harms to many people in a very short period of time. A focusing event may create a “window of opportunity” that policy makers can use to advance an issue on the national agenda. However, once disaster issues reach the agenda, the resulting extreme event policy often focuses on response and relief rather than mitigation and preparedness. Much of the previous literature on this topic discusses these problems in terms of discrete “events” that have some degree of influence on agenda setting and the policy process. This paper develops a continuous perspective on the problem by using a system dynamics approach to explore how changing relationships between various stakeholders in the system influence extreme event agenda setting and policy making. This paper will also discuss the utility of such a decision aid for public administrators who wish to have a better understanding of the policy process.

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**Building a Theory of Open Online Collaboration
Using System Dynamics**

This presentation reports an attempt to build an integrated theoretical framework for studying 'open online collaboration' as it takes place within a special type of online communities, which the author calls "open online collaboration communities." Open online collaboration communities are loosely connected groups of people, who use the Internet as a medium for carrying out collaborative projects for producing and improving a wide range of stand-alone information products, such as software, and courseware. The framework is based on leading theoretical approaches to the study of online communities, and articulated as a system dynamics model.

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**Institutional Factors in Supply Chain
Management: Experimental Studies on Reducing
the Bullwhip Effect**

The tendency of orders to increase in variability as one moves up a supply chain is commonly known as the 'bullwhip effect.' We use methods from experimental economics to study this phenomenon from a behavioral perspective in the context of a simple, serial, supply chain subject to information lags and stochastic demand. In the first experiment we find the bullwhip effect still exists when normal operational causes (e.g., batching, price fluctuations, demand estimation, etc.) are removed. In a second and third set of experiments we find that the bullwhip, and the underlying tendency of underweighting, is reduced when information on inventory levels or POS data is shared. The results also support the theoretically suggested notion that upstream chain members stand to gain the most from information sharing initiatives.

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**A Basis for Understanding Fishery Management
Complexities**

Fisheries in developed countries are over-harvested in spite of efforts by scientists and management agencies. Fisheries are well studied – data is not lacking. Complex management defeats seemingly obvious solutions. System dynamics may help, but fisheries analysis typically emphasizes population dynamics and fails to describe decision making by fishers, management agencies, and politicians. This paper provides a simple, acceptably complex, population model meshed with fishery activities and management decision making. Based on

the biomass dynamic model, it permits delayed entry of young and biomass feedback to additions of young and growth to the stock. Fishers enter the fishery when catch rates are high. When catch rates are low remaining fishers attempt to improve their fishing efficiency. Excessive fishing damages the ecosystem supporting the fish population. Managers attempt to maintain the fish stock at acceptable biomass levels, but are influenced by lobbying and politics.

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Are International Development Projects Unfair to Local Staff?: Dynamics of the Dual Salary Scale Question

Internationally funded projects typically use two salary scales: one for internationally recruited staff and a lower one for locally recruited staff. The fairness of this approach has been questioned particularly when staff members have the same training and carry out similar tasks. Administrators argue that they pay the appropriate salary, based on local wage scales, and that locally recruited staff are under no obligation to accept the positions offered. Also, higher salaries offered to local staff would drain talent from other local employers. Others argue that such unfair treatment undermines the collegial atmosphere desired in such projects, and that a more equitable salary arrangement should be adopted. Complicating this question are many peripheral factors. A system dynamics model might help clarify the problems created by a dual salary scale system and provides insights which might help formulate a better system.

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Technology Improvement Policy: The Case of Turkey

Technology has been one of the most important factors of the economic and social growth and globally scaled competitiveness, although not respected as a separate factor by traditional economists until recently. It is now widely accepted that technology improvement plays a very major role on national growth. Technology has a number of interactive and conflicting variables and parameters, which are not allowing an analysis with quantitative tools only. Complex dynamic analysis seems to be a proper tool to handle this sophistication. A system dynamics model constructed for policy analysis in Turkey with respect to technology improvement and comparison of various technology improvement policies. Under the scope of this paper; the elements effecting technology improvement are identified and analyzed by qualitative/quantitative methods, the key relations among these elements are identified, the influence

model and the system model are drawn and some scenario analysis are performed for the comparison of possible technology improvement policies.

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Modeling Uncertainty in Electricity Markets for Learning, Policy and Strategy

Since the late 80s, the electricity industry has been sustaining important adjustments worldwide, changing from centrally planned systems to open market schemes. These markets exhibit major dynamics with respect to management, technology progress, consumer behaviour, industry configuration and government policy. In some countries, consumers have benefited from changes but in others they have suffered from the new arrangements. At the company level, some have performed better than others and many have gone bankrupt. There are questions related to ill-defined policy assessment or company mismanagement. From the hindsight it can be argued that in all circumstances some modelling has been or could have been of help, particularly SD modelling. In this paper we focus on the scope of SD approach and report research that emphasize on how modelling has taken an important role in "learning environments" as well as a support tool for decision-making and policy assessment.

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Innovation and Economic Development: Toward a System Dynamics Perspective

This paper revises the theoretical approaches regarding the dynamics of innovation intending to understand whether or not they can explain the process of quick growth and stagnation of countries. It is contended that system thinking approaches might complement some of classic ones, which we analyze under a system dynamics framework, facilitating exploration and simulation, in order to assess how the dynamics innovation might accelerate the process of growth and development of societies. It is thought that the current approaches to the innovation discussion do not clearly explain what has happened to the countries with a quick growth and they do not propose frameworks that allow us to study the effects of possible driving forces that might reflect those same dynamics in countries in development stages. We argue that a systems approach supported by systems dynamics models allow us to better study and evaluate the dynamics of innovation.

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Controlling a Company Knowledge Productivity Index through the Four-Dimensional Cost of Management Model: A System Dynamics Approach

Knowledge has become the vital source of company's competitive advantage and its market value and hence an asset to be measured and managed. This paper is about how organizations can better manage their knowledge, viewed from a practical standpoint with the emphasis on the impact of investing in knowledge on a company's productivity. Investment on knowledge management in this study has been subdivided into 4 main dimensions, namely; investing on Training, allocating budget for Total Quality Management, Investing on Internal Organization Learning, and finally, Hiring New Skilled and Experienced employees. So, all costs associated to the above mentioned dimensions are considered the cost of management, that will be used to evaluate the company's productivity index using the system dynamic approach in order to quantitatively getting the sense of the subject. The proposed model is an initial attempt to build a viable predictive model for application of Knowledge Management in businesses.

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Effects of Liberalization on the Dynamics of Hydro Based Electricity Supply Industries: The Case of Colombia

This paper explores how the structure of ownership affects the sustainability of the Colombian liberalised power system which is highly reliant on hydroelectric capacity and therefore highly vulnerable to seasonality. To a large extent, investment behaviour, (which is influenced by the ownership structure of electricity supply industries) determines future capacity expansion patterns as well as security of supply. Investment behaviour under liberalised markets is also a function of the different types of companies (i.e. private, public). Not only do the demands on the returns to investment vary from firm to firm, but there can be variations in their market share aims, portfolio development goals, ability to close a sound financing scheme (e.g. raise capital, leverage financing) and risk tolerance (among others), etc.

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Latin and South America: A Case Study of Emergent Geopolitical Viruses

This paper uses influence diagramming to examine the geopolitical significance of narcoterrorism dynamics currently observed in Colombia and the Andean Ridge region. It argues that the interaction between drug production, insurgency, and social marginalization can be viewed as a dynamic system that is relatively unstable. The extensive quantity of positive feedback relations in this system implies that the current violence and social chaos could spread across the region and overwhelm the capability of governments to respond, more rapidly than a traditional analysis of narcoterrorism and other regional phenomenon suggests.

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System Dynamics Approach for Coastal Nature Conservation: An Example of Sharm El-Sheikhs' Coral Reefs, Sinai, Egypt

This paper describes a detailed computer model developed, for Sharm El-Sheikh city, using Vensim simulation program in system dynamics tradition. This model was created to estimate and compare socio-economic and ecological impacts of different tourism development strategies, in Sharm, from sustainability point of view. An outline of feedback; (cause/effect diagrams) is presented, followed by details of the model boundary and its' simulation structure. Sharm present development trend was analyzed for a time bounds 1985 - 2002. The model validity is tested based on extrapolation of such present trend of Sharm without any specific policy constrains on land or marine use. Four different development scenarios are generated for a time bounds 2002-2020. Simulation output and scenarios evaluation are then discussed.

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Coupled Human/Biological Systems in an Urban Area: Towards an Analytical Framework Using Dynamic Simulation

This paper hypothesizes a newly understood, autonomous third force that causes urban expansion even without demo-economic pressures and thus shapes urban dynamics. It is a self-reinforcing feedback relationship represented as a multi-causal feedback loop whereby roads beget roads through a process of ever declining developmental densities. The loop's dynamic structure is central to a framework for analyzing human--biologic systems in urban areas. The hypothesis is

articulated as a system dynamics model calibrated on the Salt Lake City-Ogden metropolitan area, closely validated against recent observations, and used to explore the urban system performance implications of various policy options through to the year 2030. Other relevant dynamics are then outlined peripheral to this core. Thus this paper is about the dynamics of sprawl and how it serves as a dynamic organizing principle around which to conceptualize further explorations of human-biologic systems in urban area.

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A Conceptual Model of Operating Internet-based B2C Business in Fast-growing Industries

Most existing econometric studies approached the issue of Internet-based Business-to-Consumer (B2C) operation by analyzing one or two specific relations, but few studies have been done to picture the entire dynamics of online (Internet-based B2C) and offline (traditional brick & mortar) operation in fast-growing industries. Taking the System Dynamics (SD) perspective, this paper offers a comprehensive conceptual model that portrays dynamic processes of simultaneously running online and offline business in fast-growing industries. All major functional operations such as R&D, manufacturing, inventory management, product delivery, after sales service, online store construction, as well as online and offline customer flows are included in the causal loop diagram. Five reinforcing loops and three balancing loops significantly influencing corporate performance are identified and analyzed. The implications of this conceptual model to practitioners in fast-growing industries are discussed.

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Global Socioeconomic Dynamics under Collapse Conditions

This paper describes the structure and expected dynamics of the collapse of the world socioeconomic system when consumption growth ends permanently, either through environmental catastrophe or human intervention. A collapse must occur because world human consumption is considerably larger than the Earth system can sustain. The feedback structure that controls the collapse will be different from the structure that created the growth. Both must be well understood in order to develop strategies to control the collapse. As the present global socioeconomic system declines under pressure from unprecedented, unsustainable stock prices and debt accumulation, we have a rare opportunity to view aspects of the collapse system and its dynamics under less severe conditions in which growth is expected to return. The collapse of this stock market

bubble will be used to illustrate the structure and dynamics of the near-future collapse of the “humanity double bubble” that began circa 50,000 B.C.E.

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Reaction to System Dynamics Modeling From a Woman's Perspective

"We can't seem to interest many girls in signing up for the System Dynamics modeling classes," lamented Tim Joy, a teacher at La Salle High School in Portland, Oregon, a few years ago. "They think it's a class for computer nerds." What can be done to attract more females to the study and use of SD modeling? In hopes of shedding light on this issue, a set of seven questions were posed to some women who have been formally trained in SD modeling or use SD modeling in their work. An email was sent to a group of twenty-four women. Fifteen women responded to the questions. Of the fifteen, six are in K -12, three of whom are high school students in an SD modeling class. The others are either working at the university level or in the corporate world.

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How Drugs Work in the Human Body: Analysis of a Modeling Unit Used in a Second Year Algebra Class

Second-year algebra is a course ripe with topics for modeling experiments. Topics include linear, quadratic, exponential, logarithmic, polynomial and trigonometric functions. Students usually study these functions in isolation from one another. It is not difficult, however, to add some examples where students create models that combine some of these simple functions and analyze the interesting dynamics that can result. One such example is a small unit on the study of pharmacokinetics. The unit is studied midway in the year. The unit takes six class periods. The sequence of lessons, student comments, student results on assessments, and observations by the authors are presented in the paper.

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Barry Richmond's Gifts to K-12 Education

Barry Richmond was a teacher by nature. He wanted to empower others to see the world with more clarity. He wanted the to help reveal the patterns that weave together the tapestry of the

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environment, river to wind to insect to flower, so we could learn to protect that which we often take for granted. He wanted us to live with each other in respectful, considerate, awareness. He gave us his time, so he could show us, by his example, how we could see, then understand, and then teach these things to our students. He set many flames within us and our students. We, in the K-12 community, plan to keep those flames burning.

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The Dynamics of Perception/Action: Getting Collisions Under Control

Although feedback loops are typically included in our images of information processing, psychology has tended to parse problems of human performance in ways that ignore the dynamics created by the coupling of perception and action. For example, research on perception does not typically consider the constraints associated with movement as part of the stimulus for perception. In the study of motor control, it is more difficult to ignore the role of perception. However, it is not unusual for researchers studying motor control to make naïve assumptions about what the perceptual input might be (often assuming direct input of Newtonian measures). In this presentation I will outline a dynamic systems perspective on collision control. I will illustrate how constraints on perception and action interact to create a dynamical landscape for behavior. I will discuss how this perspective has guided empirical research and how it might generalize to automotive safety.

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Simulating the Impact of a Strategic Fuels Reserve in California

This paper describes a system dynamics model of gasoline prices in California. The model was constructed for the California Energy Commission (CEC) as part of a CEC study of options to mitigate the impact of supply disruptions. One option calls for the creation of a strategic fuels reserve (SFR) to allow for prompt release of gasoline into the wholesale market in the days following a supply disruption. The paper presents simulations to illustrate the impact on California consumers of refinery disruptions of different size and duration. The simulations are repeated with a 5 million barrel reserve operated with a time-swap mechanism. The simulations demonstrate large benefits of a SFR if California experiences major refinery disruptions. With small disruptions, however, the presence of a SFR may lead to negative impacts on California consumers. The overall impact of the SFR is likely to be dominated by the frequency of the large disruptions emphasized in AB 2076.

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Modeling Real Options to Switch Among Alternatives

High uncertainty in the performance of product design alternatives has forced developers to consider multiple alternative designs in parallel. Traditional wisdom dictates the selection of the final alternative as quickly as possible. But delaying decisions on alternatives as designs develop has provided sustainable competitive advantage for Toyota, a leader in automobile development. Real options can potentially explain how Toyota's set-based development approach provides this advantage. The current work builds, tests, and uses a system dynamics model of automobile system development at Toyota to: 1) test if Toyota uses real options to operationalize set-based development and 2) propose and test a hypothesis of how real options at Toyota add value. Simulation results support these hypotheses and suggest that the effective use of real options requires a deep understanding of both the development process and the structure of real options. Research needs are discussed.

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Economic Theory for the New Millennium

Traditional mainstream academic economics, by trying to be a science, has failed to answer major questions about real-life economic behavior. Economics should become a systems profession, such as management, engineering, and medicine. By closely observing the structures and policies in business and government, simulation models can be constructed to answer questions about business cycles, causes of major depressions, inflation, monetary policy, and the validity of descriptive economic theories. A system dynamics model, as a general theory of economic behavior, now endogenously generates business cycles, Kuznets cycles, the economic long wave, and growth. A model is a theory of the behavior that it generates. The economic model provides the theory, thus far missing from economics, for the Great Depression of the 1930s and how such episodes can recur 50 to 70 years apart. Simpler system dynamics models can become the vehicle for a relevant and exciting pre-college economics education.

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Modeling the Telecommunication Market

Managing a telecommunication company requires evaluation of consequences of different alternatives to interconnection agreements and also design policies to improve profits from incoming calls.

Product pricing and capacity acquisition are complex issues, because competitor's assets are complementary, as they bring more people to call and more calls back. Economies of scale and scope are also present because high investments are involved and firms trade between leaving "money on the table" or optical fiber underground, as market saturates. The conditions for the misperception of feedbacks, MOF, are all present (Sterman 1998), exacerbated by call back misperception COM, when outgoing calls bounce back from other networks. In order to understand this complexity a System Dynamics model was constructed, where customers choose among alternatives to call, mobile and fixed operators grow, merge, offer services and set prices. Model generates profits, levels of consumption and surprises.

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**Evaluating Changes in Systems Thinking
Capacity: A Methodology Based on Alpha, Beta,
Gamma Analysis**

As one of its purposes, system dynamics seek to improve the performance of a defined system. One of the benefits of using system dynamics is the ability to systematically trace the antecedents of decisions and actions back to the underlying structures of the mental models of policy makers. Systems are impacted by our decisions and actions, and in turn, we are influenced, in reciprocal fashion, by the ways a system responds to these choices and behaviors. At the root of these reiterative feedback processes are mental models, sets of beliefs and assumptions that govern our actions. It has become nearly axiomatic in system dynamics that using microworlds can facilitate explicating people's mental models. System dynamics modeling processes normally depicts a system in question through the use of computer-generated models in the hopes of making the beliefs and assumptions used in decision making more explicit. In many cases, such models become the basis of microworlds that are designed to enrich the mental models of users.

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**Financial Statement Reports as Aggregate
Feedback: A Framework for the Discussion of
Business Value**

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**Executive Training: Game and Flight Simulator
for Business Strategic Decisions****The Dynamics of Resource Sharing and
Organizational Slack in the Growing Multi-
business Firm**

Strategy research has a long-standing interest in the performance consequences of corporate diversification. Although the diversification-performance stream of research has slowed, the matter is far from resolved. In theory, resource sharing should yield economic benefits in related multi-business firms, but the empirical research remains equivocal. While most research in this area has focused on defining and measuring relatedness correctly, this paper takes a fresh look at corporate diversification by exploring the implementation process issues of resource sharing. A mathematical model is developed that integrates content and process issues to simulate the operational consequences of related diversification. The analysis suggests economic gains are not realized simply by adopting product and resource relatedness strategies, but also require the coordinated implementation of resource sharing to extract potential synergies.

**Managing Innovation through Internal Corporate
Venturing: A System Dynamics Approach**

Capitalising on relevant literature on internal corporate venturing, I propose a System Dynamics model of ICV process to investigate the determinants of effectiveness of ICV programs and in particular the role played by tangible elements of organizational context (rewards

and incentives). The model simulation shows that the introduction of rewards and of a combination of rewards and incentives causes oscillation. Incentives combined with an active role of top managers are the most powerful way to improve effectiveness of ICV programs.

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**A Simulation-Based Approach to Understanding
the Dynamics of the Transition from Product
Manufacturer to Service Provider**

Despite the demonstrated benefits of an extended service business in driving competitive advantage, most product manufacturers found it extremely difficult to manage the transition from a product manufacturer to a service provider successfully. We observed that the transition has often led to declining business because of increasing costs, which could not be recovered with corresponding returns. Existing theory does not explain sufficiently the challenges inherent in this transition process. We develop a framework combining existing service management theories, the basic concepts for improvement programs with theories on human cognition, learning, and organizational behavior. We then translate that framework into a formal model and analyze it. The analysis suggests a new construct the degree of integration among structure, activities and behavior. It characterizes the dynamics of the transition and provides an internally consistent theory about the dynamics of the transition.

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Tampering Dynamics

Tampering can cause many of the tragedies that people and organizations increasingly face. To show pervasive forms of tampering, Deming used a funnel experiment, which quality researchers and practitioners now use to show the dysfunctional effects of not using statistical process control (SPC) charts. Interspersed with real-world tampering examples, this paper presents a system dynamics model of the funnel experiment, useful for reproducing Sparks & Field's (2000) SPC charts and statistical tests. The results also show multi-dimensional vistas of location probability and Theil's (1966) inequality statistics, plus an entropy-based view of tampering. System dynamics allows looking at the experiment causally, as opposed to merely looking at coincidental, due to randomness, SPC charts and entropy (uncertainty) measures. Looking under the hood, so to speak, one can see how the circular, feedback-loop relations among variables in the funnel experiment system produce assumption-violating dynamics as multiple feedback loops determine system behavior.

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Laboratory for Financial Engineering
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Cambridge MA 02142 USA**Limits to Arbitrage: Understanding How Hedge Funds Fail**

Even if arbitrage opportunities are found in a statistical sense, they might not be exploitable. This paper models such limits to arbitrage in the framework of a hedge fund. In particular, the paper explores how hedge funds fail given arbitrage opportunities. Dynamic relationships between a hedge fund, dealers, a bank, and market are modeled. As a case study, Long Term Capital Management is studied in the paper. The model explores a phenomenon that a fund manager who engages in arbitrage and uses high leverage might lose all his money before realizing the positions at a profit. The superimposition of both leverage and induced high correlation between assets can lead to a collapse. The paper explores these "flight to quality" and "collateral collapse" dynamics.

Mehdi Ghazanfari*mehdi@iust.ac.ir*Iran Univ of Science and Tech
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Narmak Tehran Iran**An Approach to Solving Fuzzy System Dynamics Problems**

System Dynamics is an effective method for dealing with time-varying or dynamic interactions among components in the complex system. It is generally used in the domain of social, economic and human activity systems, which deal with imprecise and vague variables or events. In this kind of system causal loop is the main concept for model formulation. Sometimes causal loops can't be explained precisely and have vague and imprecise meanings. In some cases it is better to use system dynamics with the other models. Fuzzy logic is a good interface for solving vague and imprecise problem in the System Dynamics model. This paper develops an approach for investigating fuzzy causal loop to study the behavior of fuzzy relations expressed by linguistic variables and presents an alternative approach for the analysis of problems. This approach has used Expert System as a well known tool in Artificial Intelligence for solving fuzzy system dynamics problems.

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Narmak Tehran Iran**Somayeh Alizadeh***mehdi@iust.ac.ir*Iran Univ of Science and Tech
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Narmak Tehran Iran**Understanding Schedule Unreliability: A Case Study of a Facility-Tooling Project**

Prior to any facility-tooling project start, schedulers develop a master schedule that sets out the tool arrival dates on site. The lags between the moment when this schedule is developed and the dates scheduled

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for each tool arrival increase proportionally to how late the latter are scheduled. Schedulers frequently update the schedule if suppliers fail to meet the milestones. The extent to which scheduling then follows operations or operations follow the schedule may be hard to tell. This paper delves into this phenomenon by means of analyzing data from one facility-tooling project. This data is at the basis of current efforts to develop a system dynamics model of a facility-tooling project that brings together critical scheduling and operational variables.

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Executive Force: A Dynamic Model for Strategic-Level Decision-Making in Politicomilitary Conflicts

This paper presents a model with a holistic view on the forces governing a “typical” large-scale politico-military conflict. As such, the model could be used to highlight various consequences of national decision-making in real-life conflicts such as e.g. the USA-Iraq conflict, the Israel/Arab conflict and so on. However, the model itself is designed in a very simplistic fashion, so that it will never provide decisive solutions to any specific conflict – still it gives very general guidelines that may apply to any international security conflict. The model is currently under development, and a prototype has been tested on 74 students at the Norwegian Defence Staff College (FSTS). Students report that the model succeeds in focusing on the holistic view, the critical ability to see military and political means as an inseparable whole, and the importance of the decision-making group having a common understanding of the situation.

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Blockbusters: Building Perceptions and Delivering at the Box Office

The Hollywood Stock Exchange (HSX) is an on-line market that tracks the perceived value of movie talent and their product: the movies themselves, while they are in development or production. We model the decision rules that drive this market place and estimate the underlying decision parameters by calibrating the evolution of a selected sample of 23 movies released in 2001-2002. Our results show systematic differences in the decision rules followed by the market for the eventual winners (a.k.a. the blockbusters) and the losers at the box office. Regression analysis of combined decision parameters for winners and losers cannot explain the variance in the

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box office performance. However, segmenting these data between winners and losers provides selective insights about how the aggregate market perceptions evolve.

Investigating the Causes of Returns in the Corn Seed Supply Chain

Hoarding is a common occurrence during shortages of “hot” products in industries ranging from oil to toys and from computers to pharmaceuticals. Often the induced shortage due to hoarding is much stronger than the original trigger. This paper investigates the impact of dealer hoarding on generating large amounts of seeds returned to a seed corn supplier in the agribusiness industry. To understand the mechanisms leading to seed corn hoarding and returns, we build a formal model of seed hoarding in the agribusiness supply chain. Our insights suggest that dealer hoarding and subsequent seed returns result from the interplay between supply chain characteristics (e.g. timing of information availability and quality of dealers’ orders) and human decision making (e.g. salespeople’s effort allocation decisions and managers’ pressure). In addition, a number of supplier actions can intensify dealers hoarding behavior, worsening the problem. Our analysis suggests several policies capable of effectively reducing the volume of returns.

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The Role of Learning and Risk Perception in Compliance

Human factors are crucial in most security (and safety) problems, a ubiquitous aspect being erosion of compliance. We discuss theories of the role of human factors and present models based on the theoretical paradigm of instrumental conditioning (the behavioral regulation theory - BRT). It involves learning - both adequate and 'superstitious' learning - and conforms to basic facts of human character (propensity to misperceive risk, biological roots of instrumental conditioning). Our models are able to render generic reference behavior. Also, they suggest possible reasons for why technological advances paradoxically may worsen human compliance. The concept of the behavioral bliss point - immanent to the BRT - makes the learning aspect inseparable to different

mechanisms promoting erosion of compliance (throughput/security priority conflicts, mismatch between organizational and personal goal, etc). To counteract erosion of compliance we suggest educational and social interventions.

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Deregulating into Permanent Boom and Bust: Prospects for the Electric Power Industry

The wholesale power industry is in glut in the US, and will be for several years. Deregulation changed the decision-making within the power markets, specifically on when to construct (and stop construction of) power generation plants. Not only did deregulation trigger the boom in construction, which created today's glut, but the current regulatory regimes have made the electricity market far more cyclical going forward. Another round of shortage, overbuilding and glut will likely follow the current glut. Investors who view the market as cyclical will a) not wait for firm prices before initiating more capacity construction (since prices are a lagging indicator of capacity investment opportunity) and b) not rely solely on industry standard models (which do not fully anticipate disequilibrium and market cycles). Regulators have both a responsibility and an apparently limited window of opportunity to implement market changes to stabilize the market.

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A System Dynamics View of an Island Energy System

The paper summarises preliminary research on feedback relationships and structures among stakeholders that make up the unique energy profile of an autonomous island. The model builds on data from the islands of the Greek archipelago. Despite being a small-scale application, there is a complex socio-economic structure with convoluted stakeholder interests in place that can provide insights into the current debate on technology choice in energy policy. The real world problem addressed is the great financial cost of electrifying island's not connected to a mainland grid in conjunction with a state policy of uniform subsidised tariffs. The objective is to design demand-side interventions that are able to identify appropriate technologies, early adopters, potential niche markets and amalgamate this into an optimal integrated policy to mitigate that cost.

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The Concept of Modeling the Influence of Telematic Based Services on Transport and the Socioeconomic System by Combination of an Activity-based Micro-level Model and an Aggregated Macro-level Model

In the research project OVID “Strengthening the self organization of transport by new information services” (<http://www.ovid.uni-karlsruhe.de/>) the workpackage A6 “System based assessment of information services” has got the aim to assess the specific influence of new information services on the transport system and the socio economic system in a long term sense. In existing models, the effects of new information services can be considered as factors in macro-variables like e.g. technological progress, but these factors are not based on causal models on the micro-level. On the other hand actors on micro-level are influenced by developments on macro-level. These interrelations shall be modeled by generating a behavior model, which models the impact of information services on micro-level. The output represents the input for a macro-model, which calculates long term effects of information services which backlash on actions on the micro-level. Thus a micro-funding of long-term effects of information services is possible.

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Exploring Rationality with System Dynamics Based Simulators: A Literature Review

Simulators, interactive learning environments and microworlds have attracted attention for various reasons, both within and outside the field of system dynamics. “... simulation-based learning is usually expected to motivate, to invite active and deep processing of subject matter, to allow for systematic exploration, for fruitful failure, and for unlimited practice, all of which should contribute to better learning outcomes, reduced learning time, or both.” (Goodyear et al. 1991, 274) The objectives of this paper are twofold. First, we want to demonstrate the state of simulators as well-accepted instruments in the system dynamics area. Despite of some open questions concerning their validity they are used in a variety of ways to explore human and organizational decision-making. Second, we aim at summarizing empirical findings derived from a literature analysis. This endeavor is connected to providing starting-points for identifying a number of remaining issues of simulator usage in research.

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A Software Interface Between System Dynamics and Agent-Based Simulations: Linking Vensim and RePast

A software-based integration of agent-based modeling and system dynamics is presented. More precisely, it is described how RePast and Vensim can be coupled using standard procedure calls. In an example from supply chain management, agents modeled with RePast in an agent-based simulation context are provided with system dynamics models as internal schemata, which are built with Vensim. The prototypical application shows both, the technical simplicity of combining agent-based and system dynamics simulations when using RePast and Vensim, and the potential of a combination of the two approaches.

Information Sharing to Reduce Fluctuations in Supply Chains: A Dynamic Feedback Approach

Supply chain inventories are prone to fluctuations and instability. Small variations in end item demand create oscillations that amplify throughout the chain, also known as bullwhip effect. In this research we try to understand the underlying structure that generates bullwhip effect, and try to explore the effect information sharing on this behavior by using dynamic system simulation. Analysis shows that (i) one of the root causes of bullwhip effect is independent demand forecasting performed at each stage of the supply chain and (ii) demand sharing can reduce but not eliminate the bullwhip effect.

Dynamic Process Management towards Sustained Compliance and Benefit in Clinical Research

Beyond the countless Good Clinical Practice (GCP) regulations, successfully managing the complex processes in a clinical trial takes a multitude tools. One largely untapped set of tools for managing them appears to be dynamic process modeling and simulation. What could be its contribution to sustained compliance in clinical trials? Taking a fresh perspective on clinical trials as dynamic processes addresses two important questions persistently arising in clinical research: How could trials be set up to generate intrinsically GCP compliant results? How could trials be managed to take no longer than planned? This report describes a generic modeling approach for one section of a clinical trial, from finalized protocol to the complete

Case Report Form in house. To visualize and understand dynamic sources of non-compliance in clinical trial processes, model structures published under “strategic project management” and “quality improvement programs” have been adapted.

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**Improving Hospital Winter Bed Management
Using Acute Patient Flow Simulation**

**Modeling Human Behavior as a Factor in the
Dynamics of an Outbreak of Pneumonic Plague**

We simulated three specific behaviors -- fleeing, seeking care, and isolating oneself -- on an outbreak of pneumonic plague in Surat, India, a city of 1.5 million inhabitants, in September 1994. We constructed an S-E-I-R model of pneumonic plague, using data from other 20th century outbreaks, to represent Surat. Use of antibiotics was inadequate to replicate the observations. Even incorporating flight by 30% of the population, the modeled disease failed to resolve as rapidly as observed. Only reducing person-to-person contacts by 70% allowed the model to fit the data. This latter factor was barely acknowledged by prior analyses of the outbreak; without it, no reasonable combination of modeled parameters produced the observed dynamics. The human behaviors in this model were all applied exogenously. Current efforts focus on defining these behaviors as endogenously controlled dynamics within the boundaries of the simulated Surat outbreak.

System Dynamics: What to Teach?

The topic of this paper is to discuss system dynamics as a subject in universities and colleges. The reason for my interest in this topic is that I have been giving classes in system dynamics since 1991 at Sogn og Fjordane University College. My students have mainly been undergraduates in economics and finance. This is also reflected in the cases I have chosen to elaborate - from a technical as well as a

pedagogical point of view. My lectures form the basis of a textbook I have written (also available on the Internet) that represents my understanding of what a course in system dynamics should contain. The cases are from the spheres of finance, cost-benefit analysis, macroeconomics, demography, consequence analysis as part of decision analyses and system dynamics as a tool in strategy development.

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**Acquiring Higher-Order Knowledge Using the
System Dynamics Approach in Teaching Business
Subjects**

Besides knowledge and skills for handling routines there is a growing need for the ability of qualified office staff, to cope with complex processes. This approach provides a learning environment which can foster students to think and handle in and about complex business subjects. The theoretical anchor is the construct of Mental Models. The hypotheses are that students can get access to business knowledge in a deeper mode and that they acquire different qualities of knowledge. This is influenced by different instructional approaches, students work with given models or actively build their own models. A synopsis will show that the notations of natural language and of SD-models lead to different qualities of knowledge. Results support the assumptions that this approach is useful for fostering students' insights into business administration. This can be stated in respect to the levels of declarative concepts and its interrelations, as well as for defined and detected policy concepts.

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**Economic Dynamics of R&D: Analysis of
Technology and Development**

This paper analyses a theoretical model of a technology company as an input-delayed economic transformation process. Firstly, the research environment is introduced. Some literature related to technology management and learning is reviewed. Thirdly, a system dynamics model and its parameterization are introduced. Based on the analysis, we suggest some managerial implications related to price erosion, R&D productivity, time delays and interest rate sensitivity. Finally, the preliminary results related to product development are concluded and the practical applicability of the model is discussed for further research in the area.

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Modeling at Conversation Speed: Converting Corporate Managers into Corporate Designers

Jay Forrester and others have urged the use of system dynamics for corporate (i.e. policy) design. The idea has merit, has been articulated well, but has failed to find a foothold in the corporate world. The problem is that corporate design happens in conversations, and SD modeling cannot keep pace. Managers turn to faster technologies for design – such as flipcharts and markers. The system dynamics effort is used only to add facts and “near-facts” -- fodder for the design task. The current slow-speed of modeling consigns it to science, not design. In this paper we describe an approach and technology that may increase the speed of modeling by ten to 100 times. This is just enough for modeling to keep pace with a design discussion. The paper concludes by considering how the use of SD may change when suddenly people can model at conversation speed.

Modern Electronics: Teaching Economics to High School Students with a System Dynamics Simulator

Economics is often a difficult subject for students to learn because it is taught in an abstract manner. This paper describes a simulator that

teaches students economics in terms of a familiar economic institution, the retail store. The simulator casts the economics of a store within a System Dynamics framework. This enables students to understand the importance of feedback relationships in determining economic performance and viability of a business. An SD framework also enables them to understand the relationships among concepts such as demand, price, service quality, and the range of merchandise offered and available and how they change over time in relation to each other. The paper displays screens that the students use to enter decisions and track the store's performance through a number of simulations. Teaching economics with a simulator can actively engage students and help them learn more effectively as well as having some fun.

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A Strategy Simulator for Newspapers: Overcoming 'Silos' to Do Whole-Enterprise Planning

Newspapers have faced a series of challenges for many years, not always successfully. Declining readership has led to consolidation and downsizing, especially in the US. The ability of newspapers to respond to these challenges has been compromised by having their departments function as independent "silos" without much integration. Newspapers began facing additional challenges in the 1990's as online delivery of news began to compete with print. This paper describes a simulator designed to help newspapers develop coherent strategies that integrate across the departmental silos and provide direction at the enterprise level. The simulator also enables newspapers to examine strategies for developing online businesses and making the transition to media enterprises with newspaper and online components. The paper presents screens from the simulator with a unique design that enables users to closely associate system behavior with its underlying causal structure.

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Models for Collaboration: How System Dynamics Helped a Community Organize Cost-Effective Care for Chronic Illness

Chronic illness is a large and growing problem throughout the world, and is responsible for at least 70 percent of total healthcare spending in the U.S. Experts agree that the U.S. healthcare system is poorly organized to care for chronic illnesses and, as a result, wasteful and unresponsive to the needs of patients. This paper describes a program

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to improve chronic care in a county of Washington State, and how System Dynamics models focusing on diabetes and heart failure supported the planning of that program. The models project the program's costs and benefits over 20 years and have given its leadership the ability to do resource planning, set realistic expectations, determine critical success factors, and evaluate the differential impacts on affected parties. The leadership is now seeking ways to address concerns about financial "winners" and "losers" so that all parties are willing to participate and support the program.

Constructing Numerical Reference Modes from Sparse Time Series

Constructing the reference modes is a critical step in system dynamics model. Estimating rates from sparse time series presents a unique problem. Specifically, as the counts per unit time approach zero, the time series start to look increasingly like discrete stochastic variables, i.e., not continuous, even though one might in some situations reasonably hypothesize an underlying continuous variable. Smoothing techniques are commonly used to identify patterns in noisy data, but introduce and remove features that could mislead the modeler. There has been considerable research on the optimal smoothing techniques for noisy time series. This paper presents initial work toward different approach that side steps the question of optimal smoothing and takes advantage of the emphasis in system dynamics of good models being expected to perform well over a range of conditions.

Another Modeling Approach: Using a Novice to Do the Job -- Courage to Take a Risk and You Will Have a Star!

Including a professional modeler to establish a profound and reliable model is always a regular way to do the job. But sometimes we don't have the chance to get all the necessary resources. During the project modeling process, we meet abnormal challenge and also have chance to find other way to reach the goal. The most important part is we use a novice to establish the model. In order to overcome the obstacles we would meet. We just use many ways to support the modeling work. Finally we just complete the work and win our agent's confidence to ask for our next proposal to establish another model. The purpose of this study is using qualitative research technique to share our experience to all meet the same challenges. We found that

both external and internal structures are very important to success. We concluded some topics related to these two direction findings and also propose some limits for further study.

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Postponement Strategies in a Dynamic Environment: In Terms of Standardization

For the postponement strategy, we develop a model that captures the costs and benefits associated with the redesign strategy in various scenarios. Moreover, we apply this model into one postponement approach- standardization and discuss the following: 1. What is the best point of differentiation in producing processes? 2. How should a firm design its processes to lower costs when changing is impossible? 3. If an agile firm can change its producing model quickly, how should it adjust the postponing pattern? From our decision-making model, we have the following conclusions. First, in determining at what stage of differentiation should occur, the key variables are the investment cost, processing cost and inventory holding cost. However, it may not be advisable to apply postponement when outside conditions are unfavorable for firms. On the other hand, postponement is a better choice if the condition cost. The trade-off between is beneficial.

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Development of a Simulator for Social Dynamics and Agent-Based Models

We developed a simulator called Decision-Space-Explorer for developing Socio-Informatica, a digital library system integrating academic papers with the social dynamics models and multi-agent models they explain. The integration will allow researchers to do double-checks of a model in a paper because it contains all the necessary information for double-checks in terms of Social Dynamics and Agent-Based Approach. The ability to double-check can be a tool for sharing knowledge in the humanities and social sciences based on social dynamics and multi-agent models. We provide examples and rough evaluations using the simulator for SDM and ABM respectively to demonstrate its characteristics. We also provide a set of programs using genetic algorithm (GA) to validate a model in SDM and ABM.

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System Dynamic Modeling of Engineered Landfill Covers

Engineered landfill covers are designed to prevent surface water from infiltrating and contacting waste and waste containers stored in the subsurface and thus reduce the risk to human exposure as well as environmental contamination. Waste cap designs are proving to be inadequate to the guarantee the protection that they were designed for. Despite our current attempts to contain these wastes, there is a great deal of uncertainty in the long-term performance of such engineered systems, raising questions about how to better design, manage and monitor engineered environmental barriers. The Idaho National Engineering and Environmental Laboratory is developing a better understanding of the performance of caps through the development of a system dynamic model that explores the linkages between the various environmental and physical elements that make up a cap system.

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An Examination of the Timing of Investments for PayTV Operators: System Dynamics Modeling

In this paper, we provide an additional case application of System Dynamics modelling supporting decision-making within the context of business strategy evaluation and formulation. More specifically, we model dynamic aspects of making strategic decisions within the Pay-TV markets. While our paper builds on the established System Dynamics literature, it differs from existing System Dynamics models within the media industry in that it examines explicitly the investment decisions of a PayTV organisation over time. The case study application provides additional support for using System Dynamics to support strategic decision-making in management. We neither aim to advance theory in the strategic management field nor to further develop the underlying modelling method System Dynamics, but to offer additional support about its usefulness. The target audience of this paper are System Dynamics practitioners as well as management decision makers with only limited System Dynamics knowledge.

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Application of Systems Thinking in an Innovative Teaching Pattern: Chemistry Teaching in High Schools

In chemistry teaching as part of school education, we should endeavor to link classroom knowledge with scientific practice, to initiate the creativeness and the attitude of observation, imagination, excitation and suspension in their scientific activities. Systems thinking, as a new pattern of thinking and a new method to foster innovation ability, has already accumulated extensive successful experience in application in many fields. In the teaching practice of chemistry teaching in high school, we have used the application software reflecting systems thinking (STELLA) to make a series of teaching programs for experiment. Through a creative teaching process consisting of various levels, we use the modeling method to let students perform simulation experiments on some complicated chemical systems on the operation platform provided by STELLA software, so that processes of scientific research with condition control and factor analysis can be reproduced, and the ability of students in imagination, verification, analysis and evaluation can be developed during their independent study.

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Risk and Compliance Investment Analysis

When a financial services company was set to roll-out a new risk and compliance system to be operated by brokers in the field, we first explored potential issues when brokers came on-line. The new system and policy were aimed at increasing non-compliance event identification, but we found that the effectiveness of the new system could be limited by workload backlogs and ultimately a decreased willingness to use system if other broker issues were not tackled at the same time (most notably, metrics and compensation). The presentation identifies potential limits to new system success and proposes initiatives that could reinforce its effectiveness. The presentation exposes potential unintended consequences when compensation and metrics are not considered as a part of the initiative. Without tying compensation issues into the new system use, there is the potential for higher turnover, and without efforts to increase retention, increased attrition may have the most damaging of all unintended consequences: non-compliant event creation.

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Flexibility: Bringing the One Constant Factor into Projects

Despite the significant research carried out in project management reviews, and benchmarks reveal that most projects' performance cannot meet their expectations. System Dynamics has been applied intensively in project management models, and most successfully in 'post mortem' analyses to identify the factors responsible for schedule and budget overruns. The paper intends to point out the flexibility's ability making a project system more stable and resistant to external influences.

The Impact of the Yen Loan and Japanese Bilateral Financial Assistance for Development

The Government of Japan has been the largest provider of financial assistance to developing countries since the 1980's. They believe that conducting bilateral financial assistance, the so-called "Yen Loan", is the most effective tool for socio-economic development. The Yen Loan's main use is for the construction of infrastructure such as major roads and highways, electric transmission networks, dams, water supply pipelines, water treatment plants, or other related facilities. However, recent government-to-government assistance styles have shifted from the "traditional type" assistance styles to new methods such as poverty reduction, rural development, and participatory planning and development. Also, the demand side of financial assistance is changing. Recently, medium developed countries do not always need to rely on loans from other countries because they can use private, financial initiatives from their domestic financial market instead. Low-developed countries want to get more financial assistance but donors are afraid to create another non-performing loan.

A System Dynamics Model of the Development Cycle for Future Mobility Vehicles

In the development of future air vehicles, a large number of interdisciplinary areas come into play. An overall transportation framework is introduced and key agents to a mobility value network are identified. A simulation of the overall system is needed, but the present paper focuses on the aspect of product development for a future vehicle manufacturer. A System Dynamics model is developed to investigate the importance of product development lead time and

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design failure rate. The effect of uncertainty is explored through Monte Carlo simulation. The case results show the manufacturer's net profit to be more sensitive to design and certification lead time, as compared to a lower development failure rate. In this scenario, a policy that rewards the early completion of work more than higher design success rate would be effective for the manufacturer. This study represents the initial step towards modeling the dynamics within a system-of-systems mobility environment.

Understanding the Dynamics of Information System Use

This study captures the dynamics of user behavior in the context of information systems by employing system dynamics. We have extended traditional hypotheses associated with user behavior into a dynamic hypothesis by incorporating feedbacks. Specific feedbacks lead from IS use to perceived ease of use and from productivity to IS-related work. We have tested the model under different scenarios. The managerial implication of this work is a better understanding of user behavior because these models have been able to demonstrate archetypal IS use patterns. Using such models managers can analyze different usage scenarios before making system changes or introducing new systems. The theoretical contribution of this study is the identification of archetypal user behavior by linking productivity with IS use.

Dynamics of Common Learning in Learning Alliances



The paper proposes an SD model that gives deeper insights into the dynamics of common learning in learning alliances. Although current research widely recognizes alliances as an important strategic option to achieve strategic goals, feedback perspectives are often neglected. A feedback perspective can be helpful to explain certain unanticipated long-term effects such as insufficient learning outcomes in learning alliances. I transfer findings from recent learning alliance literature into an SD model that consists of 3 major and 4 minor feedback loops which I discuss in detail. Then, different scenarios offer insights into the dynamics of common learning, perceived benefits, associated resource allocations and the development of trust in a learning alliance under the consideration of varying parent companies' expected benefits. I introduce a model that supports decision-makers to understand how expectations of learning outcomes may affect success or failure of learning alliances.

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Two Different Methods of Embedding the Optimization in Simulation on Model DYNBALANCE(2-2)

The purpose of this paper is to present the two different methods of embedding the optimization in simulation on model DYNBALANCE(2-2). This model follows the versions, named: DYNBALANCE(1-3) and DYNBALANCE(3-1). Now, authors confronts two methods of embedding the optimization in simulation on models type SD. First of the undertaking of the problem refers to the idea of Legras about so called "pseudosolution" of equation: $Ax-b=0$ which minimize the norm of these differences. The second formulating of the problem takes advantage of Linear Programming and can be named: "embedding linear programming in System Dynamics".

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Behavioral Causes of the 'Bullwhip' Effect in Supply Chains

The bullwhip effect refers to the tendency of orders to increase in variation as one moves up a supply chain. The effect is costly because it causes excessive inventories, poor customer service, and unnecessary capital investment. Most recent attempts at understanding the causes of the bullwhip effect focus on its operational causes, including demand signal processing, inventory rationing, order batching, and price. In this research we use controlled laboratory experiments, and find evidence for behavioral causes of the bullwhip effect.

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A Comparison of the Application of Performance Indicators, System Dynamics Models and the Holon Framework to Quality Assessment in Higher Education

This paper examines issues in the quality assessment and audit process in higher education institutions. Quality assessment

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management is an important issue for higher education institutions. In the UK, various structures have been established or proposed to attempt to measure the resources deployed and the impact on quality. Most current comparative structures are based on performance indicators (PIs) but those used suffer from technical difficulties and the fundamental limitations that they do not link the ‘levers’ that management can deploy with the ‘outcomes’ that are observed. They are not therefore a good method for policy appraisal. SD models may provide this linkage but in this complex environment framing the model and calibrating it is often difficult. It is proposed that the ‘Holon Framework’ may compliment and enhance the SD models so as to provide a useful and usable management tool.

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Closing the Loop on Models of Cognitively Mediated Interaction

Interactive, closed-loop models have a long tradition in psychology in manual control research. In contrast, cognitive theory has largely been built on an empirical foundation of data from discrete, non-interactive tasks. Dissatisfaction with theory resulting from this approach has resulted in calls for a renewed emphasis on cognition’s interactive nature. The roadblock standing in the way of progress, I suggest, is the lack of techniques for modeling the cognitive environment, just as the availability of models of the physical environment (e.g. Newton’s laws) were essential to modeling interactive behavior in manual control. To address this need, I present a mathematical formulation of the environmental aspects of Tolman & Brunswik’s original lens model, articulating proximal-distal relations in both the information-inference and means-ends realms. The model is useful for understanding the epistemic contribution of action, thus moving a step toward closing the loop on modeling cognition in interactive situations.

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Simulation Model of the Canary Islands for Public Decision Support: Preliminary Results

This paper deals with the system dynamics model for decision-making, related to strategic decisions for the development of the Canary Islands. The quantitative model incorporates relevant variables, which affect the sustainable development of the quality of life on the Canary Islands. The relationship between the variables was formalized in the influence matrix. The influence diagram defines the connection between the elements of the matrix. The

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Following sub-models were considered: Population, Tourism market, Agriculture, Environment, and GDP. The program package Powersim was used to build the simulation model. Several strategic scenarios are described and their dynamic response was analyzed. Presently the model is in the validation phase. The initial results are promising according to the positive validation results.

Policy and Outcome Contrasts in the Evaluation of the Effects of Structural Change in Swiss Mountain Agriculture Using Linear Programming and System Dynamics

Agricultural and regional policy in Switzerland are undergoing fundamental changes. Policy makers therefore face an increasing need for an integrated view of development relevant issues. Simulation and optimization models have proved useful in providing decision support for the elaboration of effective and efficient policy measures. This paper explores the suitability of a linear programming model and a system dynamics model for addressing agricultural development issues in the Swiss mountain area. We compare policy and outcome contrasts of the two models relating to the question of the effects of structural change in Swiss mountain agriculture on regional land use, agricultural employment and agricultural income. The linear programming model proves to be most useful for the design of optimal policy measures for a given policy goal. Combined with a system dynamics model whose strengths lie in capturing adaptation processes, implementation of policy measures is enhanced.

Automation Modeling as an Instrument for the Forecasting of Complex Economic Systems

The most effective method of the description of complex economic systems is the modern method of probability-automaton modeling, which the easily changeable structure of model, presentation of conformity between blocks of model and parts of simulated system, unique approach to construction of models, speed of calculation has by a number of the important advantages, such, as standart simulating algorithm, block. The system probability automaton devices representing model of system, is defined by five standard under the form by objects: by a matrix of the alphabets (L@), system functions of outputs (SFO), vector of initial condition (VIC), table conditional functionals of transitions (TCFT) with system of

distributions of independent probability variables (STIPV). The new method of automaton modeling is used at forecasting development of regions , ecological processes, bank activity , tax system and other complex economic systems.

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**Methods of Communication in Urban Planning
and Development: A Research Project**

The goal of a research grant, which was already approved and is being presently developed into more details, is to learn about the process of the vision's transformation into urban plans by means of a simulation model. The target of this project is the city of Brno, Czech republic. The project seems to be two-folded: first, we are interested in the process of the vision's emergence itself. Under what conditions new ideas originate, how partial private initiatives get transformed into a growth potential of a more general meaning and become a matter of a public interest. Our thinking will be focused upon what is being labeled as emergent phenomenae, the tranformation of tacit (private) knowledge into an information, the climate of learning organizations (learning regions), networking and knowledge management. Second, we will think of how to communicate visions efficiently, to choose adequate modes of communication to various target groups.

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**Using a System Dynamics Model for detection of
terrorist activities based on data warehousing and
data mining approach**

Development of a system dynamics model to find out people there committed terror attacks as well as to forecast criminal acts to avoid this acts within the framework of preventive measures. There are defining key attributes of delinquents like money transfer, e mails, hand phone calls, purchases, and are describing it with meta data. The problem of data updates and of data quality will be solve with a high quality of meta data description. The using of system dynamics model and data mining approach makes possible to detect new associations in order to change of system dynamics model by means of back-loops. That is the basis for new search scenarios with new success to avoid terrorist activities. The developed system dynamics model is an experiment to combine the data mining approach and the system dynamics method. The Result is a learning system with abilities to forecast.

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Dynamic Modeling of Three 'Personnel' Case Studies for the Department of National Defense and the Canadian Forces

Defence's Director General Strategic Planning (DGSP) authorized the production of three, quantitative SD models related to the 'Personnel' aspects of the Conduct Operations Capability Program (COCP) sub-system. DGSP's objective was to present the insights and observations from the three, dynamic personnel-related models to the September 2002, Defence Management Committee (DMC) meeting. The three Case Models offered these insights: Case Model #1 strongly suggested that measuring 'Personnel Tempo', instead of 'Op Tempo', would better serve the needs of the Defence institution. Case Model #2's 'arrayed' nature provided the various stakeholder groups with a common, view of the fundamental model structure, thereby promoting a balanced and integrated decision-making and planning framework. Case Model #3 provided insights that dynamically linked the following three important Defence issues: the Force Reduction Program (FRP), the Strategic Intake Plan (SIP), and the COCP.

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Pilot Project to Map the Causal Relationships of the Conduct-Operations-Capability Program within Defense's Performance Management Framework

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Defence's Planning, Reporting and Accountability Structure (PRAS) identifies capability gaps; however, no precise causal relationships have been established to help Defence's leadership make decisions that will improve one capability shortfall without exacerbating a problem in another capability area. This pilot project closely examined the principal cause-effect relationships related to planning and launching of new military operations. The project resulted in a set of four stock-&-flow sector maps governing the COCP of Defence's capability-based program. The overall achievement of the pilot project was the team's ability to relate the operational-forces-specific measures and indicators contained in the Performance Management Framework (PMF) to the capability goals & gaps outlined in Defence's capability-based-program.

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**System Dynamics of Optimal Commencement
Timing for Office Building Construction**

Office market cycles can be thought of as an inventory control problem with the key decision being when to commence new projects. Two years is the minimum planning and construction lag for major projects, often leading to backlogs and oscillations in supply responses. Real estate cycles would be mitigated by just-in-time inventory policies based on forecasts of future market conditions rather than basing supply decisions on current market conditions—the latter wrong because of supply lags. Both policies: “build for forecast demand” and “build for current demand” imply errors in matching supply and demand. If short term forecast errors are small, but they become larger as the forecast horizon is extended, then forecasting to an intermediate horizon short of the full construction lag would minimise the sum of forecast and “changing conditions” errors. This modelling strategy provides developers with a means for identifying windows of opportunity for major project commencements.

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**Getting More Work Out of Those Lazy Bastards:
University Policies to Increase Accountability,
Quality and Productivity**

University administrators try to increase research quality and productivity by making faculty more accountable. This poster presents four playful little models to show counterintuitive results of control or incentive systems. The problem for administrators is that people react as intelligent humans, rather than as machines. Key problems include difficulty of measuring outputs, the inevitable administrative overheads imposed by oversight systems and unintended perverse incentives and injustices that can arise from almost any system, as well as negative effects on morale and cooperation. The models can be summarised as: More administrators, less output; More papers required for promotion, lower quality papers; More incentives for faculty, worse faculty; More freedom, more output. The poster also includes a summary of some recent organisational change literature and implications for managing university researchers. The good news for administrators is that research is intrinsically rewarding and better results come from academic freedom, so little oversight is needed.

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Industry Evolution: A Dynamic Behavioral Model

This paper addresses the influence of managerial decision-making processes on the evolution of industries. Managers face very complex investment decisions due to uncertainties about customer acceptance, market size, technology, actions of competitors, and a dynamic complex feedback system. Managerial decision-making processes are almost the most influential variable to manipulate the evolution of an industry. However, managerial decision-making has been neglected in the literature of industry evolution. This paper examines the influence of managerial decision-making on the evolution of industries, and more specifically on the dynamic behaviour of three key components of any industry: firm's growth, market evolution, and technology development. This paper provides a framework termed Dynamic Behavioural Model of the Evolution of Industries to encompass all the issues that imply the analysis of industry's dynamic behaviour from a managerial point of view.

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Dyadic Dynamics in Interpersonal Cycles

Dyadic dynamics studies interpersonal interactions in pairs of people—system dynamics of dyads. The causal map for a vicious interpersonal cycle including four reinforcing loops is developed showing the system structure generating exponential growth in personal hard feelings and low regard, and interpersonal anxiety. A real-life interpersonal cycle example develops reinforcing loops, demonstrates the power of a systemic goal statement, and shows structural changes that lead to different system behavior and to a virtuous reinforcing cycle. A generalized dyadic system structure shows the effect of balancing loops and the role of corrective action. The marriage relationship is mapped to show the most intense dyadic relationship. Simple stocks and flows illustrate hard feelings as a state variable. Adjustment time for responding to behavior change is mapped. Extensions include triangular relationships, organizational dyads, archetypes, and other interpersonal issues such as trust.

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Integrating Hybrid Modeling with System Dynamics

This paper explores how hybrid modeling may be combined with the system dynamics methodology in order to serve didactical and communicative goals. It describes the architecture of hybrid models

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and argues for its compatibility with the system dynamics outlook. The paper specifies cases suitable for hybrid modeling and presents examples to demonstrate its pedagogical value.

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Models of Attitude and Belief Change from the Perspective of System Dynamics

This paper describes models of attitude change from several theoretical perspectives. Current research in persuasion, argumentation, and attitude change emphasize either cognitive, emotional, or behavioral factors, which determine how people change their attitudes. The paper reviews the pioneer mathematical work of John E. Hunter and his colleagues and then assesses his models for its loop structural characteristics. Simulation output as well as the structural characteristics of these models indicates that behavioral approaches, such as imitation and conditioning, are problematic in controlling attitudes. Cognitive dissonance and information processing models appear to be more effective in controlling attitudes. Finally, the paper concludes with an embellishment of these models to show how cognitive searching processes can give time to think about counterarguments and thus be used as a coping mechanism to resist persuasive messages.

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On the Confounding of Overshoot and Collapse Predictions by Economic Dynamics

Fey and Lam (2001) ask why system dynamicists believe world population is limited and yet do not act on this belief. This is a hard question, so this study addresses it from several perspectives. It starts by examining current critiques of *The Limits to Growth*, Malthus, and Simon's bounded rationality and finds that theories and criticisms concerning complex systems cannot be answered definitively. Instead both the theory and its criticism must be considered together, a conclusion supported by 20th century philosophy. Three heuristics are then developed. First, notions of possibility and prediction are considered. Second, the mechanics of overshoot and collapse systems are studied to discover how collapse predictions can go awry. Third, an example of overshoot and collapse is examined to understand both collapse timing and how decision makers interpret available information. Lessons from this example are then applied to Fey and Lam's concern regarding world population.

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A Framework for Requirements Engineering Using System Dynamics

In many systems engineering activities the elicitation of requirements is regarded as a central activity for the efficient and effective functioning of the intended system. In recent years, the field of Requirements Engineering has received much attention and many research and practical approaches have been proposed. In this paper we present a Requirements Engineering framework that is motivated by the System Dynamics paradigm. The framework consists of four key activities: ontology modelling, goal modelling, process modelling and scenarios generation. It is our premise that the synergy between these four activities results in a robust way of working that provides requirements stakeholders with a systematic approach to articulating, defining, debating, and agreeing on the set of desirable functional and non-functional properties of the intended system. The approach is demonstrated with examples from a very large application and claims substantiated from experiences from this project.

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Model Conceptualization: A Critical Review

Model Conceptualization is the most important activity in the development of a system dynamics model. Since Randers' classic paper 23 years ago, researchers in the field have worked in the development and refinement of tools and methods to improve the process. Although progress has been made, we still lack understanding of the process itself. The purpose of the paper is to review the progress in the model conceptualization area, and concludes with initial ideas for a research program.

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The Digital Divide: An Integrated Approach

The term "Digital Divide" refers to the gap between people and communities who have access to the information resources and those who have not. As with any complex issue, there are several approaches to the problem, and several stakeholders trying to design interventions to close the gap. The present paper uses a combination of the conceptualization tools proposed by Soft Systems Methodology and the simulation approach of System Dynamics with two main purposes: to create a rich definition of the Digital Divide, and to explore the impact of some strategies used by the stakeholders in order to evaluate their impact.

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Economics and System Dynamics for Young Students

Today's students need an understanding of economics and system dynamics to participate effectively and fully in our complex global economy, but very few K-12 schools teach either discipline. In Carlisle, Massachusetts teachers have developed several basic economics lessons using system dynamics for students in fourth to eighth grade. This paper will describe those lessons and how student response to system dynamics instruction has spurred the need to expand the system dynamics/economics curriculum.

Teaching Introductory Microeconomics Using System Dynamics: Reflections on an Experiment at WPI

Last fall this author had the opportunity to teach an introductory microeconomics class to undergraduates at WPI. Because this course was microeconomics, and not system dynamics, the topics covered were those that one would expect to see in a typical microeconomics course, for example: (1) comparative advantage, specialization, and trade; (2) markets as a means of allocating scarce resources; and, (3) the failures of markets and how governments deal with these failures. The author used a mix of traditional microeconomics tools and system dynamics to present the topics. This paper describes the topics covered in this course, the use of traditional economic methods, and how (and what) system dynamics was introduced. It concludes with some reflections on how the course went, and where I suggest we might go from here (including the sharing of experiences, ideas, and materials with others teaching economics).

Lessons From Simple Stock and Flow Models

One of the most difficult tasks system dynamicists have is presenting the key concepts of system dynamics to senior decision makers quickly. The paper presents three, very small, stock and flow models that were developed quickly and used in presentations to senior managers of New York State government agencies to show them the potential power of developing formal models to address key issues. The first model shows senior managers how their view of a program's performance could be inaccurate, and offers an alternative explanation that was not obvious prior to model development. The second model shows how a successful policy would appear to fail

when measured using system stocks. The third model provides an example of how a small stock and flow model was used to obtain the confidence of an expert advisory group unfamiliar with the system dynamics methodology.

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Modeling the Life Cycle Cost Impact of Product Development Decisions in an Aerospace Supply Chain

A dynamic model of the supply chain for an unmanned air vehicle allows assessment of the total life cycle costs of candidate aircraft system architectures. The impact of system redundancy on the cost of ownership can readily be estimated through simulation. In the UAV case study presented here, supply chain simulation early in the design phase enables much better understanding of the interaction between aircraft mission requirements, system failure rates and total cost drivers, including flyaway, maintenance and spares costs. Several spares inventory management policies were also investigated, leading to a hybrid rule based on inventory regulation supplemented by failure replacement ordering during the initial phase of field introduction of the aircraft.

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Sustainability and Environmental Externalities of Mediterranean Irrigated Lands: A Dynamic System Model

This work analyses the complex environmental and socio-economic system of Mediterranean irrigated lands to understand the highly counter-intuitive behaviour of the system. The model was also used to explore the potential effects of several management scenarios. The New Irrigated Lands dynamic model include five sectors: Irrigated Land, Profitability, Available Area, Water Resources and Pollution. The model behaviour gives results similar to the corresponding available data series. Structural validation tests were applied. Current and long term environmental sustainability has been explored using several pressure and state indicators like the area occupied by irrigated land, water consumption, nitrate leaching, water level of aquifers, water conductivity and habitat loss of endangered species. Simulation results shows that the apparently obvious solution of increasing water resources in fact worsens the water deficit problem due to the endogenous factors and feedbacks of the system.

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Structure as Behavior: Exploring Elements of the System Dynamics Modeling Process

This paper explores the implications of considering the structure of the system as changing over time. Following the tradition of system dynamics and deeply believing that “the structure conditions the behavior,” this paper makes the case for the analysis of the dynamics of the structure and its implications. In addition, the questions of what structure is and what behavior is, in system dynamics, are explored.

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Exploring Integration in Public Choice Economic Theory: A System Dynamics Approach

This research intends to propose ‘dynamic’ considerations in the voting process that would add to the ‘static’ understanding of the median voter model and the Tiebout hypothesis. It is suggested that changes in the composition of voters will influence the median-voter profile that, in turn, will have an effect on the ‘demand’ for public goods that emerges from the composition of the ‘new’ median voter. This suggests that (1) individuals trying to maximize their preferences will ‘act’ as a consequence of government policies, and (2) legislators and public officials trying to maximize their ‘political’ profits will satisfy the demand generated by the ‘dynamic’ median voter. A key element of this Public Choice Model is the recognition of the circular causality generated by the decisions of the median voter with the government policies over time. Thus, suggesting that changes in government policy are endogenous to the system and created by the implementation of the policies themselves.

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Evolution of a System Dynamics Intervention: How Changing the Rules in a Small Health Care Private Practice Can Redefine the Strategic Position of the Firm and Increase Overall Performance**Gary Wadhwa**

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This paper reports an ongoing project using system dynamics modeling as the unifying framework for understanding how to change and improve the way a small health care practice is managed. Through the development of the project we have used group model building sessions, one-to-one exploration of structural explanations, and extensive model building and testing to clarify hypotheses related to different areas of the practice considered key by our clients.

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Major insights found include: strategic management of accounts receivable, a switch in strategic orientation of the practice and its implications, and the realization of backlog of patients as a key driver of the firm' dynamics. Based on our experience, a general framework for system dynamics interventions is presented. Additionally, three system dynamics models developed for the study are presented and explained.

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Understanding Oscillations: Creating Insightful System Stories About Oscillatory Behavior

This paper explores oscillatory behavior using three simple structures derived of an Inventory-Workforce System and three different approaches to explain and understand the behavior observed. The structures used in this paper are capable of generating sustained oscillations, damped oscillations, and expanding oscillations. The languages used in the approaches chosen to explain the behavior are eigenvalue analysis, Mass and Senge's intuitive-graphic approach, and Digest-generated stories.

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Dynamics of Performance Measurement Systems in JTPA: Exploring How Learning Processes and Rule-Following Preferences Influence Changes in Organizational Rule Systems

We created a model of how systems of rules in organizations are used and, over time, changed by learning processes and rule-following preferences of their actors. The paper uses the case of performance measurement systems of the Job Training Partnership Act (JTPA) using a system dynamics model to create simulated experiments to study information about enrollment and termination processes, changes in performance measures, and changes in performance measurement systems. In our model, the principal defines the system that the agent learns how to game over time. The mutual learning (agent's learning about the rules and about the game and the principal's learning about the agents' learning) generates pressures to change the system and modify the existing rules. We present implications of the model results.

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System Dynamics and a Product-Market Matrix for Strategic Planning

A rail road company has been losing market share to road transportation in spite of the fact that it had some clear competitive

advantages over road. The company wanted to solve the puzzle and needed a new strategy to change the trend of losing its market. To design the strategy, system dynamics is used along with a market-product segmentation matrix. While the matrix is used to identify priorities of each segment, system dynamics with a marginal productivity analysis is used to design strategies for each segment to regain company's market share. The paper shows how system dynamics strengths and merits can be combined with the strengths of other tools and techniques to create a clear and convincing strategy that top management can appreciate and get committed to implement.

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On the Relation Between System Dynamics and Soft Systems Methodology in Consulting

In conducting consultancy assignments, it is often appropriate to use a systems approach and systems methodologies. It is not common to have the opportunity to use more than one methodology in a particular assignment. The paper considers the nature of consulting and reports particular consulting assignments where both System Dynamics and Soft Systems Methodology were used. It draws on the experience gained, to offer a subjective assessment of the nature of the relationship between the two methodologies.

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Incorporating Soft Variables Into System Dynamics Models: A Suggested Method and Basis for Ongoing Research

How to determine the impact of soft variables, including intangibles or social variables, and combining them as necessary with hard variables in system dynamics models is a significant challenge. This paper identifies a weakness in system dynamics modelling practice, that is, in reliably incorporating soft variables into system dynamics models. A method for incorporating such variables and a basis for further research is offered. The method combines systems thinking, research into causality analysis, multiple criteria decision analysis (conjoint analysis) and system dynamics modelling, in an integrated approach.

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Influences and Connections between System Dynamics and Decision Analysis

System Dynamics and Decision Analysis have much in common, but usually address different problem situations. Nonetheless, there appears to be scope for some cross-fertilization of ideas. After briefly

considering what the two fields have in common, we then address their differences. Firstly, the two fields emphasise different aspects of a problem situation, leading to models with a different focus. Secondly, the representation of time is quite different. The meaning and representation of causality and dependence are key to both fields, suggesting that there should be areas of mutual interest which could be explored further in a cooperative vein. Uncertainty, on the other hand, has traditionally been of more concern in Decision Analysis than in System Dynamics. It is suggested that there are occasions when a more thorough treatment of parameter uncertainty within SD modelling would be beneficial, and a simple example is provided for discussion.

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A System Dynamics Model of an Insider Attack on an Information System

There is little doubt that information systems security is a major concern for companies that are dependent on information technology. Among the risks to information system security, insider attacks seem to have the greatest potential for creating a significant system failure. Despite the likelihood of insider attacks and the potential magnitude of their impact, companies are still not doing enough to protect themselves against this kind of threat. By presenting and analyzing a model of an insider attack on an information system, this paper provides insights into the dynamics of the problem and suggests policies to minimize the risk of security failures or at least to reduce the extent of damages should an insider attack occur.

Integrating Managing from Clarity in a customized framework to support the strategic planning and managing of SAPAL in Mexico

SAPAL (Sistema de Agua Potable y Alcantarillado de Leon) is a governmental water management system in the city of Leon, in Mexico. In 1992, Felipe Polo was elected as the new SAPAL CEO. To get a picture of what was going on in the organization they made

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a deep analysis of the situation. Several symptoms of what was wrong and challenges for improvement were identified, since that moment the transformation has been a constant. The board of directors has been open to innovation in all the fields, in the technical side they usually test new materials, suppliers or processes; in the managerial field they have applied and integrate several management theories, methodologies and approaches. They have gone through several improvement cycles along the organizational change process implementing different approaches such as Organizational Development, Total Quality Management and Managing from Clarity. In 2002 an eclectic approach was developed integrating several managing and strategic approaches including systems thinking and system dynamics.

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Modelling the Grazing System: Grazing System Model

Innovation is regarded as an important factor for increasing profitability on the beef cattle enterprise. However, the profitability of the grazing systems depends not only on the simple applications of a technique such as fertilisers or pasture varieties but on the processes involved as well. Grazing systems include several components such as climate, soil, plants, animals, parasites and diseases, and complex interactions between components. In complex environments consequences of actions are often not very clear for decision-makers. Due to the complexity and the dynamic behaviour of the system there is a time gap between decision and the evidence of the consequences of the decision itself, that makes the decision process even more difficult. This paper provides a System Dynamics approach reflecting the interactions inside the system and between the system and its environment. The system Dynamics model gives an insight of the dynamics consequences of decisions in innovation management and allows testing different innovation strategies.

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Strategic Management of Natural Gas Thermolectric Plants in Competitive Environments: A System Dynamics Approach

From 1998 on, there has been a definite move towards the use of natural gas for thermal generation in the Brazilian electricity sector, where new power generation plants are developed mostly for

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independent power production in a competitive market. This is an almost universal trend, but the overwhelming participation of hydroelectric plants in the Brazilian generation system makes the development and management of a thermal plant a continuous challenge for investors wanting to participate in this market. In this context, this paper presents a new methodology and a System Dynamics based decision support tool for both planning and management of a thermoelectric generator. The model allows the qualitative and quantitative analysis of the management problem of a thermal producer, taking into account both the electricity and natural gas business environments, in order to identify the policies and policy levers that influence the decision making process at the strategic level.

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Market Imperfections and the Instability of Open Economies

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The Application of Strategy Dynamics to the Sierra Leone Conflict

This paper shows how Strategy Dynamics may be used as a tool to assist understanding and communication of strategy and policy choices in the United Nations' involvement in resolving country conflicts. Taking the conflict and subsequent restoration of peace in Sierra Leone as an example we illustrate the approach by looking at the impact of the deployment of UN peacekeepers on the progress and eventual ending of the civil war. We also highlight issues that may still remain as the country pursues social, economic and political sustainability.

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In-House vs. Outsourced Applications: A System Dynamics Comparison

This document is written for a technology decision-maker and is designed to: Define the steps associated with the deployment of packaged software dynamically in terms of graphs over time; Present two models capable of reproducing the dynamics of both in-house

deployment and outsourcing; Identify two key challenges associated with in-house deployment and discuss how these can increase the time, cost, and risk of this deployment option; Show the quantitative time, cost, and risk of in-house versus outsourced applications by comparing the results of these models in a realistic simulation. While the focus of this document is on application outsourcing, some key insights can be applied to other forms of outsourcing, such as outsourced development.

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At the Edge of New Venture Success: Growth and Survival in a System Dynamics Perspective

This study of new venture growth determinants is built upon the idea that growth is a continuous time-perspective process, which takes place in the early stage of an organization, thereby contributing to its long term success. We develop a system dynamics model to address the following key questions: What are the variables which determine growth in new firms? What are the mutual causal relationships which may be established among these variables, and how they work overtime to affect new venture performance? Which insights can a dynamic model of new venture growth contribute to explore relationships between a set of key interrelated variables and emerging new venture behavior?

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System Dynamics Models to Detect Side Effects in Apparently Sound Strategies Designed through a Balanced Scorecard Approach: Some Examples

Traditional performance measurement systems, exclusively based on financial indicators, have been criticised since they give no information about companies' ability to achieve long-term survival and growth. A new performance measurement system, the Balanced Scorecard (BSC), has been proposed to enable managers to evaluate current results and monitor the drivers of future performance. Based on the concept of cause-and-effect relationships between objectives and measures included in four key-areas, the BSC helps managers to understand their strategy and align people's efforts towards success. Though BSC's advantages have been widely recognised, System Dynamics(SD) scholars affirm that it presents some limitations, which can be overcome by integrating BSC and SD models. Aim of this paper is to give some example, based on a case studies from the literature, of how such integration can support managers to detect side effects in an apparently sound strategy designed through a BSC approach.

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Why Customers Choose Your Product: A System Dynamics Approach to Customer Choice Modeling

For modeling customer choice in industries in which various suppliers offer a number of products, we found traditional economic modeling methods inadequate. We therefore developed a system dynamics model capturing the important (dynamic) effects. In this paper, the drawbacks of the traditional method are laid out. Then, the model is presented in two stages: first, a generic structure; second, a number of useful enhancements.

Wind Energy in Colombia: An Approach from the Real Options

It is proposed to employ the real options methodology to assess an investment project of wind energy generation in Colombia, backed up by a model with systems dynamics which reproduces the interaction between market values that determine the operative conditions of the projects and that have an effect on the investment decisions. With that purpose, the Colombian Electrical System (CES) and the investment conditions within it are characterized. Then the real options methodology to assess investment projects in the analyzed market is presented and the built model is described. Finally, the found results are shown and it is given a conclusion on profitability of the real options to assess investment projects of wind generation in Colombia.

Peer Influence in Educational Reform: A System Dynamics Approach

The concept of peer influence in public education is examined in the context of its effect on student achievement. A system dynamics model based on a positive feedback interpretation of peer influence has been developed, and applied to gain insight into claims that the concept can be employed in efforts to raise the academic performance of disadvantaged students. Aggregated model results are placed in context of achievement data for a large school district and used to investigate certain of the assumptions of an educational reform that is currently gaining popularity-the Economic Integration of Schools.

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**You Can't Get There from Here: Tipping Points
and the Transition Problem in Organizational
Change**

Organizational change processes often start and then stall. Through extensive fieldwork at a manufacturer adopting lean manufacturing practices, I closely examined how people do the work of process improvement and developed a feedback theory that explains the observed successful start and subsequent fizzle. Workers were actively involved in generating ideas, but implementing those ideas strained key support personnel. As they modified work practices to address mounting workload, the change process evolved and so did the content of changes it produced. I use a system dynamics model first to demonstrate that the feedback structure accounts for the start and fizzle pattern and then to identify a tipping point beyond which the organization transitions to a regime of lasting change. The simulations characterize the transition problem in organizational change: imitating current practices of other successful firms is not sufficient to navigate the dynamics of learning and adoption inherent in an organizational transition.

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Systems Thinking and Economics Teaching

This paper discusses the position of System Dynamics and Systems Thinking in the present university education system particularly in the UK. It shows the difficulties that an interdisciplinary subject can have in finding a true home. It also discusses the difficulties experienced currently with the teaching of Economics. Much of the difficulty is caused by the paradigm used by the practitioners and teachers. The paper defines the Systems Paradigm and suggests that Systems Thinking with all its ramifications such as holism, dynamic equilibria and feedback is a useful tool which should be incorporated into all Economic Curricula. The paper is illustrated by examples from the author's own experiences. The paper concludes with suggestions for further actions.

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**The Introduction of Systems Thinking into the
Economic Curricula of Ukraine**

This paper discusses the problem of how to introduce Systems thinking into university Curricula. The problems of interdisciplinary subjects in a faculty-based system are explored and the need for a suitable vehicle is posited. Economics is proposed as such a vehicle

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and the paper then describes an experimental Masters degree that is being taught in Donetsk National University in Ukraine. This degree makes a serious effort to introduce System Dynamics and Cybernetics to the economic student. Examples taken from the degree are discussed and valuable insights are drawn. This degree was developed by an international project involving six universities from three countries with money from the European Tacis Tempus Fund. Their help is graciously acknowledged.

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System Dynamics Modeling of Material Flow of the Port Cargo System

Simulation Modelling, together with System Dynamics and intensive use of modern digital computer, which mean massive application, today very inexpensive and in the same time very powerful personal computer (PC-a), is one of the most suitable and effective scientific way for investigation of the dynamics behaviour of non-linear and complex: natural, technical and organization systems. System Dynamics Computer Simulation Methodology have been used from 1991 to 2003 for modelling of dynamics behaviour of the large number of non-linear ship electrical, thermo-dynamical, hydraulically, mechanical, pneumatically systems and managerial systems. The aim of this paper is to show the efficiency of the application of the System Dynamics Simulation Modelling in investigation of behaviors dynamics, one of the Port-Transshipment Systems be presented with mental-verbal, structural and mathematical-computing models, and it will simulate transshipment port working processes.

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Simulation Modeling of a Shipbuilding Organization

System Dynamic Continuous Computer Simulation sub model of the Business-production Shipbuilding Process – PSBP, which building started during 1991/92, in the frame work of the global science project with title “ORGANIZATION MODELING OF THE PRODUCTION PREPARING DEPARTMENT IN MARINE SHIPBUILDING” financed by Ministry of Science and Technology of the Republic of Croatia, No: 2-09-366, has been a result of the system dynamic simulation modeling of the dynamic shipbuilding process - “AMORELLA”. Authors of the paper give a well laid out science report of the executed simulation modeling of the PBSP, and they suggest further application of the same methodology for other shipbuilding phases.

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System Dynamics in Six Sigma Practice


System Dynamics (SD), like Six Sigma, is concerned with improving performance through time. Building on the Strategy and Tactics of Six Sigma from Eckes (2001), SD from Sterman (2000), and strategy dynamics (SD as applied to strategy development) from Warren (2002), this paper suggests several roles for SD in both strategic and tactical Six Sigma practice (see Table 1). The primary thesis of the paper is that system dynamics is an appropriate Six Sigma tool when the problematic behavior being addressed by the Six Sigma project may be arising from feedback structure. This thesis is illustrated using an example from High Performance Systems, Inc.

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System Dynamics Adoption at Enterprise Locations

 Anecdotal evidence indicates that efforts to acculturate enterprise locations to system dynamics (SD) are often less successful than anticipated. Experience teaching SD in Door County, Wisconsin suggests a process that holds promise to significantly increase the probability of SD acculturation in any community of adults. This paper translates this process to the context of a location within an enterprise, whether the enterprise is for-profit, non-profit, or government.

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Dairy Policy and Price Volatility

The US dairy industry is shaped by a patchwork of regulations accumulated over a long history of intervention to achieve various, sometimes conflicting, policy goals. Price supports have long been a central feature of dairy markets, but were largely withdrawn beginning in 1988. Since that time, there has been a dramatic increase in the variability of farm milk and milk product prices. The origins and desirability of volatility has been the subject of much debate; unfortunately models in existence to date have shed little light on the question due to their adoption of essentially non-dynamic methods. This article introduces a dynamic, behavioral dairy model to investigate variability and possible countermeasures. The model suggests a number of factors that may contribute to price volatility, in addition to the usual explanation of supply-chain amplification of random supply and demand shocks.

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An Application of System Dynamics to an Obesity Prevention Program: Simulation of the Risk Reduction of Cardiovascular Disease and the Savable Medical Expenses

Middle-aged people are always sensitive to calorie control for fear of attack by life-style related disease. They already knew what activity preventing activity for fat. But it is difficult to keep appropriate health behaviors control before the related symptoms has emerged, for these diseases has long latent period. We adopted cognitive intervention approach in fat prevention program. At first stage, we captured the middle-aged white color worker's pre-existing mental model which often rationalized unscientific causal relationship by focus group and in-depth interview. At second stage we showed them the whole "map" which consisted three parts, the energy metabolism factor, the medical symptom or disease factor and the economic factor. By feedback of potential risk of disease and savable expenses, program participants' perception of the necessity of change their preventing behavior were promoted and participants' mind changed to be strategic to select most effective way to be "slim".

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Sustainable Growth Rates for Emerging Firms

Financial planners define sustainable growth rate (SGR) as the maximum rate of growth an organization can maintain without issuing additional equity. Strategic imperatives that suggest aggressive growth rates (e.g., get-big-fast strategies) frequently push organizations beyond their SGR, and market distortions (e.g., investors' optimism) often eliminate the funding limitation that traditionally limits growth. Aggressive growth rates overstretch the firms' resources, frequently resulting in reinforcing processes that take firms out of business, thus suggesting other limits to how fast a firm can grow. In this study, I develop an integrated model of the firm, identify the steady state conditions for growth and find the growth rates that maximize productivity, sustainable output, and income growth. These different rates delimit four growth regions for the firm. In the attached presentation, as a way of illustration, I have outlined the analysis done in the labor sector of the firm.

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A Hybrid Model Architecture for Strategic Renewable Resource Planning

A governmental consortium in a resource-limited nation sought the services of a consultancy to construct an analytic model to guide strategy choice with respect to a limited but renewable resource. Availability and cost of this resource are of recognized strategic importance to the country, but are mediated by important stochastic factors. The consultancy developed a model triad composed of a System Dynamics model (formally a stochastic differential equation), a hybrid Multi-Sector Input-Output model, and several Decision Analytic models. This model triad provides interpretable pictures of magnitudes of economic, security and technological risks and rewards attached to capacity expansion decisions and supply and demand-side policy options. Combining System Dynamics and Decision Analytic frameworks provided both a powerful methodology and insights into desirable extensions to the functionality of available software.

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The 'Standard Method': Scripts for a Group Model Building Intervention

The process of model building with a client group involves techniques and procedures for a modeler to elicit knowledge and mental models from clients, and to guide the whole team through the conceptualization of causal structure into formal models and potentially simulation models. The literature provides a comprehensive overview of system dynamics model-building processes, which are commonly used in client group interventions. This article extends the discussion of group model-building procedures with a description of conceptual activities and scripts using the “standard method” in a client group intervention. The case discussion describes how we used a set of scripts in a group modeling intervention to help understand and agree upon the basic structures, rather than examining quantitative validation of the simulation model.

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A System Dynamics Model as Part of a Continuous Online Management Training Application

This paper captures how a system dynamics model was used to help a Fortune 1000 company train their management staff. We reflect upon experiences during model building, development of the

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application and its deployment as part of a training workshop. The model was designed to enable users see the complete picture of the company's business dynamics. The model portrayed the dynamic interaction between functional units of the company as well as the interaction between competition and customers. Model inputs and outputs were specifically selected to capture the essence of the executive knowledge in each business function. Besides customer demand and competitive forces, other external factors were introduced to make it a more realistic learning experience. This paper captures how the model was deployed as an online training tool using a web based training platform. Special emphasis is given to organization of content and controls as well as ease of navigation within the application.

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Operational Thinking, Inadvertent Evolution, Corporate Physics, and More: Barry Richmond's Contribution to the Application of System Dynamics in a Business Context

This presentation traces the development of Richmond's contribution to the use of System Dynamics in the context of business-oriented applications. Using a set of "Barry-isms" (concepts and turns of phrase that Barry used to characterize aspects of his own work) as a framing device, the presentation seeks to distill the essence of Barry's legacy. Examples from Barry's work are used to illustrate his unique contribution to the field. The presentation underscores the inherent *process* orientation and focus (in contrast to a product orientation) in Barry's work within Business. The presentation concludes by offering a prospective view into potential next steps, consistent with Barry's legacy.

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A Causal Look at the Occurrence of Biases in Strategic Change

Information is important for organizations in making their decision to change. Hence, information processing is a fundamental task, which should be done effectively. However, the vast amount of available information coupled with the limited cognitive capabilities make such activities less effective than desired. To reduce mental effort required to collect and analyze information, organizations employ various biases and heuristics. Researchers, both in psychology and decision-making, point out the persistence of biases. Such literature streams, however, mostly pay attention to the occurrence of one bias at a time even though some biases are dependent on each other and occur simultaneously. The proposition of this paper is that the use of

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biases and heuristics reinforce the factors leading to their use. The importance of this proposition is shown with a system dynamics model by demonstrating that the isolated effects of two biases generate different results than their combined effect.

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**Innovation Criterion for Evaluation of the
Organizational Effectiveness of a Retail Chain
Using a Complex Adaptive System Model and the
SWARM Simulation Environment**

In this paper we examine the application of a Complex Adaptive System (CAS) on studying the relative organizational effectiveness of Centralized and Decentralized Retail Chains. The criterion for the evaluation of this effectiveness is the rate of creation of new (innovative) ideas, related to management policies and practices, by the Shops of the Chain, which are the agents of the CAS Model. The diffusion of these innovations throughout the Organizational structure and finally their adoption as a new standard practice or policy by the whole chain, is also an important dimension of the evaluation criterion. We provide here some basics for the CAS modeling and their connection with the traditional Systems Dynamics modeling, justifying as well our decision to use the CAS formalism. We examine a generic Retail Chain organization, the corresponding structure of the CAS model and finally we give details on the simulation of the model with the SWARM software system.

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**Building a System Dynamics Model for Strategic
Knowledge Management in an IT Company**

IT companies make a lot of efforts for sharing and utilizing of experiences of their members and transforming them into the organizational knowledge as a competitive core. But they face a dilemma that they have to spend time and financial resource to perform activities around knowledge management for the long-term gains, while carrying field-works for making short-term profits. As an initial attempt to tackle this managerial problem, this paper try to investigate the mechanism of knowledge management in a small IT company in Korea with a synthetic view-point using system dynamics simulation model. It depicts the dynamic behaviors of knowledge management and presents some findings of political leverage. Although it has to be replenished further, the scheme for the dynamism of knowledge management and the findings presented in the paper could be useful for the decision makers particularly of knowledge-intensive organizations.

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Using System Dynamics to Assess Economic Feasibility of Satellite-Augmented Cellular Networks

Success of future wireless data services will depend on the ability of mobile networks to support high bandwidth traffic. Deploying adequate cellular infrastructure might prove to be excessively expensive. Alternatively, instead of ensuring QoS through overcapacity, a cellular operator may buy satellite capacity to offload congestion in its terrestrial network. In this report, we use System Dynamics methodology to assess economic implications of such integrated hybrid networks. Computer experiments reveal that in the early stages of market development by augmenting its network with satellite capacity a cellular operator may improve its performance in terms of revenue, subscriber growth rates, profit and other business parameters. As more cellular capacity is deployed, the advantages of integrated systems disappear.

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A Qualitative Analysis of Push and Pull Models

Those sub-systems corresponding to production processes are complex systems, due to information feedback, delays, and the nonlinearities present within the process of the company's decision making. The System Dynamics allows having a systemic vision of the processes, which leads to identifying some factors that might be generating behaviors not easily foreseen. With the theory of the Qualitative Mathematical Analysis it is possible to find the stability and instability zones of the systems beside the variation of some parameters and the starting values of the condition variables. The attraction basin might present behaviors such as the point ones, the cyclic ones, the odd ones, or the chaotic ones. The above mentioned concepts and techniques are used to compare two simple models of production systems: Push and Pull; the results show different behaviors in both systems when changes in the values of some parameters being common in both models are made.

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Policy Assessment for Unemployment Abatement in Colombia

The economic, social and political crisis that is affecting Colombia during the last 10 years has decelerated production and increasing unemployment. As investment and private and public expenditure have decreased enormously, the Gross Domestic Product has grown

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negative and unemployment has reached the 20% barrier. The circumstances affecting Colombia are a confluence of large levels of violence and guerilla warfare activities, not found in any other country. Under these conditions, the standard economic models seem inappropriate for assessing employment policies. A plausible option is System Dynamics grounded on the economic theories for development. Work hypotheses are based on the consideration that the economic reactivation could decrease the high rates of unemployment and violence, generating a more attractive environment that encourages both national and foreign investment, making possible to reduce the cost of defense and national security to increase the social investment.

The Second Phase of the Vila Real Modeling Project: Planning a Local Agenda 21 for Vila Real

The second phase of the Vila Real modeling project creates development scenarios for the municipality of Vila Real, Portugal, taking into consideration the identified state of development of the system as well as the vision of the community (including the local government). Jointly, and as a preparation for the last phase, a numerical version of the system model is being elaborated. This work results in the drafting of a Local Agenda 21 for the municipality, which is to remain latent until the conclusion of the project. This draft gathers the most important elements of a Local Agenda 21, namely the community vision, an analysis of the main issues, and action plan proposals. The remaining steps to fully develop the LA21 draft of Vila Real, saved for beyond the conclusion of the project, involve communication among stakeholders, implementation of the best action plan proposal, and evaluation and feedback.

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The Optimization of a Picker to Product Order Picking System: A Supporting Decision Tool Based on a Multi-Parametric Simulation Approach

This paper summarises the collaborative work undertaken by a group from Victoria University, the NZ Customs Service (NZCS) and the NZ Ministry of Health. It shows how the system dynamics methodology was used to demonstrate the value of the relationship of Customs outputs to desired Government outcomes in relation to the collection of tobacco excise duties and cigarette smoking in New Zealand. Group model building workshops addressed the organising question: “What are the affects of price on tobacco consumption in New Zealand?”. A demonstration system dynamics simulation model using the ithink dynamic simulation software was developed, consisting of 7 sectors: NZCS Air & Marine sector; duty paid cigarette imports; duty free cigarettes; NZ tobacco manufacturing sector; NZCS duty collection; NZ tobacco products market; and a health sector. The model variables are simulated on an annual basis from 2000 to 2010. Policy experiments with the model include examining the effects of changes in tobacco excise duties.

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Barry Richmond, System Dynamics and Public Policy

Barry Richmond left a rich legacy in many application areas of system dynamics, including the field of public policy. The paper identifies a key belief that motivated Barry’s efforts in this arena. It draws out Barry’s view of the relative value-added of various system dynamics activities, explaining Barry’s bias toward simpler, smaller applications of the framework, tool and language. The paper then distills five principles which characterize Barry’s work in public policy, illustrating each with a recent example. The paper concludes with a brief reflection on what it might mean to carry on Barry’s legacy.

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Financing Retirement: A Basic Economic Analysis of the Pay-As-You-Go (PAYG) System and the Expected Consequences from a Transition to a Fully-Funded (FF) Scheme

In this paper an attempt is made to illuminate the basic problems that are associated with financing retirement. The currently prevailing, in most developed countries, Pay-As-You-Go (PAYG) system and its

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deficiencies are analysed initially from a traditional economic perspective and the expected consequences from a transition to a Fully-Funded (FF) scheme are also presented. A System Dynamics model is subsequently described which enables the employment of considerably more realistic assumptions than are commonly employed in economic models, and its results prove to challenge mainstream economic findings. In addition many novel features of PAYG schemes are uncovered.

A Sound Idea in System Dynamics: Using Sonification to Understand Complexity

Can understanding of complex, dynamic systems be improved by using a combination of senses to receive information? Is there any improvement, either in the short term or the long term, in the effectiveness of conveying system dynamics principles by adding auditory information to standard visual graphs and diagrams? The purpose of this research is to use sonification, the use of non-speech audio to convey information, as well as system dynamics tools, to enrich a learning environment for college biology students traditionally using visual displays of a computer simulation to study ecology. The hypothesis to be tested is that presenting visual and artificially created auditory information simultaneously, and in conjunction with system dynamics tools, will significantly improve scores on comprehension tests of a complex, dynamic computer simulation.

A System Dynamics Microworld for Investment in Electrical Generation Capacity in Latin America

The restructuring of several Latin American Electric Sectors raises the necessity of developing analysis tools focused on the understanding of the new electric energy trading structure. In this work two Microworlds were developed for the two main market schemes in actual use in Latin America: dispatch by prices and by cost. The main tool used in the microworlds was System Dynamics. Both intend to facilitate learning processes of the complex mechanism that characterize the investments in Latin American electricity markets. The developed system can also be used to analyze possible investments in electricity capacity in Latin America. An effort has been made to introduce risk and uncertainty criteria to analyze possible decisions. Some results are presented by applying the developed tools to Colombian and Panama Electric Markets.

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**Dynamics of a System as a Process of Realization of its 'Potential'**

It is proposed to describe the system dynamics using the terms “system potential” and “conditions of realization of this potential”. It is supposed that these terms may be regarded as mathematical variables. The formalisation of logical interrelation of these terms brings the “evolution equations”. The solutions of “evolution equations” are matched by «evolution curves» in the plane: “potential” – “conditions”. The system dynamics at this abstract level is entirely characterized by dynamics of these parameters. Analysis of evolution equations allows complete understanding of problem of self-organization of systems in the process of Evolution. The classification of several possible ways of systems evolution is considered.

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**A Dynamic Model of Spatial Planning in Metropolitan Areas**

The fast pace of development in metropolitan areas does not allow them to forecast their own growth and development. The high rate of population growth that becomes a typical characteristic of metropolitan area has caused planning efforts always to lag behind realities. This work is an attempt to provide urban planners and policy makers in Indonesia with a “micro-world” in which they can experiment with their policy options, prior to adoption. This helps them test their mental models regarding the solutions they see for the problems associated with rapid urban growth. The application to Semarang City as one of the emerging metropolitan cities in Indonesia is a case study, and a part of a larger project aiming at building a generic model for spatial planning for metropolitan areas in Indonesia. The model is focused to accommodate the proposed policy of the city’s government, to develop the industrial sector in Semarang.

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Mr. Hamilton, Mr. Forrester and a Foundation for Evolutionary Economics

In a 1953 book, David Hamilton first argued that the fundamental difference between classical and institutional economics is that the former is based on the notion of Newtonian change while the latter is based on the concept of evolutionary change. Newtonian change takes place within a given socioeconomic structure, while

evolutionary change occurs when there is an alteration of a society's socioeconomic structure itself. The purposes of this paper are to: (1) extend Hamilton's idea to seven additional schools of economic thought that are based on an evolutionary view of change, and (2) argue that system dynamics can be used to add value to the eight schools of evolutionary economic thought. After providing an overview of the eight schools, the various ways that system dynamics models (and the system dynamics modeling process) are evolutionary are discussed. The paper concludes with a presentation of an evolutionary system dynamics model.

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Achieving Breakthrough Thinking in Entrenched Marketing Teams

Breakthrough in a strategy-consulting project can be achieved also in severely entrenched marketing teams. This paper describes how model conceptualisation, resource structure mapping and model parameter quantification have enabled a project team to challenge the client's "view of the world" and create consent and excitement around the new recommended strategy. In particular, it is shown how stock and flow diagrams have allowed for new ways to visualise critical challenges posed by the industry, segment the market, and support research designed to quantify the value creation from the identified strategic initiatives. Based on a real case, this paper provides an actionable framework to guide consultants and practitioners achieve breakthrough thinking in entrenched marketing teams. Additionally, it represents evidence supporting the claim that the value creation of System Dynamics goes beyond the insights that can be generated through model simulation.

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Teaching System Dynamics in a French Engineering School

The purpose of this article is to describe how SD is taught in a French engineering school. We try to develop four complementary aspects of our teaching : The philosophical aspects: We have the students look systematically for feedback loops in whatever system they want to study and analyze. We repeatedly insist on the necessity to explain the cause(s) of results obtained through simulation. The practical aspect: We pass very quickly to the practical aspects of SD by constructing causal diagrams and the use of modelling software. Developing Imagination: We feel that giving students a freedom of choice in their modelling is one way of letting them develop their imagination. Obtaining and showing practical results: we always insist on the need to develop a realistic simulator. Our paper ends

with the presentation of two models : in the first one, we can forecast the behaviour of a system, in the second one, we have a better understanding of the behaviour of a system.

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Using Simulation to Explore the Dynamics of Organizational Knowledge

Our work examines the interaction between the knowledge-generating processes of a firm and its own dynamics. It links staff time and resources to the development of an explicit knowledge repository, and its effects on the knowledge available to the firm. It was developed through literature review combined with case study and several dozen interviews conducted at two international IT consulting firms. A system dynamics simulation produces behaviors characteristic of successful knowledge management programs. Under alternative conditions, including fast changing knowledge, underfunding, and unmet expectations, outcomes are unsustainable. These failures are characterized by decay and marginalization of the knowledge management program. Knowledge management experts reviewed the results of the model. Analysis of their reactions demonstrated that the model depicted plausible behavior for both the sustainable and unsustainable scenarios. Implications for knowledge management programs and other extensions of the research are also identified.

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Tussling with Barry

In the months prior to his untimely death, Barry Richmond and I were arguing. About a month before he died, I traveled to Hanover to have dinner with him and spent that evening and most of the next day in heavy conversation, and we followed that meeting with a lot of emails back and forth. The disagreements were important to both of us, because they involved how we can best help K-12 teachers acquiring systems thinking and system dynamics capabilities and nurturing them in their students. More generally, our disagreements were about crucial foundations of patterns of conceptualization and thought in our field. We talked about letting others in on the conversation. This paper is my attempt at a “jointly” edited version of our conversations. It is a small “thank you” to Barry for the commitment, intelligence, and unending creativity that always characterized his contributions.

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Improving the Logistic Performance of a Food Company Using a System Dynamics Model for the Internal Supply Chain: A Case Study

A system dynamics model has been built to simulate the internal supply chain of a food company enabling research into the effects of logistic improvement options on four selected performance indicators. Selected indicators were: product inventory level, delivery lead time, delivery reliability and profit. Model parameter and input values were collected from operation, sales and planning departments of the food company to describe current practice. Model output has been compared with company data over a production time period of one year to validate the model. Five policies to influence the values of the above mentioned performance indicators have been investigated. Policies were combined into strategies to reduce undesired side effects. To investigate effects of external influences, four scenarios have been drawn up to capture different possible future conditions.

Process and Outcomes of Modeling: An Attempt at Formulating a Conceptual Framework

The purpose of constructing a system dynamics model of any real world issue of concern is to improve system functioning. The vehicle for doing so is an increased understanding of relations between structure and behavior or a change in mental models, leading stakeholders to implement conclusions of the modeling effort. In recent years much attention has been given to involving stakeholders directly in modeling, leading to various forms of group model building. Involvement in modeling is expected to increase change in mental models and thereby foster implementation of conclusions. However, only a few years ago leading authors in the field have called group model building more an art than a science, and pointed to the lack of evidence for its effectiveness. In this paper an integrative conceptual framework of modeling process and outcomes is proposed, drawing on theories of persuasion (mental model change) and the influence of beliefs and evaluations on actions.

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Methodological Problems in the Formulation and Validation of System Dynamics Models Incorporating Soft Variables

While formulating and then analyzing a system dynamics model that incorporates soft, qualitative variables, problems are encountered. First most of the variables of this kind are measured using a quasi-quantitative framework. The question of reliability and validity of such measurement needs to be addressed. Second, the causal relationships among the variables would have to be ascertained in a way that takes into consideration such a measurement approach. Further, there is the critical question of validating such a system dynamics model. The paper attempts to probe into the problems of developing system dynamics models that incorporate soft variables, and critically examines the model validation exercise in system dynamics in this context. It argues for enriching the methodology of system dynamics by establishing an interface with the methodology of structural equation modelling that would help address the issues of reliability and validity of the measures and the formulation and subsequent validity of the system dynamics model.

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Development of Multiplayer Games through Group Modeling

Group model building can be used as a tool to increase the efficiency of game development. In a development project done for an Air War College, group model building was used as a core method to create a multiplayer, decision training game. The method made it possible, within two working days, to progress from the first meeting between domain experts and modeller to a tested, multiplayer game. The development work was perceived as involving college instructors in a positive and useful process of knowledge elicitation and sharing. The final product was evaluated by both instructors and students as a suitable tool for decision-making training at strategic level. At the same time the development required very limited use of resources.

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Why Slower Growth of the Labor Force Complicates the US Transition to Sustainable Development

This paper elaborates the notion of viable quasi-periodic motion bounded in the phase space that generalizes stationary growth and stationary cyclical growth. This elaboration has been supported by

the simulation experiments, based on the original hypothetical law (HL) of capital accumulation, and by statistical data. The long wave is exposed not as long-term fluctuations around an equilibrium trend but as a quasi-periodic non-equilibrium trend and stochastic attractor. This presentation differs essentially from the neo-classical view on economic growth as a convergence towards equilibrium. The fundamental equation of neo-classical growth is a special case of the more general dynamic regularity, presented as a direct consequence of the HL. The application of the HL with exogenous growth of labor force to the U.S. economy has shown that moderation of the secular tendency of the average profit rate to fall is conditioned by the society's strategy to invest in natural capital.

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**Designing an Environmental Responsibility
Institution: The Environmental Mitigation
Banking System**

While institutions are a key determinant of economic behavior and new institutions are often formed as a part of an economic policy, a systematic way to design these institutions and test their potential performance before they are created does not exist. I have attempted in this paper to create and test such a design for an environmental mitigation banking system using system dynamics modeling and computer simulation. Experimentation with my model attempts to outline implementation plans for a successful mitigation banking system operating in free market or in public sector. The experimental process for designing a new institution adopted in this paper is seen in general to be of value to mobilizing the powerful concept of institutional change for creating operational plans.

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**The Work Seeking Motivation: Where It Comes
From? A Study Based on the Polish Case**

In economies under transformation, an increase in unemployment rates is not a surprising development. However, data show that in Poland this increase has recently reached alarming levels. In 1998, eight years after the transformation process had begun in Poland, the unemployment rate exceeded 16% or even 30% in the northern regions of the country. Since then the unemployment has become not only an important economical but also social problem. As the overall unemployment level is still increasing, reaching the level of 20% in 2002, policies that would effectively combat the phenomenon are now urgently needed. The permanent and worsening unemployment situation that developed during the past decade suggests that possibly some of the applied anti-unemployment policies have not been as

effective as it was hoped for. In this paper we focus our attention on one policy tool, namely, an unemployment benefit system. We explore in what way the benefit system have been applied in Poland, and how this tool is likely to impact the unemployment situation.

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Choice under Risk in IT Environments According to Cumulative Prospect Theory

How do people choose between action options in risky environments and why do they so often opt for not following prescribed security measures? In our research we focus on human factors in modern work environments that rely on information technology (IT). To effectively counteract noncompliance, a good understanding of its origins is indispensable. In this paper, we analyze what contributions cumulative prospect theory (CPT) – one of the currently most prominent theories of choice under risk – can make to our understanding of human behavior in IT-security systems. We present a system dynamics model of laboratory experiment to collect data on IT-security observance. Subject's actions are modeled in accordance with CPT. Using the model, we discuss the behavior patterns implied by CPT, providing some tentative policy recommendations and outlining ways in which the basic model may be extended to provide a viable tool for IT-security policy design.

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Evaluating Economic Feasibility of Environmentally Sustainable Scenarios by a Backcasting Approach with ESCOT

The aim of the System Dynamics Model ESCOT is to describe a path towards a sustainable transport system in Germany and to assess its economic impacts. ESCOT was developed within the environmentally sustainable transport (EST) project of the OECD that was designed to consider the ecological and technical aspects of a transition towards sustainable transportation. ESCOT comprises five models: the macroeconomic, the transport, the regional economic, the environmental and the policy model. The economic assessment for environmentally sustainable scenarios show that the departure from car and road freight oriented transport policy is far from leading to an economic breakdown. With an expansion of the time period for the transition we derived even more encouraging results. For the economic assessment it is important that ESCOT considers not only first round effects but also secondary effects. This ability makes ESCOT to a powerful instrument for the assessment of such large ecological changes.

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Human Personality as an Information Processing System

This work focuses on modeling of personality-specific behavior in complex situations. For that purpose we describe the basic assumptions of the underlying PSI - theory and point out which cognitive, motivational and emotional parameters seem to be suitable for modeling characteristics of different personality types. The modulation of parameter settings in the PSI-model generates different personalities patterns, which differ in the way of coping with specific situations. We will show the accordance of behavior pattern produced by the computer model with empirical data from human subjects.

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Modeling the Forest or Modeling the Trees: A Comparison of System Dynamics and Agent-Based Simulation

System Dynamics and Agent-based Simulation are two approaches that use computer simulation for investigating non-linear social and socio-economic systems with a focus on the understanding and qualitative prediction of a system's behavior. Although the two schools have a broad overlap in research topics they have been relatively unnoticed by each other so far. This paper contributes to the cross-study of System Dynamics and Agent-Based Simulation. It uncovers and contrasts the primary conceptual predispositions underlying the two approaches. Moreover, ideas about how the approaches could be integrated are presented.

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Understanding the Dynamic Complexity of the Editorial Process for an Employee Portal: Lessons Learned at Lufthansa German Airlines

Corporate intranets and portals have attracted increased attention among information managers (Detlor 2000). Although intranet and portal developments aim to diminish the costs for internal information publishing and to increase corporate information dispersal (Rice 1996, Thyfault and Marx 1996), real-world implementation projects show that for a successful content management, there are still a lot of open questions. Particularly the management of a standardized editorial process suffers from clear concepts. To address this issue, this paper explores the structure of an

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intranet editorial process, the dynamic behavior resulting from this underlying structure and presents a first conceptualization for a successful process management.

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Linking Balanced Scorecard to System Dynamics

A Balanced Scorecard is usually based on simple cause and effect relationships. Therefore it is not useful for success-oriented strategic controlling of an enterprises. In the paper it will be shown that cause and effect relationships of various elements described in the literature on the Balanced Scorecard are not suitable for an identification of measures to reach long-term financial success. With the help of system-dynamic causal-loop diagrams this objective could be reached. A simple cause and effect relationship of some elements, which was taken from the standard work provided by NORTON and KAPLAN, will be used as the basis for the investigation. It will be transferred into a causal loop diagram, particularly in order to make the inadequacies of this concept more transparent. In a second step a system-dynamic model for a simple enterprise will be developed based on this causal-loop diagram. Finally, the comparison and evaluation of short and long-term developments of financial key figures is in the focus of the investigation.

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Labor Market Dynamics within Rival Macroeconomic Frameworks

This paper develops a simple framework within which one can analyze alternative macroeconomic approaches to labor market dynamics. By dynamics I mean both disequilibrium dynamics and growth dynamics. The former is the foundational level, at which real wages and employment respond to labor market imbalances of some sort. The latter extends the analysis to the case of growth. We will consider the basic neoclassical, Keynesian, Harrodian, and Marx-Goodwin models, each of which embodies a particular approach to macroeconomics. Although we will highlight several interesting properties of each approach, one particularly striking finding is that the standard formulation within all four approaches implies that social factors have no influence on the long-run equilibrium ratio of profits to wages (rate of surplus value).

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Managing R&D in a Knowledge Economy: Dynamic and Portfolio Incentives

To improve the performance of R&D, the important issue of managing R&D is how to motivate the staff of R&D department. Based on dynamic and portfolio incentive, the paper builds the incentive model of system dynamics, and simulate through the different portfolio incentives and different stages of companies evolution. Authors suggest some new portfolio methods according to different period of career development and companies evolution. The paper also provides some suggestions about how to balance the portfolio incentive to improve the value of intellectual capital.

A Strategy for Enhancing Enterprise's Human Capital: A System Dynamics Model for Allocating Resources

This article deals with two investment decisions of human capital by the approach of system dynamics modeling: the resource allocation between different types of human capital and the suitable investment intensity which may be in the terms of the ratio of the training expenditure to sales. In this article, human capital of organization is divided into two types: general human capital and firm-specific human capital, and the employees be divided into two groups: Key employees and general employees. The system employed here consists of four sub-systems: workforce system, resource allocation system, operating & performance evaluating systems and competencies development system.. Through the analysis of interaction between these sub-systems and simulation results using the actual data, the suggestion for decision makers on the resource allocation on human capital investment will be given out.

Can System Dynamics Flow Reach an Economic Equilibrium?

Systems dynamics and economics seem to be following separate, paths when addressing issues of development. Both have valuable contributions to make. Neither has all the answers. In many areas, their contributions can be complimentary. Economics describes how markets work based on assumptions about the behavior of agents involved (homo economicus) and forces assuring equilibrium (the

invisible hand). However, the conditions required for these markets forces to work are rarely achieved in the real world. Systems Dynamics describes how integrated sets of activities interact as a result of empirical observations about causal relations, stocks, and feedback loops. Systems dynamics can model and analyze a much broader range of social, environmental, and economic interactions over time. Economics incorporates behavioral responses. I have spent most of my career as an economic doing modeling and development, I have recently come to appreciate the contributions Systems Dynamics can make.

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Manufacturing Supply Chain Adaptive Management under Changing Demand Conditions

The paper presents a system dynamics approach to analysis of generic manufacturing supply chain model and considers the problem of determination of adaptive effective strategy on production, supply rates and price according to inventory levels and the market situation through a demand curve estimation. The special focus lies on the investigation of the product price influences on demand and its optimal regulation. The simple manufacturing supply chain, which includes manufacturing unit, storage and distribution unit without having a direct customer orders is considered. The model for demand curve adaptive estimation and forecast by ordinary least squares and exponential smoothing methods is proposed. The problem of optimal management for price, distribution rate and production start rate under invariant and shifting demand curve is investigated. The obtained results can be used in research to understand and improve managerial decision making in real complex dynamic systems.

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Unknown Parameters and State Estimation of Manufacturing and Selling Firm Under Uncertainty

For the built model of a manufacturing and selling firm problem of unknown parameters and state estimation is solved. The estimation is necessary to find an optimal control of the firm and is solved under incomplete and inaccurate information about parameters, state and market situation. The problem is solved during firm functioning as new data come from information system of the firm. The data of the information system is considered to be incomplete and inaccurate. Solution of the estimation problem is described when disturbances and information system errors are casual or have uncertain nature.

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Using System Dynamics to Model Cesium Partitioning in the Rhizosphere

System Dynamics modeling is used to predict cesium (Cs) partitioning between bound, aqueous, and phytoextracted phases in the rhizosphere. The model categorizes processes that impact Cs fate into six sub-models. A seventh sub-model describes Cs flux between the three phases. Functional relationships and parametric values were developed based on literature, field, and laboratory data. Sensitivity analyses were conducted to evaluate the effects of root exudates on Cs partitioning, and the effects of root density, aerial plant density, potassium requirement/concentration, sodium concentration, and moisture content on root exudates and Cs partitioning. An increase in root exudate concentration results in a decrease in the bound Cs concentration and increase in the aqueous and phytoextracted Cs concentrations. Although the other parameters affect Cs partitioning partly according to how they affect root exudates, the comprehensive nature of the system complicates the overall effect.

Geniusys: Systematically Developing Genius

The Geniusys model aims to model and replicate the structure of human excellence. It uses System Dynamics to model the structure of our thinking process and identify the leverage points in this complex dynamic feedback system. Identifying the leverage points allows us to focus our valuable resources on them in order to accelerate the strategic transformation process by: minimising the adjustment time in flexibility of the filters in our mental models; maximising the range of flexibility of our cognitive filters; choosing the allocation of meaning to create primary and meta states ; and using observation to create genius states The cognitive behavioural psychology models of Neuro Linguistic Programming and Neuro Semantics utilise language patterns to change our thinking and subsequently, our behaviour. This allows us to convert our potential for genius into performance so that we can live our lives with excellence.

Modeling Reforms and Growth of the Economy: A System Dynamics Approach

 This paper considers a simulation model, which was obtained using system dynamics methodology. The model arises from analysing causal links among households, firms and government into a closed economy. A base generic model calibrated from European economies

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serves as reference to examine different policies, which try to attain various objectives. In particular, the model studies the actions and the responses of rational agents to policies that tries to improve unfounded state pension schema and the fertility rate in a way which also pursues an economic growth over extended periods of time.

A First Approach to Model Satisfaction at Work Under Equity Theory Using Fuzzy Set Theory and System Dynamics

This work examines how individuals “determine” their job satisfaction based on changes in situational factors. A simulation model, using Fuzzy Set Theory and System Dynamics, is used. Equity Theory in conjunction with the Equity Sensitivity Index is used as the base models to describe individuals’ behavior. A review of Equity Theory and Equity Sensitivity and their relationship to satisfaction at work is presented, from which an approximation to a formal model is stated. The model presented in this paper is part of a larger ongoing research project that intends to generate a macro-model that is capable of more closely approximating individual behavior in organizations. Data from the ISSP Social Survey is used to construct the model and test the relationships between individual variables.

Investigating the Effect of Account Receivable and Delivery Delay on the Profitability of a Medical Department: Siemens Case

This study focuses on the problem of getting Account Receivables and delivering products/ systems on time for the Medical Department of Siemens Turkey. The Balanced Scorecard approach was used as a base platform which served as a decomplexifying element for the initial modeling tangle. In the department, there are salespeople who does the sales via monthly visits to customers. After collecting the orders, they follow some processes. When the order is delivered, the payment does not occur immediately, especially for the state customers and there exists an oscillating delivery time. This simulation model achieves giving the knowledge and ability to the managers to make plans accordingly. Having seen the outputs, they

organize their plans pre-active, but not reactive in the long term. The project had one more tenet which is launching the system dynamics approach internally and making managers use it as their regular thinking style.

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Evaluating the Effectiveness of Simulation-based Instruction about Water Resources in the Middle School Science Classroom

This poster describes research comparing the effect of system dynamics-based instruction versus traditional teacher-directed instruction about water management in 6th grade science classes. The study tests the hypothesis that learner use of a simulation model promotes greater understanding and better retention of the material than a teacher-led presentation of the same material. Approximately 180 sixth grade students from a Middle School in Las Vegas, NV participated in the study. Half received a "traditional" teacher-directed lesson using visual aids (in the form of a powerpoint presentation) followed by a discussion led by the teacher. The other half received the same introduction followed by a session in which students used a simulation model to explore the issues on their own. Both groups were given a pre-test, a test immediately following the instruction, and another test approximately one month after the instruction. This poster discusses the results of the study.

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A Model to Understand Population Decline of the Devil's Hole Pupfish (*Cyprinodon diabolis*) and Support Habitat Management Decisions

This paper describes a system dynamics simulation model created to help the Devil's Hole Pupfish Recovery Team understand reasons for population decline since the mid-1990s and to evaluate potential interventions to reverse the population decline. After intensive efforts in the 1970s to stabilize the water level in Devil's Hole, the population of the Devil's Hole Pupfish showed slight but steady increase from the 1970s until the mid-1990s. The Team is seeking ways to reverse the recent population decline in the native habitat, but has limited information about the system as well as limited resources for data collection. The focus of this study is the development of a system dynamics model that can help the Team understand the reasons for the population decline, identify critical parameters that should be monitored to anticipate future population changes, and help find habitat management levers that can reverse the population decline.

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Learning Bathtub Dynamics: A Follow-Up

At the Bergen ISD Conference in 2001, John Sterman and Linda Booth-Sweeney gave a talk entitled “Bathtub Dynamics”. That talk has inspired teachers across the world to repeat Sterman and Booth-Sweeney’s experiment to test different populations on the system dynamics concepts inherent in the bathtub exercise. These educators have used the Bathtub Dynamics Protocols from Sterman and Booth-Sweeney in their classrooms ranging from middle school through college. The discussion covers : 1. Methodology for using this activity and data gathering; 2. Usability of this activity at various age levels; 3. The ability to teach these concepts at various levels; 4. The implications for future teaching and learning.

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Heuristic Principles in System Dynamics Modeling: Through the Valley of Simplicity

When practicing system dynamic modelling, a variety of obstacles needs to be surpassed. System dynamic modelling consist of three major phases; Problem formulation, including mental modelling, causal loop diagramming etc; Model building; which encompasses the steps from a Causal loop diagram, sometimes over Box and arrow diagrams, to a model, including parameterization; and Model use; which includes scenario analysis, back casting etc. Many make the mistake by including too many variables in their first SD model, underestimating the difficulties of understanding the output, overestimating model understanding. This leads to repetitive failures and is the most common problem in SD modelling. The valley of simplicity is deeper than we think; taking apart and simplifying, before putting together and complexifying is underestimated. We report from 5 years of SD course to a broad variety of students. We suggest some heuristic rules to improve the SD modelling learning curve.

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The Dynamic Urban Model: Transport and Urban Development

This paper describes a model built to simulate the interaction between transport, land-use, population and economic activity in an urban area. It provides a brief discussion of how the need for such a

model arose, and of other modelling methods that have been used to address the problem, touching on the contribution of Forrester's original Urban Dynamics. It describes how Forrester's model has been adapted and extended to allow a zonal representation of an urban area, coupled with a full representation of road and public transport networks allowing choice of mode and route. A discussion is provided about how hierarchical logit models are used to model choices by travellers on the networks. Finally brief descriptions are given of four applications of the model, three of them consultancy assignments carried out by Steer Davies Gleave, and the other a hypothetical town that has been used to develop and test the model.

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Small Business Insurance Dynamics

Small business insurance carriers vie for position with independent agencies who broker the product for small business clients. The insurance company's position with an independent agency determines the amount of new business written and is the focus of most business growth initiatives. Most carriers are attempting to improve their position with agents by increasing ease of doing business with the carrier and providing a high level of customer service with the brokered client. The presentation reveals a system dynamics model with a market clearing function (Vensim's "Allocation by Priority") at its core. The clearing function forecasts sales based on the carrier rank in agency, the strength of demand, and the carrier appetite for the agent's customers (insurance companies set "supply" through underwriting decisions). The model is rapidly deployed at a client site and helps broker discussions swirling around the agency clearing function, including: service center capacity requirements, marketing focus, underwriting appetite, and claim capacity requirements.

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Insurance Claim Capacity Dynamics

Property and casualty insurance businesses track three key metrics for the claims process: loss adjustment expense (costs), severity (the claim amount) and customer satisfaction. Historically, companies have managed the three metrics separately with specific initiatives targeted at specific metrics without recognizing interdependencies. The result has been unintended consequences on the metrics not targeted, and a cycle of continually re-working the three metrics as they keep coming out of alignment. This presentation describes a

system dynamics model that includes all three metrics. The model exposes the relationship between metrics and the impact of initiatives targeted only at loss adjustment expense (cost = the latest industry focus). The presentation puts the model in the context of a new planning process to test new initiatives and it attempts to draw an analogy between the Ideal Gas Law and the simulation model in order to engage a quantitative client not versed in system dynamics.

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The Application of Influence Diagrams for the Development of Military Experiments

The use of qualitative, diagrammatic, modelling is a growing trend in system dynamics with a well-developed literature, designed to deal with problems with a multitude of 'soft' variables, strong influences from human actors, and profound effects from political forces. An application area is the design of defence experiments to assess the effects of contemplated military investments on the ability to meet national goals. The difficulty lies in the design of experiments to test the system under a range of reasonably realistic, but sufficiently different, contexts to provide a comprehensive understanding of the issues. The paper will describe a hypothetical instance of tensions between nations and develop an influence diagram that inter-relates the political factors with the military factors. Study of the feedback loops connecting the political and military factors show how distinctly different experiments can be designed to test the totality of national crisis management capabilities.

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Stock and Flow, and Unified Modeling Language Relationships

Finding synergism between UML and SD is a win-win situation for the systems development and system dynamics communities. Organizations that are familiar with UML will have an opportunity to "see" the relationship of systems defined in static UML artifacts being described in SD stock and flow models that lead to dynamic simulation models. Likewise, dynamic simulations that focus on critical system capabilities as stocks and flows will be describable in UML artifacts that support the development of new system capabilities, whether as a new product or information system process. Without a bridge to communicate between the information system development and dynamic modeling communities, significant strategies or policies may not be implemented in information systems. And, as information systems are built without a focus on critical capabilities that implement key strategies or policies, they will have little business impact and a poor return on investment.

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Adaptive Balance of Causes in Social Ecological-Economic Systems

In this paper we used the Adaptive Balance of Causes (or ABC) method of complex systems modeling. We formulated several main concepts of system analysis. Based on these concepts general information technology was suggested which enables complex systems management in three main steps: concept model construction by a selection of most important purpose-oriented processes in the system, and determination of cause-effect linkages; concept model formalization by ABC method, which means writing a set of standard differential equations; stochastic determination of the model's coefficients by reanalysis of past scenarios and developing an agent-based technique for taking into account specific features of inner processes in the system and its relations with the external forcing. The new methods were suggested to perform all these steps. We demonstrated how they work on an example of a social macroeconomic-ecological system.

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Decision-Field Theory: A Dynamic Theory of Decision Making Based on the Ornstein-Uhlenbeck Process

Decision Field Theory is a quantitatively rigorous approach to decision making that is founded on psychological and biological principles rather than expected utility theory. As such it is inherently dynamic although it can reduce to standard static, subjective utility theory in very restricted cases. First appearing in the late 1980's it has been applied to many aspects of human decision making and has been expanded to include cyclic motivational situations, multidimensional and multichoice environments. Originally, among other data, it was able to explain several so-called choice paradoxes in a natural way as a function of the inherent dynamics in the theory. It has recently been shown to make accuracy predictions for certain other 'intractable' challenges in the decision literature. This talk will give an overview of the basic theory and some sample applications.

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On the Theory of Rent and the Dynamics of Profitability

For virtually all firms, successfully setting performance targets has proven difficult, likely due to the inherent structure of their environment's competitive dynamics; multi-loop, nonlinear feedback systems. This seems especially true for firms competing with a low cost strategy, in commodity markets, because the mechanics of profitability seem simple but are actually counter-intuitive. This paper presents a dynamic Low Cost Strategy model that explicitly models the competitive dynamics peculiar to commodity markets (energy, agriculture, ...etc) to investigate the dynamic causes of rent-type profit. This paper shows that a simple system dynamic model is able to confirm, and make explicit, the abstract propositions of Adam Smith, David Ricardo, John Stuart Mill, and Vilfredo Pareto in regard to Rent-type profit.

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How to Design a Streamlining Macro System with Autonomous Micro Units

In the systemic design process, one should not ignore the autonomy of system components for the sake of the contingent variability required to perform tasks. For example, a well-designed supply chain should consider both the system performance and the distinct nature of every stage in the chain. This research proposes a compromise

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approach with “synchronization” and “asynchronization” concepts to design a system with half-independent units. In this paper, all parts in a supply chain system are redesigned to operate at the same rate and at the same time first. This synchronized design is an extreme system-oriented design with high system performance. After the previous synchronous design, asynchronous mechanisms are used to modify each part’s assigned pace, in considering the operational constraints and related conditions of local units. By simulation and scenario testing, the asynchronized units can streamline with each other on the premise of the synchronous design.

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Corporate Business Ethics: Analysis and Leverage

Corporate business ethics have become a major topic in Japan as well as in the United States. Last year, as many as six major corporate wrongdoings were revealed in Japan, resulting in severe damage to public image and profit. Furthermore, falsification of inspection records regarding cracks at three nuclear power plants by Tokyo Electric Power Co. (TEPCO) is certain to affect the nation’s energy policy. Through systemic analysis and model building of the process of the six major corporate accidents, we have identified that most important common causal factor was low business ethics, and that openness is the leverage point to improve them. Based on the findings, we have designed a gaming/simulation for a Japanese power utility company to help top management and employees make openness a part of their theory-in-use of action through experiential learning. Gaming/simulation can change actions of participants in their work and in their life.

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VMI and International Supply Chains: The Case of the Fastener Industry

Vendor Management Inventory (VMI) is one of the most widely discussed partnering initiatives for improving supply chain efficiency. Also known as continuing replenishment or supplier managed inventory, VMI became popular in mid 80’s pioneered by the famous case of Wall-Mart and P&G. Through information sharing and procurement collaboration, VMI allows suppliers to manage inventory for their customers, thus streamlining the entire supply chain process and leading to cost reduction for the overall

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supply chain. VMI suits best for high volume and long product-life-cycle commodities, and fastener falls into this category. VMI was first implemented in the fastener industry in mid 90's in USA, and later was applied in Taiwan by QST International Corp. (To be Continued...)

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A Study of Connected Dynamic Data Sources to Improve Simulation Techniques for System Dynamics

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Dynamic Interactions between Citizen Choice and Preferences and Public Policy Initiatives: A System Dynamics Model of Recycling Dynamics in a Typical Swiss Locality

The outcome of recycling initiatives depends on both citizens' policy compliance and on the development in the recycling markets. The task of localities is to find incentives to motivate citizens to participate in recycling programs producing a high quality recycling material. However, different local policy initiatives in Switzerland and in NY State showed some undesired consequences. A System Dynamics model is proposed in order to analyze the undesired effects and to test further policies. The model design is based on a feedback theory about human behavior and public policy that stresses both the importance of contextual and personal factors. Hidden attitudinal stocks in the system create adaptation delays, leading to unexpected system behavior. A plausible personal structure is suggested that represents the overall propensity to separate waste. First policy runs show that a combination of interventions altering personal and contextual factors is superior to single focused strategies.

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**The Dynamic Models of Economic Policy in
Depiction of System Dynamics**

The study is a scientific and teaching approach of the issues of economic policy in depiction of System Dynamics. There has been presented the dynamic version of the model of aggregated supply - aggregated demand: AS-AD, the model of rational expectations and the model of the economic cycle. Conducted simulations concerning a theoretical economy enable to indicate the general recommendation for decisions-makers.

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**The Reformed Pension System in Germany: A
System Dynamics Model for the Next 50 Years**

This paper analyses the 2002 reform of the German public old age social security program. Reforming the traditional pay-as-you-go system the reform firstly implemented a complementary funded system which every contributor finances via additional private savings. An elaborate System Dynamics model (Vensim) has been used in order to examine both the necessity of the reform and its sustainability. Official data from the Federal Office for Statistics (demographic development 2002 to 2050) and published research data of the economical development from 2002 to 2050 (integrated as table functions) served as input values. Different pension systems and scenarios will be presented. System Dynamics provides an outstanding instrument to compare these different systems. Results show that reforming the pension system was inevitable to avoid a collapse of the pay-as-you-go system.

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**Tradable Green Certificates: The Dynamics of
Coupled Electricity Markets**

Liberalisation of markets previously under regulatory control require new instruments for environmental policy making, because subsidies and regulatory intervention does not conform to trans-national, liberalised markets. This is the case for newly regulated electricity markets. An arrangement of Tradable Green Certificates (TGC) as a market-based subsidy for renewable energy has been proposed in several countries and already implemented in a few. However, introduction of TGCs have been postponed and delayed mainly due to the uncertainties involved for suppliers of renewables. Several studies have been undertaken using economic static comparative

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analysis and partial equilibrium models. However, few of these analyses address the dynamic price formation process or the mechanisms that are important in the design of a well-working stable market. To analyse the stability of a TGC market, we construct a system dynamic model of the TGC market coupled with the Nordic electricity market (Nord Pool). A set of trading strategies for the participants under various marked designs is examined.



Stability and Bifurcation of a Model of the Price Mechanism of Export-Import Transactions

The article is devoted to the research of the dynamic modes in difference-differential equation which describes the domestic prices for goods during export-import operations. The analysis of the stability of the model considered was carried out and the parameters fields of the initial equation localized. They coincide with in linear approximation with the Marshall-Lerner conditions. The situations at the bounds of field stability with appearance of corresponding cusp bifurcations were studied in detail. The critical parametric meanings when bifurcation cusp and Bautin bifurcations become possible were found. The presence of the corresponding modes in the considered model is determined by the specific kind of non-linear functions of export and import.

Timing of Entry into New Technologies: Strategies for Technology Developers

Consider a company with a significant technology development capability. Suppose the possibility of a new technology appears on the horizon, and the company decides it wants to get involved in the new technology. This paper studies the question of the most appropriate timing for the company to start investing in the new technology. The early stages of the technology life cycle are expanded in more detail than usual, identifying specific activities typical role players engage in during each stage. An itthink model is then used to compare and probe different strategies for timing the start of investment in the new technology.

A System Dynamics Model of Bank Geographic Diversification

In 1997 the Riegle-Neal Interstate Banking and Branching Efficiency Act went into effect. With this one move, the government opened up

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the arena for banks wishing to operate across state lines. We examined how this change was incorporated into the cognitive map of a large regional bank holding company, and tested some of the resulting implications with output from a system dynamics model. Specifically, we tested five possible strategies--improve control; let go of preference for contiguous-state operations; examine acquisitions with a less than perfect cultural match; abandon community bank image; and expand outside of home area. The fourth strategy was chosen by the bank, but our testing revealed that the last strategy was the highest leverage.



A System Dynamics Model of the Pacific Coast Rockfish Fishery

This paper presents a model of the dynamic behavior of the yellowtail rockfish of the Pacific Coast of the United States. The purpose of the model is to generate endogenously the historical data for fish population, fishing vessels, regulatory parameters, and fish harvest. The model was subjected to a variety of tests to determine its sensitivity to changes in key parameters and initial values, including extreme conditions. Model results indicate that acceptable biological catch and fleet capacity must be adjusted quickly in response to changing conditions, in order to improve fishery sustainability. Additional analysis reinforces the policy of setting the maximum sustainable yield at 40%.

Conceptualization of Developing a System Dynamics Financial Model: A Subsystem of a Chinese Macro Economy Model

As Chinese enlarges its opening level, Chinese economy will be widely influenced by world economy. From the systems thinking perspective, this article closely tested the varying of constant change of the international finance. We built up a research direction aiming at Chinese macroeconomic System Dynamics model. Under the frame of finished and simplified macroeconomic model we began to explore an important subsystem in macroeconomic dynamic model of financial system. At present stage, we have completed a simply dynamic model of macro economy, on whose base finance sub-

model is a relatively independent dynamic model. In our whole model assumptions, this is one of important sub-models. This research will disclose the impact of the international financial crisis on national macro economy of a developing country.

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System Dynamics Study on Complexity

Since last century, complex systems, complexity problems and their research have become the basic problems of systems science, social-economic science, physics, biology and so on. Complexity science is so called the science of the 21st century. This paper looks back to the progress made on the study of complexity and complex systems in recent years and compares the Santa Fe approach with System Dynamics methodology in their dealing with complexity problems in social-economic systems. The latest outcomes of social-economic complex systems research, which were made by using the theory and method of System Dynamics, are also the focus of this paper. When System Dynamics came into being, it has faced a complex system of society, economy and ecology and already made important contributions to the study of social-economic systems. The key points of the study of System Dynamics are system structure and its relationship with corresponding behavior modes.

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Systemic Analysis of a Team's Self-Organizing Processes: Some Insights into Knowledge Management

Fast changing and complex environments have become more and more severe challenges to organizations. Researchers devote efforts to finding out how organizations adapt. Self-organizing is one of the important concept for organizations to change effectively and quickly. However, until now, we do not clearly know how to build organizations' self-organizing capability. Based on Cognitive System Theory, we build a model to analyze the practical behaviors of self-organizing in a navigation team. The model increases our understanding about the self-organizing mechanisms in the process of simulations and scenario testing. To knowledge management, the policies designed have several important implications, such as what kind of knowledge should be shared and when and how those knowledge to be shared. Related KM policies to facilitate the focal self-organizing team to cope with environmental jolts are further designed and evaluated. Some guidelines and suggestions about KM policy are proposed.

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Attacking the Communications Challenge for System Dynamics: Bringing Stock Accumulation into the Daylight

Those most involved in System Dynamics (SD) believe it offers the power to tackle and solve a vast range of challenges throughout all fields of human endeavour. This community therefore shares a profound and continuing disappointment at the very slow uptake of SD by society at large, especially those with policy responsibility whom we seek to help. Whilst various explanations have been posited for this failure, we remain unclear as to why it continues and, more importantly, what can be done about it. Since the SD method is (to us) clearly powerful, the finger of suspicion must point towards how we communicate the method and demonstrate its power – ‘If the joke is OK, maybe the problem is with the way we tell it!’ This paper explores whether the field’s adoption of causal-loop diagrams (CLDs) as both an entry-point and communications device has, in spite of its intuitive appeal, been a dead end.

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The Consequences of Guilt by Association as an Investigative Decision Rule

As public concern for security is raised, the public tends to support allocating added power to investigative agencies cutting back on regulation. Traditionally, with added power, such agencies have moved toward using an investigative decision rule based on guilt by association rather than signs of criminal activity. In order to accommodate this decision rule, the public is asked to sacrifice civil liberties for the sake of added security. Cole & Dempsey (2002) make the case that it is not necessary to make such a liberty for security trade-off. Further they argue that the use of the poor decision rule leads to a waste of resources, ultimately undermining the quality of investigation. Their case is explored using a Taylor-Russell signal detection analysis within a system dynamics model.

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Model Facilitated Learning of Essential Macroeconomics

MacroLab is a series of interactive learning environments (ILEs) for introductory macroeconomics. It is currently used in a distance learning course taught by the author. The underlying system dynamics structure consists of a national accounting model of aggregate income and spending, linked with behavioral models of

consumption, investment, production and pricing, labor and capital utilization, and fiscal and monetary policy. After a brief review of the problem that motivated the development of MacroLab, this paper summarizes the rationale for a solution based on system dynamics and model-facilitated learning principles, highlights key features of the ILE series, and outlines a future research agenda. Workshop participants will gain economic understanding by “test driving” some of the ILEs. In addition, they will gain ILE development skills by experiencing the step-by-step content design and delivery process, and discussing analogous steps for ILEs in their own fields.

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A Qualitative System Dynamics Model of Human Monitoring of Automated Systems

This paper describes the problem of human monitoring or supervision of automation. It includes a review of current research describing how automation monitoring increases the chances of error if the operator is not involved in the control process. A qualitative systems model is developed because of the lack of sufficient data to completely describe the causal pathways and provide a numerical simulation. This leads to a number of research strands for which data is not available or needs to be improved.

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When You Assume...

This paper shows how to develop better causal loop diagrams by using simple thinking tools borrowed from other fields of endeavor. It will be a valuable starting point for long-time practitioners looking to add a new dimension to their work, as well as for educators wanting to offer a richer learning experience. That is not to say that any of the diagrams found in this paper are works of genius, or even that they are anything more than early drafts - only that the "after" versions are better than the "before" versions, thanks to the use of the tools described here.

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Theory Building with System Dynamics: Ice Age Extinctions

A recently developed system dynamics model specifies a new hypothesis for the extinctions at the end of the Pleistocene – Second Order Predation – and compares it with the overkill hypothesis (see <http://quaternary.net/extinct2000>). It provides a quantitative description of the interrelationships between four plant stocks, four herbivore stocks, carnivores, and *H. sapiens*. Different assumptions

regarding *H. sapiens* in-migration, hunting of prey or predators, can be simulated. Second Order Predation: i.e. *H. Sapiens* killing of other carnivores, leads to herbivore overpopulation, environmental degradation, and differential extinction of herbivores. The paper suggests thinking about whole system evolution and calls for additional models that will support comparison of competing hypotheses, allow precision in quantities and timing, and exhibit internal dynamics. It challenges scientists conversant with models to simplify models to encourage their use by their colleagues.

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**Challenges of System Dynamics to Deliver
Requirements Engineering Projects: Faster, Better
and Cheaper**

The success of Requirements Engineering (RE) projects for complex software systems critically depends upon the effectiveness of RE process improvement. This paper presents a model for improving the delivery of requirements engineering projects. The paper applies system thinking/ system dynamics (SD) to the complexity and dynamics of the RE process. Poorly defined requirements process cause projects to fall behind schedule, go over budget and result in poor quality of system specification. The paper seeks to understand these problems from a feedback control viewpoint since there is lack of agreement on the nature of deficiencies in current RE processes. In developing such a model the paper fills an important gap in both RE and SD modelling literature. The paper suggests that the model makes a useful contribution both in providing the foundation for theory building on RE projects and in improving the management of RE projects in learning and training situations.

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**A Systems Dynamics View of the Theory of
Constraints**

System Dynamics can be used to facilitate the understanding and develop alternatives for a system. In the same way, The Theory of Constraints (TOC) is based on Eli Goldratt's work on "how to think"¹, System Dynamics (System Dynamics) is based on a way of thinking about systems from a global perspective. The primary application of TOC embodies a systems thinking approach to manufacturing systems. By knowing how to think from a systems perspective, we can better understand the system under study. Through better understanding, the performance of these systems can be improved. The concepts of ongoing improvement embodied in the TOC are enhanced using System Dynamics. By providing a way to

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model and simulate the system under study through System Dynamics and applying the rules of TOC to the model, alternative solutions to improve system operation can be developed. System Dynamics software further enhances this process by adding the ability quickly evaluate various alternatives.

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System Dynamics Modeling of Manpower Forecasts and Programming

With Delphi Expert Prediction and mathematical model, forecasting has been made in the paper for the professional technician demand and its reasonable composition of certain sizeable state enterprise in the future fifteen years. On base of forecasting, the dynamic model of the professional technician planning was constructed with method of System Dynamics. The model has been applied to analyze the enterprise's manpower policies and simulation result has been given for the reasonable policy to manpower exploitation.

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Principles of Accounting System Dynamics: Modeling Corporate Financial Statements

Understanding financial statements is imperative for better management of corporations, while system dynamics (SD) offers dynamic modeling and simulation skills for better strategies of management. This paper tries to present a consolidated principle of accounting system dynamics on the basis of simple principles from SD and accounting system. It is, then, specifically applied to model corporate financial statements (income statement, balance sheet and cash flow statement) described in the book: Financial Statements, by T.R. Ittelson, Career Press, 1998. It is shown that cash flow statement is indispensable for modeling financial statements. At the same time, a limitation of the current accounting system as a dynamic guidance for management strategies is pointed out. This demonstrates the importance of SD modeling in the field of accounting system.

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A General Stock Control Formulation For Stock Management Problems Involving Delays and Secondary Stocks

It is known that if the stock management formulation ignores the supply line delay, the behavior of the system can be oscillatory. There are naturally other types of delays in stock management problems; information delays in decision processing and delays caused in controlling a primary stock indirectly via a secondary stock. But there exist no general decision rules in SD that explicitly consider these different delays in stock management structures. We first investigate the implications of ignoring such indirect delays, the behavioral consequence is equivalent to ignoring the supply line delay in the standard case: large oscillations. Next we derive a general stock control heuristic that does take into account these more advanced types of delays and show that the result is a stabilized dynamic behavior. Finally, we implement our decision heuristic on an example involving all three types of delays. The combined result is a significant improvement in the stability of the system.

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Developing a Balanced Scorecard from a Feedback Loops Perspective

Balanced Scorecard (BSC) makes both practitioner and academic take notice these years. The reason is that BSC rethinks performance measurement system of organizations. And furthermore, BSC has become a strategic management system that can facilitate organizations to identify the operational factors which driving future success. This research adopts case study method and focuses on the feedback structures of developing a balanced scorecard. The purpose is to find key success factors of building and implementing BSC from a feedback loops perspective. We choose one typical case that implementing BSC successfully and study on its feedback structure by performing feedback loops analysis. We hope for accumulating knowledge of facilitating organizations to implement BSC more effectively. The result represents and explores the feedback structures of the case. And we find some dynamic pitfalls and key success factors of developing and implementing BSC.

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An Action Research on System Dynamics Learning through Cooperative Learning

We explored instructional design of system dynamics by action research, improved the situation of teaching, learning, and practice constantly, and accumulated some knowledge and experience. This paper describes some teaching innovations by action research with three fundamental principles: (1) structure influences behavior, (2) set up the goal and feedback learning, (3) from easy to difficult. We want to design the curriculum from three dimensions: learning environment, process, and content. We acquired five: (1) the scope of system dynamics is quite broad, thus, teaching needs to be adjusted in accordance with various conditions. (2) cooperative learning can enhance learning results and learning enforcing. (3) action research will be a good guidance for teaching system dynamics through cooperative learning. (4) systems thinking and system dynamics are complementary. (5) instructional design must have systematic characteristics and be implemented step-by-step.

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A System Dynamics Approach to Analyzing a Power Industry Facing Unstable Demand

We have spent more than one year using system dynamics approach to construct a model for a power company, a monopoly electricity supply company, from 1 September, 2001 to 31 November, 2002. The model focused on the collocation of three main instruments in power industry including power generation, transmission, and distribution system. From the simulation we found strategically when the power industry faces continuous growth demand situation, the main strategies it must consider is optimal invest decisions, how to optimally allocate its resources and make the electricity supply as smooth as possible. When power industry faces demand decline, especially continuous demand decline, there will be no solutions for the whole industry to make profit and match stable electricity supply at the same time. Capacity lies idle, revenue will decline, the only thing you can do is to sell the power generation capacity. The most influencing point is the bottleneck that will be created from the collocation of the three main instruments.

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A Quantitative Assessment of Organizational Factors Affecting Safety using a System Dynamics Model

The purpose of this study is to develop a system dynamics model for the assessment of the organizational and human factors in a nuclear power plant which contribute to nuclear safety. Previous studies can be classified into two major approaches. One is the engineering approach using tools such as ergonomics and Probability Safety Assessment (PSA). The other is the socio-psychology approach. Both have contributed to find organizational and human factors and to present guidelines to lessen human error in plants. However, since these approaches assume that the relationship among factors is independent they do not explain the interactions among the factors or variables in Nuclear Power Plants. To overcome these restrictions, a system dynamics model, which can show cause and effect relationships among factors and quantify the organizational and human factors, has been developed. Handling variables such as the degree of leadership, the number of employees, and workload in each department, users can simulate various situations in nuclear power plant organization.

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Modeling the Differences and Conflicts between North and South in the Context of Global Sustainability

Today, the world is divided into two main blocks: Developed nations with excess capital, or North, and developing nations with excess labor, or South. It is a widely accepted fact that interactions and conflicts between these two blocks play a major role in the context of global sustainability. In this paper, a global SD model with North-South differentiation is built in order to investigate the long-term outcomes of certain policies regarding interactions between these blocks (such as natural resource transfers, capital investments, external debt, immigrations, and trade) in terms of welfare distribution, global persistent pollution, population growth and non-renewable resources. In modeling the world with a North-South differentiation, certain structures and assumptions of WORLD3 are used as a starting point. Causal structure of the model is completed and research is currently at the stage of equation writing and parameter estimation.

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Using Group Model Building to Inform Welfare Reform Policy-Making in New York State: A Critical Look

Building system dynamics models directly with groups requires skillful combination of problem analysis and group facilitation. This paper provides an overview of an applied research project –using this growing and innovative approach– to model and analyze a complex social issue in the public sector. It provides a synopsis of the design and products of this intervention involving three counties in New York State. It reports how GMB was used to inform welfare reform policy-making, drawing upon the perspective of key welfare service providers. This paper is focused upon the final product of this intervention –a system dynamics model used to experiment with management strategies and to explore scenarios. It addresses the policy aspect of the research, and is focused upon documenting the model elicited, built, simulated, evaluated, tested and extensively used throughout this intervention. The analysis is organized around three policy questions. The conclusion is a summary of the findings, and a discussion of the limitations of the analysis in terms of policy evaluation for the purpose of system’s redesign.

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The Wine Chain in Argentina: The Influence of Production-Consumption Dynamics

This study reports on the main structural details of the wine chain, with the aim of identify the production/consumption dynamics. The causal diagram integrates structural elements of Vineyard, Cellar (elaboration of wines), Sale/Shipments, Demand/Consumers and Price. The influence of grape price modifies the dynamic going from a balancing loop to a reinforcing loop. We detect an important delay between the Demand and Sale giving place to a chain break which is due to the distance from real behavior. The information comes too late to advance in the changes and the value put on a product by the consumers depends on the degree of product-information that is available to them. Using system dynamics we will be elaborated a model that will pick up the operation of the supply chain, feedback and non-linear relationships to explain the coordination mechanisms among the different actors and we will help the chain to be able to work more coordinately.

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Using System Dynamics as a Core Tool for Content Teaching: A Mature Use of System Dynamics in the Pre-College Environment

Most efforts to bring System Dynamics concepts into the pre-college environment have focused on episodic use of System Dynamics in traditional classes or on teaching modeling. At Wilson High School, in Portland, Oregon, this effort has been extended for the last eight years by the development of two courses in which Systems Dynamics is more fully integrated into the curriculum. One, an Environmental Science course, uses models to develop traditional content and allow students to experiment with scenarios and policies that cannot normally be explored in depth. Most course topics are explored using models. The second and older of the courses, Science, Technology, Society/World Issues, was designed from the beginning to use systems concepts to explore all topics. The course has evolved substantially, but continues to base content choices on the unique capabilities of System Dynamics to explore complex problems.

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The System Blocks: A Physical Interface for System Dynamics Learning

We present the System Blocks, a physical interface that makes it easier for kids to model and explore dynamic systems. A set of computationally enhanced blocks, made of wood and electronics, the System Blocks can assist K-6 educators to teach the complex concepts of system dynamics and causalities. Learning to understand dynamic systems is an essential step in understanding the world around us. However, learning it at university, college or even high-school level might be too late. By this age children already develop their own view of the world. In this paper we will show how a set of physical objects can be used for modeling and simulation, merging hands-on tinkering with computer simulation. Using blocks that behave as stocks, flows, variables and constants, our hope is that System Blocks would enable children younger than 6th grade to model, simulate and analyze systems that are meaningful to them.

Special Sessions

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Supply Chain Management I and II

Recently, effective management of supply chains has gained unprecedented interest from academics and practitioners from the fields of mainstream operations management (OM) and operations research/management science (OR/MS). However, many of the most urgent and challenging puzzles in this area appear to be in need of a new research perspective if they are to be solved. Examples of such "hot topics" include the interaction of product development and manufacturing during new product introduction, information sharing in decentralised supply chains, dynamic interactions of "hard" performance indicators and "soft" variables such as trust and customer satisfaction, root causes for upstream demand amplification and ways of overcoming the resulting "bullwhip effect". All these topics can be effectively tackled by system dynamics and the many supply chain-related papers at the 2003 conference show that this is precisely what is happening. The two parallel sessions scheduled read like a showcase of the vibrant state-of-the-art here.

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Information Science

Emerging information and communication technologies have tremendous impact on the socio-economic structure of our society. Many contemporary issues related to information technology and policy involve complex, non-linear, dynamic feedback systems. System dynamics have been used effectively to address such issues over the last several decades. This session is a showcase of current studies based on applying system dynamics to information technology and policy related issues.

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Outstanding Applications

One of the wonderful things about system dynamics is that it can be applied to so many different problems in so many different ways. This contributed plenary session brings together three presentations that stand out as interesting, insightful and helpful. There is an application of system dynamics to health care that really goes beyond that to look at how a community can work together to accomplish

joint goals using a system dynamics model as a basis for joint understanding. Looking at research and development performance in the automotive industry offers insights into how to think about a variety of public and private research programs. Looking at the dynamics of human perception and learning as they affect our ability to maintain security and order provides valuable lessons for a very topical problem. These works present a slice of the large variety of work being done in system dynamics today.

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Organizational Adoption of System Dynamics

At least once a year someone asks Jay Forrester what he thinks the world will look like when system dynamics has been fully adopted by all organizations. This always leads to interesting discussion, and though the answers are never the same, there are some common elements. These two contributed works provide some helpful insights into this question. One is a fairly personal experience, as one of the authors is also responsible for running the business. The other looks at things from a somewhat greater distance and advocates a path toward achieving more adoption of system dynamics thinking on a daily basis. Two interesting approaches to answering a persistent question.

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Defining and Refining Methodology

What are we doing and how should we change? This always seems to be a useful question to ask and these two contributed papers again come at this question. One tries to define the place of system dynamics in the scheme of things and presents an interesting, if contentious, perspective. The other defines an evolution of how we do what we do that could dramatically change the effectiveness of system dynamics. Together, the two works may raise as many questions as they resolve, but they should lead to some very interesting discussion.

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Economic Theory for the New Millennium

Traditional mainstream academic economics, by trying to be a science, has failed to answer major questions about real-life economic behavior. Economics should become a systems profession, such as management, engineering, and medicine. By closely observing the structures and policies in business and government, simulation models can be constructed to answer questions about business cycles, causes of major depressions, inflation, monetary policy, and the

validity of descriptive economic theories. A system dynamics model, as a general theory of economic behavior, now endogenously generates business cycles, Kuznets cycles, the economic long wave, and growth. A model is a theory of the behavior that it generates. The economic model provides the theory, thus far missing from economics, for the Great Depression of the 1930s and how such episodes can recur 50 to 70 years apart. Simpler system dynamics models can become the vehicle for a relevant and exciting pre-college economics education.

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Alternative Approaches to Modeling Epidemics

A fundamental strength of model-building revolves around its power as a common language to engage multi-disciplinary practitioners. This session describes the processes through which five diverse practitioners developed and pursued a series of "better questions" leading to the development of more powerful and useful models. The initial focus of this work was the spread of pneumonic plague through Surat, India in September 1994. The initial paper presents a modeling effort to explore the epidemiology of that outbreak and the role played by human behaviors. Subsequent presentation and discussion will focus on (1) Core feedback structures in public policy involving the role of system capacities in generating Type I and Type II errors in the classification of cases; (2) Robust testing protocols - development of common metrics for comparative assessment of policy models and their generic core structures; (3) Opportunities for using social psychology in the modeling of human.

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Computed, Heterodox and Untapped: Economic Dynamics in New York City: Pre-Conference Session at Fordham University Business Schools

Business leaders gradually see that we are not only failing to solve persistent, recurring business problems, but are in fact causing them. As we devote tremendous energy to squeezing out the last drop of efficiency in operations, we often miss a well of untapped value hidden in organizational process interdependencies. Our traditional analytical tools do not focus on these interdependencies and therefore fail to recognize their value. They are not looking for it. But system dynamics, the study of cause and effect through time, is ideal for solving recurring, persistent problems in business and other social organizations. Its coherent modeling methodology, which includes the computer simulation tools necessary to understand the complex

systems in and about which we live and work, helps avoid the policy resistance endemic to our business systems and enables high-leverage strategies for sustained improvement.

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Security

Security dynamics is about systems intended to cope with malice, error or mischance. Security work systems consist of users, organizational aspects, tasks, environment and technology. The session topics include error, erosion of compliance, risk perception, choice under risk, dynamic prospect theory, priority conflicts (throughput vs security, personal vs organizational aspects), learning from incidents and security culture. Methods employed include system dynamics modeling, experiments in microworlds and event-driven simulation of emergency management for diagnosis and training. One paper concerns choice under risk according to cumulative prospect theory. Two papers deal with case studies (Tim Lloyd/Omega case – a famous instance of a disastrous insider attack on an information system; Westray Mine disaster – an equally famous case of an organizational accident) and lessons that can be derived from them (including learning from incidents and policy design). The last paper is about the Crisis Management Simulation approach for assessment of decision-making processes in emergencies.

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A Big SMILE Discussion

The commercial simulation environments available to SDers are probably the best available in any simulation discipline. Unfortunately, a model written in one commercial environment won't automatically run in another, and innovative but specialized 'amateur' products are not given to the community because those products can't easily import to or export from the wonderful (and complete) commercial environments. A Simulation Model Interchange Language (SMILE) – if widely adopted -- would remedy this situation, allowing greater sharing of models and greater innovation. Everyone with an interest is invited to participate in a community discussion about the desirability, the implementation, and the success factors for providing our field with a big SMILE.

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Health Policy Roundtable

Thorny issues of public health and healthcare delivery and financing are increasingly being recognized as in need of systems approaches, though what that entails is not clear to most in the health policy field.

Following a brief presentation on "SD in Public Health" by Mr. Bobby Milstein of the U.S. Centers for Disease Control and Prevention, we would like to have a roundtable discussion about opportunities for SD in health policy, perhaps including international collaborations, as well as relevant work in progress. We hope that this conversation and chance for networking will be continued beyond the conference, and would like to propose the formation of a Health Policy Special Interest Group of the Society.

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Military Roundtable

The Military Roundtable enables sharing of experiences about the application of SDM to military problems. This includes, for example; strategy development; force-on-force analysis, war-gaming, military decision making, training of military decision makers, and command-post exercises; preparedness studies, management of human resources; development and management of military capability, management of materiel acquisition, military logistics modelling and in-service management. Opportunities exist for participants to provide updates on recent research and consulting activities, to discuss opportunities for the future and challenges that confront those working in or having an interest in system dynamics modelling in a military context. Building on previous work in this area, time will be set aside for discussion on: enhancing the awareness of senior defence executives of the utility of SDM; sharing knowledge and experience derived from significant system dynamics modelling projects; and assembling a compendium of models and readings on system dynamics modelling in defence.

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Modeling Assistance Workshop

Modeling assistance is available at the conference to enable modelers to discuss their specific modeling questions with modeling coaches. Modeling assistance opportunities include two workshops, as well as the possibility of assistance at any time during the conference. Assistance is available for modelers with all levels of modeling ability, from beginner to advanced. Modelers' questions range from a specific model that modelers are developing or studying, to something that modelers don't understand in one of the system dynamics textbooks or software packages. Questions range from problem articulation, formulation of a dynamic hypothesis, formulation of a simulation model, model testing, or policy design and evaluation. Modelers bring whatever materials they need to

describe their modeling question, including pencil and paper, books, posters, or laptop computers. Spectators are welcome to observe modeling assistance coaching sessions.

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Celebrating the Diversity of System Dynamics: A Tribute to Barry Richmond

Barry Richmond had an immense impact on the field of system dynamics. His contributions were widespread, impacting the course of evolution for system dynamics software, shaping the development of the system dynamics methodology, and charting a course for the application of both in a variety of settings. This special session seeks to characterize Barry's contribution to the field. Speakers will use Barry's work in business, in public policy, and in K-12 education as the context for drawing out insights into the nature of this contribution. The session will be retrospective (examining the work that has been done) as well as prospective (considering the work that is being done and is planned for the future). Mark Paich of Decisio and Steve Peterson of the Peterson Group will convene this session.

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Economic Dynamics

The conference theme of "economic dynamics" will be the focus of a special plenary session featuring presentations from Glen Atkinson, editor of the Journal of Economic Issues, Jed Shilling, a former World Bank economist from the Millennium Institute, and Michael Radzicki, an economist from Worcester Polytechnic Institute. The speakers will discuss the future of system dynamics within the economics profession in general, and within the hetrodox economics community in particular.

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Economic Roundtable

The economic roundtable has two main purposes. The first is to bring together individuals who are interested in the application of system dynamics to economic problems, with a special focus on (but not limited to) advancing the Post Keynesian-Institutionalist paradigm. The second is to discuss the formation of an economic dynamics chapter of the System Dynamics Society. This will be the first of an on-going series of economic roundtables that will be held annually at the system dynamics conference.

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Economic Dynamics II and III

The conference theme of "economic dynamics" will be the focus of a second special plenary session featuring presentations from Jerry Barney, Founder and President of the Millennium Institute and Khalid Saeed, an economist from Worcester Polytechnic Institute. Dr. Barney will discuss a review of available national economic planning models, funded by Conservation International, that ranks the Millennium Institute's T21 system dynamics model number one. He will also present an overview of T21 and some of its applications to national economies. Professor Saeed will present a system dynamics model that he used to test designs for an environmental mitigation banking system. He will also discuss how this work fits nicely into the field of institutional economics.

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Learning Bathtub Dynamics: A Follow-Up

At the Bergen ISD Conference in 2001, John Sterman and Linda Booth-Sweeney gave a talk entitled "Bathtub Dynamics". That talk has inspired teachers across the world to repeat Sterman and Booth-Sweeney's experiment to test different populations on the system dynamics concepts inherent in the bathtub exercise. These educators have used the Bathtub Dynamics Protocols from Sterman and Booth-Sweeney in their classrooms ranging from middle school through college. The discussion covers : 1. Methodology for using this activity and data gathering; 2. Usability of this activity at various age levels; 3. The ability to teach these concepts at various levels; 4. The implications for future teaching and learning.

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PhD Colloquium

The 4th International Ph.D. Colloquium is an event of the System Dynamics Student Chapter. Its objective is to bring together Ph.D. students involved in System Dynamics research and to give them the opportunity to raise key questions and/or concerns related to their research and discuss these in depth in a constructive and international atmosphere. The diversity and the interactive setting provide a unique learning opportunity for all participants. During the Colloquium, students closely interact with established faculty and others of the wider system dynamics community. The all-day Colloquium includes four presentation blocks. In each block there are two consecutive 20-

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minute presentations. Differing from the Conference set-up, the presentations are followed by two parallel 30-minute workshops. These workshops are intended for discussing the questions raised. Students who are considering participating in the Ph.D. Student Colloquium should be in the early phase of their research, but after having settled on a research area or thesis topic. The Colloquium is a valuable and beneficial, but also swinging, ebullient, and of course smashing learning experience!

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Business Roundtable

This year's Business Roundtable -- formerly known as the Consultants' Roundtable -- will start with questions, submitted in advance, to practitioners in industry and consultants. Our panel will offer two or more responses to submitted questions and, time permitting, we will open the roundtable to questions from the floor. We hope that this roundtable will be lively and informal. Our panel includes Jonathan Coyle (U.K.); Nathan Forrester (U.S.); Alan Graham (U.S.); Michel Karsky (France); Nathaniel Mass (U.S.); Frank Schoeneborn (Germany); and Jim Thompson (U.S.). As of three months before the conference, we have received questions including how to describe SD to non-practitioners, how to improve academic preparation, whether SD is primarily a strategy consulting tool, and how to estimate and shorten time-lines for consulting engagements.

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Psychology Symposium

A symposium on psychology will be convened by Elise Weaver of Worcester Polytechnic Institute. This will feature presentations from well-known people in the field of psychology with a goal of promoting greater interchange between researchers in psychology and system dynamics.

Workshops

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Starting a System Dynamics Program in your School

The workshop will demonstrate a multi-faceted approach to the problem of starting a system dynamics program in a K to 12th grade school environment. Student work will be demonstrated. A CD containing training materials used in the National Science Foundation CC-STADUS/CC-SUSTAIN Project will be available (at no cost) for all participants. These materials have been developed over the 8 year history of the project, training high school and middle school math, science, and social studies teachers to create STELLA models and curricular materials to use in their classroom. The CD will also contain teacher created project modules that have been edited. The workshop will also introduce materials developed in Carlisle, Massachusetts for younger students in kindergarten through eighth grade.

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Building a Web Simulation with Forio Broadcast

The workshop will be in two parts. The first hour will consist of a presentation discussing how to build an online simulation. After a short break, the session will continue with a hands-on session. Specifically, 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. If possible, participants should bring a laptop with an ethernet card (or plan to share). Participants can also 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 for the workshop.

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Creating Better Models Faster: System Dynamics Molecules and Their Use

The productivity of an experienced modeler may be one-hundred times that of an inexperienced modeler. And, the quality of models created by experienced folks typically exceeds the quality produced by the inexperienced by as much or more. A significant part this difference in speed and quality is attributable to the warehouse of small SD structures (or “molecules”) that an experienced modeler carries around in his head. Almost ten years ago we collected and organize a set of these molecules so that less experienced folks could learn them faster. The most recent revision – completed earlier this year – expanded the number of molecules to about 200, and organized them in a new way that makes learning and using them significantly easier. In this seminar we’ll take a serious look at molecules, their organization, and their use in creating better models faster.

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Sable

This two-part workshop will introduce you to the Sable interface application for Vensim models. In part one, your tutor will demonstrate the creation of a simple interface, from project inception to packaging of the final solution: starting a Sable project; creating screens and using background graphics; linking screens and project navigation; running and analysing models in Sable; and creating a run-time application. In part two, you will be provided with all the tools required to create a simple interface for a model. You will be able to include your own model, or use the tutorial model. To make the best use of available time, a number of template screens will be available for use with your model, to include analysis and run screens. The tutor will be available to assist individuals in the creation of their first interface.

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A Balanced Approach to Measuring your School's Performance

Many measures of organizational performance use past performances measures that are often one-sided and “look in the rear-view mirror” to inform management. In 1992 Kaplan & Norton developed the Balanced Scorecard [BSC] Framework to overcome these traditional

shortcoming and has become the leading methodology to help organizations translate strategy into action. Educators have slowly been recognizing that they too need to have a performance framework that captures the rich, multi-faceted views of school performance. In particular, there is a need for a measurement framework that does not solely rely upon standardized test scores or focus on the comparison of school to school performance but allows insights in how resource allocation to one area of the Institution affects the other areas. A dynamic model based upon BSC framework is used to engage all stakeholders in the school to improve the overall, long-term school performance. The framework has four main “views” of the school with associated measures.

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Digest: Automated Detection of Important Feedback

Digest is an experimental piece of software that reads the text version of most any system dynamics model. It automatically detects and displays the most influential structure for any given variable in that model. Bring your laptop to this half-day workshop and you will gain a running beta test version of the software, copies of several models that you can work with, plus training in how to load models and use the software to detect dominant structure in your model. This workshop is designed for researchers and skilled modelers who are seeking a chance to work with Digest in the beta test stage of its development. We are actively seeking user feedback on their experiences using this new approach to detecting dominant structure.

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Using Cybernetics with System Dynamics to Solve Problems

This workshop is based around the collaborative work between the university of Sunderland and British Telecom, the major telecommunications company in the U.K. The collaboration involves a Mixture of Cybernetics and System Dynamics. As most participants will be familiar with System Dynamics, the first part of the workshop will be concerned with the major elements of Cybernetics. Audience participation will be encouraged in the form of debate and role-play. The Second part of the workshop will show how the two areas have combined together and will stimulate debate on the success of the synthesis. The workshop will be useful to people who wish to learn about cybernetics and to both academics and industrialists who wish to discuss how system thinking ideas can help solve their problems.

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Getting the Best of both Worlds: Reconciling and Combining the Classical System Dynamics Approach with the Direct Use of Data, Parameter Estimation, and Forecasts

The founder of system dynamics has long argued that data should be qualitative, optimization is pointless, forecasting is misguided, and that models should be used for policy, not decisions. Meanwhile, some successful system dynamicists cheerfully match model behavior to data, estimate parameters, make forecasts, and optimize decisions as well as policies. Which camp is right? This workshop will show that each camp is self-consistent and valid. The crucial issues will be clarified with a simple nonlinear model and some data. A straightforward postulate of what Jay Forrester is "really" advocating ("hyper-robust servo design") will be illustrated with the model and data, and then the exercise will be repeated with an intuitive application of modern stochastic control theory. It will be shown that in the model-building phases the two approaches are identical, but that they differ on how to design improved policies or decisions. It will be shown that each approach, done correctly, requires massive numbers of simulations and tests.

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Clarity: Unleashing Value by Applying Systems Thinking

Tremendous energy in recent years has been devoted to squeezing out the last drop of efficiency in operating processes. However, there is a well of untapped value hidden in the improved management of tangible and intangible resources that are shared across these processes and throughout the organization. Traditional analytical tools do not focus on these interdependencies and therefore generally do not recognize this source of value. They are not looking for it. Participants will work individually and in groups to start to learn the basics of the Managing from Clarity approach, a rigorous framework for identifying and unleashing this hidden value. The workshop format is founded on exercises, discussion and an introductory presentation.

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Strategy Dynamics in Action

The three-hour workshop will outline the impact of resources on performance and how strategy dynamics can help map these within the business. It will show how the interaction of these resources and

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the capabilities that link them together can be brought together into a map of the firm's Strategic Architecture. Throughout the key ideas will be illustrated by examples from large and small businesses. In addition, the facilitators will share their experience in the client engagement process, helping the client use the approach to solve real problems. The workshop will; be suitable for anyone who has an interest in applying the core ideas of System Dynamics within the context of organisational performance. It will not assume and prior knowledge of Strategy Dynamics but will assume that you have an understanding of and some experience in using the stock-flow modelling language.

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Geniusys: Systematically Developing Genius

The Geniusys model aims to model and replicate the structure of human excellence. It uses System Dynamics to model the structure of our thinking process and identify the leverage points in this complex dynamic feedback system. Identifying the leverage points allows us to focus our valuable resources on them in order to accelerate the accelerated transformation process by: Minimising the adjustment time in flexibility of the filters in our mental models; maximising the range of flexibility of our cognitive filters; choosing the allocation of meaning to create primary and meta states; using observation to create genius states. The Geniusys model uses these leverage points to implement accelerated transformation in our thinking and consequently our behaviour. This is done by using linguistic patterns to influence our thinking and behaviour, converting our genius potential into performance. If you had the instruction manual for developing your genius, would you use it?

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Teaching Strategy Dynamics

If System Dynamics is to increase its impact on improving the professionalism with which strategic management is practised, it will have to become an integral part of teaching in Business Schools, and management education generally. To accomplish this, it needs to pick up, and build upon, what is already being taught. It will also need to be accessible to management teachers, who have a large investment in other teaching methods and materials. This workshop covers - The foundations for a contribution SD can make to existing management teaching - Developing and using learning materials needed to make this contribution - Adding 'dynamic' elements to existing subject-courses - Executive education situations - Developing full, SD-based courses [Note: this session will seek to build on experiences of

participants.] Anyone who either teaches in management, or wishes to do so, whether on a substantial scale or via small teaching or workshop activities.

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Strategy Dynamics Masterclass

Many participants at previous SD conferences have taken part in introductory Strategy Dynamics workshops, with the result that a significant number are now delivering strategy analysis and development activity in real-world situations. This workshop will provide a forum to share the accumulated experiences and learn from others the pitfalls - and solutions. Who is this workshop for? ... Anyone who has carried out management problem-solving using the Strategy Dynamics approach. What will it cover? ... Participants' experience of using the Strategy Dynamics frameworks with management teams - Participants' experience with the process of facilitating teams via this approach - One or more live case discussions, drawn from participants' experiences. [Note: this session will work best with some prepared case examples from participants. Please let us know of any examples of Strategy projects on which you have worked with a management team - disguised if necessary to protect confidentiality.]

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**MacroLab: Model Facilitated Learning of
Macroeconomics**

What is MacroLab? A series of interactive learning environments (ILEs) based on system dynamics; an instructional tool currently used in a macroeconomics course. Who should attend the workshop? Anyone interested in how economics can be learned; creators or dreamers of interactive learning environments; instructors or trainers interested in using system dynamics; anyone curious about learning technologies. What will you do? Gain economic understanding by test-driving the ILE; gain ILE development skills by experiencing the step-by-step content delivery process, observing the corresponding design process, and discussing analogous steps for an ILE in your own field. What will you take away? A MacroLab demo disk and user guide; insights gained from hands-on activities and group discussions. Who is the facilitator? An experienced consultant and award-winning instructor; a PhD candidate in system dynamics, University of Bergen, Norway.

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ExTrain: Management Training Platform for Simulation-based Learning and Knowledge Management

System dynamics models are being used by businesses today to train managers, communicate strategic change, share and align business perspectives within their company. This workshop will introduce you to ExTrain®, a web-based platform that facilitates the use of simulation models in management training. After a brief introduction to the ExTrain® environment, participants will take part in hands-on demonstration of the system, an exciting way for learning and knowledge management. Working in groups of 3-4 participants, you will be running a virtual technology company for four years. Facilitation will be provided to help you understand the key business dynamics.

Addenda

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Stock/Flow Models of Blood Donor Restrictions: Why the vCJD Problem is Worse than Expected

This paper examines the impact of restrictions to blood donations to examine the dynamics of the interactions between the restrictions, on one hand, and the existing donor base and the eligible donor base, on the other. The paper suggests that when the impact of restrictions such as those imposed for the outbreak of vCJD in the US and Australia, are modeled using stock/flow analysis, the results suggest a much greater loss of donations than is suggested in the literature. The paper discusses simulations of both the Australian and UK blood services and suggests that there are similar dynamics in both systems. The required recruitment patterns to recover from the losses were modeled and discussed.

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System Dynamics Modeling of High Technology Industry Development in China

High technology industry is a complicated, multiple information feedback and non-linear system. Its developing process includes the interaction of many factors from the interior and exterior of the system. The dynamics of high technology industry development (HTID) in the field is influenced by a series of factors. The motivation that drove the effort to study the dynamics of HTID is to analyze two issues: (1) How corporate R&D intensity, and the proportion between corporate internal R&D fee and technology import fee have effect on HTID; (2) How the behavior patterns of government have influence on HTID. To analyze these issues, a formal model ---- HTID SD model was built. The main conclusions are as follow: (1) At the different stage, Chinese government should choose appropriate behavior pattern. (2) During the transitional economy, the main work of Chinese government should create favorable entrepreneurial environment; offer policy and regulation to minimize institutional obstacles of firms' innovation.

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