System Dynamics Society

Proceedings
of the
18th International Conference
of the
System Dynamics Society

Sustainability in the Third Millennium

6-10 August 2000
Bergen, Norway

Conference hosted by:
Department of
Information Science
School of Social Sciences
University of Bergen

Conference
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Pål I. Davidsen
David N. Ford
Ali N. Mashayekhi

Production Team:
Elizabeth F. Andersen
Vedat G. Diker
Robin S. Langer
Jennifer I. Rowe

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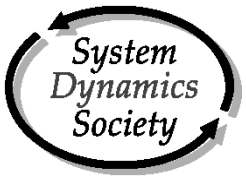

ISBN 0-9672914-2-9

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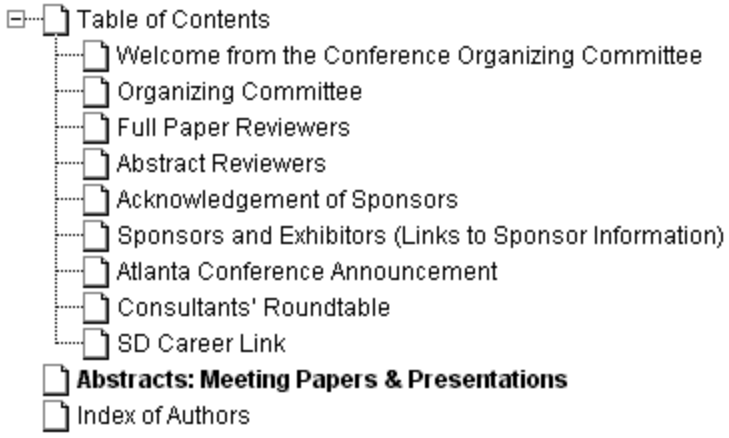
Navigating the Conference Proceedings

The electronic version of the 2000 Conference Proceedings, Abstracts and Presentations is being distributed as Adobe PDF documents for portability and ease of use. This document offers a brief outline of how to navigate the Proceedings, Abstracts and Presentations.

Participants familiar with the Acrobat Reader will recognize the common navigational features including Bookmarks, hot links and menu icons. Users unfamiliar with Acrobat may want to print this page for reference. See **Print a PDF Document** below for additional information.

Table of Contents

The Table of Contents that appears in the left pane of the Acrobat Reader displays the main sections of the Proceedings document. Clicking any Topic Title on the left will display the corresponding Topic in the right pane. This bookmark view stays visible while navigating the main Proceedings document only.



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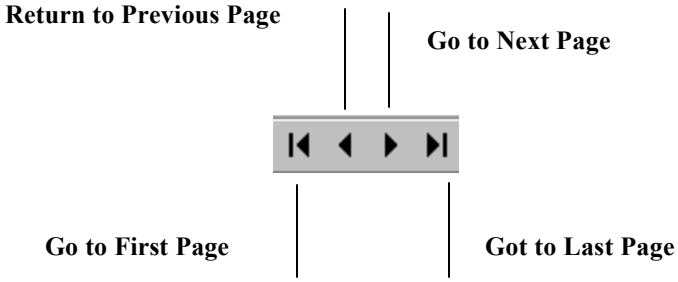

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Welcome

Dear Members of the System Dynamics Society:

Welcome to the 18th International Conference of the System Dynamics Society! Almost 300 papers, workshops, and panel discussions will be available over three and a half days, as well as social and cultural events. So you will be busy! These activities have been designed and organized to help you learn, collaborate and share your experiences with others in the system dynamics community.

We also welcome you to Bergen, Norway, to share in the city's celebration surrounding the honor of being named European Cultural City 2000. The University of Bergen is pleased to host this year's conference in the traditions that were established in 1977 and 1984 under the chairmanship of Jørgen Randers. The '77 and '84 conferences were attended by a number of participants who are in attendance at our conference in Bergen this year. We are quite pleased that the widely-esteemed scholar and practitioner, Jørgen Randers, is one of our keynote speakers.

This year we will discuss, among other things, "Sustainability in the Third Millennium." The theme is challenging and forces us to focus on the balance between what we desire and what we are capable of; personally, among family and friends, in the workplace, and organizations of which we are a part, in our regional, national and global societies, and in nature. We will be concentrating on the tradeoffs and potential synergies between near-term opportunities and their long-term consequences.

This year we had a total of 59 volunteers who reviewed the paper abstracts and/or full papers. They reviewed 348 abstracts and 27 full papers for this year's conference. Their insight was invaluable and much appreciated. The success of the program would not have been achieved without the passionate and endless efforts of the entire organizing committee and volunteers working together for a common goal.

We sincerely hope that your participation in the 2000 Bergen, Norway conference will be rewarding and enjoyable. Thank you for joining us.

Best wishes from the

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Pål, Ali, David, and Roberta

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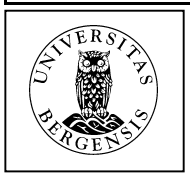

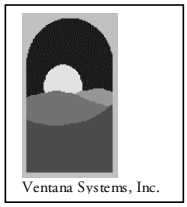

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Many organizations and individuals contributed to this conference. We wholeheartedly thank our sponsors and encourage you to thank their representatives during the conference. Please see the complete list of conference sponsors and exhibitors included in the proceedings. In particular, we would like to thank the City of Bergen for hosting the Welcome Reception at the Bergen Castle, and the Department of Information Science at the University of Bergen. Due to their support, this conference is a reality today.

In addition to sponsoring program sessions, we would like to thank Andersen Consulting for being a co-sponsors of the conference banquet; HVR Consulting Services Ltd. for sponsoring the conference satchel; and Powersim Corporation for the printing of the CD-ROM proceedings as well as the Printed Abstract Proceedings. Global Strategy Dynamics Ltd. is sponsoring the pens and note pads. The SD Career Link would not have gotten off the ground without the support of Society members and volunteers at McKinsey & Company. Pugh Roberts Associates and Vestec AS are sponsoring coffee/tea breaks for our enjoyment. PricewaterhouseCoopers is this year's sponsor of the Consultants' Roundtable.

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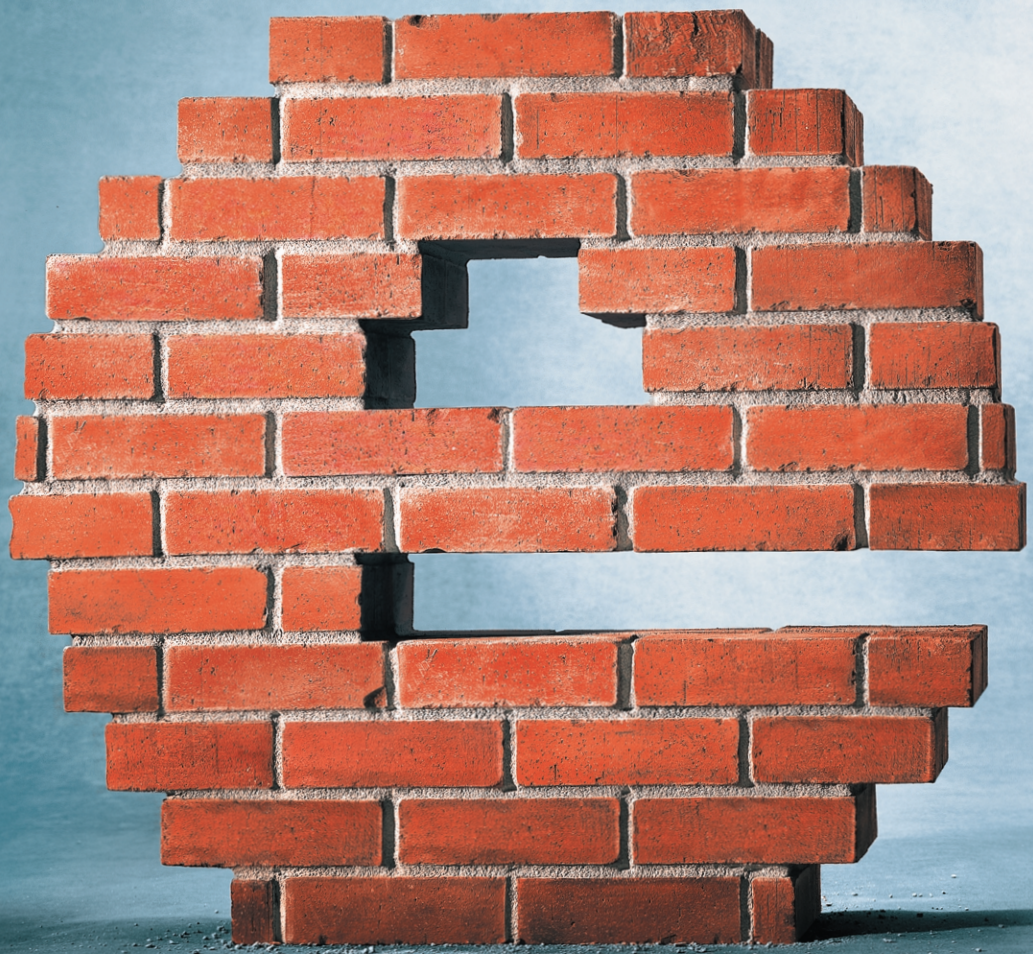

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Our Modelling and Analysis Group includes one of the largest System Dynamics teams in Europe. We have undertaken a wide range of assignments for Government and commercial clients in the UK, Europe, and North America. We also have our own active research programme in the field, an example of which is our validation methodology. The combination of practical experience and research capability ensures that we can always provide our clients with innovative and focussed solutions.

The focus of the Modelling and Analysis Group, and of our System Dynamics consultancy, is on the provision of analysis and assessment services to government, industry and prestigious Blue Chip organisations. HVR-CSL has established an enviable track record of conducting such analyses and of identifying critical areas requiring strategic or operational remedial action. This capability has been built up through a large number of defence contracts, with clients including the UK MoD, US DoD, Canadian DND and BAE Systems and in the commercial sector through clients such as BP Amoco, Mercury Asset Management, Scottish Hydro Electric, SmithKline Beecham, HSBC, Cable & Wireless and the European Union.

The Group has close links with a number of major universities in the UK and maintains a large database of consultants in industry and academia, thus ensuring contact with the latest thinking and developments in principle areas of interest, including System Dynamics. This helps to ensure that the Group provides the highest quality product at all times.

Application areas where System Dynamics has been utilised by HVR-CSL include the following:

- Resource Planning
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- Command and Control and CIS Effectiveness Modelling
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For information contact: Jonathan Coyle, Operations Director, HVR Consulting Services Ltd., Selborne House, Alton, Hampshire, GU34 2QJ, U.K., Tel: +44 (0)1420 87977; e-mail: jonathan.coyle@hvr-csl.co.uk.

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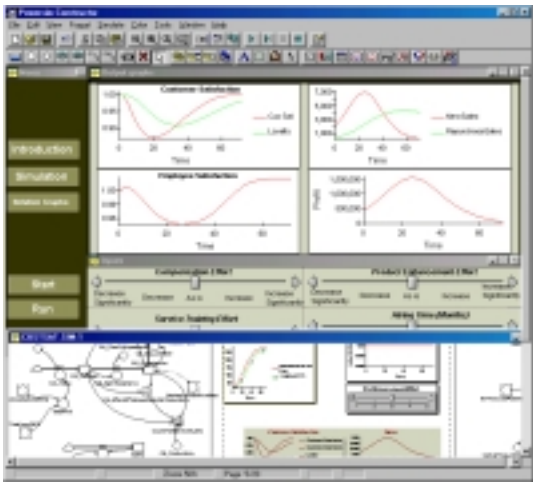

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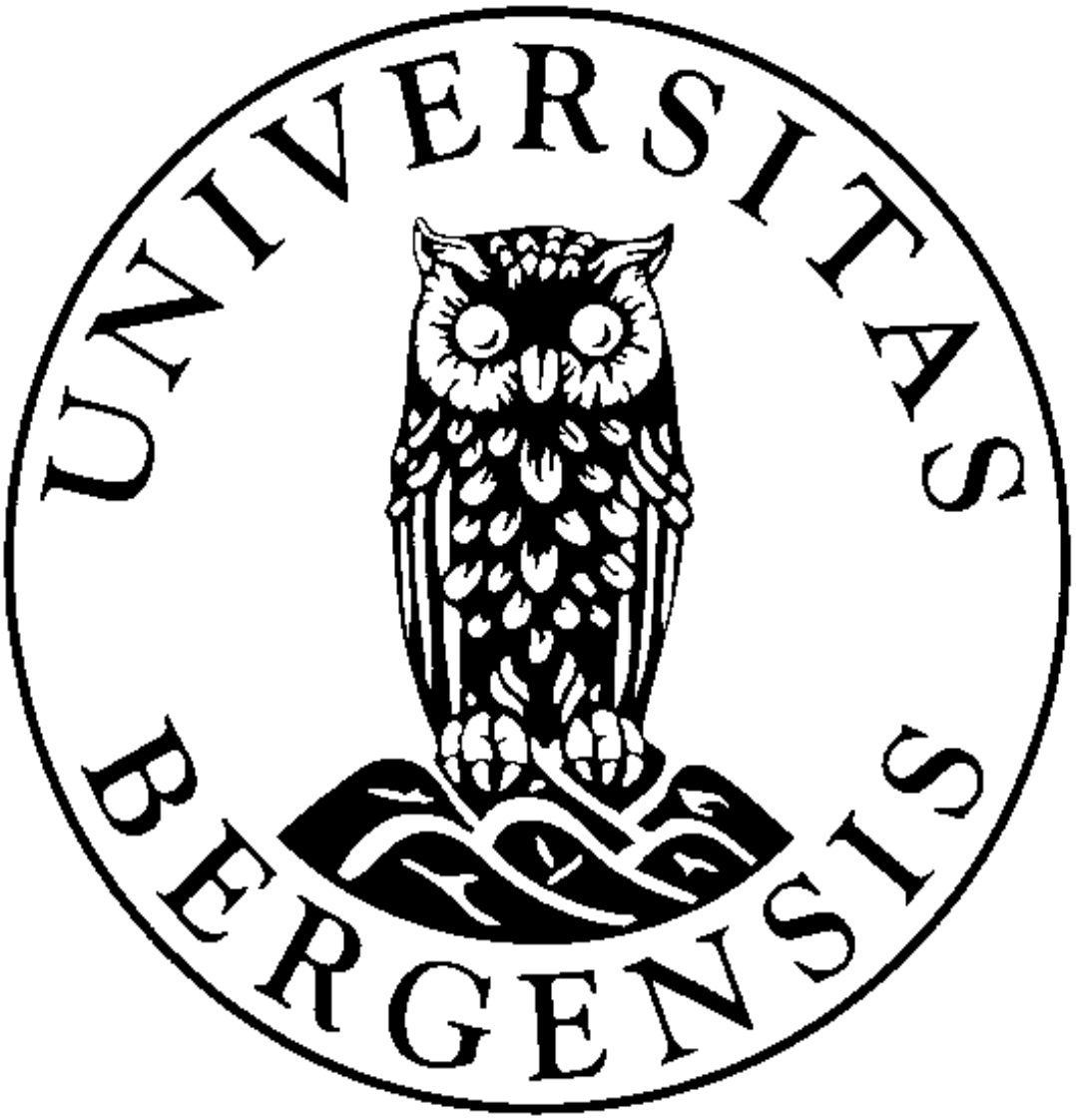

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For more information on the study of System Dynamics contact:

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We offer services in four main areas:

Strategic Modelling: Highlights interactions between the client, customers, competitors and other market players. We help clients make strategic decisions, such as major structural changes or new product investment, introduce integrated performance management and deal with regulatory reviews. Using systems thinking and system dynamics to combine quantitative and qualitative judgements, we can identify value drivers and work with clients to influence them to optimise their market position.

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VESTEC AS

Vestec AS is a development company within the area of information and communication technology, including interactive learning and e-commerce. The company develops high tech companies by active ownership from the stage of the idea until the company is self-sufficient. Vestec AS has its main office in Bergen, Norway, but strives to develop companies with an international market potential.

One of the primary goals for Vestec AS is to create environments for interactive learning. This is achieved through a strong focus on interactive education through the Internet. The business focus has so far been on customised continuing education packages for major companies and trade unions. The challenges within this field have mainly revolved around the development of a sound technological and pedagogical platform, and the presentation of content and its formal anchoring in the educational system. To meet these challenges one of Vestec's subsidiary companies owns and operates a platform and a portal for web-based education. In addition, we are currently developing system dynamics models for web-based education material.

Vestec AS cooperates with a range of suppliers of learning material. Several major Norwegian companies and trade unions have chosen our platform as a standard for their web-based education. We intend to establish a national center for web-based continuing education in Bergen while Vestec's concepts also have great potential outside Norway.

Vestec's staff consists of persons with different administrational and academic background. An aim for Vestec AS, is to use systems thinking and system dynamics in our evaluation of business prospects, and in the development of new companies.

The City of Bergen, European Culture City 2000

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Calendar of Events

The City of Bergen will host Cultural Programs before, during, and after the conference:

Thursday, August 03, 2000 to Sunday, August 06, 2000

Nordsteam 2000 - A festival of veteran ships and transport. The pulsating rhythm of the 1950s is recreated in Bergen by veteran ships and cars, coastal steamers and bustling harbour activity.

Sunday, August 06, 2000 to Saturday, August 12, 2000

Orchestra Festival 2000 - A week-long orchestra festival in which young musicians from string and symphony orchestras are the main participants. There will be indoor and outdoor concerts, activities and seminars. An orchestra from each of the other eight European Cities of Culture will also be invited.

Sunday, August 06, 2000 to Sunday, August 20, 2000

Maria Music Festival

Thursday, August 10, 2000

Football - Brann FC - Liverpool FC

Saturday, August 12, 2000 to Friday, August 18, 2000

Open-air opera at Bergen Fortress.

It is the City of Bergen's pleasure to host the Welcome Reception for the 18th International System Dynamics Society Conference.

Announcing the
19th International Conference of the System Dynamics Society

July 23-27, 2001 - Atlanta, Georgia, USA

The 19th International Conference of the System Dynamics Society will be held in Atlanta, Georgia at the Emory Hotel and Conference Center on the campus of Emory University. The conference will bring together about 400 participants and practitioners interested in system dynamics and systems thinking. Presentations by practitioners and world leaders in the field will cover a wide variety of topics including: theory, methods, tools, techniques, pedagogy, case studies, and applications. Application areas will include: business, economics, public policy, engineering, K-12 education, and social and natural science.

The conference site is a lovely, full-service facility that lends itself to close interaction among participants. Family members are encouraged to stay at the conference center and visit the many sights around Atlanta during the conference.

The program will include various formats. Plenary sessions will feature refereed presentations on topics of general interest. Parallel sessions will be organized by themes and will feature the full range of work being done in the field. Poster sessions will provide an opportunity for participants to engage authors directly on subjects of particular interest. The program will also include workshops, tutorials, panel discussions, special interest group sessions, a student colloquium, events of historic interest, vendor displays, and demonstrations.

Tentative Key Dates:

August 6, 2000	Conference Announcement Call for Papers and Sessions
January 31, 2001	Deadline for preliminary version papers, abstracts, and proposals
March 15, 2001	Notification of acceptance Invitations for submission of plenary papers
May 15, 2001	Deadline for plenary papers and CD materials
May 30, 2001	Deadline for conference center room reservations
June 20, 2001	Deadline for room payment and/or cancellations
July 23, 2001	Attend the conference in Atlanta

For further information and updated details, please visit the Society web site at: http://www.albany.edu/cpr/sds/

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CONSULTANTS' ROUNDTABLE

Monday, August 7th at 12:30 pm

Using A Simple Classification Framework To Share The Benefits Of Different System Dynamics Modelling Approaches

The main objective of the roundtable this year is to facilitate learning about the benefits of different modelling approaches. Using simple definitions, we have developed a 2-by-4 classification framework for system dynamics models. The purpose of this framework is to provide a common language for the consulting community to discuss the benefits delivered by different approaches to the system dynamics process.

The roundtable will consist of an introduction to the framework placing it in context, not as a framework grounded in rigorous analysis, but as a tool for facilitating learning from shared experiences. Five presentations will then follow from the consulting community using case studies to highlight the benefits of the development paths in terms of addressing clients' problems. Other participants will then be given the opportunity to use the framework to contribute their own experiences to the roundtable. In addition, the usefulness of the classification framework will be debated.

This year the Consultants' Roundtable is hosted by PricewaterhouseCoopers.

We are pleased to announce…

THE *SYSTEM DYNAMICS CAREER LINK*

What is it? The *SD Career Link*, sponsored by volunteer members from McKinsey & Company, and hosted by the System Dynamics Society at the University at Albany, includes on-line information and links to organizations seeking candidates specifically with system dynamics and systems thinking backgrounds.

We hope that the SD Career Link will provide a valuable exchange of information about positions and people in the field of system dynamics. The System Dynamics Society will not serve as an intermediary between interested parties. The SD Career Link will provide contact information only.

How to participate? Please refer to the System Dynamics Society website at www.albany.edu/cpr/sds/ or send an email message to the Society office at <system.dynamics@albany.edu>. We look forward to your participation.

Note: All information about access to and use of the site will remain confidential and information submitted for posting will be used only for the direct purpose described above.

Abstracts

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Systems Thinking And Scenario Planning: A South African Case Study Of The Strategic Transformation Of A Manufacturing Company

This presentation is a case study on structured transformation through the application of systems thinking in the manufacturing industry of South Africa. The post-apartheid era initiated radical changes in business paradigms within the country that led, inter alia, to changes in stakeholder profiles and requirements. Against this background Iscor Ltd (a privatised former state corporation) embarked on a scenario-based process of structured transformation.

The application of systems thinking approaches and scenario-based planning in an environment never exposed to such logic, caused its own contextual challenges. Getting acceptance from decision-makers for the application of software in the modelling of thinking patterns and the prioritisation of issues and strategies was particularly difficult.

Both authors are involved in the design and execution of the transformation program. This presentation is based on the experience gained in the application of the scenario planning methodology within the company's overall strategic planning cycle.

The presentation will focus on the approach that was used, the tools utilised and the challenges experienced. Thus it provides insight into the application of scenario planning as a tool for the systemic understanding of organisational problems in the context of rapid political and socio-economic change and transformation, and of increasing globalisation.

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The TPI Framework: An Integrated Approach To Strategy Development

This paper presents a framework that integrates several prominent streams of research and practice in strategy development with system dynamics group model-building approaches to create a new and integrative approach to organizational strategy development. With respect to the theory and practice of strategy development, the TPI framework draws heavily on the approach of Bryson (1995) coupled to that of Eden and Ackermann (1998) with an approach to stakeholder analysis and management that is drawn from Finn (1997). The system dynamics component of the framework draws from both standard principles of system dynamics modeling (Richardson, 1981) as well as more recent work in group model building (Andersen and Richardson, 1997 and Richardson and Andersen 1995). Finally, the framework links to an explicit theory of organizational leadership as articulated by Bryson and Crosby (1992).

The framework posits the existence of a number of conceptual principles that underpin a coherent approach to organizational strategy development, strategic change and realignment. In turn, these principles are linked to a set of software, groupware, and organizational development tools that are used by strategy change agents when they engage in client-based projects.

The TPI framework was developed and refined in a series of workshops held between 1995 and 1999 by the authors of this paper and has been recently recast as a graduate course in Strategic and Systems Thinking (Andersen 1999) at the Rockefeller College, University at Albany. The framework will be taught during the summer of 2000 at the Humphrey Institute as well as at the Strathclyde Business School. The framework continues to evolve as it is tested and refined in practice.

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Dynamic Modeling Of Flood Management Policies

Economic and social impacts related to flood disaster are two important and interdependent issues addressed by flood management policies. Economic impacts include structural and non-structural damages caused by the floods and the social impacts of flood disaster are mainly related to evacuation, where public response to disaster warning plays an important role. This paper

presents a system dynamics model that captures dynamic interaction between different components of the flood management system. The model provides a platform for evaluation of the consequences of various policy alternatives for flood management. The operation of reservoir and floodway has been simulated. Operating rules are developed for high flow/flood years to minimize flooding. Alternative operating rules are explored by changing reservoir storage allocation and outflows. Impacts on the flood management capacity of the reservoir are investigated by simulating gated spillway in addition to an existing unregulated spillway. Flood damages to buildings and infrastructure are calculated. Sensitivity analysis is performed on the reservoir levels at the start of the flood season and outflow from the reservoir. The modeling work on economic impacts of flood management policies is complete. However, the work on social aspects of flood management especially public response to flood warning and people's perception of risk with special relevance to evacuation planning is in progress. The model is implemented for the Red River basin in Canada using recorded data of large flood events.

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Power Plant Performance: Identification Of A Relationship Between Availability, Reliability And Productivity

Quality of electrical energy is measured by means of two categories of indices: One category is technical indices which are integrated in availability (A) and reliability (R). Another category of indices is economical which is integrated in productivity (P) index. Three mentioned integrated indices are collectively abbreviated to ARP indices and performance is a function of them. The ranges of ARP variations are vast and every country based on the level of its technological, economical and based on its social conditions should find the optimum level of the indices and then try to increase them gradually. This paper, at the level of power plant, describes the performance improvement via internal relations of the ARP indices and shows their interrelations by means of causal diagram and determines the strategies and related policies, as managerial manoeuvres, to improve the performance

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The Dynamics Of Water Allocation In Semi-Arid Regions

The critical role of water for sustainable development and limitations of supply management have increased the importance of demand management in meeting water needs. As an integral part of demand management in water-stressed regions water allocation policies address the competition between different user groups for scarce water resources. This paper presents a dynamic simulation model of a water system in semi-arid regions for the purpose of analyzing the effectiveness of allocation policies in meeting two objectives: 1) fill current demand and 2) provide adequate supply for future use. The model was calibrated and tested with data and policies from the Mediterranean island of Cyprus. Analysis of water allocation policies reveal that locally rational but overly risk adverse policies degrade performance and that counterintuitive water allocation policies can be more effective in satisfying both current demands with future water supply needs than current policies.

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Moving The Masses: Modeling Customer Segments Using System Dynamics

In the past, System Dynamics has been used primarily to model business processes and policies with the core of the model focusing on these very processes and policies and how they affect the business's performance. Recently, however, models, while still including the policies and processes of the business, center on the business's various customer segments. In these models, not only are the policies and processes key elements in the results of the business, but the segments of the customers play an important role as well, as certain attributes make some segments more "attractive" than others. By choosing policies that maximize the attractive segments of your customer base, the company can more effectively identify strategies that optimize profits. The categorization of customers can include, but is not limited to, segmentation based on customer tenure, loyalty, and behavior.

The model of interest is of a credit card company segmenting its customers based on account age and spending behavior. It explores the policies of acquisition, development, and retention, and their effect on the customer segments. By understanding the

drivers of their customer segments, the company is better equipped to improve its business performance through the utilization of policies that optimize its customer mix.

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An SD Approach For Assessing An Eventual Peace Process In Colombia

The Colombian conflict has been lasting for over 45 years and no expert on the topic foresees peace within the near future; however, very little research has been conducted intending to evaluate the positive impact that peace may have in society if it eventually occurs.

A recent scenario exercise, Destino Colombia (DC), provides four qualitative scenarios for Colombia, but little can be inferred from them in terms of a quantitative assessment of the improvement or deterioration of the situation. However both a parallel study, under an econometric methodology, and the one reported here, taking an SD approach to modelling, have supply qualitative indications on some of the outcomes of the DC scenarios.

In this paper we present results of two of the DC scenarios, which indicate likely credible benefits, in case that they occur, in terms of life savings and reductions in number of clashes in the conflict as well as in The authors believe that GDP improvement, budget reallocation for education, health and justice.

The results found in this research may provide further grounds for speeding the peace process, as it shows figures of the consequences, in case that the conflict continues, or the likely benefits, in case that the conflict stops. Compare to the econometric approach, the dynamics exhibited in this research may create a more believable story for the scenarios exercise.

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Learning Models/Models For Learning: Issues In Representing Adaptive Behaviour

Advances in modelling pratice and computer power have led to the development of several kinds of self-adaptive algorithms within social system simulation models. Applications of such algorithms to system dynamics models, can be in the form of either self-adaptive structures or evolutionary model components. These developments address the criticism that fixed model structures are unpalatable because they seem too mechanistic and deterministic or because they don't reflect real-world adaptive behaviour. They

use various approaches such as evolutionary agents, cellular automata, agent-based simulation and self-adaptive structures in which the model itself "learns". However, use of these enticing techniques implies different roles for participants in the modelling process and different modes of personal learning. In contrast, "modelling for learning" is concerned with upgrading mental models.

Consequently, this paper suggests a hierarchy of levels of abstract thinking needed in model building, divided between problem solving and strategy research/analysis. Modellers should recognise these levels of abstraction when building models and should be wary of combining multiple levels of abstraction in one model without careful reflection. This may help clarify the nature of a model's effectiveness or implied purpose when representing adaptive behaviour.

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Macro Regional Economic Development From Micro-Level Partnerships Between The Higher Education And Business Sectors

A major thrust in UK government policy to achieve sustainable economic development concentrates on innovation and strengthening the competitiveness of small and medium-size (SME) firms in regional contexts. A core mechanism for promoting such development lies in encouraging partnerships between the higher education and private business sectors, particularly to enhance knowledge-based skills. University managed schemes with government funding that aim to generate improved business performance are also a highly effective way of creating new job opportunities.

The south-west region of the UK is characterised as a peripheral region where employment turnover and skill levels are typically below national averages. Previous research has developed system models showing how slow staff turnover can paradoxically harm aggregate skill levels in an organisation in times of rapid business change. The consequent need for rapid importation of expertise can be met by academic-industry partnerships based on short-term (½ to 2 year) applied research and development projects mainly in SME firms. Such firms often otherwise lack the resources for substantial investments in staff training. Causal diagrams prove their utility as an effective communication tool for preliminary discussions about the main feedback relationships and possible business development policies. Improved linkages between the

academia and industry sub-systems, which tend otherwise to be ineffectively connected, set off mutually reinforcing long-term feedbacks.

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Building A Sustainable Strategic Advantage In The Third Millennium: A Case Method Approach

The study and practice of strategy making is greatly enhanced by incorporating both a systems thinking approach and the tools that systems dynamics provides. We argue that the use of case studies augments business simulations, thus providing students with the opportunity to apply newly acquired skills to real business situations. We discuss our experiences incorporating a systems thinking approach to our teaching of strategy and consulting as well as two cases we wrote to help students master this approach.

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The Doing Of Model Verification And Validation: Balancing Cost And Theory

Much of the model verification and validation (V&V) guidance and literature is useful for explaining the principles of V&V and how V&V is ideally integrated into the simulation model development life cycle. There is less information available, however, on how to execute V&V, especially, as is often the case, when the resource commitment for V&V is limited. There are few examples that illustrate concrete application of the available V&V techniques or discuss the tradeoffs between theory and cost that are often made.

This paper describes the V&V approach used by Raytheon Company, C3I Systems and Project Performance Corporation in developing several low-resolution multi-purpose simulations of integrated industrial facilities and industrial sectors for a government customer. These projects were characterized by (i) the need to deploy each simulation model within a 60- or 120-day period; (ii) the need to utilize a commercial-off-the-shelf system dynamics software application; and (iii) heavy reliance on subject matter expert input to assess real-world fidelity. Furthermore, V&V had to be performed with little guidance at the outset as to what the acceptability criteria would be and V&V budgets of no more than 8 to 10 percent of the total project cost. Consequently, while the V&V efforts conducted for these projects were built

upon the "what and why" guidance outlined in the customer's policies and in such documents as the Defense Modeling and Simulation Office's Verification, Validation, and Accreditation Recommended Practices Guide, tradeoffs had to be made in developing an efficient "how to" approach.

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Public Sector Overextension, Downsizing And Sustainability: A Case Of Unintended Side-Effects In The Norwegian Defence

New production and administrative technologies, together with increased focus on core activities, have lead private and public sector organisations to downsizing. More often than not, such ventures are unsuccessful. In the public sector, job security makes lay-offs virtually impossible, and downsizing often entails hire freezes and subsequent growth in the relative number of elderly officers in the work force. In the Norwegian Defence real budgets have been virtually standing still over the last 10 years, whereas average NATO budgets have been reduced by more than 1/3. However, relatively modest governmental goals of Norwegian employee reductions have been largely unmet over the last 7 years. This has been a puzzle to many, and a problem that may cause the government to fall in the next parliamentary defene debate spring 2001.

In spite of largely constant employee numbers, key activity indicators have been reduced by half in the same period. A simple ageing chain model– with a small defence activity sector- shows why as a consequence of two mutually supporting problematic developments: Hiring freezes lead to non-planned use of older and much more expensive officers in operative positions. With constant budgets, the only why to balance budgets is through heavy activity reductions. On the other side, the increasingly elderly officer corps continually analyses an eventual downsizing of general staff numbers. Threatened by their own extinction, they find ever increasing needs for their own efforts – and so staff officer positions continue to increase – and operative elements are being sacrificed.

In addition to reproducing the reference model, the model also shows a way towards a sustainable organisational development and size. Key factors are a reduced average retirement age (such as many NATO countries have adopted), increased junior officer hiring, and the reintroduction of the under-officer corps dismantled in the early sixties.

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Modelling And Simulation Of Integrated Farming Systems: The Case Of Bangladesh

Bangladesh farming systems consist of crop, livestock, fish and other production systems including off-farm activities. An attempt has been made to develop a computer model of farming systems using system dynamics methodology for its use as a planning and management tool for sustainable agricultural development to alleviate the poverty of rural mass through integrated farming of crop, livestock, fish and other related activities. The model essentially consists of crop production, crop growth, population, cattle population, poultry production, fish production, fuel consumption, pollution and quality of life sub-models. This model includes the crop growth sub model to address the potentiality of the model for its adoption in different agroecological zones of Bangladesh. Simulated results of the model show significant increase in income, food productivity, labour productivity and quality of life for different technologies, interventions and enterprises. The model can be used as a computer laboratory for planning appropriate technologies, interventions and enterprises for sustainable agricultural development.

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Structure-Oriented Behavior Tests In Model Validation

Structure validation means establishing that the relationships used in a model are an adequate representation of the real relationships and it can be done in two ways: direct structure testing and indirect structure (or structure-oriented behavior) testing. Direct structure tests assess the validity of the model structure, by direct comparison with knowledge about real system structure. This involves evaluating each relationship in the model against available knowledge about real system. These tests are qualitative in nature; no simulation is involved. Structure-oriented behavior tests on the other hand assess the validity of the structure indirectly, by applying certain behavior tests on model-generated behavior patterns. For example, extreme-condition (indirect) test involves assigning extreme values to selected parameters and comparing the model-generated behavior to the "anticipated" (or observed) behavior of the real system under the same extreme condition. These are "strong" behavior tests that can provide (indirect) information on potential structural flaws. In a typical

structure-oriented behavior test, the modeler makes a claim of the form: “if the system operated under condition C, then the behavior(s) B would result.” The model is then run under condition C and it is said to “pass” this structure-oriented behavior test, if the resulting behavior is similar to the anticipated behavior. This article presents a computerized algorithm that automates this comparison/testing process. The modeler would hypothesize a dynamic pattern from the template of all basic patterns (such as "exponential growth", "S-shaped growth", "oscillations", "exponential decay"…) and then run the model under condition C. The algorithm would take the dynamic behavior generated by the model, “recognize” it and test if it belongs to the class hypothesized by the modeler. The algorithm, a Hidden Markov model-based pattern classifier, has been tested with various typical test patterns and proven to be quite effective and reliable.

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The Dynamics Response Of The Mexican Energy Sector To Regulatory Policies And Budgetary Restrictions

The Fuel Policy Group was created to integrate energy and environmental policy in Mexico and to determine the investments required to satisfy future electricity and fuel demand at the lowest cost, while complying with the expected evolution of environmental regulations. An output of this group was to change the trend of consumption of industrial fuels, reducing the use of fuel oil for power generation and industrial use by creating incentives to shift to cleaner fuels such as natural gas. Accomplishing such a strategy requires establishing appropriate environmental regulations; power sector investment to convert electric plants from fuel oil to gas; investment in gas production and processing capacity to cope with increase in demand; and refining capacity investment to destroy fuel oil displaced by gas. However, the relationships between the electricity, gas and refining sectors involve complex linkages and feedback effects, making the system sensitive to both internal and external perturbations that could drive the system away from the desired Fuel Policy Group objectives. With the use of a system dynamics model, this study is addressed at understanding the dynamic response of the Mexican oil and gas industries to perturbations such as: lack of availability of investment funds; changes in regulatory and environmental policies; and changes in institutional arrangements such as those arising from market liberalization. The study also intends to assess

how regulatory policies can be designed to minimize the economic inefficiencies arising from the business cycles disruptions that some perturbations often cause.

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Presentation

Applying System Dynamics To Scenario Based Software Project Management

Complex software development is a risky job. The number of unsuccessful projects largely surpasses the number of successful developments. Many studies relate this situation to non-technical problems, especially to inadequate project management. Scenario based software project management is an extension of the risk management paradigm that uses system dynamics abstract models to describe potential problems that can affect a software project. Dynamic models are also used to describe possible resolution strategies applicable to eliminate or reduce the potential problem impact over the software project.

Scenarios are defined by integrating combinations of these models to a project model. The project model is based on Abdel-Hamid and Madnick's software project model, which uses system dynamics notation to formulate several relations among development staff, software products, quality, project control and planning. The original model was adapted to allow a fine-grained description of project tasks, personnel abilities, and error propagation. The modified model also allows operational project monitoring.

The proposed technique allows the development of a standard problem and resolution strategy model library, to be integrated to new and ongoing projects. These models are abstract, in the sense that they cannot be directly simulated. The simulation is only accomplished when they are integrated to the project model. Their variables and equations affect the project model behavior, replicating the impact promoted by the problems and resolution strategies that they describe. The system dynamics notation was expanded to allow the definition of the integration interface.

Scenario analysis is a valuable tool to predict project results, such as cost, schedule and effort, in face of several combinations of problems and resolution actions. System dynamics complements the technique, describing nonlinear relationships and feedback loops among model elements.

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Modelling Shareholder Value

Value–based management and shareholder value measures represent the basis of one of the most important organising principles used in major companies. These measures provide a single integrating rationale for business decisions, performance criteria, and reward structures. However, the usual way of modelling value drivers is to use static spreadsheet frameworks conceptualised as DuPont charts. This framework ignores three sets of dynamics- the manner in which a failure to achieve a shareholder value target impacts on strategy, the inter-relationships between changes in primary inputs such as labour and capital, and the internal dynamics of decision processes within the organisation being considered.
This paper demonstrates how System Dynamics models overcome these problems and relates experience of modelling value drivers in Australian companies.

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The Importance Of The Assumption Of Continuity In System Dynamics

The paper draws on the history of System Dynamics methodology in an attempt to articulate the importance of the assumption of continuity in System Dynamics method.
It is argued that continuity describes the fundamental worldview that underpins System Dynamics. Comparisons are made with the continuity assumptions made in other systems-related fields such as social ecology and complex adaptive systems.
The significance of these comparisons is that they reinforces the importance of continuity in System Dynamics thinking and further builds the relationship between the System Dynamics approach and the assumptions of synechism and tychism in C S Peirce's philosophy of pragmatism.

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The Development Of The Holon Planning And Costing Framework For Higher Education Management

This paper discusses the emergence of the Holon Planning and Costing Framework for Higher Education management. We briefly discuss the key concepts that underpin management of the university system in the United Kingdom. An outline of the dominant HE planning approach is undertaken and criticisms are produced to suggest that an alternative is needed. We believe most mathematical techniques used for planning can be linked with Hard Systems Thinking (HST). Therefore, the essence of HST is highlighted, and a serious weakness identified, to explain the development of soft methodologies and Soft Systems Thinking (SST). We outline the distinguishing features of SST and key characteristics of the Soft Systems Methodology. Additionally, a significant limitation of this methodology is highlighted to justify the need to combine it with the Goal/Question/Metrics methodology. The combination of these two methodologies has been called the Holon Methodology, which was originally designed as an informal software process improvement approach. We advocate the view that an informal approach to controlling and improving HE management is needed; this will empower the relevant academics and administrators. This complements the view that there is a need for a systemic approach to HE planning. Therefore, we combine the Holon Methodology (rooted in SST) with the System Dynamics technique (rooted in HST) to produce the Holon Planning and Costing Framework. An outline of the work that is currently being undertaken to establish this planning framework is given.

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The System Diagnoses Itself - Using Causal Loop Mapping To Deal With Fundamental Problems At The Feisgasse School, Vienna

How can a group of administrators, teachers, and students use systems tools, like causal loops, to investigate the underlying systems that will affect their school's survival? Here is one approach, from a Catholic school center in Austria. The author is a faculty member at the Vienna University of Economics and Business Administration and one of the leading champions of

"fifth-discipline" work in Austria. (He helped edit the German edition of The Dance of Change, for example.) The particulars of this story (Catholic school, local academic, etc.) may not apply to you, but we think the basic experience, and most (if not all) of the steps, are applicable anywhere. It also shows how causal-loop diagramming can form the foundation of a university-level course in any form of management.

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Presentation

Measurement And Evaluation Of Policy-Concepts Using A Scorecard Based Approach

Decision making processes in complex business settings in many times result in undesirable system statuses and/or negative side effects (s. DOERNER). One explanation for this is the inapropriateness of the mental models applied by the decision makers (s. SENGE).
An approach for the provision of learning experiences which aim at the enrichment of mental models makes use of microworlds. With in such learning environments students can get feed-back on the appropriateness of their policies.
One objective is that the actors become aware of the structure of the respective business field and its behaviour. From the perspective of business administration additional ones are that they should become able to capture the interactions between different activities within the depicted organisation, that they should focus the customers´ needs and should become aware of the long-term strategies of the organisation and should not target on short-term financial objectives only.
The evaluation of learning effects based in the use of microworlds makes use of different ap-proaches (s. STERMAN). One refers to performance indicators like total profit acquired at the end of the simulation. This however falls short in respect to the considerations above. It rather is desirable to use a multidimensional approach which includes indicators derived from the target system of the microworld. The paper elaborates on this by proposing a scorecard based (s. NORTON/KAPLAN) evaluations concept. It allows for a multidimensional view on the results from the application of policies. The paper reports on the development of the measurement and evaluation logic. It also will represent findings from first applications of the logic within field studies.

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Lessons For Futures Studies From System Dynamics And Reinhold Neibuhr

Futures studies extrapolate the implications of current trends into the future. The objective is to either change undesirable futures or take advantage of desirable ones. The process has characteristics in common with System Dynamics methodology. Multiple social systems often interact in the analysis. Quantitative and qualitative variables work side by side in effecting the genesis of the future. Calibration is critical in ensuring that conclusions are supported. But, it can also suffer from traps that system dynamics has recognized and addressed. For example, basing decisions on conclusions derived from simple causalities is the source of unintended consequences and faulty policy. Or ignoring the implications of long term feedback loops. The results are calls to action but provide no clues as to what effective action may be. Beyond methodology and operational issues, there are broader lessons to be learned from System Dynamics about responding to insights into the future. Proactive, optimistic futurists assume that any future can be changed to a desirable one. System Dynamics would question how realistic that premise is. In fact, the most powerful learning futurists can get is stated simply in the Serenity Prayer of Reinhold Neibuhr - “God, grant me the serenity, to accept the things I cannot change, the courage to change the things I can, and the wisdom to know the difference”. This is the gift of System Dynamics.

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Fostering A Strategic Network Culture In Entrepreneurs' Education To Enhance Small Business Growth: "The Blue Bay" Flight Simulator

The management literature on ‘strategic networks’ has proved the opportunities for business growth management associated to resource sharing among firms located in a same geographic area and positioned along a common value chain. Small-medium enterprises (SMEs) provide a very important research field on this subject. However, in spite of the wide record of cases on successful networking among SMEs, empirical evidence suggests that the pursuit of such networks often encounters major difficulties particularly when the ‘hub’ firm is also a small company. Entrepreneurs’ cultural limitations (individualism and

suspiciousness above all), together with a bounded awareness of the networking processes and lack of contacts with bigger companies that might take the role of the 'hub' firm are among the most important causes of the scarce diffusion of strategic networks in most less developed economic regions.
The use of system dynamics (SD) interactive learning environments (ILEs) as a teaching aid in small business entrepreneurs' education can significantly contribute to develop a 'strategic network' culture, thereby fostering a deeper awareness of the pitfalls and benefits underlying small firms' networking processes. An SD network game, "Blue Bay", has been built to simulate cause and effect relationships underlying the rivalry, co-operation and negotiation processes among different 'actors' operating in a same industry.
The "double loop" learning process enhanced by the ILE stems from the understanding of:
a) relevant system boundaries;
b) key-variables affecting system behaviour;
c) feedback loops related to product positioning;
d) counter-intuitive short and long term effects generated by collaborative and non-collaborative policies.

Promoting Entrepreneurship Through Open-Distance-Learning Management Flight Simulators: Ecoroll Educational Package

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The start-up phase is a very critical step in small business growth management. Many potential successful ventures are destined to fail due to difficulties in generating and evaluating business ideas. Inconsistencies in the envisaged future business system and lack of understanding the peculiar complexity of small entrepreneurial firms are a primary cause of unsuccessful take-off.
Promoting entrepreneurship implies that the training process ought to be primarily focused on the perceptions and mindsets of people, rather than simply on the transfer of management concepts. Open-distance-learning techniques and system dynamics (SD) management flight simulators can play a crucial role in the education of new entrepreneurs. In fact, an educational package based on both the above techniques allows one to experiment in a 'safe' environment the impact that business decisions will be likely to generate in different time spans, according to a feedback perspective.
ECOROLL is a management flight simulator focused on main

problem issues related to product portfolio management in a small start-up firm operating in the in-line skates industry. The simulator consists of an SD model linked to a spreadsheet accounting-based model, aimed to show the financial implications of a business plan. Such models can be downloaded via the Internet together with a web based training (WBT) course, which both illustrates the case-study and provides basic business management concepts. Such a package aims to support potential entrepreneurs in questioning their own mental models and giving free play to their intuitions. Each participant can also share his views on simulation results with others and be supported by a tutor through the net.

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How To Define A Profitable And Sustainable Growth Policy In A Changing Market: A Case Study: A Small Publishing Company

A tireless architect founded Grafill, a small book publishing company, at the end of the 80s. He believed that in the real estate and construction sectors there is a lack of practical, reliable and punctual sources of information. To cover such a gap, he launched a monthly review and, started to publish a series of specific books and software to better support engineers, architects, and public utilities in their tasks. During the last two years, both the number of books published and software released, and their relative prices have been sharply increased. Such business strategy contributed to strongly increase company sales revenues, but it didn't generate a proportional growth in company bank balance. Such period has been also characterised by investments in E-commerce and related customer services, which shows a growing contribution in terms of company sales. On the basis of such results, the entrepreneur believes that this is the right way to pursue Grafill's growth. In particular, for the next two years, he foresees to reinforce the number of product to be launched and E-commerce activities. Such growth policy, according to owner's vision, will enhance virtuous circles that will allow the firm to increase direct sales and related margin, so that to finance further business development. A system dynamics modelling approach has been adopted to better understand business areas interconnections, to assess sustainable strategies and to share learning among the entrepreneur and his direct collaborators.

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Presentation

Improving The Practice Of Process Improvement

Despite empirical evidence that process-oriented approaches such as reengineering and total quality management can and sometimes do provide gains in effectiveness, efficiency, and financial metrics, few companies have strong records of using process tools to achieve enduring improvements. I hypothesize that companies often founder on process-oriented efforts because a process, by definition, is dynamic and cross-functional. Process improvement requires that people work across hierarchical and functional boundaries with no obvious ways to reconcile or clarify differing vocabularies, conflicting objectives, or vague notions of sequential and logical dependencies among tasks. Additionally, cognitive inability to manage dynamic complexity can lead people to focus on short-term strategies at the expense of long-term investments. Drawing on an organizational theory of boundary objects and the system dynamics modeling method, I argue that the process of building a dynamic model of the problem at stake can serve as a boundary object, providing an iterative process for cross-functional groups to overcome obstacles posed by differences in practice and dynamic complexity.

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Presentation

The Opportunity Cost Of Solving Problems: The Role Of Testing In Product Development

Many companies have established stage-gate processes in efforts to ensure that product development processes remain on track and on schedule. In addition, many scholars advocate that work for multiple years' new products proceed concurrently with staggered launch dates. In a situation of overlapping product development efforts with stage-gate milestones, engineers often become a scarce resource that must be allocated among projects in various phases of development. In this context, I study the effects of allocating engineers to the main product development activities of design, testing, and problem-solving. While, in keeping with a stage-gate process, practitioners and researchers often structure their work and methods as though design and testing were sequential phases, many acknowledge that design and testing emerge iteratively. In the context of multiple projects, unanticipated cycles of testing and re-design in one project can jeopardize other efforts' schedules, resources, and management attention. This paper develops a simulation model in which to explore the long-term effects of

testing and prototyping in an ongoing stream of new product development. Based on research conducted at a manufacturing company, I hypothesize that actions undertaken rationally to "solve the most important problems first," such as allocating as many engineers as necessary to fix problems in the products nearest to launch, systematically undermine testing activities in other development projects. The analysis focuses on identifying policies for resource allocation that prevent systematic underinvestment in early problem identification. Policies evaluated include the timing of testing and prototype builds; priority of testing among other development activities; correcting a fraction of the defects found through testing; and postponing and canceling development efforts that fall behind schedule.

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Optimisation Of Employment Dynamic Model: Comparative Analysis Of Optimisation Approaches

This paper details the analysis of the application of two different genetic algorithm optimisation tools to a system dynamics model of the Australian Army's Staffing.

In 1997, the System Dynamics team at the Australian Defence Force Academy created a Powersim-based Employment Dynamic Model to analyse various employment scenarios for the Australian Army. However, because of the large number of decision variables, the model user was faced with virtually an infinite number of possible employment scenarios, which limited the value to the user. To address this, proprietary genetic algorithm optimisation software (Evolver) was integrated with the Employment Dynamic Model to identify sound (if not 'optimal') initialisation settings for subsequent 'what-if' analysis (refer Linard and Blake, 1999 ISD conference). This integration, however, had a number of problems, not the least of which was a 5 day simulation run time.

Since this work, Powersim have released 'Powersim Solver 2' which includes a powerful genetic algorithm and Monte Carlo simulation capability. The Employment Dynamic Model has been modified to utilise the full strength of this software. This paper critically analyses the Evolver and Powersim Solver optimisation tools for application to complex system dynamics models.

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The Development Of Internet- And Intranet Enabled Enterprise-Wide Knowledge Bases: The Case Of System Dynamics Applications In The United States Air Force, 1975-2000

The development of the Internet and related intranets has allowed large enterprises to create valuable knowledge bases containing the results of research (e.g., production process studies for manufacturing firms or marketing studies for computer software companies). The collection of system dynamics applications within and for the United States Air Force between 1975 and 2000 is such a knowledge base. This paper presents a comprehensive survey of the unclassified system dynamics literature relating to applications within the US Air Force between 1975 and 2000, and classifies that literature according to such categories as traditional peer-reviewed publication, traditional publication (non-peer reviewed), internal working papers, internet available documents, and intranet (or restricted) materials. The paper empirically documents how the system dynamics-related knowledge base for the USAF is currently distributed between various sources and how well that knowledge base is referenced and cataloged using available reference tools. Additionally, the paper explores how the recent development of the Internet and associated intranet systems for the USAF has influenced the development, distribution, and cataloging of this knowledge base. The paper concludes by speculating on what proportion of the specific system dynamics literature base may be in the readily catalogued public domain and how the development of electronic access technologies over the past 25 years has affected on that accessibility.

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Do Numerical Simulation And Optimization Results Improve Manangement? Experimental Evidence

Numerical models are frequently used to aid decision making. Among modellers, models and methods are often evaluated based on their ability to produce correct forecasts and/or optimal solutions. Rarely are the methods or tools judged by their ultimate aim, the impact on actual decision making. To address this question, a laboratory experiment is performed. We investigate the practical usefulness of two decision tools to aid quota setting for

cod and capelin. An optimization tool reflects economic literature on two-species management under uncertainty, while a simulation tool represents biological single species models. N=64.
The two tools turn out to have approximately the same positive effects on management. However, the models are useful for different reasons. The optimization tool helps subjects identify appropriate target stocks. When the optimization tool is lacking, subjects tend to equate the target with historical stocks. The simulation tool provides more accurate forecasts. The value of both tools is moderate (18 percent improvement) compared to expected values by the subjects.
It is difficult to generalize from our example. Different results could have been obtained for other problems and other decision makers (e.g. experienced ones), or if numerical results and model insights had been presented differently (e.g. group model building). However, we do provide an example where the answer is not either simulation or optimization. Thus, in general, we should be open to the possibility that simulation and optimization serve as compliments rather than substitutes.

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Presentation

Readability Of Glass-Box Models As Part Of Learning Environments In Vocational And Economics Education

Office clerk apprentices within the German dual vocational system, are considered to learn how to perform within complex business environments. Within an ongoing R&D-project, vocational schools within the state of Rhineland-Palatinate try to contribute to this objective by means of learning environments which include the use of SD-based models and simulations. The approach makes use both of active modeling by students (expressive mode) as well as the guided use of micro-worlds provided to the students (exploratory mode). This paper focuses on the exploratory use of micro-worlds within such classroom settings. Respective micro-worlds have been developed in cooperation with expert teachers from the field. They represent business concepts which have to be acquired by students as part of the given curriculum. A focus of the developmental activities is the design of glass-box models which can communicate the structure of complex economic concepts as origin of the dynamic behavior of the very system. We address this notion as simultaneous presence of structure and dynamics. A core question to be addressed with such an approach is, whether students can make use

of such models in a constructive way. Phrased in different terms, the question is: Are such glass-box models readable by students? Within experimental classes students have worked in learning environments defined by means of complex business cases, corresponding micro-worlds, worksheets and teachers' guidance. We have collected data on the 'readability' of the glass-box models via the worksheets into which students have entered their understanding of the given structures. Our data cover learning activities by about 70 students within 4 classes from different schools. We have applied a method of content analysis to reflect the students' conceptions of the economic concepts represented in a model of a generic enterprise. The paper presents the methodology applied and the findings from the study.

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SD-Forum Mainz - A Platform For Sustainability In Teaching System Dynamics

The SD-Forum Mainz is located at the department of business and economics at the Johannes Gutenberg*-University Mainz. The general objective of the forum is the establishment of an integrated and sustainable framework for SD-based activities. We consider SD not to be a mere methodology, no mere communication tool, no mere theory, but an integrative stage. This is reflected in certain related fields of action. Today three major field are:

Research on the elaboration of Mental Models and the development of Glass-Box models

Modeling and simulation of business applications in partnership with industrial corporations

Teaching of business concepts in classes for apprentices within the German system of dual vocational training

These fields of activities define the frame of reference for lectures and courses for graduate students at the department of business and economics. Studies are organized in an integrated approach around cases from the fields of application.

We propose to present a poster with the intends to introduce the forum to the SD community, to present examples from the fields of activities, to discuss our approach to lectures and courses, and, last but not least, to learn about options for cooperation.

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A Systems Approach To Tropical Deforestation In Amazonia

Tropical deforestation is a complex human and natural problem. The reasons for unsustainable use of the forest resource vary from area to area around the world, but in Amazônia, the basic causes are lack of economic opportunity, lack of investment capital, lack of training, and lack of support services. These problems suggest a solution that employs sustainable use of the resource through a private/public partnership.

This paper discusses a project in the Brazilian State of Amazonas to use a commercial plywood-production business as the basis for a comprehensive effort to alleviate the problems that cause deforestation. The project will: (1) increase sustainable harvest of the forest (new products and new factories), (2) build locally owned resource-based businesses (bio-mass electric generation, eco-tourism, non-timber products, aquaculture, etc.), (3) develop scientific knowledge of proper forest use (silviculture, bio-diversity, and preservation), and (4) develop human infrastructure (job training, career paths, business management, and higher education). We use dynamic systems and knowledge gained through research and experience to coördinate and to control project elements to ensure that they contribute to sustainable use of human and natural resources. Project participants include: Grantham, Mayo, van Otterloo & Co. (USA), Gethal Amazonas S.A. (Brazil), Banco Axial (Brazil), Prò Natura (Brazil), The Social Capital Group (Brazil), EcoSecurities (UK), United Nations Development Programme, Instituto Nacional de Pesquisas da Amazônia (Brazil), Tropical Forest Foundation (Brazil), and private US and Brazilian investors.

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Presentation

A Dynamic Model For Studying The Impact Of Resource Estimation And Allocation Processes On R & D Performance

In many industries the research and development function is responsible for producing innovative products that fuel corporate growth. A primary challenge of R&D management is to develop robust work processes and decision processes that allow the stream of innovation to be as consistent as possible. This is made difficult by a range of issues including the inherent uncertainty in the

outcomes associated with new product testing, varying degree of difficulty in R&D projects, and even the work processes and decision processes themselves.

A system dynamics model is presented in which we explore the performance of an R&D process as a function of resource estimation and allocation policies, corporate constraints, and shocks imposed on the system. We consider the R&D process as a sequence of staged activities whose goal is to deliver new products to the market. These new products serve as the source of R&D funding required to move even more products to the market.

The salient features that drive the behavior of our model include: 1. The time required to complete work in each stage of the R&D process is resource dependent, 2. Each stage of the process requests resources from the same limited pool which is dependent upon the output of R&D, 3. Acquisition and reallocation of resources involve significant time delays. We will review the behavior of our system under a range of conditions, policies that make the process more robust in its ability to adapt to change, and how the model has been used in strategic decision making.

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The Long And Winding (And Frequently Bumpy) Road To A Highly Successful Client Engagement: A Case Study

In my four years of consulting to management teams within Hewlett-Packard using system dynamics, my colleagues and I led many successful client engagements, but in my experience, none as successful nor as challenging as this one, with one of our youngest yet most successful and rapidly growing businesses. The client and I rate this engagement as highly successful because in the end, in addition to using the model results to guide their strategic decision process that year, the client took on full ownership of the model, its use as an ongoing decision-making resource, and its maintenance. Yet between the smooth and relatively easy sales process, and the incredibly successful result were a myriad of ups and downs. Beginning with a requested destination to model the "system", our client/consultant team trudged through a morass of business complexity and model details, almost became lost without data to guide us, and struggled with team frustration and divergence. With both a visionary General Manager and a pragmatic Controller as the client leads, I was unsure whether we would ever make our way clear of this modeling jungle!

Yet each obstacle in our road brought learning, insight and new

engagement processes, to be shared in this paper. As a result, we developed a model to guide a specific but not restrictive strategic decision area, facilitated an understanding within the entire organization of the dynamic complexity of their business without the detail complexity, organized their data in a way that made it useful for them as it had never been before, and built a strong client-consultant team relationship. This last point is confirmed by their enthusiastic recommendation of our consultant team to another highly important and visible business within HP, the key to our success in winning that contract.

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Social Learning Laboratory For Urban Sustainability

This paper describes the experiences gained through the design and implementation of a learning laboratory (SLLS) aiming to create an interface among city officials and citizens on issues related with resource management, standards of living, municipal services and process improvement. SLLS allows integrated learning for cross-cultural teams on systems thinking, sustainable development principles and concepts, city processes and services.

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A Methodological Framework For Integrating Systems Thinking And System Dynamics

This paper discusses a methodological framework for integrating the fields of systems thinking and system dynamics. A discussion of the four levels of thinking and their implications for organisations and management is followed by the core of the paper, which presents a methodology for systems thinking and modelling. The methodology includes five major phases: problem structuring; causal loop modelling; dynamic modelling; scenario planning and modelling; and implementation and organisational learning. These phases follow a rigorous systematic process, each involving a number of steps. Some general and specific applications of systems thinking are then discussed, and hard and

soft modelling approaches are compared and contrasted. Finally, some cases are provided to illustrate applications of the systems thinking and modelling methodology.

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Urban Dynamics In Information Age

Information and telecommunication technologies such as computers, the Internet, digital cellular phone, and the other software applications carry great significance in modern cities for it's power to transform urban structures and activities. Recently, Urban transportation, environment, economy, life style, and urban management paradigm are being re-shaped broadly by using Information technologies. Classical urban dynamics model describing simple internal forces that controlling the balance of population, housing, and industry within an urban area. However, in information age, the role of information infrastructure is more important than any other urban infrastructure as a key engine of urban growth and development. And the evolutions of information technologies have impact on the interrelationships between urban subsystems, as it is, diffusion of digital cellular phone and traffic demand, emerging of digital economy and business structure, adaptation of UIS-GIS and urban management, universalrization of Internet and new urban life style, and so on. So, this paper revisits Urban Dynamics on the basis of Information paradigms. At first, this paper will explore the subsystems of urban system in information age, which reproduce urban dynamics with influence from the information technologies. Next, this paper will present neo-urban dynamic models with scrutinizing the relationship between information technology and variables by reviewing vast literature and analyzing empirical data, which was considered major characteristics and problems of urban dynamic behavior. In this study, the modeling city is Seoul metropolitan.

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Evaluating The Impact Of System Dynamics Based Learning Environments: Preliminary Study

This paper reports results of preliminary study for developing a methodology on evaluating impacts of system dynamics based learning environments. Specifically causal loop mapping tool is suggested to determine the impacts of system dynamics learning on dynamic problem understanding. During the preliminary study was developed a tool for testing the understanding of the structure of system underlying a dynamic problem. The pilot experiment determined some means of characterising the complexity of a dynamic system and how the performance of the subjects can be evaluated and compared with the characteristics of the system.

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Overcoming The Barriers To Building Shared Understanding

A sustainable future is one that guarantees all present and future humans a decent quality of life. We must balance the basic needs of today while ensuring that adequate resources are available for future generations.

As the world "shrinks" and we become progressively more interdependent, it will become increasingly necessary to share resources and information. To effectively share resources, we must build a shared understanding. History has shown us that this is not an easy task. Systems thinking offers the language, methods and tools to enable us to do this but so far we have not been effective in building this capacity.

This paper will report on research that examines:

1) Why it is so difficult to build the capability for shared understanding and what the barriers are, and

2) The ways to overcome these barriers to increase the adoption of the systems thinking approach.

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The CVUHS Management Model: Policy Analysis For School Sustainability

Champlain Valley Union High School serves one of the fastest growing communities in the Northeastern U.S. The school, built in 1965 for 850 students, now faces an enrollment increase to 1400 students by 2009. Traditionally the community response is to build additional space, but system constraints do not allow for this. School administrators, in an effort to understand how to respond to this crisis, enlisted the aid of the school's Systems Dynamics Mentor Teacher. A group modeling project was undertaken and led to a simple model of internal dynamics that resulted in development of a "flight simulator", allowing school and community members to explore various policy options to alleviate overcrowding. This approach led to new learning by the organization and new, innovative policies including changing the school day, course design, and professional staff scheduling. The work has now expanded to include team members from regional planning groups and representatives of surrounding communities to address regional demographic and development dynamics, and their impacts upon the local educational system.

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Presentation

Systems Thinking/Systems Changing: A Computer-Based Simulation For Leaders Of Learning

School leaders as well as other managers faced with ever-changing workplace policies and processes now have an innovative tool to add to their change management and systems thinking knowledge and skill-building repertoire. New in 1999, Systems Thinking/Systems Changing ™ is the latest in a planned series of change leadership CD-ROMs from The NETWORK, Inc. These breakthrough simulations are designed for group learning in PC or Mac labs as well as facilitating independent team and self-learning after initial group instruction. The simulations, grounded in extensive experience with board-based learning products, blend the best of research and practice with interactive technology to leverage an organization's investment in people and technology.
Central to the simulation are Senge's five disciplines. The simulation provides participants with an interactive experience that can serve as introduction, reinforcement or progress checks on

major organizational improvement efforts that depend on systems thinking, effective leadership, team work and change management. Dr. David P. Crandall, President of The NETWORK Inc., will be the primary presenter. The NETWORK, a highly regarded research and training organization, has conducted a wide array of evaluation, research, training and technical assistance activity in public and private sector organizations since 1969. Its work in human systems improvement has motivated adults to expand the boundaries of what they believe possible.

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Studying Behavior Patterns In Production Systems Through Qualitative Analysis

The production techniques are sometimes classified according to the effect that they produce in the manufacturing/assembly lines when the external conditions in demand change (push, pull and hybrid production schemes). This paper studies, by means of system dynamics and qualitative analysis, the relationship between these techniques and the different existing levels of integration – of the information flows - within the production system. At the same time, the possible utilization of this analysis to improve the understanding of the supply chains behavior is discussed.

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Modeling Social & Demographics Trends Using System Dynamics

In the context of a project funded by the European Commission, a panel of European experts was created with the goal of studying the key issues conditioning social and demographics trends within the Union for the next 15-20 years. The results of this study was a list of expected trends and drivers of change in the social and demographic sphere, and on the other hand, change in the business sphere related to the interplay between technology, work/employment and production/services activities. Later and besides this work, a system dynamic model was developed for assessing the possible effects of policy actions, by tailoring the generic model to a detailed and realistic simulations of different parts of the EU. This papers offers an overview of the process followed by the model development team, and presents the generic structure of the SD model.

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Benefits Of The Activity Based Costing (ABC) For Smes: A System Dynamics Perspective

Empirical analysis of firm implementation experiences with ABC states that there is a wide rage of variations in the success of the implementation of these techniques. In average, there are moderate levels of success.
In the process of implementation, the behavioral and organizational variables seem to be even more important than the technical ones. Therefore, there is a need for additional research in the design, implementation and use of cost management systems in general, and ABC in particular.
With that purpose, we do in this paper an effort to make relevant the utilization of ABC techniques for the SMEs (Small & Medium Size Enterprises). Particularly in environments of modern manufacturing technologies, where the cost assignment to the different products plays a very important role in the business development.
The paper includes a practical example, using System Dynamics, to understand the benefits to be introduced using ABC techniques. At the same time, the paper explores the critical variables to control during the implementation process.

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Presentation

Planes, Trains And Automobiles... A System Dynamics Model With Discrete Elements

This paper will describe a Powersim Constructor system dynamics model of military operations for the Canadian Department of National Defence that was developed to investigate the potential impact of the Millennium Bug on their effectiveness.
The features of the problem situation meant that the choice of modelling approach was not clear-cut. The presentation will review the pros and cons of each approach for the study and highlight the structures that were used to implement discrete behaviour. It will conclude with lessons learned for future modelling of systems where discrete and continuous elements apply.

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Triple Combination Antiviral Therapy In The Treatment Of HIV/AIDS: Model Fitting And Epidemiological Scenarios

The advent of triple combination antiretroviral therapy in the treatment of HIV/AIDS, which has been widely adopted in Western countries since 1996, is responsible for a dramatic turnaround in prognosis for most patients. However, there is no certainty that this new therapy will continue to be efficacious indefinitely. AZT monotherapy, introduced in 1987, was eventually shown to offer only a transient benefit.

A system dynamics model of the spread of AIDS has been fitted to the latest U.K. data on new diagnosed cases. This data reflects the recent dramatic reduction in new diagnosed cases experienced in most Western countries. The optimisation involved a two-stage procedure: parameters of the original model structure were determined (pre-1996) and then the parameters relating to the introduction and use of triple therapy (post-1996) were optimised. Three possible model structures to account for triple therapy all gave excellent fits to the data and one outcome of this exercise was the percentage of cases put onto the triple therapy. This can be compared with official figures from the National Health Service.

The fitted models were then used in scenario mode so as to offer some insight into possible future trends and a consideration, in particular, of what the epidemiological consequences might be if HIV is able to overcome the effect of the drugs and re-commence attacking the host's immune system. This and other model-generated scenarios relating to triple combination therapy will be presented.

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The Economic Consequences Of The Introduction Of A National Minimum Wage Scheme: A Systems Perspective

One of the most politically sensitive issues whose economic effects remain – as yet – largely unclear, despite the impressively extensive research and the multiplicity of economic theories developed, is that of the minimum wage legislation. The ever-lasting debate in the UK regarding the potential effects of its recent introduction and its appropriate level, the continuous deliberation in the US over what the appropriate minimum wage increase

should be, and the countless studies carried out all over the world in an effort to identify its effects, largely signify the political and economic importance of this issue.
Through the construction of a system dynamics model an effort is made to provide a means for exploring of some of the potential economic consequences arising from the minimum wage legislation. System dynamics is considered an appropriate methodology which will enhance the debate surrounding this issue. Analysis has thus far been restricted to estimating possible effects on inflation and employment but the various feedback loops involved suggest that wider effects may well be in evidence over the medium term.
Some of the questions that will be explored in relation to the minimum wage are the following:
Are minimum wages always bad for business? Is labour cost the most important factor to consider when trying to establish the potential repercussions of a certain minimum wage level in a particular industry? How would the minimum wage affect inflation? Could it be that under certain conditions a minimum wage would, paradoxically, create a strong boost to employment levels?

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UMTS Growth Model, A System Dynamics Model For Simulating The Take-Up Of Umts

Within a few years, the Universal Mobile Telecommunication System (UMTS) is expected to be commercially available. This system is the European implementation of third generation mobile telecommunication and is expected to be the successor of second generation systems like GSM (Global System for Mobile communication). A key uncertainty is how and at what speed the customer take-up of UMTS is likely to proceed, especially in relation to the current use of second generation systems. This question is of importance to telecom operators because it could significantly influence their strategic decision making.
Since this problem involves strategic, long term considerations and it does not have the level of detailed specification required for more exact forecasting techniques, a System Dynamics approach was used to build a Powersim model. The model takes into account the key factors in the take-up and migration process and allows the user to simulate different scenarios of UMTS take-up in the United Kingdom in order to develop a general insight into the market dynamics.

Three different groups of UMTS users are taken into account: (1) new users (users that have not used second generation systems), (2) second generation users migrating to UMTS and (3) users who migrate to UMTS but keep on using second generation systems (dual users). The market is divided into two segments: business and residential users. Important factors relating to the take-up of UMTS that are taken into account are: quality of service, hardware quality, cost, technological developments and customer attitude.

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The Classroom As A Learning Organization: Focus On Feedback Revisited

Increasingly, post-secondary educators have recognized the value of, indeed, the need for students to have "hands on" experience. At my institution I conceive the public speaking classroom as a "learning laboratory" where we have an "exploratory attitude," that is, where students discover their own individual strengths and discover, usually by trial and error, how best to gain and maintain the interest of the class. The purpose of this paper is to show how I have combined the conceptual model of the interaction between speaker and audience using a system dynamics approach and recent literature on learning organizations to redesign my public speaking courses.

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Communities Of Practice And Sustaining Learning: Creating Classroom Environments For Learning That Lasts Beyond The Exam

Oftentimes knowledge in classrooms is used solely to produce a score on an exam. After the exam the knowledge is never used again and mostly disappears.

Creating communities of practice within classrooms wherein students become users of knowledge and develop a culture of using knowledge in authentic tasks has been found to create learning that is sustained for years. In these communities students gradually move from peripheral participants in a community (a more teacher directed classroom) of practice to full practitioners who can set standards for performance and determine what constitutes knowledge and practice (a student directed classroom).

Developing communities of practice within traditional classrooms is not always intuitive nor a result happenstance, but the result of careful planning, creative use of outside communities and

opportunities of reaching beyond the school setting.
Systems dynamics tools offer a set of learning environments for students to create communities of practitioners within the classrooms. These tools can help create tasks which require a broad range of knowledge, practices and participation in a community with a purpose.

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Scenario Planning For E-Commerce Using Systems Dynamics Models

This paper will discuss the use of system dynamics in developing and analyzing scenarios for rapidly changing markets, typical of e-Commerce. A general model and approach is presented with a case history of a major European financial institution undergoing revolutionary changes in business strategy.

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A Practitioner's Experience Of Using Field Anomaly Relaxation (FAR) To Craft Futures

This paper reinforces the utility of Field Anomaly Relaxation as a key tool for the construction of futures in which to position areas of interest for analysis. Its use here is focussed on the environment occupied by Special Operations as an instrument of national security policy. Seven drivers are examined which provide the boundaries for five future world situations arrayed on a Faustian tree. These future worlds are further developed into rich narratives that describe 20 individual scenarios. The product of the futures work is linked back into the organisation in question to provoke creative thought and unconfined dialogue for change.
"The past is of no importance. The present is of no importance. It is with the future that we have to deal. For the past is what man should not have been. The present is what man ought not to be. The future is what artists are."
(Oscar Wilde)

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Profiler: An 'Effects-Based' Military Capability Manager

'Profiler' is a sophisticated military capability management tool that links strategic outcomes with the physical elements of capability that can be bundled together to deliver those outcomes. It utilises a powerful many-to-many relationship structure that binds and links the outcomes (or what I have termed 'effects') with the means, through capacities and finally to the physical elements of capability which are specified as People, Organisation, Support and Facilities, Training, Equipment and Doctrine.

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The Rotten Mango: The Effect Of Corruption On International Development Projects

Corruption diverts perhaps 30 percent from billions of dollars spent annually for international development loans. Importantly, this illegitimate cash flow becomes the primary reason why funds are requested. Desire to maintain this flow alters project planning, design and implementation. Bureaucratic and personal work characteristics become imbedded in, and reinforce, these corrupt systems.

Corruption literature provides a rich source of data and theory which can serve as a foundation for SD models of corruption including mathematical sub-models and typologies of corrupt systems, narratives of instances of corruption, and proposed remedies. An overall paradigm, allowing us to consider, in a holistic way, the many sub-systems of corruption has not been developed.

This literature provided a basis for SD model building. Additional experiences in Indonesia maintained model realism. One SD corruption overview is based on the oft cited idea that 'amount of corruption' is part of reinforcing loops linked to 'amount of bureaucratic red tape.' In this view, corruption is imbedded in positive feedback loops also linking it to lowered economic openness, a weak legal system, and excessive economic rents available. Stabilizing influences are provided by negative feedback loops in which increasing corruption provides pressures to improve the legal system and causes, through mismanagement, decreased economic rents. Other more detailed SD views include factors that affect the likelihood that a bribe is paid and the psycho-social

aspects of corruption within the work environment. Taken together these indicate that SD modeling has considerable potential for elucidating corrupt systems and cures.

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System Dynamics In The Colombian Energy Sector

The Colombian Energy Sector has been widely studied by our System Dynamics (SD) Group at the National University of Colombia for over ten years. During the late 80s we used SD under a centrally regulated scheme and since the mid 90s SD has been applied to understand open markets and regulation. Research was undertaken to support public and private companies and utilities for strategic intents and also to assist the Ministry of Energy for policy and regulation purposes. Research has been both topical and methodological.

Themes for research have included problems arising in the energy demand, supply and transport sectors, as well as in regulation. Issues such as rational energy use and demand-side management have been studied. From the supply-side, capacity expansion and strategic bidding into the pool have also been investigated. Network expansion, training traders and revisions of the present regulation schemes have likewise been part of our resent research projects.

The methodologies applied have been based on the traditional SD approach, introducing new concepts according to the requirements of modelling. These have arisen for the need of incorporating strategic behaviour, optimisation, uncertainties and stochasticities. Ideas such as platforms were developed. As a result of all these exercises, the general SD approach has gradually been accepted in the energy industry in Colombia, formerly dominated by classical OR methodologies.

This paper provides a general overview of these research themes, shows some of the broad research protocols and explains how useful System Dynamics has been for the Colombia Energy Sector, as a whole.

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Bounded Rationality In The SD Approach For Energy Modelling

The liberalisation of energy markets provides a challenge for what is known as rational energy use, and therefore for the understanding of end-users behaviour under both government policies and traders strategies. In this environment, it is important to assess the decision making processes of energy end-users for policy and strategy intents.
The methodologies reported in the literature generally make strong assumptions with respect to the decision making processes of end-users, including: complete information, full rationality and lack of risk perception. In this paper, Simon´s bounded rationality (BR) is picked up, seeking for alternative grounds to the traditional methodologies.
System Dynamics (SD) modelling, with the help of other approaches, seems to provide a most appropriate environment for a wide number of BR applications in the energy field, as it has been claimed in the literature that this approach is well grounded on bounded rationality. However, both this claim, as well as to how SD handles uncertainty, which basically accounts for BR, needs to be clearly justified.
In this paper we undertake BR under the SD framework in two areas: modelling methodologies and applications. First by indicating, explicitly and implicitly how to incorporate uncertainty in SD and second by providing guidelines for establishing how variables are included and discarded from models.

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Causal Loop Model To Describe Transport System's Effects On Socio-Ecomonic Systems

In the recent past more and more negative impacts on quality of life in western oriented countries are caused by the transport system. A lot of different approaches (most of them technical) to reduce the negative effects of motorized transport were developed and practically implemented. But none of them were capable to turn around the prevailing trend caused by inherent system dynamics. This paper tries to address the complex dependencies in socio-economic systems. To produce a discussion base the so-called causal loop method was applied to depict existing cause-effect-relations in an explicit manner. Main principles of transport

planning, economy, land use planning and social science were translated into causal loop language and therefore connected together. The resulting model was evaluated through interviews with experts of involved disciplines. To predict the overall system behaviour over time, minimum and maximum time lags were assigned to all cause-effect-relations in the model.
The intensive work with dynamic systems helps to understand complex system behaviour. Interesting insights could be derived during the process of designing the model – for example that a decrease of fuel cost could reduce overall quality of life or that there exists a positive feedback-loop between supply and demand of transport infrastructure. These and a lot of other findings about system immanent effects shall initiate a fruitful scientific discourse about the used model elements, the derived cause effect relations, the system borders and the drawn conclusions.

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The Competition Of Beliefs: A System Dynamics Interpretation Of C.S. Holling's Five World Views

In a significant article about sustainability, C. S. Holling (1992) notes that, "So much presently seems uncertain or unknown that many of the calls for action or inaction, however well supported by technical argument, are largely determined by beliefs and opinions." He then describes five belief systems, four well recognized and the fifth newly emerging. These, he argues, "are driving present debate and public confusion." Each is distinguished by assumptions about the nature of growth and change. He caricaturizes these as exponential view, hyperbolic view, logistic view, nested cycles view, and adaptive evolutionary view.
My purpose is to surface the assumptions implicit within each belief system. A simple dynamic systems model helps with this by replicating behaviors suggestive of Holling's belief systems. Each belief is described. Its reference behavior is portrayed. The social characteristics and individual values of adherents to each belief system are noted, and generalizations are advanced as to their most applicable domain and range.
The value of this lies in helping identify beliefs used by policy decision-makers, to define the shared structure of these beliefs, to understand when each is used appropriately, to stand firm before efforts to privilege but one single belief and to focus upon strengthening the shared structural foundation of competing world views.

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Conception And Implementation Of An Introduction Course In System Dynamics And Powersim

As a response to the increasing need for modeling and analysis skills system dynamics at the Brandenburg University of Technology of Cottbus the Chair of Managerial Economics, Management Accounting and Control Systems developed an introduction course in "System Dynamics Modeling using Powersim" for an university wide audience.
The paper presents the specific needs, target groups, the structure of the course and first experiences with its implementation. Additionally some future targets are discussed.

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A System Dynamics Analysis Of The Effects Of Capacity Limitations In A Multi-Level Production Chain

In a production chain machines, man power, space and other resources are limiting the available capacity to produce a certain output in a given time. The paper investigates different ways of modeling such a limited production chain.
One way is to build a chain of single levels, each with a first-order-delay and a capacity constraint of its own. Usually this modeling is substituted by a single level with a n-order-delay (n>1) having a capacity constraint. A second simplification is a single level having a capacity restriction and a first-order-delay with a longer delay time.
It can be shown that in case the limit is achieved the behavior of the different production chain models are different to eachother. The paper presents the structure of the underlying system dynamics models and their behavior for certain scenarios. Finally the restrictions of black-box-delay-functions, available in different system dynamics modeling software packages, are discussed in general, focusing on their functionality and the risk of misinterpretation.

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Architecture Development Process Dynamics In MBASE

The purpose of this study is to understand the dynamics of architecture development processes. The MBASE (Model-Based Architecting and Software Engineering) approach establishes four distinct phases, each separated by a milestone or an anchor point. During each distinct phase, the architecture of a system is successively refined to cover a larger system scope. Our model focuses on the dynamics of architecting processes in MBASE during its early phases i.e. Inception and Elaboration. The model also considers the impact of RAD (Rapid Application Development) factors such as collaboration and prototyping on the process of architecting. The models described show that initial completion rates for the requirements identification and architecture development activities significantly impact the number of approved items. Prototyping factors such as IKIWISI and collaboration also significantly affect the rates of completion and approval. The model also produces a declining curve for staffing analysts and a linear growth for architecting and design personnel. The architecture development process model developed successfully models the activities during the initial phases of MBASE. This model is able to replicate the effort profiles for requirements and architecture/design activities based on a concurrent development model and a dynamic resource allocation scheme.

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Developing Management Flight Simulators For Packaged Models

When the intended user of a simulation model is not the model developer or an expert on the system being modeled, designing an adequate user interface (Management Flight Simulator or MFS) is critical to developing a simulation model that provides value to the user. To promote the user's understanding of the system being modeled, the MFS should utilize features that explain the conceptualization of the system, link this conceptual model to the simulation model, and provide a transparent interface between the underlying model and the simulation output. To make the MFS user-friendly, all of these features should be presented in an intuitive structure that facilitates easy navigation.

The authors have refined the essential elements of an effective MFS in developing several models that simulate the operation of industrial chemical production facilities. This paper presents: 1) the methodology used for structuring, organizing, and navigating these MFSs, 2) examples of how interactive multimedia features, messages tied to model results, model tracing, causal tracking, and links to other applications can be used to achieve the aforementioned goals, and 3) guidance regarding the choice of appropriate structure and features when considering the specific characteristics of a model (size, intended user, etc.) and the simulation software package being used.

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The Application Of System Dynamics Theory As Checking And Ratifying Mine Capacity

The cause and result analysis for main factors which affect mine capacity is made mainly using the System Dynamics Theory. On the basis of the analysis, the Feedback cycle and flow diagram have been made. According to the actual situation the simulated model of system dynamics for checking and ratifying mine capacity has been established in order to check and ratify the mine capacity.

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Beating The Production Distribution Game

Everyone plays the Beer Game, but no one really wins. The classic production-distribution game has been used to introduce generations of SD practitioners to the complex behavior and misperceptions of feedback that can arise from seemingly simple systems. Participants reportedly underperform simple benchmarks by a factor of 10 to 100, and repeat players seldom outperform novices. Is this because memories are short and board game players are sloppy, or is the challenge of the beer game, and inventory management in general, more than meets the eye? This article explores the beer game from an optimal control perspective. We explore a variety of simple heuristics for inventory management, and compare typical SD ordering decision rules to those of other domains, including stochastic optimal control.

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The Application Of System Dynamics And Systems Thinking To Brand Management-- Creating A Dynamic Perspective

Brands are increasingly the most valuable asset for brand owning companies (from Coca-Cola to Microsoft and Amazon) but brand management is a highly complex business task. Brand value is constituted of many factors: ability to make consumers make a preference choice, ability to attract the best employees and develop synergistic partnerships and alliances. Many companies now have good tools to manage and control operational processes and the cost side of the business equation. Few companies have processes to manage what is classically termed intangibles and the 'intangibly-driven' consumer processes that are the fundamental components of the revenue generating part of the business equation. Arguably, competitive advantages in the intangibles can create substantial value and 'hard to copy' processes for the companies that apply this successfully. In the past these processes have been hugely complex to understand, decode, and quantify. Therefore, brand management has been dealt with intuitively and with inappropriate management focus justified by poor understanding of the causality between drivers and outcome over time.

The use of System Dynamics simulation modelling and Systems Thinking as a framework to support the development of more informed brand strategies has proved to be very effective. We have spent a number of years developing and refining systems-based approaches and methodologies that allow any brand owning company to get to grips with how to manage their brand. The companies who take early steps to become leaders in this area stand to develop lasting benefits

This paper will describe a number of examples where these systems approaches have been applied to a variety of brand strategy projects.

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What Behaviors Are Desirable In Students Creating System Models?: A Step Before Assessment

Assessment is a major concern currently in the K-12 systems community. If parents and other teachers are to be encouraged to accept this new paradigm for problem solving and analysis then some method for measuring the improved thinking skills of students must be demonstrated. How to accomplish this assessment using traditional tools has proven to be elusive, to this point. This presentation attempts to take one step back from the assessment issue and determine what we feel are desirable traits in a student or student group that has chosen to study problems from a systems perspective. The analysis will be broken into three categories: creating models in a modeling course, transferability to other classrooms/disciplines, indication of improved understanding of concepts presented in other classrooms/disciplines. In a modeling course attention will be given to skills involving determining reference behavior, model design, model validation, and model explanation. For transferability the topics will include a focus on model structure and what lends itself to transferability. For improved understanding, some student behaviors that demonstrate a student has surpassed typical conversations will be suggested.

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Materials For Introducing Systems Modeling In Mathematics, Grades 9-12

If a system dynamics modeling paradigm is ever to make its way into the high school classroom in a significant way materials must be available for interested teachers. A set of lessons for use in supplementing a traditional secondary school mathematics curriculum has been developed with emphasis on the study of the behavior of traditional functions over time. The first chapter, for example, is about functions which change at a constant rate. The chapter starts with the use of the motion detector, a sonar device connected to a computer lab interface. Students move in front of the detector in specified patterns as the graphs of the motion are displayed in real time on a projector. The students are to study the connection between the words describing how they were to move and the characteristics of the graph displayed. Different lessons

are provided so students in a beginning Algebra course, an advanced Algebra course, or a Pre-Calculus course use similar motion but interpret the motion using increasingly sophisticated vocabulary and with attention to more depth of analysis. From the motion detector, lessons proceed to the study of the theory of finite differences. From the theory of finite differences STELLA model diagrams are constructed for the particular function type and application problems are presented requiring students to build diagrams that will exhibit the appropriate behavior to solve the problem. The problems start simply, matching those that might appear in a traditional math text. However, small extensions are made to some of the problems so they begin to ask the student modify a structure and apply it to a more interesting problem that students would have been able to study at a given level, using an equation interface for quantification. Also, some problems require that structures be combined, once students gain experience with more than one type of structure. Each lesson requires one or two 45 minute class period to complete. Periodically, story projects are included, so students who really enjoy this approach can expand their study. The projects are expected to be completed outside of class and may take one to two weeks, depending upon the time a student can commit to the project. An outline of the lessons is included below. This set of student lessons, teacher answers, and all models on disk is being published by High Performance Systems, the publishers of the STELLA software. A final title for the materials has not been determined.

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System Dynamics Models Created By High School Students

For the past eight years Franklin High School has offered a one year course in System Dynamics Modeling. Each year students were required to construct an original model during the third quarter of the school year. This modeling effort required deciding upon a topic that students felt they could model, a search for data, communication with an expert in the field on the topic being modeled, creation of a working model, and an explanation of the model in the form of a technical paper between seven and twenty pages in length. In this session student models and papers will be presented, demonstrating the evolution of the modeling course at Franklin High School over the past eight years. Models and papers will be used to identify what is considered a good model and/or student explanation and what is considered undesirable in a model or explanation. The focus is to assist instructors in their efforts to guide/reinforce good modeling practice

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Starting A System Dynamics Program In Your School For Students In Grades 7 Through 12

The workshop will demonstrate a multi-faceted approach to the problem of starting a system dynamics program in a 7 to 12th grade school environment. Hands-on activities will be provided for the participants to help them understand what methods might work to influence teachers to try this experiment. Student work will be demonstrated. A presentation about the SyM*Bowl (student modeling) competition, how it is designed and executed, will be made. 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 7 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 CD will contain a run-time version of STELLA for both the Windows and Macintosh operating systems, so that the models included on the disk can be used for demonstration easily by the participants.

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Strategic Management Of Production Systems -- A Longitudinal Analysis On The Evolution Of Models: Experiences From A Research Project

Between 1982 and 1999 the University of Stuttgart carried out an extensive interdisciplinary research project dealing with flexible production systems. Within this project the Department of Strategic Management developed several System Dynamics models in co-operation with various companies. The objective was to support strategic decision making in production management. The models were designed to prepare and to evaluate decisions considering the achievement of both long term profitability and sustainable competitive advantage foremost. The paper shows how the different System Dynamics models have been changed over the years. As they were all referring to the same basic issue it is thoroughly possible to compare them in a longitudinal analysis. This study on one hand concentrates on the development of modeling methods, i.e. by combining System Dynamics models with knowledge based tools, or by creating a modular modeling concept. On the other hand it focuses on aspects like model size and aggregation level. Another intention of the paper, however, will be to answer the question if and how the different kinds of models – e.g. in terms of model size and level of aggregation – had influenced decision making and its results. It will be discussed how and to which extent these model features had an impact on making either strategic or rather operative decisions in production systems.

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Microworld For Training Traders In The Colombian Electricity Market

As the Colombian electricity market has moved into a much more competitive environment opportunities have emerged in the trading business. Although this activity can be exercised by a wide number of agents, traders required specialised knowledge of the market to support their decisions making processes and strategies.
ISA, the Colombian Grid Company, and the National University of Colombia, aware of the necessity of the diverse agents in the market, developed a training environment for energy trading in Colombia, from which the sector as a whole can benefit. The most important aspect of the training exercise are the workshops, two which are based on a Systems Dynamics microworld, that provide a good inside of market behaviour under different scenarios.
The microworld user, through a friendly interface, assumes the role of a trader that defines his own strategies under different hydrology scenarios. In this way he will be able to learn about the electricity market before confronting his task under real life situations.
The microworld for training traders presented in this paper exhibits unique characteristics: a) supports developing specific electricity trading capabilities, b) supports developing skills for strategy and risk management, and c) competes with no similar product in the market place.

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Overwhelming A Digital Carrying Capacity: The Case Of Oxford Health Plans

Since the early 1980s, one of the major forces driving the dynamics of managed care in the health care industry has been the need to obtain a high volume of patients to ensure financial success. In some cases, the growth of patient membership due to aggressive marketing has outrun either the development of provider networks, the infrastructure needed to support patient volume, or both.
One example of an HMO exceeding its infrastructure carrying capacity is Oxford Health Plans of Connecticut. During the late 1990s, the growth of Oxford's membership base, along with its concomitant growth in patient treatments, began to strain its management information system causing many reimbursements to member physicians to be lost and/or delayed. This generated

significant dissatisfaction among Oxford physicians and eventually led many of them to separate from the plan. In response to the defection of Oxford physicians, Oxford members became concerned that their ability to obtain quality care would be affected and they thus began pursuing alternative health care options. In addition, the falling member and physician populations created concerns about Oxford's long-term viability among its stockholders which, in turn, led to a fall in its share price. Finally, Oxford's troubles with its current and former physicians intensified when the doctors filed a multimillion dollar lawsuit alleging that the HMO owes them millions of dollars in reimbursements.

This paper presents a system dynamics model of the Oxford Health Plans case. In addition to capturing the dynamics of Oxford's problems managing its growth during the 1990s, the model reveals insights into what Oxford managers could have done to prevent or limit the damage caused by the demands on its digital carrying capacity. The paper concludes with some generic insights into the dynamics associated with digital carrying capacities in organizations and some suggestions for future research.

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The Sustainability Of Synthetic Policy Decision Groups

One major issue in group decision-making concerns the duration of a group as an effectively functioning entity. Many factors provide possible explanations for differences in the expected life span of a group versus its actual life span. We lack adequate knowledge about the dynamics and duration of "synthetic groups," that is, groups who would not otherwise form nor operate, unless and until they are brought together by external authorities and/or events, such as a crisis, to serve a specific purpose or address a particular issue.

Using literature on groups and group model building, we model the dynamics of synthetic groups in crisis situations. We identify several factors to guide group behavior and development and serve as useful variables for construction of dynamic models or simulations. These variables include "group factors" such as: 1) number and types of agenda items, 2) number, intensity, and persistence of issue conflicts, 3) number, types, and quality of policy proposals, 4) sources, quality, and consistency of information available and used, 5) number, types, and frequency of official representation at meetings, 6) number, types, and influence of experts, 7) frequency and duration of meetings, 8) quality and

acceptance of the group's decisions, and 9) expected versus actual duration of the group. Additionally, we consider the elements of argumentation (e.g., claims, evidence, warrants, and backings) taken from the work of Steven Toulmin, as a fundamental orientation for understanding group decision-making. We find that Toulmin's argumentation forms are applicable to group policy decisions, in general, and specifically to crisis policy decision-making by synthetic groups comprised of public officials operating in the public domain and for the presumed public interest. The model is tested for two cases. The first case is based on materials from Allison's study of the Cuban Missile Crisis, including recently de-classified documents involving White House recordings of group discussions held in the Office of the President. The other case involves intensive interactions between national, state, and local government officials who responded to a crisis with potentially serious health, economic, and political consequences in the local government arena. Data for this second case comes from extensive notes and transcripts of group meetings and follow-up, in-depth interviews with key participants.

System Dynamics Analysis Of Stability During Non-Equilibrium Stage In Physical Distribution

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As it is known, instability of inventory occurs due to lag in the information transmission in a distribution system. Excess reaction to the change in demand at each distribution sector is considered to be one of the main causes of this. Demand forecast is generated among multiple linked sectors, and as a result causes the development of estrangement between the actual demand and ordering by each sector. The complex behaviors exhibited by such chain systems have been thoroughly studied to date. However, in practice, all instabilities have not been eliminated. They have merely been tolerated within certain limits. This situation presumably suggests the existence of certain tolerable range in instabilities. This paper proposes to identify experimentally the assessment index measuring the quantification of the instability degree. Also it reports on the simulation that minimizes this instability region using the identified index through several example models.

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A System Dynamics Approach To The Study Of Alcohol Tolerance In Mice

Many diseases are the result of disturbances of biological feedback systems; examples include diabetes, hypertension, osteoporosis, and drug-induced tolerance and physical dependence. However, biomedical researchers rarely possess the mathematical and engineering skills to investigate these issues from a systems point of view.

Forrester has described systems analysis from two perspectives. The engineer seeks to design and build a new system to meet identifiable performance standards. The system is completely described (although not necessarily completely understood), because it is built from scratch by the engineer.

In contrast, social systems already exist, although we generally cannot describe with confidence the structure of these systems. Adding to the difficulty, it is virtually impossible to conduct controlled experiments in these areas. Nevertheless, the social scientist seeks to understand the system well enough to improve policy decisions while simultaneously minimizing unintended consequences.

I present here a third scenario, relevant to biomedical research. Again, biological systems already exist in nature, and again, they may not be thoroughly understood. However, we have an opportunity that may not be available to other system dynamicists. We can conduct carefully-controlled experiments, allowing us to develop a model, conduct experiments, compare the model with experimental results, refine the model, and conduct further experiments. Examples are provided to illustrate the analysis of alcohol tolerance in 25 inbred strains of mice. Initial sensitivity, maximal tolerance, and the time course of tolerance differ among strains. In most strains tolerance appears to be consistent with a first-order delay model, while in other we see evidence of a second-order delay. These dynamic information allows us to differentiate among a variety of possible biological mechanisms which are believed to contribute to alcohol tolerance and physical dependence.

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Managing The Strategic Resources To Sustainably Achieve The Global Goal Of The Mexican Light And Power Company

Historically, the Mexican Light and Power Company has faced a great challenge: how to decrease the huge number of failures in the generation, transmission, distribution and commercialization processes of electric power. There is an emerging need to find new methodologies to help the company design their strategy for the maintenance group, using the same resources they have being using so far.

During this continuous search, the reliability and quality of the service has improved due to several new ideas incorporated from different approaches. However, the fundamental objective is still very far from being accomplished. In a new attempt, a modified system dynamics approach, the "Managing from Clarity" framework, has been applied to the distribution and commercialization process, by creating a model that simulates maintenance decisions and analyses the impacts on the rest of the company. This framework has shed light on the global goal, the strategic resources and the action points to accumulate and maintain these resources, as well as the structure and the people's incentives that determine the overall maintenance group's performance.

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A Crucial Role For Managerial Policies In Multi-Business Resource Sharing

This paper focuses on management's role in implementing resource sharing in a related multi-business firm. Leveraging existing resources in a new and growing, related business results in synergy benefits, but also gives rise to resource sharing coordination costs. This research focuses on investigating the nature of these costs by examining management's role in coordinating multi-business firm activities at an operational level. At this level, it is important to understand organizational responses to additional strain on the stock of shared resources in a related firm, to identify the managerial policies guiding resource investment and allocation, and to determine if these control policies are aligned to match the new business growth rate. In

addition, given the dynamic complexity of management's coordination task, there may be managerial misperceptions of the feedback system resulting in pressures which only exacerbate underlying problems and negatively impact performance. Even if significant synergy benefits exist for a related diversification move, these benefits may be wiped out if the implementation of resource sharing is not managed properly. This paper draws on field work with two multi-business companies and a simulation model of resource sharing to investigate these issues.

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The Austrian Carbon Balance Model (ACBM) (A System Analytic View Of Austrians National Carbon Cycle.)

The Austrian Carbon Balance Model (ACBM) aims to a comprehensive description and analysis of all carbon stocks and flows within the federal area of Austria as well as (carbon) interactions with the external compartments atmosphere and lithosphere. The project is based on the results of a former study about the carbon balance in Austria for the Year 1990. The developed system is a national dynamic model based on official statistical data from Austria as input values. The system dynamic model enables the user to make improved estimations and predictions for the future in comparison with the previously used method, which accounted the net release of carbon into the atmosphere, by avoiding the risks of double counting or omitting carbon sources. Furthermore we are able to analyze and understand the national carbon flux system, which supports policy makers to establish and implement policies for reducing carbon release into the atmosphere and therefore, to guarantee a sustainable development in the future. The carbon system is divided in the five main parts Agriculture, Forestry, Energy, Production and Waste, which were separately developed by relevant Austrian experts [ACBM Team].

Two scenarios were defined to show the carbon system's behavior in the future. A no major change scenario and a scenario in which we met special assumptions for carbon sequestration to meet environmental protection aims and simulate a socio-economic development towards sustainability in Austria.

A sensitivity analysis was performed to identify key input parameters for a more reliable prediction of the Austrian carbon system's future.

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Life's Last Chaper Dynamics: How Well Will We Care?

As we transform our thoughts into digital incarnations and try to make the world a better place, one pixel at a time, the time is approaching quickly for North America's baby boomers to retire. An estimated 77 million of them will soon do and some of them will be entering nursing homes. That is, if the capacity exists to accommodate their huge influx. Despite the overwhelming number of baby boomers, entrepreneurs are not stammering to build more nursing homes for the foreseen stampede of retired people, partly because a few states attempt to eliminate excess demand by increasing supply. If the state Medicaid programs refuse to warrant the creation of more nursing homes, however, then a serious problem might arise, whereby millions of baby boomers will be forced to join the extant waiting lists for nursing homes. Over the past decade, nursing home liability insurance has become the fastest growing type of insurance coverage in the US. New sales increase between 20 and 25 percent per year, while competition has pushed long-term care premiums down by 20 to 25 percent. With eleven major players in nursing home insurance controlling more that 91 percent of sales, insurance settlements reach outstanding figures. In a recent case settled in Texas, for example, an elderly man died, reportedly of neglect and malnutrition. The settlement awarded to his family was US$250 million. The purpose of this system dynamics modeling project was to determine what insurance firms might expect from the combined effects of more people living to old age and state regulatory policy. Three computed scenarios capture the dynamic evolution of alternative behavior patterns that might play for the population in nursing homes, those waiting for nursing homes, and the profitability of insurance firms that provide liability insurance to nursing homes.

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Renal Care Dynamics

Human kidneys remove metabolic waste products and regulate our body's water, electrolyte and acid/base balance. Our kidneys filter approximately 190 liters of blood per day. End-stage renal disease (ESRD) is the state of advanced chronic kidney failure, characterized by the irreversible loss of kidney function that requires routine kidney dialysis or transplantation. A system dynamics model capturing end-stage renal care dynamics shows behavior patterns that interest both the private sector and the US federal government. The model's computed scenarios result from the distribution frequency of the available treatments for ESRD. As far as the private sector is concerned, biotechnology firms, for example, while deciding where to invest their resources, they must know what form(s) of treatment is (are) most frequently used, the rate of donations and the results of various treatments on the affected population. The model building process helped biotechnology firms understand which treatment option represents a better business opportunity. As far as public policy is concerned, the modeling team's objective was to identify the cost/benefit of increasing organ donation. The simulation results show the relationship between the level of organ donation and the relative reduction in dialysis costs, attributed to expenses corresponding to non-surgical patient care.

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Presentation

Spreadsheet

Limits To Growth On The New Economy: An Exploration Of The "Get Big Fast" Strategy In Dot.Com's

Many Internet companies have decided to follow a 'get big fast' strategy: they invest heavily in marketing to build their user base and market share. At least for now, the capital markets seem to encourage this strategy: the stock price of the leading competitor in a category (say, Amazon in online book selling) typically trades at a significant premium to the stocks of other category competitors, as a multiple of revenues or users.

Is this behavior rational? We believe that a SD model could shed some light on the issue. We build a generic model that reflects a particular industry within e-commerce (say, booksellers), capturing the characteristics of the main competitors -- their basic economics (how they make money), operating and financial strategies -- and

the behavioral decision rules for consumers, managers, and investors in the enterprise. The purpose of this model is to evaluate the different growth strategies seen in Internet businesses, explore their sustainability under different competitive scenarios, and to test the 'rationale' that capital markets are using to value these companies. We identify a typology of strategies and the range of scenarios under which each of those strategies is successful. Finally, we explore the reference modes for the eventual reduction of the 'speculative excess' in dot.com stocks and the return to more traditional valuation heuristics (multiples of earnings, discounted cash flow analysis).

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WITHDRAWN -- Exploring Detail And Dynamic Complexity

Management scientists have used various approaches to capture and annotate detail complexity by elaborating relevant business processes (eg, using deployment flow charting) and organizational processes (eg, using the viable system model). Simultaneously, during the last 10 – 15 years, powerful software and hardware systems have enhanced people's ability to model and simulate dynamic complexity using system dynamics. Managers are increasingly recognising that this enables a better understanding of systemic behaviour and importantly informs their decision making processes.

This paper explores a pragmatic way of using detail and dynamic complexity in the same study. Whether we like it or not, people are beginning to combine detail and dynamic complexity within the same intervention in order to gain additional insights on the workings of their organization in a competitive environment. Critically important is the need to address the associated problems (eg, the potential for paradigm incommensurability). In essence, this is at the heart of what has been defined as multimethodology.

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Simulating A Story: How Just-In-Time Help Can Explain Cause-And Effect In Business Training Simulations

System dynamics is a powerful but incomplete technology for creating simulations that effectively teach participants to understand how their decisions impact business performance. However, a SD model combined with an interactive storyline can

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make the model results tangible and turn a dynamic simulation into a learning simulation.

System dynamics brings many advantages to the training world. Specifically, an SD business model allows users to see the feedback between their decisions, customer demand, competitor reaction, and company performance. However, the resulting dynamics are usually too abstract to be fully internalized by the user without involvement of a live instructor coaching participants during the activity and facilitating a post-simulation discussion.

This paper will discuss new methods that can help solve this dilemma, namely, the marriage of a system dynamics model to a dynamic storyline implemented with "Just-In-Time" help technologies. Users playing such a simulation are presented with a detailed setting that describes the type of simulated business, the location, the other [simulated] actors in the system, and a specific role for them to play. As the users make decisions they view (in addition to the standard Management-Flight-Simulator style tables and graphs) video interviews from customers, simulated emails from managers, and text-based customer surveys. All of this feedback is dynamically scripted to appear based upon the evolving business conditions, helping users to see both the short and long-term consequences of their actions.

The end result is a simulation that can encourage reflective thinking and learning without the involvement of an in-person facilitator. This is particularly useful for simulations that are meant to be used from the world-wide web or are in large workshop settings where personal attention from an instructor is impractical.

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Introduction To System Dynamics Modeling

This course will present a quick overview of system dynamics and business simulation. Participants will work together to build a simple model that provides insight into a case from the recent business press.

Topics to be covered include:

What is system dynamics?

What are the basic concepts of system dynamics (feedback and stocks/flows)?

What are the steps I should follow to build a model?

How do I use a system dynamics model to gain insight into my business problems and strategies?

Participants should bring or share a Windows laptop computer. Free copies of Powersim Constructor Lite, a system dynamics modeling application, will be provided.

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WITHDRAWN -- System Dynamics Modeling Of The Installation And Repair Field Force At Bell Atlantic Corporation

This paper discusses an initiative focused on improving the quality of information used in decision-making processes in Bell Atlantic Corporation. This effort was initiated by comments of the Chairman and CEO of Bell Atlantic Ivan Seidenberg about the significance of installation and repair problems as a core of reliable customer service and the reputation of Bell Atlantic. In general, the goal of this project is to help make clear the system of causal interrelationships and interacting feedback loops inside Bell Atlantic which determine profitability, sustainability, and prosperity of the Corporation. The deliverables are explicit and testable models of dynamic behavior of the Corporation under given circumstances and policies.

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Evaluating The Time-To-Market And Quality Trade-Off In Multi-Product Development Environments

In a multi-product development context with scarce resources, Repenning (1999) characterizes the boundary conditions for a self-reinforcing phenomenon, where a greater fraction of resources are allocated towards fixing problems in existing projects and away from preventing problems in future ones. We extend his study to allow for flexible launch and floating quality goals. We find that the self-reinforcing phenomenon still takes place under launch and quality flexibility, but its boundaries are more restricted. We develop a performance measure to capture the product's quality and time-to-market tradeoff and find that launch date flexibility makes the design process more robust to changes in product development. Using loop gain analysis, we further characterize the disequilibrium dynamics of the system. Our analysis suggests that managers having the option of slipping quality to meet schedule and slipping schedule to meet quality are worse off than managers with only the latter. Taking solely into consideration the robustness of the design process, our findings suggest that managers can be flexible with launch date, but should be strict with quality.

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Implementing Formal Model Analysis

There have been a number of important contributions to the field of system dynamics in the recent past. One of the most exciting has been the development of eigenvalue elasticity theory (Forrester 1982, Kampmann 1996), which promises to increase our capacity to understand our models, enhancing our ability to get insight from modeling. In this paper, we critically review the current state of knowledge and provide an improved approach to determining loop gain elasticities.

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Fragmented Knowledge And Group Model Building

We are conducting a study of SD group model building that is based on the following aspects:
1. The availability (in the near future) of object-oriented components in at least one System Dynamics modeling tool.
A component is a model piece that can be used as a building block of another component (Myrtveit, 2000).
2. The integration of SD simulation tools in Enterprise Resource Planning systems.
As an example we mention the integration of Powersim Constructor in the SAP Strategic Enterprise Management (SAP SEM) solution. Enterprise models tend to be large and complex. Hence, they would benefit from an object-oriented approach, i.e. decomposition into model components.
Further:
3. The fact that the available knowledge in any enterprise is fragmented; i.e. that it exists as a sum of narrow, specialized know-how that is scattered across thousands of minds.
Arguably, consensus-seeking group processes would not make much sense if they were to amalgamate genuine domain expertise and superficial knowledge under the declaration of «expertise.» In other words, to capture relevant knowledge and to avoid knowledge «dispersion» the expertise in a modeling group must be sufficiently focused.
We discuss the following considerations as a guide for group-modeling processes:
How to define model components that align with domain

expertise.

How to decompose the modeling group into subgroups that match the domain knowledge requirements in model components.

Criteria for consistent definition of reference behavior modes for each model component separately and for the total model.

Criteria for consistent validation of model components and the total model.

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Organizational And Individual Learning In A Textile Operational Environment. An Application Of Systems Dynamics Modelling

Continuous learning is a key source of competitiveness for the firms but organisational learning is more that the sum of individual learning.

An organisation learns when knowledge of people and teams is stored into routines and methods or translated into the culture of the organisation.

Information Technologies plays an important role in the process of acquiring and distribution of this knowledge.

This paper tries to explore this reality via the construction of models with system dynamics and their application to a textile Spanish firm in the frame of an operational environment.

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A Simulation Methodology Unifying System Dynamics And Business Objects

In order to encourage the participation of business people in the modelling phase and to abstract business concepts from their simulation complexities the proposed framework combines system dynamics with business objects. The approach eliminates the isolated modelling for simulation and operation and enforces a common business model that accomplishes both. The unification consequently assists in concurrent evolution of the simulation and operational model. Since the simulation model is directly linked to the operational model information collected during systems operation is directly communicated to the simulation model for processing and vice versa. In addition, the integration provides an intuitive interface to the simulation engine based on real world concept.

For the unification of business object and system dynamics paradigms, the Powersim constructor and Visual Basic 6.0 are

employed. The former is used to construct the system dynamics models and the latter to develop the infrastructure for the business process and business objects. A number of system dynamics co-models are distributed in equal number of business objects each one related to the business aspects that the object represents. Business objects run the various co-models simultaneously and exchange information concerning the simulation through the business object infrastructure. The business rules incorporated in each business object act as navigators for the encapsulated simulation model and the business object itself.

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Using Group Model Building To Support Strategic Reform Of The Real Property Tax System In New York State: A Case Study

Between 1997 and 1999, the New York State Office of Real Property Services undertook a reform strategy designed to change some important aspects of the real property tax system in New York Sate. Central to this strategy was a proposal to move up to sixty percent of the local assessing units toward annual reassessment practices over a period of three to five years. In New York State, the local property tax raises over 30 billion dollars for public purposes with an annual cost of administration in excess of $150 million. In spite of the scale and importance of this taxation source, real property tax is a local tax and the assessment function for this tax is clearly stipulated in the New York State as a home rule function. The Office of Real Property Services annually reviews and certifies the tax roles of all taxing jurisdictions to assure that state aid based on the tax rolls is being distributed equitably between local taxing jurisdictions. In addition, ORPS administers a number of aid programs designed to create uniformity in assessment practices across the state. To a large degree, these programs are intended to foster within jurisdiction equity.

ORPS's annual reassessment initiative is designed to cause a greater number of New York state localities to use data sharing, statistical analysis, and other assessing innovations to assure that tax assessments are updated once each year. Many of these innovations are standard practice in larger communities (such as New York City), but are less prevalent in smaller jurisdictions since these practices would require new skills, approaches, data resources, and perhaps inter-organizational arrangements.

The annual reassessment reform is a complex reform effort that

involves developing new ways of doing work, increasing cooperation between state and local governments, and making use of new statistical and data techniques. The innovations are still in the planning phase with the first communities becoming eligible for the new program in the year 2000. Planning for this policy innovation was supported, in part, by a series of group model building innovations sponsored by ORPS.

These group model building sessions involved teams of state and local managers coming together to plan strategy innovations and to create a shared map of what might be the implications of such innovations. Two system dynamics models were developed with two different groups and a third model used the Decision Explorer software to create maps of the goals and objectives of annual reassessment as well as some of the strategies that could be used to implement these new policies.

The proposed paper describes briefly the policy development environment surrounding ORPS, the real property tax system, and the proposed annual reassessment innovations. The model then shows the models that were used to support the strategy development process and discusses both the utility and limitations of group model building to support strategy development in this particular public policy system.

The case study illustrates some of the strengths and weaknesses of group model building as a way to support strategy development in the public sector. The paper concluded by speculating on how future efforts might benefit from lessons learned in this case.

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Methodological Issues Of Using Business Simulators In Teaching And Research

Business simulators can be used for psychological experimentation and for teaching purposes. It is briefly discussed why these uses seem promising. The teaching effectiveness can be tested in evaluation studies comparing two slightly varied simulators. In both cases, psychological experiments and evaluation, methodological issues can occur which are due to the nature of experimenting, but are also caused by specific characteristics of simulators. Twelve issues can be identified. It is shown how a formal development process for business simulators can mitigate some of the potential problems. Therefore, a prototypical life-cycle model of the development of business simulators is described.

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Dynamics In Spatial Logistic Chains

The motivation of production, distribution and transport of commodities can be said to be purely economic. As such it might be said that the demand for freight transportation lends itself better to formal analyses using economic demand theory, but the dynamic processes involved make it necessary to incorporate feedback mechanisms. The choices available to the firm include location of production and distribution, level of output and inventory and a series of choices that are related to transportation of the product like: modes, shipment size and routing. These choices can be classified into long, intermediate and short-term decisions [Kanafani, 1983]. In 1958 a paper was published in Harvard Business Review; Industrial Dynamics: A Major Breakthrough for Decision Makers, which started with:
"Management is on the verge of a major breakthrough in understanding how industrial company success depends on the interaction between flows of information, materials, money, manpower and capital equipment" [Forrester, 1958].
Since 1958 a lot of progress has been made in understanding the dynamics in production and distribution chains but still we do not fully understand the complex interactions and dynamics. Depending on the market that is being observed (production, trade, logistics, transport or infrastructure) frequencies with which logistics decisions are subject to review or renewal are between once every 5 to 10 years for production and once every day for routing decisions. Over a long period all these decisions will interact with each other and therefor a large number of models have been developed by economists and transport-planners over the century to gain insight. Each model is concerned with a specific part of the economy or transport and makes different assumptions on the processes that influence this specific part. Only recently increasing attention has been given to the relationships between the economy, environment and transport. Complex dynamic models are required to allow a description of these interacting markets over a longer period. Clearly most freight transportation models are capable of dealing with short-run decisions, but most existing integrative modeling approaches today treat economic factors as exogenous instead of endogenous. Dynamics in production locations, production networks and regional characteristics are usually not within the scope of the model.
The paper focuses on the development of an aggregate spatial

system dynamics model that is being developed at the Delft University of Technology and TNO Inro in the Netherlands. The paper describes the different approaches in aggregate freight transportation modeling, system dynamics modeling and the combination of these two approaches. Finally some intermediate results of the system dynamics model that describes a spatial logistic chain will be presented.

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Understanding Integrated Sustainable Regional Development In The Information Society: The ISIS Dynamics Model Package

The global and fast-growing information potential that enables the development of information-based economies offers manifold social, cultural and environmental opportunities for sustainable regional development. The main objective of the Information Society Integrated System (ISIS) dynamics model package (short ISIS model) is to build an understanding of the integrated relationships and dynamics for these potentials of present transition to information society. The approach requires an integrated frame of spheres like economy, jobs, social and ecological systems and their implementation into the ISIS Model. Several sub-models generate the various interdependencies between the global information potential, the global market, old and new economy, regional population, land use patterns, regional attractiveness and quality of life. Key-people and the available knowledge for the new economy are found as most important factors which triggers the emergence of the regional information-based economy. The basic parts of the model are linked as Cross Catalytic Networks (CCNs). The structure of a CCN consists of two subsystems each of which is capable of exponential growth on its own and, additionally, one link from each subsystem to the other which can increase the growth of the other.

To realise what factors are most relevant for the dynamic behaviour of the system, printed and digital media have been observed continuously to find policy actions in relation to the support of information-based economy development. Both, successful examples and failures in regional development and insights from ISIS Models are suitable to formulate the general framework for the new understanding of the emerging new economy because it provides a general feeling of what is suitable and what not.

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Leadership, Management And Management Control - A System Dynamics Approach

Utilizing a system-dynamic interpretation of the term leadership, we aim to identify the current challenges to companies from their environments, and to explain the consequences of these challenges for company design and control
As well, we aim to develop a dynamic approach to leadership based on theories of system dynamics and living systems. The purpose of leadership is to create a living and learning organization capable of development that is both internally guided and externally oriented. For a company to achieve sustained development, there must be a healthy proportion of growth and balance. Management needs to be counterbalanced by control: management and management control together enable viable leadership.

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Using A System Dynamics Approach For Integrated Channel Management In Financial Institutions

Increasing customer sophistication, broadening competition and changing technologies have significantly impacted retail financial services and the channels through which customers interact with financial institutions. It's not only the number of channels that has increased dramatically, but also the functionality of those channels has expanded significantly.
This paper is based on a recent study completed using System Dynamics methodology to demonstrate the challenge of managing the broadening channel network to achieve the best financial performance in the long term. It first elaborates on the A.T. Kearney approach to channel management in the financial sector – Integrated Channel Management –, which forms the basis of the study. In the second part of the paper, the System Dynamics model and the Flight Simulator will be briefly depicted.

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System Dynamics Approach To Find Policy Leverages Of Information Policy: IT Utilization Strategies For Three Sector's Users

In recent years, how to promote the Utilization of Internet is a main issue of national information policy. In this study, we focused our approach to find promoting strategies for Internet utilization on three sector's users, governments, enterprises, and households. Promoting the Internet utilization of these three sectors' users is a very difficult problem, because their information levels are different and information gap among them can be regarded as bottleneck. And since the interactions between users' demands and diverse information sectors' factors are very complex, policy leverages can not find easily. By the system dynamics methodology, this paper examines the interrelationships between three users' demand mechanism and information policy sector. Information policy sector consist of four sectors, infrastructure policy sector, application-contents sector, governance sector, and access and price policy sector (free access policy, literacy policy, telecommunication price policy, etc.). To find and investigate policy leverage that will help understanding dynamic behavior of users in using Internet, we build a causal loop diagrams and SD models by using survey data obtained from three sectors' specialized users, 488persons.

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Options In Source Code Documentation

Customers using system dynamics models for multipurpose applications require varying degrees of documentation of a model's source code and design. A broad range of factors can influence the customers' documentation requirements. Because the model developer plays an important role in determining a model's functional requirements and has often been exposed to a range of model applications and documentation requirements, the developer is in an excellent position to understand and advise the customer on what level and form of source code documentation may be appropriate for a specific application.
This paper will discuss the range of documentation alternatives considered by Raytheon Company C3I Systems, Project Performance Corporation, and U.S. Government customers in documenting source code for various system dynamics models.

The paper also discusses the factors that were considered as potentially influencing the customer's documentation requirements. The most expeditious documentation is often developed automatically when using commercially available off-the-shelf system dynamics software. More rigorous documentation can also be developed manually, either during or after development of the model. In addition, rules-of-thumb and informal professional practice standards exist for documenting source code. Source code documentation serves two primary purposes. First, it is a quality assurance tool that helps to minimize the number of defects or bugs in the source code. Second, it can lower the life-cycle cost of the model by reducing the learning curve and costs associated with evaluating and modifying the source code. These two purposes are the dimensions of the cost-risk decision that model owners face when making documentation decisions. Factors considered in the decision include the model purpose, the expected frequency and duration of model usage, the experience and knowledge of model users, the potential costs associated with model misuse or failure, and the direct costs of preparing and maintaining documentation.

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Is Ecological Living Sustainable? - A Case Study From Two Swedish Villages In South Sweden

Sustainable issues need to be investigated on both spatial and temporal scales. Scale level interactions in different societal sectors suggest that the sustainability concept is ranging depending on the observed time scale. A western household system has an expected duration of 50 years. The sustainability time perspective is thus limited to this period, as since households do not plan generations ahead. Lifestyle patterns, including "ecological living" is influenced by several factors, mainly living and consumption. Dynamic simulation can identify important components of a lifestyle that maintain the highest Ecological Footprint value through time. Ecological footprints are calculated by converting the living and consumption to corresponding ecosystems areas required to support the production of the needed material. System analysis was used to simulate development of the ecological footprint over time of two lifestyles from two different townships in southern Sweden; an ecological village; Toarp; and a conventional village; Oxie, both situated in the same region in South Sweden. The Simulation spans over a 50-year period and included sensitivity analysis of several scenarios of living and

consumption pattern. The construction of ecological houses is only giving minor reduction in the environmental impact. The result indicate that the "food" consumption and space heating, which contribute around 70% of the total ecological footprint, are the most realistic alternative in order to reduce the environmental impact of households.

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A System Dynamics Analysis Of The Victorian Workcover Authority Insurer Scheme

The Victorian Workcover Authority is charged with responsibility of administering insurance for work related injuries in the state of Victoria, Australia with a cost of work related injuries at over $1B ($1,072,000,000 for 1998/99) per year. The Authority contracts the claims management and premium collection to major insurance companies.

The companies are paid according to the size and risk of their portfolio and their performance in injury prevention, early return to work for injured workers and claims cost reduction. The companies are rewarded for improved performance and for maintaining good performance.

A system dynamics model was built to provide the insurers with a clear indication of the financial implications of their being able to improve their portfolios performance. The model was also designed to show the impact of gaining and/or losing clients whose overall performance may differ from the average performance of any given portfolio. This model raised a series of questions, which are discussed in the paper, about appropriate strategies for improving the financial performance of individual portfolios. The model was also used to examine the effectiveness of the incentive aimed at improving the portfolio performance.

The paper also discusses a series of related issues which involved questions of whether different financial performance by the insurers is related to structural considerations in the survival curves of injury claims or performance of individual insurers in handling claims. The reward calculations used by the Authority builds significant delays into this process. The impact of these delays is discussed in paper.

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Growth And Decline Of Religious And Subcultural Groups

Within any population there are subcultural groups, based on religion, political be-lief, or lifestyle, which hold the allegiance of people. Often such groups include membership of an organisation such as a church, cult, political party, or some looser group that encourages the beliefs and practices of the subculture. These groups may survive for many generations, before eventually dying out. Many remain small mi-norities with little potential for growth. However a small number not only flourish, but eventually influence the bulk of society. A prime example of a successful group is the Christian church which, having grown for two millennia, is well poised to con-tinue growing in the future, except in Western Europe where it still declines.

This paper examines the dynamics of the growth of such religious and subcultural groups and attempts to explain, using system dynamics, the causes of their growth and decline. Based on a mathematical model of church growth, published by the au-thor, a systems dynamics model is developed incorporating births, deaths, and rever-sion. It is argued that the primary cause of growth is the existence of enthusiasts within the group who spread the belief, and hence recruit, through contact with un-believers. It is further argued that growth is limited because they are only enthusias-tic for a limited length of time, falling back to ordinary members of the group, with virtually no recruitment potential.

The model is applied to the spread of the Christian church and other subcultural groups, discussing their potential for long-term survival.

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System Dynamics As A Foundation For A Course On "Sustainable Development"

"Sustainable Development" is currently a topic of great social relevance and one that requires the integration of a challenging array of themes from a variety of disciplines spanning the physical and natural sciences, economics and other social sciences, and the humanities. In addition, the focus of 'development' points out the inescapable need to consider these themes through their evolution over time. Both the interdisciplinary breadth and the temporal dynamics of this topic argue that system dynamics should be a

valuable tool in helping to guide students in its exploration.

Over the past two years we have explored the use of system dynamics as the central tool in building and presenting a course on Sustainable Development to both standard undergraduate classes and a class composed of middle school and high school teachers, high school students, corporate executives, and leaders in non-profit organizations in our community. These experiments have led us to a course design with several distinctive features, including the use of system dynamics as a central organizing focus.

We have come to see the power in using a limited number of case-studies as vehicles allowing us to focus on specific aspects of depletion and sustainability through a critical lens of human innovation and ingenuity. Included in that mix of cases were intellectual explorations of Easter Island, societal affluence as represented by the !Kung and other hunter-gatherer societies, the development of western agriculture and its projection into the future to meet the needs of a growing human population, commercial fishing and the micro- and macro-economic consequences of stock depletion, energy development and utilization and the impact of substitution and enhanced efficiency, and the integration of these themes within specific individual countries including the simulated scenario represented by STRATAGEM.

Within that organizational framework we consistently strived to support our students in identifying, expressing, comparing and contrasting, and strengthening their mental models of the relevant systems; in developing the ability and inclination to continuously test and extend their understanding through the asking of progressively "better questions;" and in reflecting on the possible futures based on a variety of historical experiences. To those ends the various tools of system dynamics (behavior over time graphs, causal loop diagrams, stock/flow concept maps, and computer simulations) were used consistently to aid the students in developing and refining their understanding. We also consciously explored the repeated utilization of simple transferable structures and relationships. The most obvious such repeated structure was the three-strand depiction of resource utilization (strands of human population, the resource, and per capita usage or demand for the resource) which provided a powerful template for the discussions of many of the case-studies.

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Sustaining System Dynamics Innovations In The K-12 Arena: A Mental Model From A Ten Year Perspective

Early in the 1990s, educators adopting system dynamics to affect curricular change (via computer simulations) and systems thinking to affect organizational change were subjected to skeptics' assertions that system dynamics was only a passing fad. A decade later, with exponential growth in the production of curricular material (see the Creative Learning Exchange's collection) and the number of organizational experiments, "better questions" focus on sustainability of these ventures.

For the Waters Center the challenge of nurturing and sustaining such innovations requires a focus on two critical and related elements that broadly address the "motivation" and the "ability" of the potential innovators. Motivation enters our thinking primarily through our view that innovation within an organization can be powerfully discussed through the context of a generic infection process. Think of individuals within a school. In considering any innovation (such as the use of system dynamics) these individuals will fall into one of three Stocks: "Ignorant of the Innovation," "Knowledgeable of the Innovation," and "Profiting from the Innovation." The progression of individuals from the first Stock through the second to the third involves a reinforcing "infection" dynamic that can be very effective, if it is supported and nurtured so that those "Profiting from the Innovation" can spread the "infection" by providing a visible benefit which motivates others. If no one moves to a point of being able to profit from the innovation or if those profiting from the innovation are not visible, there is little motivation for others to invest time or energy. Alternately, if those profiting are exhausted in supporting others, they have little time and energy themselves to toward further applications.

The related aspect of our model compares the educators' current ability to use system dynamics with their desired ability. A key element here is the recognition and monitoring of the "gap" between the educators' motivation and their abilities to achieve their goals. Ability should always lag desire somewhat to provide a target for continuing growth and improvement, but too great a gap can be debilitating. This challenge to sustainability rests with introducing tools early that 1) are readily comprehensible, 2) have broad applicability across a variety of educational domains, and 3)

facilitate the educators in achieving a modest, but noticeable, improvement in meeting their professional obligations. Often this will mean developing and practicing a variety of tools (e.g. Behavior Over Time Graphs, Causal-Loop Diagrams, Stock/Flow concept maps) before or instead of using or building computer simulation models.
Investing scarce resources in ways to support the powerful infection dynamics and managing the competing dangers of pushing or pulling too rapidly or of permitting educators to remain satisfied at one level of accomplishment for too long, are the twin challenges that this mental model allows and, indeed, obliges us to address.

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Modelling Product Development Productivity With System Dynamics

This paper analyses the performance of product development as an input-delayed partial productivity. Firstly, the total productivity concept is introduced in the framework of firm-level performance measurement. Some recent literature related to new product development is reviewed and three related system dynamics models are reviewed. Based on the analysis we suggest that productivity measurement of product development requires knowledge in project and resource structure. Finally, the preliminary results related to product development are concluded and the practical applicability of the productivity framework is discussed for further research in the area.

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Modeling And Simulation Of The Effects Of Nitrogen Waste On Oxygen Consumption In A Norwegian Fjord

We consider a model of a small, industrialized community in the Sørfjord, a branch of the Hardangerfjord, Norway. For one century, waste from the factories has been dumped into the fjord. There has been a low rate of inflow of fresh seawater, and part of the fjord was previously known as the most polluted one in the world. Both the fjord and the factories are crucial for the sustainability of the community.
The effects of water pollution have been an important topic since pollution became a political issue in the 1970's. Data on the concentration of various chemicals has been collected to find how

severe the environmental contamination is. There is, however, a lack of models that can transform data into relevant and coherent information and help us identify additional needs for data. The design of such a model requires the cooperation of experts from many different fields. In a system dynamics model, it is possible to combine knowledge elicited from various experts, so as to obtain a coherent theory of the dynamic physical and biological processes that takes place in polluted water.

Over the last years extremely low values of oxygen have been measured in the Sørfjord, and the life in the water is at the point of extinction. We have developed a model that identifies the effect of nitrogen being disposed from one of the local factories, and how the resulting process consumes large amounts of oxygen through a complex biological process. The model incorporates the expert knowledge of physicists and microbiologists on the life cycle of chemical components and associated bacteria, and how their effects are influenced by the inflow and outflow of water.

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Business Modeling Process

This paper discusses the key issues in modeling process. In teaching business simulation, the most frequently asked question is, “How can I get to develop such models?” It is easier to explain the structure of existing models and managers can easily learn how to use simulation software. Modeling is integration of several techniques; techniques for collecting necessary information, techniques for summarizing them, techniques for mapping them into diagrams, and computer simulation technology. In this paper, I discuss the key points in modeling process through my experience in teaching business modeling not in classroom but in real business fields. I also introduce the effectiveness of the KJ Method, a useful technique in collecting and summarizing information, which is frequently used in Japanese organizations. This paper is based on the case study in NTT Data, applying the SD modeling to software quality management. This case study has two main implications for effective modeling. First, it suggests that understanding whole process of modeling is the most important to develope a good modeler. Second, some techniques for TQM are also useful for SD modeling.

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Presentation

Learning By Building And Using Models In Business Education

Objectives for apprenticeship programs in the German dual vocational system, for instance within the curriculum for industrial office clerks, are that students shall be trained to acquire the ability of thinking within complex economic environments, to become able to understand complex business-related tasks, and problems and to develop according solutions.
One core problem is an appropriate support for the acquisition of knowledge in complex subject-matter domains that include the interrelations between the elements involved and the dynamic behavior of the domain.
The theoretical framework referred to is the notion of Mental Models (Senge). The assumption is that active modeling by students supports the elicitation of the often 'naive' Mental Models, moreover leading to elaboration and reconstruction in the modeling process. This includes SD-based simulation, which takes place on behalf of, or supplementing the cognitive (simulation) process. Basic concepts of the approach are the use of complex business cases which are modeled by the students. Worksheets and the teacher's moderation guide the learning processes.
This problem-orientated approach aims at the development of a deeper understanding of complex economic issues and wants to avoid looking at concepts or vocational tasks in isolation.
Results on students activities in active modeling will be presented. The approach makes use of tracing software which can record the development of the individually constructed models over time. This allows to mirror the process of the elaboration of the respective Mental Models. The paper will report on such learning processes in classroom settings.

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The Source Of Poor Policy: Controlling Learning Drift And Premature Consensus In Human Organizations

As system dynamicists, we spend our days finding and patching up faulty policies. We give surprisingly little thought, however, to the origin of these faulty policies. And yet, if we understood their origin, we might be able to attack the problem of poor policy at its source.

This paper presents a theory of policy formation that is consistent with what is known about evolutionary processes and human psychology. The theory is translated into a computer simulation model, which is used to illuminate several "handles" on policy creation. The handles influence two potential failure modes in policy creation: (1) "learning drift", a process in which people learn without making progress, and/or (2) "premature consensus", a process in which managers agree on a policy before the "best" one has emerged.

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A Dynamic Theory Of Antibiotic Resistance: Work In Progress

Many common bacterial pathogens have become increasingly resistant to the antibiotics used to treat them. Experts agree that the essential cause of the problem is the extensive and often unnecessary use of antibiotics, a practice that encourages the proliferation of resistant mutant strains of bacteria while suppressing the susceptible strains. However, it is not clear to what extent antibiotic use must be reduced to avoid or reverse an epidemic of antibiotic resistance, and how early the interventions must be made to be effective. To investigate these questions, we have developed a relatively simple system dynamics model that portrays changes over a period of years to three subsets of a bacterial population – antibiotic-susceptible, intermediately resistant, and highly resistant. The details and continuing refinement of this model largely reflect our growing knowledge of Streptococcus pneumoniae, a leading cause of illness and death worldwide. The paper presents the model's structure and behavior, including its ability to reproduce time series from four different countries, and explores possible directions for further model development.

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A System Dynamics Model For Improving Railroad Performance

Since the deregulation of their industry in 1980, America's freight railroads have engaged in fierce competition both among themselves and with the trucking industry. The early focus of this competition was cost reduction, but today the emphasis is equally on performance, that is, the speed and reliability of service. Railroads attempt to maximize weekly and monthly on-time performance through the use of operations research tools for scheduling trains and train resources (crew, locomotives, terminals, track) and for routing and blocking (i.e., grouping) cars to get them efficiently from origin to destination. These OR tools are useful for optimizing individual subsystems of the railroad, but are unable to accurately assess how changes in customer demand, resource levels, or operating policies might affect the system as a whole, and thereby affect performance over a period of months to years. One important example of such whole-system effects is network congestion, in which train delays may lead to resource shortages, which may lead to further delays. System dynamics is a natural choice as a strategic planning tool in light of such chronic and volatile performance issues. This paper describes an SD model developed for a major US railway, outlining its creation and validation, structure and behavior, and areas of application.

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Developing A System Dynamics Model Of The UK Private House Building

The paper describes the construction and the validation of an UK house building system dynamics model. The purpose of the model is to determine the drivers on new private house building demand. Such features as house building starts, construction in progress, housing completion and economic indicators are incorporated in the model.

The focus of the paper is the development of the construction lag sub-system. The development and validation of the model are based on:

archival evidence from UK and USA literature,

econometric housing industry models,

governmental data on housing starts, in-progress and completions,

economic data such as the consumer industries indicator,
opinions from industrialists and academics.

Causal loop, block diagram and difference equation representations of the sub-system model are presented. Statistical analysis of the housing data is undertaken to determine lags/leads in the sub-system and to determine valid causal relationships. The paper evaluates construction lead-times and shows that they lead economic indicators by 5 months. Average lead-times are 17 months although they can vary from 13-20 months. The result concurs with published information that found an average construction lead-time of approximately 16-18 months between 1976 and 1986. Inputting actual starts and comparing the model completions and construction in progress outputs with published data finally validates the construction lag sub-system model. The model fits actual data to within 3%. The validated sub-system model is the first phase in the development of the total house-building model that is of particular interest to UK policy makers and industrialists.

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Presentation

The Concept Of Change: A Review Of General System Theory, Chaos Theory, And System Dynamics

One of the current challenges for the field of system dynamics has been the difficulty of communicating system dynamic principles and methods to other social scientists while preserving the heuristics of good model building. A number of factors go into explaining this challenge, one of which is repeated failure to distinguish system dynamics from what is often called systems theory. "Systems theory" operates loosely as an umbrella term for any theory about social systems. This presents a problem for the field when system dynamics gets understood and evaluated through systems theory. Articulating the distinctions amongst different system theories helps practitioners analyze and correct some of the fundamental misconceptions.

Within system dynamics, there has been an intellectual tradition of developing conceptual distinctions between system dynamics and other methods of studying social phenomena. For example, this was present in Forrester's early work, as well as Richardson's work on the concept of feedback in the social sciences, and Sterman and Radzicki's work on chaos. This paper builds on this tradition by reviewing general system theory, chaos theory, and system dynamics with respect to the concept of change. Special attention is paid to change in structure versus parameters, and endogenous versus exogenous causes of change.

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Analyzing Dynamic Systems: A Comparison Of System Dynamics And Structural Equation Modeling

System dynamic models are able to represent a wide variety of phenomena using systems of differential equations to represent feedback loops and nonlinear interactions. Structural equation modeling (SEM) is a method of testing systems of equations against observed covariance matrices. SEM has typically been constrained to linear systems of equations, but more recent developments have allowed SEM to represent nonlinear as well as non-recursive (feedback) relationships. In this sense, SEM path diagrams are superficially beginning to look like system dynamic causal-loop diagrams, and SEM is being used to model a variety of

dynamic phenomena, especially in sociology and psychology. This paper analyzes the relationship between system dynamics modeling and structural equation modeling.

A formal notion of equivalence between system dynamic models and structural equation models is developed. This is then analyzed by comparing the implied covariance matrices from one system dynamics model of "fixes that fail" against the implied covariance matrices of "equivalent" structural equation models. The demonstration uses Powersim's API interface with a Visual Basic program to manage the Monte Carlo simulations and record sample covariance matrices. These matrices are then compared against two LISREL models. The first tests whether an "equivalent" model can explain the entire family of covariance matrices, while the second is developed to fit the data.

The results suggest that structural equation models are able to explain the covariance matrices of a system dynamics model with changes in feedback loop dominance, but only by sacrificing a substantial portion of the latent structure representing feedback loops.

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Domestic Violence And Court Mandated Batterer Intervention: A Community Model

Many communities in the United States are responding to domestic violence by developing a coordinated community response, which typically involves key stakeholders such as domestic violence shelters, prosecutors, judges, police departments, mental health professionals, as well as other service providers. Court mandated batterer intervention programs have emerged as a key element in the coordinated community response. There has not been, however, a general consensus about whether these programs work. This has taken on an increased urgency as there are now more programs in the community, but the level of domestic violence has remained unchanged. One explanation has been that batterer intervention programs are ineffective because they do not hold abusers accountable. This has led many states to implement minimum standards for batterer intervention programs. This paper presents a system dynamics model of the problem of batterer intervention program capacity expanding while there being no observable impact on the overall level of domestic violence. The model is at the community level, and includes a number of effects, including deterrence from police arrest and batterer intervention program effectiveness. The results indicate that the problem is

best explained as a resource allocation problem in police arrests and not as problem with batterer intervention programs' standards. Specifically, the single largest effect came from allocating resources across the full spectrum of domestic violence crimes.

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Exploring Criteria To Assess The Suitability Of System Dynamics To Model Disruption And Delay In Large Projects

System Dynamics (SD) is a method that has been used for many years to model a wide variety of situations. However, how can the suitability of SD to model a situation be assessed? In particular, the author has had experience of asking this question when involved in the modeling of large projects for a number of different litigation cases. This presentation investigates the assessment of the suitability of SD by searching the literature for criteria which have been used to identify whether or not a situation can be modeled using SD. Three separate views have been chosen from the literature. Two of these views are put forward by researchers who have devoted the majority of their working lives to SD. The first is taken from early comments made by Forrester and the second from some practical advice laid down by Coyle. The third view is taken from Flood and Jackson. These researchers differ from the previous two as they adopt more of a multi-methodological viewpoint. The three views are discussed in terms of real data taken from the author's experiences of constructing SD models for a number of large engineering projects. The results of the discussions highlight the most useful criteria with which to assess the suitability of SD to model a situation.

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System Thinking In The Study Of Housing Development In Hong Kong New Towns

In this paper, we have applied system dynamics to analyse housing development in Hong Kong new towns. Because housing development is concerned with many factors such as population growth, employment, personal income, gross domestic product and government policies, it is a complex social-economic system that demands system thinking for its solution. We have constructed a system dynamics model that attempts to describe housing development in new towns. In this model, the interactions of various factors in urban housing development are taken into

consideration. The model has been implemented in a computer simulation package named “I think”. The simulation provides a trend of future housing development in Hong Kong new towns. These results can assist decision makers produce more appropriate plans for future housing development. We found that the application of system dynamics into housing development is a new and fruitful attempt.

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An Integrated Statewide Dynamic Simulation Model For Sustainable Policy Analysis & Design

In 1997, designing and implementing sustainable growth policies became one of the most important activities for the government of the State of Guanajuato, in central Mexico (about 160 miles northwest of Mexico City). Based on an existing 20 year-horizon fore-sight study for the State and a series of interviews with decision-makers in the private and public sectors, an integrated, statewide dynamic simulation model was built. Its purpose was to test the plan of government policies to examine their long-term effects on the sus-tainability of the growth of the State.

There were two phases of development of the model that was named ProEstado. In Phase I, an aggregate model was built to simulate demography, education, labor supply and demand, production of the ten most important industries and the use of natural re-sources of the State. Two scenarios with different rates of economic growth were tested and their impacts on natural resources, employment, education and migration flows were examined. The need to modify several government policies was detected. Among the most critical issues, water supply and demand was identified.

For the second phase, ProEstado was regionalized for the nine hydrologic watersheds of Guanajuato and detailed models were built for each one. Scenarios that combine im-proved water uses with industrial growth scenarios were tested. The results were utilized to elaborate the 2000 to 2030 State Water Supply and Demand Plan.

A description of the Stella version structure of ProEstado as well as the methodology to build and test the scenarios mentioned is presented.

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Informational Technology For Ecological Economics Systems Management

General structure of the informational technology for ecological economics systems sustainable development was suggested on the base of system analysis principles. This technology consists of dynamic-stochastic environmental model, dynamic-stochastic ecological economics model and special algorithms for the models parameters adjustment in the course of a system's controlling. The main goal of the technology was to produce the scenario of ecological economics system development consistent with some criteria prescribed and capable of improvement by some validation procedure. Adaptive Dynamic Balance method was used to construct various dynamic-stochastic models of ecological economics systems. This method utilizes the concept of general balance between environmental integrity and economic efficiency of natural resource consumption. An example of natural bioresource management was considered. An ecological economics system of the "sea-land" type was introduced for the Sea of Azov (Sough Ukraine) region and informational technology for the system's management was constructed . This technology enables to follow the space-time variations of marine bioresource concentrations under weather conditions changes and under the industrial activity of their consumption. Special cost-benefit analysis of the resource use was suggested to control the environmental impacts of proposed industrial development scenarios.

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Modeling On Fundamental In-Tree Sequence Of SD Rate Variable

System Dynamics (SD) is a subject on studying information feedback systems. SD modeling is a structural approach, obtaining structural model through causal relation diagrams and flow diagrams. The modeling approach has achieved success in practical applications since the 1950's. However, in the course of researches and applications, we have found out some problems. Based on the knowledge of the concrete system background and subsystem analyses, modelers who use this approach obtain the Level-Rate couple serial, and then through adding auxiliary variables, external variables and so on in step, they establish the

complex flow diagram structural model. Nevertheless, the procedure is obscure and non-standard. Furthermore, the modelers can not explicitly explain how the concrete complex flow diagram is established by adding variables in step. Moreover, the number of feedback loops and the feedback variance of concrete feedback loops in the flow diagram can not be explained clearly. However, the explanations and analyses are very important for structural model debugging and result analyses.

Pointed to the problems above, we once presented a graphic approach to SD flow diagram analysis - a recursive approach to obtain feedback loops by partitioning complex flow diagram in step. But the approach only made analysis of the modeling process. Therefore, through the investigation of several years on SD, we catch the essential concept, Rate variable on SD, and introduce conceptions, such as fundamental in-tree sequence of SD Rate variable, embedded operation, derived in-tree in SD Rate variable, incremental derived in-tree on SD Rate variable. And in light of modeling on fundamental in-tree sequence of SD Rate variable. Using the novel approach, we have efficiently developed a project. By the research and application, several features of this approach are achieved, as flows: - simultaneously realizing the standard modeling and feedback loop analysis; - being beneficial to model debugging, model redeveloping and result analysis; - introducing a new view on looking for loops in graphs the paper describes the modeling approach in great detail.

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Physician Decisions As A Source Of Variation In Chronic Disease Outcomes

In this paper we describe an investigation into the dynamic relationships between physician practice behavior, patient information, and chronic disease outcomes. Using data from a study of 1000 patients with adult type 2 diabetes we develop a dynamic computer simulation model of archetypical diabetic patients. Simulated pPatients are specified as a sets of standard and fuzzy logic rules that represent physiological and psychosocial disease parameters. The model captures the time-dependency of treatment dose-response as well as the dynamic psychosocial effects of physician treatment moves as reported in the medical literature and as expressed by experts and the research literature onin the treatment of type 2 diabetes. Using the simulation model we study the behavior of physicians who attempt to manage a variety of archetypical patients across multiple encounters, with

feedback and time delays spanning multiple years of patient experience. Using both time-series and process analysisdata, we partition variation in physician behavior into a macrostructure of treatment outcomes and practice goals, and a microstructure of physician treatment moves in response to patient data. For each simulated patient, we determine conditions under which practice goals are pursued by means of a (feedforward) strategy in which physicians make decisions and choose clinical moves based on predictions of the future patient states, versus a (feedback) strategy in which physicians make decisions and choose treatment moves based on information about the patient's current state and context of care. For each patient archetype and physician reasoning strategy, we identify the effect (including time-lagged effects) of variation in patient information on physician behavior and disease outcome.

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Training Citizens: Infusing Personal Gifts With A Social Conscience

Each student comes to school trailing clouds of exquisite experience and a longing, in spite of popular perception, to know something, to be somebody, to tell a story—something inside aches to know and be known. Our traditional response in K-12 education is to sit such a ripe prospect in a chair for six hours a day as well-meaning adults tell him what to know and when to know it: lectures, quizzes, lists, worksheets. Twelve years of such passive, prescriptive treatment, so the wisdom goes, ought to yield a nimble, independent mind capable of participating in a democratic society.

What stellar lunacy!

Students in system dynamics, on the other hand, do none of these things. Rather, compelled to confront their world through an elegant template of levels and rates, students construct understanding based on personal intellectual battles on what is, and what is not. Even from incomplete, though revelatory simple models of population, for example, students assemble meaning from fundamental understandings: exponential change overwhelms our good intentions.

Not so much beholden to norms or departments or benchmarks or state unit requirements, system dynamics students explore deep problems, building computer models that frame personal experience and research, something schools ought to hope they can provide. These young people increasingly exercise their

citizenship in unsettlingly profound venues: teaching peers and adults about blood alcohol content, or discussing urban dynamics with professional city planners. As one student put it, “Finally, after 12 years of school, I’m doing something real.”

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The Commonweal Rests Upon Learning

For quite a long time, students have had their collective brains tuned to a curricula from far away: the sciences and humanities all hailed from distant times and places. Naturally, the curriculum rarely came home, keeping most topics, once the test was completed, not much more than an annoying abstraction in a child's mind. Instead, students ought to turn their intellectual and imaginative powers inward, toward themselves and their community ‹ a place they know something about.

School folk must see their students as a community treasure. This, not surprisingly, carries a moral imperative: provide inquisitive minds with social purpose, and we foment hope within that community. Conversely, to the extent we continue to separate these populations ‹ the adult world of workers and doers from the young world of students ‹ we also cleave learning as a life pursuit and ultimately fracture that community.

Every county in America hires people to measure things: water, ground contamination, animals, sewer, money, people, trees, miles of road, erosion, acreage, houses. Students might adopt special community projects, years long in their construction, in which one grade adds new data and structure to the work of a previous class: one cohort teaching the next . . . knowledge building . . . a community helping itself. Imagine the desire of a community to support a school if its students are a resource.

Students and locals will come to value their school, their stake in what that school means to where they live, and they will have something to offer, though knowing those values about their school may be virtue enough.

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Dynamic Process Of Internet Companies: An Abstract Model

While every 100 days the number of clicks of Internet gets double the total revenue of e-commerce will grow to more than $400 billion in year 2001. Currently, second generation of Internet companies become major players in Information technology and

software industry. One of the great aspects of current shift in technology is the dynamic process of Internet companies. Financing, prototyping, teamwork, marketing, research and development, and the whole process of current Internet companies have evolved in a new model. In this paper we briefly look at one aspect of such phenomenon. The main purpose of this paper is to provide an abstract model for dynamic process of Internet companies with emphasis on new features. We introduce these factors as Internet Rapid Application Development (IRAD). While we consider Full Rapid Application Development factors for an Internet product development, we explain four major factors in IRAD. These main features are outsourcing, hiring strategy, early error elimination and instant bug fixing. We study the effect of each factor in the process of software evolution. IRAD modeling is investigated in the context of two different Internet companies: companies with Internet as the core of their business and companies with Internet as a portal for their services. We provide a general simulated model of Internet process along with a modified version of Evolutionary Delivery life cycle model. Moreover we study the model sensitivity to the key factors as staffing pattern, outsourcing overhead and instant bug fixing and Integration cost.

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Review And Validation Of Early Japanese Local Government SD Models

During 1970s, many Japanese local governments built their SD models for formulating their long and medium term development plans. However, as we mentioned in our presentation last year ISDC at Wellington, these models have not been used any more for their policy making.

However, sufficient time has passed to verify these Japanese local models. We have reviewed some of these models such as Saitama Prefecture Model, Hyogo Dynamics Model and Tokyo Metropolitan Model and found some meaningful hindsight as follows:

Conceptual validity: SD as the design methodology based on the core concept of feedback is exclusively valid. Without the feedback concept it is impossible to design complex social systems.

Institutional validity: Connected with institutional resources such as annual budget, SD model can carry its validity into the practical planning and implementation processes of local government policy.

Operational validity: Simulation results of above models were not always valid. But errors can be accrued defendable to initial conditions, while intrinsic operational properties of the model remains.

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Sustainable Business Development: An Attempt To Get Out Of The Environmental Resource Paradox

The sustainable business development takes an interest both in the avoidance of negative impact and in the promotion of activity with positive long-term effect. However, resource refinement for the future is hardly an explicit priority in today's environmental assessment methods. There is an apparent paradox in the resource concept as it's used in environmental assessments. Raw materials are conceptualised as given by nature, although we know that in fact much of the present resource values have evolved as a result of human activity. This paper uses a cleaner technology view on effectiveness in a system dynamics model which includes added resource values as an explicit link in the business development loop. A suggested model focuses on the quotient customer utility per environmental load and how this may improve when present activity generates additional system knowledge. This resource enhancement may evolve through learning about interrelations to surrounding systems that can be used in development of business relations and technical systems. The model emphasizes the importance of the business loop in the mobilization of resource development activities.

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Developing A Pricing Strategy For A Former Monopolist Now Entering A Competitive Environment

The client is a public organization that provides pilotage services. Client is and has always been the only provider of pilotage services in the Netherlands. The client's operations have been rigidly regulated by the national government since its foundation in 1859. Client is obliged to pilot all ships in all Dutch harbors. Prices for services rendered are defined by the national government. In fact, client is in a monopolist position, not because of achieved superiority or uniqueness, but because of national legislation.
Applicable legislation will change dramatically in the near future

allowing other parties to start providing pilotage services. Besides having to learn the mechanism of competition and to perform in a competitive environment, client will have to develop its own marketing strategy, including pricing. At this stage client has developed a pricing structure and wants to simulate the effect of this pricing on (random order) a) marketshare, b) number of competitors entering the market, c) market growth, etc. System Dynamics appeared to be the suitable tool for providing them with the requested insight with regards to pricing, its effects and consequent decisions.
Complicating factors:-
(a) Current pricing is in no way related to costs;
(b) Client has to be guided in understanding its new identity, which requests an entirely different way of thinking (organizational learning);
(c) Size and type of competition are difficult to predict as this market has never known competition and is not easily comparable to foreign markets;
(d) The service area is divided in four regions, which all have their own characteristics (in terms of number and types of ships and therefor in pricing structure and effects of competition) and differences in current pricing;
(e) The proposed pricing structure itself is quite complex as different clients can choose from different service subscriptions.
The System Dynamics project covers the entire process from problem definition, group model building, workbooks, conceptual model through to simulation model.

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Possible Futures For High-Mountain Agriculture In Berchtesgaden, Germany: Results Of A Scenario Driven System Dynamics Model And What Happened In Reality

The presentation describes an integrated system dynamics model, that was designed in 1988 to analyse and evaluate possible future developments for high-mountain agriculture under difficult economical and ecological conditions in the Biosphererereserve Berchtesgaden, Germany. The general goal of the modelling approach was to improve the understanding of the relationships of farmers economical activities, different land use options and the regional landscape attractiveness. Most farmers income result mainly from business outside of agriculture and additionally from agricultural production and farm holidays. Three scenarios focused

on different possible future developments, which were the continuation of the actual trend of creeping abandonment of agricultural land use, the sudden termination of agricultural activities due to economic restrictions and the revitalisation of agricultural production under improved economical and ecological conditions. The linkage of the System Dynamic Model to a Geographic Information System (GIS) allowed the translation of the dynamic pattern of land use changes into spatial patterns. About a decade after the first simulation runs it is now possible to look at the real development of the system. For this approach the original model could to be kept alive and adapted to the Stella 5 environment. Predicted possible changes , for example in land use, could be compared with actual changes to prove the quality of scenario assumptions and model structures.

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Presentation

Utilizing The System Dynamics And Geographic Information Systems For Planning Ecological Nets

The game SD-GIS-based simulator "ECONET" to manage the regional ecological nets of natural protected territories in a context of cross-sectional environmental-social-economic "sustainable" development was designed in Moscow State University with support of Russian division of WWF. It develops the ideas of SD simulation game "POPLYSPHERE", designed by V.N. Sidorenko and M.M. Krjukov in 1997. As compared with existing SD-GIS-based model of sustainable regional and interregional development such as PANGAIA (Kanegae H., Kaneda T., 1995/1996) this model enable the experts, federal and regional managers and NGO leaders to test some concepts of regional econets construction by means of simulation of spatial and temporal environmental-social-economic decisions making. This model is a new type of toolkit for researching and solving underlined problems in comparison with GIS-based cellular automata (Cecchini A., Rinaldo E., Batty M. et al., 1999) and artificial neural nets (Almond N. Et al., 1992, Brondino N.C.M. and Silva A.N.R., 1998). It develops the works of SD-GIS-based modeling (Mikula B., Mathian H., Pumain D. and Sanders L., 1996). The "ECONET" demo is planned.

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Towards A Taxonomy Of System Dynamics Models Of Higher Education

A number of papers have been published on various System Dynamics (SD) Models of Higher Education Institutions, on topics including the role of SD in Corporate Governance, Planning, Resourcing & Budgeting, Teaching Quality, Teaching Practice, Microworlds and Enrolment Demand. An international seminar on "Using System Dynamics as a Tool for Decision Making in Higher Education Management" was held in June 1999 at the Royal Society, London and South Bank University.
The paper contends that there is a need to catalogue and classify this work in order to highlight potential areas of research in this field of study and to identify system archetypes at different hierarchical levels and discover new ones. This paper therefore presents an initial Taxonomy of System Dynamics Models in Higher Education.
The initial Taxonomy is based on a limited survey of completed SD investigations in higher education management. The findings from these investigations are briefly described. The taxonomy classifies the completed investigations into six specific areas of concern and five hierarchical levels.

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A Systems Dynamic Perspective On The Development Of Recycling Strategy For End-Of-Life Vehicles

Sustainability in the motor vehicle industry is an increasingly important topic. Popular opinion in both North America and Europe is increasing attention on this issue. This research paper considers the adoption of a systems dynamic model for the management of natural resources to the exploration and analysis of the development of recycling strategies by car manufacturers in Europe.
The systems dynamics model for the management of natural resources that has been selected grew from the environmental movement which emerged in the early 1970s. The model deals with natural resources and its related issues such as recycling and regeneration. As such, it should be applicable to the key issue of End-of-Life Vehicle (ELV) handling in general, and ELV recycling in particular.

The model attempts to explain the decision making processes underlying actions by organisations on resource usage. In order to apply this model to ELV handling it is necessary to further develop the model itself. This expanded model is then applied to ELV related issues through an examination of the actual practices of European car manufacturers.
Car manufacturers in Europe have adopted a wide variety of strategies towards ELV handling. This paper attempts to explain the reasons for this and hence improve understanding of how this issue might be better approached in the future by both car manufacturers themselves and those seeking to increase sustainability.

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Firms' Global Expansion And Sustainability

Firms globalize when their domestic market can no longer offer growth opportunities. But, there is always a delicate tradeoff between growth and sustainability. How fast can a firm grow and still be profitable? Should the firm pursue growth before profit? How can a firm determine when its growth strategy is no longer sustainable? These are the questions as well as motivations of our research. In this paper, we first present the case studies on two firms that have expanded into global markets, following their globalization strategies. The two firms are very similar except for their 'strategic intents' for globalization and their domestic market positioning: the two firms are in the same industry, and headquartered in the same country. One company with a relatively strong domestic market position has pursued its globalization based on the profit-first strategic intent, while the other with an inferior domestic position has chased a growth-first strategy. Using the conceptual framework of system dynamics, we formulate the firms' globalization dynamics and derive managerial implications for the issue of firm's sustainability and its growth strategy via globalization.

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Cognitive Biases In Perceiving Feedback Loop Dominance

Feedback loop dominance is a key concept to understand structural driving forces of system behavior. In this paper, we propose two kinds of shifts in dominant feedback loops: continuous shifts (CS) and discrete shifts (DS). With the help of questionnaires, we verified three hypotheses regarding cognitive biases in perceiving the shifts in dominant feedback loops: 1) failure in perceiving continuous shifts, 2) tendency of decision making based on discrete shifts, and 3) different perception on the dominant feedback loops between level variables and rate variables. We discussed the implication of these cognitive biases on time delay and timing strategy in decision-making processes.

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A Method For Direct Conversion Of Causal Maps Into SD Models: Abstract Simulation With Number

Causal maps and cognitive maps have been widely used to get insights into complex systems and minds of decision-makers. When insights come from the system behavior rather than its structure, there is a need to simulate causal maps and cognitive maps. In this paper, the concept of abstract simulation is proposed to allow simulation of causal and cognitive maps to see their dynamic behavior without distorting them too much. As a way of abstract simulation, NUMBER is introduced in this paper. NUMBER is an abbreviation for 'Normal Unit Modeling By Elementary Relationships'. In this paper, NUMBER is applied to several causal maps of system archetype and a cognitive map of policy maker to show its usefulness.

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Technical And Decisionnal Robustness Using Smallest Convex Hull Analysis

In the process engineering applications field the most promising optimization principles are based more and more on the multiple criteria approach. However the best solution suggested should satisfy not only compromises established between criteria levels, acceptable by the decision maker, but the others security and stability considerations related to the process. For this purpose it seems to us essential to introduce a " virtual " maximizing criterion being added to the criteria originally attached to the process. This robustness criterion can be representing by the smallest distance between the possibles solutions and the border points of the Pareto set. Our conception will be illustrated by two chemical processes applications.

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Modeling In Corporate Real Estate

Corporate real estate (CRE) and facility professionals are constantly searching for better ways to predict future operational and financial performance. Simulation tools can help overcome challenges in planning and managing complex business processes. This paper explores some of the metrics and business processes common to CRE and how simulation modeling is starting to be used in this industry.

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Evaluation Of Group Decision Process On Enterprise Simulation Model

Decision processes in modern enterprises are primarily based on the participating subjects. The results of choice are therefore not dependent on the individual decision but rather on the group of experts working in the specific field. Their interaction in the process of solving decision problems is supported by group support tools and interactive business simulators, which enable individual and group analysis of problem states. The simulation scenarios considered are made of two subsets: a subset of input that anticipate the impact of the environment such as demand and competitors (exogenous scenarios), and a subset of management decisions influencing production, quality of products, capacity

development and other parameters that represent endogenous scenarios. Each member of the experimental group, who participated in the described experiment, can evaluate different alternatives for given input scenario in order to get the highest score for criteria function. The evaluation of scenarios was treated using two different methods: 1. Each subject had own feedback information provided by the simulator while, method 2. implemented group feedback connection. In the case of method 2. subjects had the opportunity to compare their decisions made by using method 1. with the group decision gained by the same method. Group feedback information has caused a faster convergence of decision process. The methodology was tested in an experimental environment and in the real case.

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Resource-Oriented Acquisition Strategies And The Effects On The Corporate Value

The Globalization of the economy is one reason for the increasing number of Mergers & Acquisitions. This tendency can be seen on a national as well on an international level, especially between the TOP 500 companies of the United States and of Europe. Although these companies have experienced managers on a high level, company reports and studies of consulting companies show that these forms of alliance face major problems during their realization. In some cases even a revocation takes place, leading to high costs and image problems.
Taking the long-term development of the corporate value as one possible motivator for a merger or an acquisition, the question can be asked whether acquisitions accelerate the growth of the company and with this the increase of the corporate value. The influence factors for an acquisition decision as well as the analysis of its effects include a broad variety of hard and soft facts. Such a complex decision situation should be simulated and analyzed with System Dynamics. This paper will give a general overview of the perspective taken and the assumptions made in the basic model.

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Strategy Development In Regulated And Random Environment

In the research undertaken the issue of a strategy development for a large business in highly regulated environment is considered. The case concerns the recent corporate game in tobacco market in

Ukraine. The market might be characterised not only by the constant conditions (e.g. strong consumer demand, number of main players) but also by the variable (often random) ones, such as huge but uncertain smuggling, competitors' lobbying attempts and new brands introduction, etc.
An approach of dynamic simulation, based on graphic interface tools (like Simulink and Ventana) to be applied to strengthen corporate strategy, modelling the better level of excise duties for cigarettes in terms of having market position better than competitors'. The role of dynamic simulation tools here proves to be extremely fruitful due to easy adaptability of the strategy model and team communication.

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Building Sustainable Interest In Modelling In The Classroom: The Implications Of The S-Curve For Hooking New Practitioners In Schools

System Dynamics has had a tough time breaking into High Schools. Like all good ideas the most difficult part is convincing those who would most benefit that this new approach is in their self interest. When system dynamics is only presented as a computer based tool, most teachers will not try it. When we introduce systems methodologies in a way that focuses on the richer, softer and more human side, teachers start to simulate more quickly. Learning the "System Dynamics Way" is in fact introducing a changed relationship of learner, teacher and subject material. Five strategies that have been practiced in three countries will be presented in detail. Systems Thinking can help to build a sustainable learning process. The three distinct parts of the classic learning S-curve that can be represented as "curriculums" are: build Passion slowly, accelerate learning through Risk taking and consolidate understanding by Reflection. Using computer models is the goal because computers are the best tool for student controlled exploration and reflection. To bring practitioners on board stealth should be used to implicitly train students and teachers about systems thinking.

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Client Involvement In Simulation Model Building: Hints And Insights From A Case Study In A London Hospital

This paper describes the collaborative process of building a simulation model to understand patient waiting times in an accident and emergency department. The purpose is to explore the issues that arise when involving health care professionals in the process of model building. The study background is presented, along with some general process themes which can be seen to run through the account that follows. That detailed account of the modelling process then forms the core of the paper. The general process themes are revisited in order to suggest some hints and insights on how the standard system dynamics methods for involving clients may apply in the health care context. Further collaborative studies are encouraged, since system dynamics has much to offer health care policy, whilst the process of building such models can be rewarding for all concerned.

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How Accurate Should Model Output Be? Three Questions For Model Builders

This article offers a critique of a recent paper which proposed the application of Richardson's Method to produce improved accuracy in performance measures (PMs) created by system dynamics models. No criticism is made of the purely technical content of that paper. Instead, three different questions are raised. The improvements in accuracy of the PMs are shown to be: (1) small compared with likely errors in the model; (2) of unproven relevance concerning their ability to steer the system; and (3) a distraction from the goal of understanding the modes of behaviour produced by a model. The perils of confusing the system dynamics methodology with systems engineering and control theory in this way are discussed.

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Rerum Cognoscere Causas: Part 1 - How Do The Ideas Of System Dynamics Relate To Traditional Social Theories And The Voluntarism/Determinism Debate?

This is the first half of a two part paper which deals with the social theoretic assumptions underlying system dynamics. The motivation is that clarification in this area can help mainstream social scientists to understand how our field relates to their literature, methods and concerns.

Part I has two main sections. The aim of the first is to answer the question: How do the ideas of system dynamics relate to traditional social theories? The theoretic assumptions of the field are seldom explicit but rather are implicit in its practice. The range of system dynamics practice is therefore considered and related to a framework - widely used in both OR and systems science - which organises the assumptions behind traditional social theoretic paradigms. Distinct and surprisingly varied groupings of practice are identified, making it difficult to place system dynamics in any one paradigm with any certainty.

The difficulties of establishing a social theoretic home for system dynamics are exemplified in the second main section. This is done by considering the question: Is system dynamics deterministic? An analysis shows that attempts to relate system dynamics to strict notions of voluntarism or determinism quickly indicate that the field does not fit with either pole of this dichotomous, and strictly paradigmatic, view.

Part I therefore concludes that definitively placing system dynamics with respect to traditional social theories is highly problematic. The scene is therefore set for Part II of the paper, which proposes an innovative and potentially fruitful resolution to this problem.

Rerum cognoscere causas ("To know the causes of things")

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Rerum Cognoscere Causas: Part II - Opportunities Generated By The Agency/Structure Debate And Suggestions For Clarifying The Social Theoretic Position Of System Dynamics

This is the second half of a two-part paper dealing with the social theoretic assumptions underlying system dynamics. It was concluded in the first half that analysing system dynamics using traditional, paradigm-based social theories is highly problematic. An innovative and potentially fruitful resolution is now proposed to these problems.

In the first section it is argued that in order to find an appropriate social theoretic home for system dynamics it is necessary to look to a key exchange in contemporary social science: the agency/structure debate. This debate aims to move beyond both the theories based only on the actions of individual human agents, and those theories which emphasise only structural constraints. Emerging from this debate are various theories which instead aim to unite the human agent view of the social realm with views which concentrate solely on system structure. It is argued that system dynamics is best viewed as being implicitly grounded in such theories.

The main conclusion is therefore that system dynamics can contribute to an important part of social thinking by providing a formal approach for explicating social mechanisms. This conclusion is of general significance for system dynamics. However, the over-arching aim of the two-part paper is increase understanding of system dynamics in related disciplines. Four suggestions are therefore offered for how the system dynamics method might be extended further into the social sciences. Presented in the right way, the formal yet contingent feedback causality thinking of system dynamics should diffuse widely in the social sciences and continue to make a distinctive and powerful contribution to them.

"Felix qui potuit rerum cognoscere causas"
"Happy is he who comes to know the causes of things"
Virgil - Georgics, Book II, line 490. 29 BCE

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Simulation Of Qualitiative Models To Support Business Scenario Analysis

When we look at the research that is concerned with the modeling and analysis of business scenarios, we can recognize an unfortunate yet profound dichotomy of research methodologies; qualitative versus quantitative research. There seems to be an almost unbridgeable gap between the two approaches, which has also errected high barriers for communication between the two corresponding research communities. On the one hand, we have the "qualitative" or "behavioural" people who criticize quantitative methods as inapplicable and far removed from most of the real-world situations that are observed in organizational environments, and, on the other hand, we have the "quantitative" or "mathematical" people who only believe in numbers and equations and accuse any research that is not somehow based on a mathematical theory as unscientific. In the following discussion we try to show that qualitativeness and quantitativeness are not mutually exclusive concepts. Quite the contrary, we argue that they are, in many ways, closely related and that they form the two ends along a common dimension of knowledge discovery and knowledge representation. Based on recent work in qualitative reasoning, a newly emerging field in artificial intelligence, we present a system that offers modeling and simulation capabilities while only requiring qualitative information about the variables and relationships included in a model.

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Winning The Landline Vs. Mobile Battle

New technologies give rise to new businesses that could displace rivals based on earlier technologies as the internal combustion engine, for example, undermined blacksmiths by giving rise to the automobile.

Businesses on both sides of a technological transition want to know how many consumers will adopt the new ways, and when. At present, these are the questions facing European telecom companies as they assess the possibility that residential voice traffic, now carried mostly on landlines, will shift to mobile networks. In most European markets, over half of the population will have a mobile phone by the end of 2000. In some countries, mobile phone penetration doubles each year. If it continues at its

current rate, growth of the mobile subscriber base in Europe will reach its limit as a significant engine of value creation within two or three years.
There is much at stake for both landline and mobile players over voice traffic hence a big battle is looming. We need to understand (at least) four things well: consumer choice, network economics, capital market reaction and pressures, and pricing/marketing/investment strategies. Furthermore, we need an "integrated" perspective to create internally consistent market scenarios. We have built and calibrated a dynamic market model which generates alternative landline/mobile transition scenarios, including indicators for price, usage, subscribers etc.
System dynamics can help answer the "what ifs" of such transitions by generating plausible future scenarios. Managers can then use the model to develop policies appropriate to each of them and to identify leading indicators about which scenario might be playing out in real life. We show alternative landline vs mobile pricing strategies and the impact on value for both players, and discuss some general insights from the work about winning strategies.

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Prediction Of Exchange Rates

Classic tools in the financial environment are mostly based on econometrics. This means they are centered on establishing correlations, which for a prediction are extrapolated to the future. The formulas used in these econometric correlations however clearly adress cause effect relationssships. E.g. the inflation is tied to variations of free cash in an economy.
We report a preliminary exercize of using system dynamics models complementing econometrics by using and extending the content of cause effects identified. Using such a system dynamics tool allows not only extending trends into the future, but opens the view on quantitative simulation based scenario prediction. Which means we are able not only to give trends but to give predictions and assessments on longrange scenarios, giving also an assessment of the likely timewise developments.
All such tools are of course validated using e.g. some past period of recorded history. Again unlike the correlation finding econometrics topic of such a validation is balancing and adjusting the building blocks of the models connections and not averaging correlation coefficients.
Given very different scenarios of the development of exchange rates in the past and the investigated future, correlations are likely

to break down, not so a validatated system dynamics model which bases itself in simulating the main cause effect relationsships on a timewise development of the situation.

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Kondratyeff Cycles Stifled By Increasing Taxation Rates?

In the last few years with the US-economy going full steam and the EU-economy showing up as a chronic laggard with stubborn unemployment rates, the debate about the causes of this disparity in economic performance is still puzzling many people, including financial experts.
Based on a first paper presented at the Stirling System Dynamics Conference in 1994, we present the findings on the subject with a revised simulation model, extendible to a microworld.
The classic approach for modeling economic long cycles has been covered extensively by the work of Prof. J. Sterman. It was presented as a simplified version of the national model (US) and is widely accepted. We on the other hand started with a model for understanding the interaction of public policy of wellfare programs on the employment. This model analysis led to the finding, that because of political decisions delayed indended changes of employment by wellfare programs can easely leed to cyclical behaviour countering the intended effects over severel 10 years.
At present the state of the model exersize is to couple the longrange cycle model with the model introducing state policy interactions payed by the taxpayer. What can be demonstrated is that if the taxation rate gets high enough, no more kondratieff cycles will develop and the status of the economy degenerates in such a way, that high unemployment, defying any measures to reduce it, will set a restrictive economic climate barely allowing survival of only the most pofitable businesses.

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A SD Approach To The Efficiency Improvement Of Electric Power Industry In Korea--Focused On The Nuclear Industry

In this paper, we propose a System Dynamics (SD) model for the efficiency improvement in the electric power focused on the nuclear power plants. This strategic model will contribute to cope with promptly the business situation, energy generation, production, and pollution.

The current study methodology, using SD approach, deals with the detailed drawing of our key points on nuclear power generation systems in electric power industry of Korea. These include such factors as the operation of nuclear industry and parameters related to the decision making for business policy. Based upon the above-mentioned influence diagram drawn, we developed SD simulation model to evaluate and analyze strategic management of KEPCO (Korea Electric Power Corporation).

Recently, according to report from KEPCO, they are considering of delaying a new power plant construction. It is based on Business fluctuation downsized from Korean economic crisis in 1997 and freezing of fund from raise in exchange rate.

Thus, these results enable Electric power industry authorities to develop an evaluation model of strategic management.

Based on our analysis, we could demonstrate how simulation model can be applied to the real electric power generation in Korea.

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Coflow Structures: Some Problems And Solutions In Representing Psychological Characteristics And Processes

The coflow structure is useful when changes in one level simultaneously drive another set of changes in a second level. Coflow structures can represent how psychological variables, such as average attitudes, are carried over as a group of people change status or designation. In modeling a problem of an agency, we had difficulties using the classic form of the coflow process to represent average attitudes towards the organization. Total Attitude, which is defined as a state variable, is hard to interpret. This is particularly true when attitudes are also influenced by organizational experience and may erode over time. This paper compares an isolated coflow structure with the coflow structure combined with an eroding process. Adding an eroding process to the classical coflow structure generated interesting behavior modes, such as logarithmic decline to a minimum and growth toward a higher equilibrium point.

We suggest directly using Attitude as a stock rather than using Total Attitude as the level. Changes in (Group) Attitude would depended on the influence of those coming in from the previous stage, experiences happening at that stage, and perhaps upon a naturally occurring eroding process. The influence of new people coming into the group affected Attitude in proportion to their

numbers. If only a few entered the organization, their attitudes would have little effect on the group's Attitude. We suggest two alternatives to the classical coflow formulation. We also show how each formulation behaves when we allow attitudes to erode.

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System Dynamics Applied To Psychological And Social Problems

Originally, system dynamics dealt with problems in manufacturing, management, resource use, and in urban problems. With notable exceptions, there are very few applications of system dynamics to psychological problems, per se, or the use of psychological variables in models which focus on management problems. Some psychologists have influenced the system dynamics, but their contribution has focused upon studying the process of systems thinking, cognitive maps, and the limitations of people dealing with feedback processes.

Unfortunately, one rarely finds psychologists who are interested in and are competent in system dynamics. This paper suggests ways to include the use of psychological and social variables in specifying the structure of one's model. It examines the underlying assumptions of system dynamics, such as the use of the bathtub metaphor. For modeling problems of attitudes, it is argued that the bathtub metaphor, which assumes potential conservation of material, may not be appropriate. On the other hand, emotional variables, such as anger, do display properties that are analogous to a draining process. I also suggest overt behavior (such as fighting) should be represented differently from inner psychological states. Thus, you can be angry without showing it. Also, I note the potential incompatibility between the trajectories of the SD model and the empirical time series, if the data (such as self-esteem level or level of depression) were measured on an interval scale. Finally, the paper will integrate personality and individual difference psychology into a system dynamics framework.

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Genetic Simulated Annealing Algorithm With Selective Generation

The general Genetic Algorithm has the weakness of premature and poor ability of local searching and general Simulated Anneaing doesnot have fast speed of global searching. The paper uses the conception of selective generation,designs an algorithm accompanying Genetic Algorithm and Simulated Annealing, which improves the searching speed and avoids the premature. Computing results of optimizing some hard-optimizing functions show that the method has more fast conver-gence speed.

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A System Dynamics Model Of IT Operations And Maintenance

Growing costs, increasing portfolio of computer platforms, decreasing attractiveness and increasing turnover in personnel are only some of the problems encountered in IT departments in most industries. These problems will persist and deepen. As electronic commerce and the Internet economy sweeps over the world, the pressure on the IT departments will increase drastically. Management often deals with the problems mentioned by budgetary cuts and general rationalisations. In this paper we will argue that this is wrong. From a system dynamics point of view we argue that management should invest in improvement projects and education rather than cutting costs. This is the only way to improve cost efficiency in the long run.

To support our claims we will present a system dynamics model of a general IT operations and maintenance department. The model focuses on the tasks of the department, the disturbances that cause the tasks and how priorities between different kinds of tasks are set. What is particularly interesting is that we have identified two generic reinforcing loops that are present in this kind of business.

The model is designed for departments concerned with IT operations and maintenance in particular, but should be applicable to most activities which aims at maintaining a system or a structure, be it the maintenance of real estate or a country's legislative structure. The model has been implemented and simulated in iThink.

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Sexual Harrassment In The Workplace: System Dynamics And The Economic Evaluation Of Public Intervention

Equal Employment Opportunity (EEO) has traditionally been seen as primarily an ethical issue. However, the past decade has seen increasing demands for value for money in all areas of public policy, including EEO. Unfortunately, the direct costs of EEO are visible and immediate and, on the surface, appear to outweigh the benefits, which are more subtle, difficult to quantify and delayed. It was in this context that the author was contracted by the New Zealand government to undertake a benefit-cost analysis of EEO policy, with particular emphasis on workplace harrassment. As the report was subject to scrutiny by a sceptical audience of Treasury economists, it was decided to support the benefit-cost analysis with detailed causal loop analysis and system dynamics model. The systems thinking framework focused on the interrelated causal chain, not just an harrassment event itself. For example, an harrassment incident, pre EEO, at best might have resulted in a 'quiet talking to' for the perpetrator; at worst, further harrassment. No direct costs would enter the accounting balance sheet. A systems thinking perspective, however, would recognise the anger, frustration and powerlessness of the victims and their work colleagues; would highlight productivity impacts and staff turnover in the short term, and the ability to recruit and retain competent staff in the longer term. Systems thinking focussed on the very significant long run opportunity costs - reduction in total profitability. The systems thinking approach provided a strong reality check for many initial assumptions and strong justification for inclusion of many indirect costs and benefits in the final economic evaluation.

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A Dynamic Balanced Scorecard Template For Public Sector Agencies

This paper describes a dynamic balanced scorecard template developed for the Australian Federal Department of Communications Information Technology and the Arts (DCITA) by a research team from the University of New South Wales and CSC(Aust) in conjunction with senior DCITA executives and ministerial staff.

The project involved the development of a prototype management flight simulator, built around the Kaplan and Norton 'balanced scorecard' (BSC) concept. The engine for the simulator is a system dynamics model, built in Powersim, designed to draw real time data from departmental information systems. The prototype was designed as a template that could be customised for any level of the organisation.

The model is broadly structured around the traditional BSC sectors, adapted for the Australian public sector environment. It incorporates the following sub-models:

Resources: (human capital; outsourced services)

Internal Process: (workflow; corporate communication)

Customer Perspective: (service quality, corporate governance & corporate health)

Learning & Growth: (intellectual capital; personnel development)

The paper includes illustrations of causal loop and stock flow diagrams of key components.

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An Operational Application Of System Dynamics In The Automotive Industry: Inventory Management At BMW

The application of system dynamics modelling in strategic decision-making and the analysis of market scenarios has been widely recognized. However, little attention has been placed on the application of system dynamics models to support operational decision-making. This paper presents a simple system dynamics model developed for BMW's production planning department to support decision making on production schedule, -mix and inventory management on a day-to-day basis. As we will show in the paper, production planning in car manufacturing is

characterized by high complexity and uncertainty due to various parameters influencing the inventory levels and production progress. In this situation a static monitoring of inventory levels is not sufficient for production planning, since the inventory levels are critical for the car production process to work properly. Therefore a dynamic monitoring tool is needed. Based on a relatively simple structure, an easy-to-use interface, and online data-exchange, the developed system dynamics model described in this paper offers a tool to assess the risk associated with different inventory policies and improves the management of inventories and production schedules. The paper concludes with the experience made during the last 1½ years, in which the model has been used by the production planners at BMW's production plant in Regensburg.

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On Trade And The Environment As A Complex System

Issues regarding trade and the environment have gained increased policy salience as highlighted by the recent World Trade Organization (WTO) meeting in Seattle. Economists maintain that trade helps the environment citing numerous empirical studies that correlate international trade with increased national wealth and national wealth with cleaner natural environments. Environmentalists, in contrast, maintain that the opposite is true as environmental degradation is historically coincident with industrialization and trade. Lofdahl (1997; forthcoming) argues that trade hurts rather than helps the environment using a range of computer-based techniques including data visualization, statistics, and system dynamics. This study highlights the complex system and system dynamics concepts that underlie this larger body of work.

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The Dynamics Of Franchising Agreements

A franchise company is a hybrid or plural form, typically set by both company-owned units and franchised units, where the latter receive an entire business format. The importance of franchising is well documented. In this sense, it is estimated that more than a third of retail sales occurred through franchised chains in the U.S. in 1997 –this is the country where franchising is more developed, although the use of this contractual arrangement is increasing all over the world.

We explore the reasons that explain franchise chains growth and how franchising firms choose the extent of company ownership. There is an extensive literature that has addressed these topics, but a dynamic approach has received little attention. Therefore, we build a dynamic model including contractual and system variables such as fees, royalties, investment, chain size or trade name recognition. These variables have been commonly included in empirical tests conducted in this field, since they are periodically published in professional yearbooks. Through this model, we go on to analyze the dynamic behavior of a chain and how its ownership structure evolves over time as a result of the interaction of variables mentioned above.

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Using System Dynamics Methodology To Analyse The Economic Impact Of Tourist Multipliers

The importance of tourism for economic development is widely recognised . This is reflected in the great interest shown by governments by promoting foreign direct investment and freeing both public and private sector projects. Most tourism studies concentrate on analysing the economic and social effects of tourism. The impact of the multiplier has been studied widely using traditional econometric techniques.
This paper focuses on analysing the economic impact of tourism revenue on the Egyptian economy. The economic theory and the mathematical modelling involved in such scenarios is discussed but the main thrust of the paper is the encapsulation of this situation by Causal Loop Models .
A dynamic model, run in Powersim, is then described where important non-linear dynamical movements and the significance of systems thinking in this framework are considered . This model considers the dynamics of tourism in Egypt and its impact on GNP.

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Bringing System Dynamics And Systems Thinking To A School Near You

The key to system dynamics in kindergarten through twelfth grade (K-12) education lies in the classroom—in the interactions between teachers and students. Experience has shown that when systems instruction succeeds at this level, the education process is greatly enhanced for both students and teachers. Education becomes more learner-centered, engaging, interdisciplinary and relevant for students of all ability levels, across all grade levels and subject areas. Experience has also shown, however, that it can be very difficult for one teacher to achieve this success all alone. Such a fundamental change in education needs the support and cooperation of many other people from both within the school and without. A supportive school administration is essential. But, parents, system dynamicists, academics, businesspeople and taxpayers also play vital roles.
Systems education has begun to flourish in several pioneering schools across the United States, thanks to the skills of enthusiastic teachers and the help of others. However, the continued growth of this change in education will rely on the contributions, both large

and small, material and intangible, of a wider circle of supporters. This paper will explain how system dynamics is introduced and sustained in schools. It will outline some of the many generous contributions which have made the early growth of K-12 system dynamics possible. Finally, it will give readers many resources and practical suggestions for how they can participate too.

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Group Model Building For Consensus Building And Team Learning: A Case Study

Routinely, so much well-intentioned effort is thwarted and morale is destroyed in organisations because of the lack of commitment to decisions. The likelihood and consequence of this is greatest where divergent groups, ie, different divisions, department or units are involved. This paper discusses a Group Model Building case study using qualitative system dynamics to create consensus, team learning and shared vision in a public organisation. The case involves determining planning priorities for a division of the Ministry of Health in New Zealand, leading to the creation of a business plan.

The methodology involves a three-step process starting with structured brainstorming using the partial KJ (Jiro Kawakita) technique to identify priority areas and clustering them into 'affinity' groups. Next, the priority clusters are condensed into 'variables' and used by the participants to construct causal loop diagrams representing 'systems of priorities' (in contrast to list of priorities). Finally, through a group process, leverage points or key priorities are identified and translated into a business plan. Strong group resistance was encountered at this stage when attempting to reduce the number of priority areas as suggested by the traditional priority matrix technique. Systems thinking approach was used to alleviate this problem.

The approach offers significant promise in using qualitative system dynamics with non-systems experts. The methodology can be applied to any change management initiative and complex decisions such as restructuring, reengineering, and supply chain design. The expected outcomes are greater commitment and shared vision.

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KPN Research

Development And Usage Of A Management Game For The Dutch Telecommunication Industry

The telecommunications industry experiences rapid changes. New actors are entering the telecommunication market and almost weekly new merges and acquisitions are announced. In the Netherlands the regulator plays a mayor role in regulating the market while consumers get used to high quality for less money.
For a telecommunications company it is essential to have an insight in the dynamics and growth patterns of these developments and the short and long term effects of certain strategies of the company. KPN Research has developed a management flight simulator to support and to fasten this corporate learning process. The management game has been developed on the basis of a more complex simulation model of the Dutch Telecommunications Industry (StratTel) as a whole. The game focuses on experiencing some of the dynamic behavior caused by interactions between economical, political and social environment, your own strategy and competitors actions on the Dutch Telephony Market. Until now the flight simulator has been successfully used for different purposes.

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Hybrid Modelling: System Dynamics Combined With Multi-Criteria Analysis

This paper proposes a methodological framework blending System Dynamics (SD) modelling with Multi-Criteria Decision Aid (MCDA). The PROMETHEE-GAIA methodology, based on outranking techniques, has been used here.
The approach will be illustrated by an application in the intermodal transportsector. Intermodal transport is the combination of at least two transportation modes in a single transport chain, without a change of container for the goods, with most of the route travelled by rail, inland waterway or ocean-going vessel, and with the shortest possible initial and final journeys by road. The aim of the model is to find ways to further stimulate this sector in order to move towards sustainable mobility.

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System Dynamics Based Simulation And Gaming: A Case Of Transparent Competing Companies

SITMECOM 1.0 PC is a multifunctional simulator that represents three companies competing in real time in the same market. Each firm can be simulated on a different computer, which is linked to the others in one of the following ways: via a direct cable connection, via a local area network, or via the Internet. We have also allowed for the possibility of having one computer play the role of the competitors, making it possible to use our simulator on a single computer without the need to be connected to any others.
In the design process, we endeavor to fulfill three basic objectives:
To promote the system dynamics approach, since we consider it the most appropriate to use in order to analyze and study complex systems, such as companies. To fulfill this goal, one of the main features of this simulator is Transparency, that is, the possibility of relating the system´s structure to its behavior [2].
To provide attractive self-learning instruments which facilitate self-learning in Business Management with a systems approach.
To provide an user-friendly interface which does not require previous knowledge of computer science. In order to achieve this, we exploit the potentiality of new technologies in information and communications systems.
In our opinion, SITMECOM 1.0 PC offers clear advantages over traditional business games and bring an improvement to teaching and learning methods in Business Administration and Management. It has already been used in a course on Business simulation with a system dynamics approach at the University of Sevilla during two academic years (1997-1998 and 1998-1999) and, in our opinion, the obtained results were very satisfactory. However, in a next future we want to undertake a controlled experiment which would allow us to test our hypothesis about the advantages offered by our simulator.

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Presentation

Recent Results In Software Process Modeling

Understanding software process interactions and feedback is increasingly important given changing software development and evolution paradigms. Towards this end, a new graduate course in Software Process Modeling was developed by this author at the

University of Southern California Center for Software Engineering (USC-CSE) [1]. It was first offered in the Fall of 1999, and the term projects were original investigations into critical process issues.

This abstract summarizes the student research projects, and highlights some results in terms of identifying important feedback in software processes. Rather than focus on previous contributions [2], [3], only new and previously unreported student work is described herein. The in-process book Software Process Dynamics [4] was the primary text for the class. Some of the student work incorporates new concepts in the book, such as inter-phase iterative feedback, process concurrence, personnel factors, learning feedback and model calibration techniques.

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Combining SD Simulation With Enterprise Level Multidimensional Planning Systems

This paper covers conceptual and technical sides of linking System Dynamics software with OLAP-based (Online Analytical Processing) planning and simulation systems. The first result of our approach is presented, and shows how Powersim's modeling software POWERSIM CONSTRUCTOR is completely embedded into the SEM (Strategic Enterprise Management) software of SAP.

Special attention will be given to address problems of linking SD-variables to items that can be stored directly in a business data warehouse. Furthermore problems of multidimensionality in the SD-data and their correct mapping to a business data warehouse environment is treated and a possible solution is discussed in detail.

The benefits of using System Dynamics as part of multidimensional planning processes will be presented on examples based on live software.

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Success And Failure Of Preventive Maintenance Programs--An Evaluation Of Statistical Research Results In The Context Of Feedback Structures

Operations management literature considers preventive maintenance and in particular the concept of Total Productive Maintenance (TPM) as important means to minimize machine downtime and to ensure that manufacturing systems is always in a

high state of readiness for production, flexibility and productivity. Several success stories described in literature document the impressing outcome of TPM-programs in a wide range of industrial plants. Failures remain more or less unreported. However, in the context of an international, empirical research study about success factors in manufacturing plants, we found that by far not all plants implementing the concepts of preventive maintenance programs achieve such tremendous successes. Moreover, in several plants, preventive maintenance has to be regarded as a failure. Hence, our hypothesis that preventive maintenance shows a significant influence on plant performance, can not be proven satisfactory on the basis of our empirical research data base.

MIT's 'Improvement Paradox'-research (see e.g. Repenning, 1996; Repenning, Sterman, 1997) gave some important hints about possible reasons for the failure of improvement programs. Among others, they suggest that self-confirming attributions caused through positive feedback loops are a potential reason for failure. These ideas are the starting point for the development of a general system dynamics model of preventive maintenance programs. The model then is used to investigate whether the unsuccessful plants in our database are likely to show the temporary dominance of the self confirming attributions. The model is initialized and parameterized based on the data collected in the particular plants. It can be shown that the feedback perspective explains the outcome of preventive maintenance programs much better than statistical analysis and that for theory building feedback dynamics have to be considered.

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The Application Of Business Intelligence Tools In System Dynamics Model

The SD methodology emphasizes the development and validation of a dynamic hypothesis. The refinement, exactness and glanularity with which a modeler could validate the dynamic hypothesis depend on the quality of data and the kinds of tools available to the modeler. We have investigated the use of business intelligence tools in particular data mining machine learning algorithms and compared it to more traditional valiadation techniques.

With use of the time series analysis and the application of smart machine learning algorithms to the same historical data sets, we argue that it is possible to discover and develop a number of business rules that are hidden in the embedded historical data.

These business rules can be extracted, interpreted through data visaualisations and translated to enhance the fundamental dynamic hypothesis.
The approach is very useful to help understanding of the dynamic hypothesis and its reflection of the models' reality using a boxed-in microworld representation.

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Modelling The Human Interactions In Product Design Process

Design for manufacturability' is a strategy, which is advocated by many in attaining a competitive advantage. The main thrust in this strategy is to make error free design of products, which would be compatible to manufacturing systems. Any human error in the design stage will lead to costly modifications in the manufacturing process and that would negate the competitive advantage that the company may otherwise enjoy.
Human errors in product design emerge because of primary three factors: lack of design skills, time pressure and the degree of parallelism in the design process. The level of design skills is a well-recognised factor and it is expected as skill level increases (with the number of years of experience) the incidences of errors will fall. In relevance to the design of a new product there could be three categories of designers in the organisation: new designers (recruited fresh from the employment market), designers inducted from other design projects and expert designers. Each of these categories will show a different value of error proneness. Time pressure is likely to increase the errors committed by the designers. Similarly, the parallelism (the number of activities being designed concurrently) will influence the number of errors committed by designers.
This paper uses systems dynamics methodology in developing a computer model of linking the factors mentioned above in the design process of a new product. The model consists of the induction/recruitment process of designers, determination of designers' error proneness, and the process of identification and rectification of design errors. The model is used to test a number of policy alternatives with respect to recruitment of designers, their salary, complexity of design process, and the complexity of the manufacturing process. The analysis of alternative scenarios provide a better understanding about how to manage the design process more effectively and thus reduce the modifications and save costs.

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Governing A Complex Social System With System Dynamics: The Development Of An Airport Hub

Managing the creation and the development of a successful hub imply the interaction of numerous actors, both public and private operating at a local, national and international level. Such a complexity imply that, rather than the content of the single decision, it is important to understand those dynamics emerging from an articulated system of decisions. In order to improve the quality of the single decisions, it is required the ability to generate valid systemic conceptual models aimed at the understanding of the long term consequences, avoiding counterintuitive and undesirable results.
The paper is articulated in three parts: The first is dedicated to the statement of the problem; dilemmas, possible strategies and key decisions related to the creation of a hub are discussed. In the second part the systemic conceptual model is presented with reference to a simulated European airport context. In the last section some consideration about the implication in terms of decision making, the directions proposed by the model and the possibility to generalise it in other systemic context are explored.

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The Validation Of An SDBILE: The Case Of GREENWORLD M.F.S.

A valid tool for environmental decision making is an important issue for practitioners in business management. In order to help decision makers in integrating an environmental vision into the regular business planning activity, a clear “picture” of the system they are acting in has to be provided. One of the main purposes of The Greenworld M.F.S. is to give an answer to these needs, particularly, by providing learners a better understanding on how departmentalized versus holistic management approaches in policy design may differently impact a complex system, generating different behavior patterns of key-variables. Here we report our current experience in the validation process of Greenworld. The validation of a SDBILE is much more than validating the SD model itself. A real flight simulator can be as accurate as one wished because the physics of aircraft flight is well known. One can, therefore, learn valid lessons about how to fly in different conditions from such a simulator. There is no such theory of the

business firm. An increase in efficacy of the validation process can be provided by involving in this process experts in different professional fields, all related with the problem object of analysis in the Greenworld. Several firms are already involved in this project. Our purpose is to build up a virtual corporate system in which the user will see the environmental sector as an integrant part of it, as a peer with the other subsets : finance, marketing, production, and, eventually, to assess the capability of SDBILE to stimulate a learning transfer.

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The ASTRA Platform For The Strategic Assessment Of European Transport Policies

The ASTRA project is part of the research studies awarded by European Commission Directorate General VII - Transport - in the IV Framework Research Programme. The aim of the project was to develop a tool for analysing the impact of the Common Transport Policy (CTP) and the construction of the Trans European Network (TEN) including secondary and long-term effects.

The ASTRA Systems Dynamics Platform (using ithink and Vensim commercial software packages) has been designed and implemented to model how specific impacts are passed through different sectors of the overall system under analysis. The model is formed by four sub-modules: macroeconomics, regional economics and land use, transportation and environment.

A reference scenario was developed and the ASTRA model was subsequently used to test several demonstrations examples. The main indicators of the reference scenario comprise GDP, population, employment. The transport infrastructure investment component of the reference case is determined by a constant share of GDP (e.g, 1%) that is invested annually in transport infrastructure.

The model was used to test the impact of different initiatives: pricing policies (e.g. road km-charge, charge plus reinvestment in infrastructure, green tax…), infrastructure policies (a stepwise implementation of the high-priority TENs) and environmental policies (a new vehicle category introduced for passenger cars).

From the viewpoint of sustainability the ASTRA platform is one of the few tools that provides indicators for all three dimensions of sustainability, which are: society, environment and economy. Therefore policy tests with the ASTRA platform can provide inherently consistent insights into the question of whether European transport policy is really moving towards sustainability.

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Towards A Theory Of Practice

System dynamics has been founded to study the real world problems in order to help mangers to deliver more effective and efficient performances. Although the practice of system dynamics usually creates valuable insights for the modeler to improve real world conditions, rarely such insights shift the mental models of managers and get implemented to impact the real world conditions. Thus, the full potential of system dynamics to improve real world systems has not been materialized. One reason for this low practical impact seems to be lack of a theory of practice. A theory that can guide applications of system dynamics to the real world problems in a way that will have more influence on the management thinking and practice in the real world systems. This paper presents a framework for such a theory of practice. The theory presented in this paper is formulated around a generic problem sensing and problem-solving process as occur in the real world. The theory provides guidelines from data collection and problem formulation stage to policy implementation and creation of new system structure.

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Unsustainable Growth In An Auto Industry

Iran auto industry has been enjoying a growing demand in protected domestic market. In such a market environment, the auto industry has been fore-selling their products and collecting money in advance. Collected money can has been invested in fixed capital to increase the production capacity. However, demand for product could show an overshoot and collapse for different reasons. One reason for the overshoot is market saturation and the other can be extra demand by traders who are buying the product to sell it later to final customers. When such an overshoot occurs, the industry will face extra capacity and shortage of cash and will be unable to continue production for delivering what has been already sold through fore-sell policy. Excess capacity combined with shortage of cash will create major interruption in the growth of industry and could even cause bankruptcy for some companies. The model presented in this paper is used to analyze different financial and marketing strategies to achieve sustainable growth in the industry.

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Oil Prices And Sustainability In Supply Of Energy

This paper presents a model to analyze the behavior of crude oil prices in the world market. While oil reserves are decreasing, in the last twenty-five years, oil price in the world market in the real term has shown fluctuations with a decreasing trend. As a sharp rise in oil price in early 1970s and carbon tax then after in most of oil importing countries caused energy conversation and put a downward pressure on oil demand, increasing dependency of economic structure of oil exporting countries caused a higher desire for oil exports and revenues. Desire to export more from the supply side and energy conversation from the demand side created a downward pressure on oil prices. As oil prices go too low, collaboration between oil exporting countries strengthens to set quota for each country in order to restrain oil exports and cause the oil prices to go up. However, increasing oil revenues requirement in oil exporting countries, cause each or some of them not to observe the quota and push for a higher oil exports and put a downward pressure on oil prices again. However, due to limitation of oil reserves, this downward trend is not sustainable and can lead to a severe energy crisis in the future when low oil prices slow down development of alternative energy resources and exploration for new oil reserves in more costly area.

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A System Dynamics Model Of Academic Journal Publishing

The advent of the Internet has changed dramatically the way that academic researchers both disseminate and seek information. Increasingly direct internet searches supplant library searches and current materials posted on the internet compete with traditionally published documents as the source of current scientific information. Proceedings of academic conferences are "published" not in hard paper form, rather on CDs or even in virtual WWW format. In many cases, publishing houses have opened access to their traditional journals for subscribers over the internet. In some cases, journals are being published exclusively over the internet in electronic form with no paper copies being produced or distributed. The movement toward the electronic publication of academic journals dramatically shifts the economics of journal publication as

well as traditional limits on what constitutes excellent peer-reviewed work (e.g., page limits can be lifted or supporting material can be electronically linked to the article). The basic process of review can also shift as reviewers no longer deal with paper manuscripts and editors need no longer consider strict page limits imposed by the cost of paper printing and distribution. Issues relating to journal pricing, the role orty also impact on the dynamics of electronic publishing.

This paper presents a system dynamics simulation of an electronically published academic journal. The paper explores the feedback processes that control the review process, journal quality, size of readership, size of author pool, and the size and quality of the journal itself (including number of issues, articles per issue, and average page length per article). The paper explores how these feedback processes that structure the publication process are the same or different from the feedback processes that control the publication of a paper journal. The simulation model presented in this paper is based on a group model building exercise involving editors of both paper-based and electronically published journals. The simulation models presented in this paper are loosely calibrated to the System Dynamics Review and the Journal Of History and Computing.

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When To Use Qualitative Or Quantitative System Dynamics Techniques: Guidelines Derived From Analysis Of Recent Man-Made Castastrophes

Events found by Boards of Inquiry, Royal Commissions and Inquests to have caused, or contributed to, a number of recent man-made catastrophes were analysed. The basic premise for this research was … 'if, by studying historical events we can better equip ourselves to recognise symptoms and circumstances that were precursors to past catastrophes, we might learn to avert tragedy in the future'. Concept mapping techniques were used to analyse events and their complex interrelationships.

This research not only provided valuable insights into how and why systemic failures occur, it revealed much about the nature of problems, problems comprising both detail complexity and dynamic complexity. Detail complexity describes myriad, interrelated factors or forces, just too many to be considered at any one time. Dynamic complexity describes something insidious and self-organising. The research reinforced the need to be able to

identify and understand what underlies and produces spontaneous self-organisation, and the relationship between systemic structure and dynamic behaviour.
The research also revealed recurring systemic structures. Except that in the catastrophes studied the sequences of events resulted in death, the precursor situations identified are strikingly similar to those characterising complex dynamic problems we face daily.
Systems thinking and system dynamics modelling can help: this is widely acknowledged. Not so is when it is most appropriate to use qualitative versus quantitative techniques to aid our understanding and strategy development. This is addressed. Analysing what might have been reasonably known before each of these catastrophes occurred provided insights guiding the choice between qualitative and quantitative system dynamics techniques.

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System Dynamics Practice In A Non-Ideal World: Modelling Defence Preparedness

In an ideal setting the conduct of a strategic intervention using systems thinking and system dynamics modelling might start where the client identifies he has a complex, dynamic problem, and seeks the services of a consulting team. The team then goes through a logical, progressive series of interviews with stakeholders, workshops, group model building exercises leading to presentations to senior executives outlining strategic alternatives. Whilst much of the literature suggests this is how it should happen, in practice it can be quite different.
This paper describes how, in response to a government audit, a major system dynamics project was initiated by the Australian Defence Organisation. A scoping study was commissioned which recommended 'textbook' practice. The Defence Department, however, launched straight into quantitative modelling. Problems understanding of the problem and ultimate purpose of the modelling soon surfaced. In parallel, and somewhat fortuitous, a doctoral research project focusing on the same problem was conducted into qualitative dimensions of the problem specification.
The paper discusses the evolution of the project and the significant learning that took place as a result of the interplay of qualitative and quantitative modelling activities. It also highlights the fact that the outcomes were less than hoped for, principally because of project management failure from the outset. Lessons for system dynamics modellers are identified.

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Modeling And Optimal Control In Ethnosocial Systems

The mathematical description of the social and ethnical groups development proposed. The social and ethnic groups had the multilevel hierarchical system structure which had their internal constructions, the behaviour in the environment (among other groups), and their holding systems are able to change their constructions and dynamics. The group description on isolated level may be considered as a typical synergy problem for the open systems. The configurational and informational entropy in the Shannon sense for the system is a key parameter of the model. General entropy of an ethnos is a complex superposition of the levels of intellectual evolution of individual members of society and depend on the structure of society. The holder system on ethnoses level is in the hierarchical hazy but its mathematical expression can be constructed from point of view their subsystems (their details of lower levels).

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Product And Process Innovation: A System Dynamics-Based Analysis Of The Interdependencies

Innovation is regarded as a crucial factor for survival and competitive strength of organizations. For industrial companies innovations of the product system and particularly innovations of the processes generating these products are essential. The majority of the scientific literature focuses either on product innovation or on process innovation. In many cases the interaction between product and process innovation is not explicitly taken into consideration.

Referring to the complexity and the inherent dynamics of the industrial innovation process decision-making in innovation management is a challenging job. In addition to numerous interactions with the environment the complexity of innovation processes in industrial companies results from interactions between product and process innovation. An effective innovation management has to take these interdependencies into account coming to a congruent implementation of the different types of innovation.

In complex environments consequences of actions are often highly intransparent for decision makers. This paper provides a System

Dynamics approach reflecting the interdependencies of the product-process innovation system. The System Dynamics model gives a first insight into the dynamic consequences of actions in innovation management and allows to test different innovation strategies. Finally, conclusions concerning the implementation of product and process innovations in industrial companies can be drawn.

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Change Through Effective Communication: A System Dynamics Analysis

Due to the complexity and dynamics of markets, businesses, laws, and the environment the need for continuous change of and learning within organizations is an accepted Ñfactì. Nearly all consulting firms offer projects in change management; however, are those programs successful, do they last for a longer period of time? The lesson we learn is, that most modern management initiatives fail, a classic example is Total Quality Management. A system-dynamics based research project of the reasons for failure by Sterman and Repenning shows the need for a better acceptance within organizations. Or as Senge explains, the initiative persists only as a religion of a small group of Ñtrue believersì and not of the whole organization. Therefore, to overcome these limits to change, it is important to create an open-minded atmosphere to support the success and a better sustainability of these business programs. We use a system-dynamics modell to simulate the diffusion of acceptance and will to change within an organization to create a sustainable base for success and change. This model is based on classical diffusion models but enhanced with inhibitors and prohibitors specific to organizations. It can be shown, that by supporting internal communication we can improve the possibility of success and sustainability. Other than the microworld by Shapiro, we allow no user interaction but use sensitivity analysis to examine the relevant variables and parameters.

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"Risk Manager": A System Dynamics Simulation Tool To Identify And Mitigate Project Risk

According to a recent study, only 16% of all information technology projects occur within satisfactory guidelines of cost, time, and quality. This statistic suggests that there is a definite need in the IT industry for better tools to identify and control the kinds of risks that can lead a project off track. The "Risk Manager" tool is a dynamic model developed for IT project managers so they can monitor potential risk, and take steps to address it before it becomes a realized risk. Specifically, the model is targeted at managers involved in large and complex projects, meaning there are a large number of people involved, a multi-year project horizon, and a high level of potential risk. The Risk Manager Tool allows these managers to take a look at the typical project management factors such as staffing, timelines, and budgets; as well as a number of "soft factors" often overlooked such as sponsorship, communication, burnout, and work environment. Research has shown that these "soft factors" can often present the most significant risks to projects. In this paper, we will discuss the Risk Manager tool and its advantages over mainstream project management tools as well as the ways in which Risk Manager can offer unique insights to a project manager in the IT industry.

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System Dynamics Modelling Of Occupational Safety: A Case Study Approach

Occupational safety is a complex phenomenon. If occupational safety management is to be successful, not only the systematic but also the systemic aspects of safety need to be understood. System dynamics modelling appears to be an appropriate methodology for exploring the array of occupational safety strategies open to employers. Many system dynamics models of industrial systems have been built entirely for specific host firms. This paper illustrates an alternative approach. The process of developing a generic system dynamics model of occupational safety and testing it in an industrial setting is outlined. Particular emphasis is placed on building confidence in the model through the use of a rigorous set of structural, behavioural and policy tests. The findings of discussions with senior managers and other workforce employees are summarised. This discourse demonstrated that the model had

both empirical validity and pedagogic utility. The outcome of this study is a robust system dynamics model. This model should have the capacity to be parameterised for any workplace in order to aid learning and policy making in the domain of occupational safety.

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Digest: A Tool For Creating Insightful System Stories

Creating insightful feedback rich system stories for strategy formulation and conducting model-based dialogues aimed at the advancement of a shared vision call for a shift in focus from detail complexity to dynamic complexity. One way to master dynamic complexity is to divulge the dominant structure within a mass of interrelationships in a system dynamics models. Despite its importance, tools for understanding the linkages between the structure and dynamic behavior in simulation models are lacking. A new software approach, Digest, has been developed to bridge this gap. In this presentation, we introduce Digest and demonstrate how it can help you pinpoint dominant feedback loops as the behavior of your model unfolds. Just save the equations of your model, built in any system dynamics software package, as a text file and watch how shifts in loop dominance give rise to the dynamics of the system.

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Firms As Resource Accumulation Systems: A Synthesis Of Resource-Based And Evolutionary Models Of Strategy-Making

The article presents a model which integrates resource building decisions and intra-organisational ecological process model of corporate strategy-making. Firms are investigated as complex dynamic systems and the emerging dynamics of such systems are explored looking at the properties of the structure of feedback loops between resource allocation and accumulation.
The first section develops the conceptualisation of firms as resource accumulation systems. The second section briefly illustrates some evolutionary theorising on strategy-making. The third section merges the two approaches and develops a feedback model of corporate strategy-making and resource position evolution. Finally, a few simulation runs are presented and further lines of research are indicated.

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System Dynamics In Telecommunications: A Case Study

Telecommunications are developing rapidly. An imminent change is that of GPRS, General Packet Radio Service. GPRS means a fundamental change to the way telephony works. It means e.g. that subscribers can have permanent mobile access to their network and always be connected, just like with fixed access today. It also paves the way for IP telephony.
On behalf of a telecom operator, we have investigated some important consequences of GPRS. The operator wanted to find out above all what pricing alternative should be preferred and the effects on the required network capacity.
We performed the investigation as a System Dynamics process. As key variable the competitive power of the operator was chosen. Information was elicited as we built a loop diagram with the reference group. The loop diagram was translated into an ithink computer model. Consequences of different price settings was built into the model by means of the graphical functions available in ithink.
As for the tangible results of the process, some were outcomes of the System Dynamics course of action and others were side-effects. When evaluating the process, we believe that the information gathering could have been improved if it had been carried out with individuals instead of in the group. We did not succeed to quantify the competitive power, since it was generally talked about as “the strength of the trade mark”. This is a frequent problem in business modelling.

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Probing Into The Unknown: A Case Study

Entering into the third millennium, we see the emergence of new business logic. Daily, we hear news and discussions about the "New Economy", converging industries, the "death" of traditional businesses etc. Not many businesses remain untouched by these discussions and many managers spend a lot of resources on understanding how all this will effect them and their business.
The main problem for all of these managers is the fact that they are probing into the unknown. There are no given rules for success, the management literature has just begun to explore this field and there is definitely no equivalence to e.g. "In search of Excellence" to be found yet. So, does this mean that the managers once again have to

confine themselves to their own gut feelings?
Well, the answer to this question is partly yes, since successful managers often rely heavily on their gut feelings, but there are methods to be used in situations of great uncertainty.
This paper will show how the use of System Dynamics has aided a company working at the very edge of the converging telecommunications and Internet industries. The needs of this particular company were to understand the coming business logic and to develop its own revenue streams.

The paper will show how the use of a well structured modelling session facilitated the analysis and enabled simulations of the unknown.

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Dynamics Of Non-Rational Investments In Power Generation

Newly created markets are characterised by profound dynamics that creates opportunities for investment. Current models for investment decisions need to recognise the challenges concerning the apparent non-rational behaviour of the market agents. Firms may take advantage of such opportunities, taking into account reflexivity and feedback processes in the industry. Here we describe a system dynamics model aimed to support investment decisions under a "non-rational" framework, which incorporate game theoretical arguments and financial option valuation.

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Dynamics Of Knowledge Based Industries In Korea

The purpose of this paper is understanding dynamics of knowledge based industries in Korea and suggesting policy recommendations for supporting those industries. Following KIET's (1999) definition of knowledge intensity, this paper classified industries in Kyung Ki Province according to several knowledge indicators including R&D activity and human capital content. Having classified industries, this paper investigates growth dynamics of knowledge based industries in Kyung-Ki Province. Based on surveys on some 280 knowledge based industries in Kyong-Ki province, growth path of those industries were identified using path analysis. Using the growth path and coefficient identified by the analysis, system dynamics model was build to simulate

dynamics of knowledge based industries in Kyong-Ki Province in Korea. With the model, further analysis was made to investigate some policy measures that can promote knowledge based industries.

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Dynamics Of Sustainable Development: Korea's Experience

The purpose of this paper is to examine dynamics of sustainable development in Korea from a system dynamics perspective. Since Rio's Earth Summit in 1992, government as well as civil based organization , NGOs, have been trying to put forward the sustainable development in Korea. However, achieving a sustainable development in Korea was easier said than done. Even if the Rio's Earth Summit gave a great impetus to Korean society for a sustainable development, there are at least three layers of constraints that prevent Korea from a sustainable development. Those constraints come from international, national, and local level that have to be overcome for a sustainable development. Constraints in each level show their own dynamic characteristics. This paper examines dynamics of three level of constraints using causal loop analysis. Having understood the dynamics of constraining factors of sustainable development, some suggestions were made for a sustainable development in Korea.

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SD-Modelling On Corporate Strategic Planning And Scenario Building

As in many other companies, KPN, the largest Dutch telco operator, has used scenario planning as an aid to strategic planning and business development. We experienced that to give scenarios a full-grown and independent place in the planning cycle of the company, just writing future stories at a highly qualitative level is insufficient. To really get in contact with financial officers, planners and strategists, the scenarios should have a strong quantitative component.

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The Evolving Discipline Of System Dynamics

This presentation reviews the foundations of system dynamics from the early 1960s through the 1990s. From a base of information feedback theory and numerical simulation several important new ideas have since entered the field including (among others) behavioural decisionmaking, bounded rationality, systems thinking, visualisation and graphical software. At the same time much greater appreciation has grown for the process of group model building and the value of modelling for learning. System dynamics today is a comprehensive discipline especially suited to examining purposive behaviour and puzzling dynamics in all sorts of organisations. The discipline continues to evolve. Ongoing research at London Business School is linking system dynamics with contemporary resource-based strategy theory to yield a "dynamic resource based view of the firm". Asset stock accumulation, operating policy and feedback processes provide a powerful way of visualising and simulating the network of tangible and intangible resources that underpin firms' performance and relative competitive advantage. This new framework connects directly to core strategy research themes such as the dynamics of competition (understanding how the structure of resource systems yields sustainable differences in firm performance) and business transformation (guiding the evolution of firms' resource systems in a changing competitive environment).

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Presentation

In Search Of Archetypes Of Supply Chain Systems

Supply Chain Systems (SCS) or Supply Chain Management (SCM) has been a hot issue in management, especially nowadays with the advent of information technologies. Since Forrester's model by System Dynamics in 1961, the issue still remains in industry. Some people associate SCS or SCM with software for supply problems. One big problem with the education is what materials or models instructors should use in the class. For example, some businessmen respond by saying "our situations or systems are different with your cases. It looks more complex and your models can hardly applied to our problems". We need to have some archetypes to show main phenomena related with SCS, which students should understand.

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The Problem Of Managing A Hydroelectric Power Plant: An Approach Based On Traditional And System Dynamics Techniques

The purpose of management planning is to synthesize the management's objectives and goals, and to formulate, analyze and suggest strategies that permit attaining them.

Before formulating and adopting the management strategies it is necessary to formulate the tactical plans of the different component areas, that is, the process of formulating the management models consists of the integration of these tactical plans into an overall management plan.

The state of the art of the integration processes is, at present, almost integrally based on optimization methods that, with regard to the problem dealt with here, present some difficulties, such as:

Ø They are static methods, and as such, for each alteration in the initial conditions of the analysis require the repetition of the entire calculation process.

Ø Do not allow feedback, a characteristic involved in management planning.

Ø There is a large correlation between the process variables, due to which, the results provided by this methodology are only adequately precise for periods of time where this correlation does not significantly affect the results.

With this background, our work intends to direct the preparation of the management plans based on modeling techniques that permit the development of models that are adequate for dynamic systems. This approach proposes the solution of the management problem based on the following steps:

Ø The formulation of tactical plans as dynamic problems.

Ø The transformation of the dynamic problems into simulation models per area, and

Ø The integration of the area models to form an overall plan, by means of a continuous feedback process.

The Paper analyzes the advantages and disadvantages of both methodologies and concludes by suggesting the joint and simultaneous application of both techniques in more refined management planning.

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Value And Risk Evaluation Of Power Projects: A System Dynamics Approach

This paper describes a computational model denominated SUN (Business Unit Simulator, in Portuguese), which evaluates financial-economic performance of Strategic Businesses Units (SBU's) and/or investment projects under two approaches: deterministic and stochastic. Under the deterministic approach, each project is associated to a single cash flow, that may be evaluated with both the traditional methodology (Net Present Value and Internal Rate of Return) and the value based methods (Economic Value Added and Market Value Added). Under the stochas-tic approach, a set of cash flows is associated to each project, representing postulated scenarios. Based on these scenarios, the CAPM (Capital Asset Pricing Model) method is used to assign a risk index (Beta) to each project. The model evaluates the potential impact of a project, either stand alone or as part of the investment portfolio of a utility, on the SBU profitability. Therefore, it fills a gap in the available project analysis "toolkit", under two main aspects: shareholder value creation and project risk analysis. Given its flexibility, SUN may become an important component of a decision support system, from project analysis to the evaluation of value and risk embedded in SBU and firm wide restructuring.

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A Decision-Tool For Renewable Resources Management

Numerous renewable resources have been mismanaged, in spite of steps taken to eliminate the commons problem and in spite of the existence of at least general models and analyses. The problem seems to be one of information diffusion. Here we propose and test a decision-tool based on insights from system dynamics, laboratory experiments, and optimization. The case is reindeer management.
Previous laboratory experiments of reindeer management have revealed a stock and flow misperception. Winter fodder, lichen, differs from grass in that it accumulates the difference between lichen growth and consumption from year to year. The problem is further complicated by a nonlinear relationship between the level of lichen and the growth rate. Stochastic dynamic optimization shows that in case winter lichen is the limiting resource, the optimal level of lichen is close to the point of maximum

sustainable yield. If summer pastures (grass-like vegetation) are limiting, the maximization of yearly profits provides a close approximation to the maximum expected net present value. The theory of optimal learning implies that it might pay off to deviate from the current optimal strategy, to gain better understanding of the system parameters. The ideas from "group model-building" imply that user participation is important.
Different from the practice of group model-building, which requires the participation of a skilled system dynamicist, our tool is meant for self-study or in-house planning in a particular district. To achieve the goal of user participation, the tool provides a mean to transform raw data by trial an error and in a Bayesian manner. The transformed data provide indications about the rates of change in lichen, where the maximum sustainable yield is located for the district, and it indicates what herd size leads to maximum yearly profits. With these transformed data in place, simple heuristics should indicate what rough strategies to follow in order to maximize profits and to learn about the system. A series of laboratory experiments are performed to test the tool using a renewable resource simulator with hidden system characteristics.

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Object Oriented Extensions To System Dynamics

This paper describes Object Oriented (OO) extensions that can be made to the System Dynamics (SD) modeling languages. A component is a model piece that can be used as a building block of another component. As such, the component corresponds to a class in the OO world. A component is very similar to a normal variable, except that it can hold other variables and that it has a customizable interface for communicating with the rest of the model. Polymorphism is achieved through the component interfaces, as components with equal interfaces are interchangeable. This can be used to define several alternative solutions (models) to a problem, and quickly change solutions to see their effects on the whole model.
The basic SD modeling languages contain abstract building blocks (levels and non-levels) for creating models in any domain. The introduction of components makes it possible to create concrete building blocks within a specific domain. Domain specific building blocks create new and exciting opportunities for the system dynamics world, e.g. model re-use, industry specific component catalogs, quality control, standardization, and division of labor between component maker (fabrication) and component user (assembly). It can be expected that a market will develop around

components, both within corporations and on the web.
Links of basic SD can be connected freely between variables. To complete a connection, the definition of the variable at the head of a link must be edited by entering a mathematical expression. The proposed extensions to SD include sockets, plugs and wires. Sockets and plugs are typed interfaces. Wires can only be connected between a matching pair of sockets and plugs, and the mathematical definition of the model will be updated automatically to reflect the connection. This technology will make it possible for non-technical users to create models by inserting ready-made components into a diagram and connecting up components using wires. Models will be runnable at any stage of the development process.

Superimposing Dynamic Behavior On Causal Loop Diagrams Of System Dynamic Models

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The importance of feedback analysis is stressed by SD the community, and the subject is taught at most SD classes. In the practice of business simulations, the identification and study of feedback loops is not so ubiquitous as it deserves. The weak technical support for dynamic analysis of model structures makes it difficult to apply feedback analysis on large models. In addition, the understanding of the dynamic nature of models seems to be quite rudimentary in many areas.
Powersim has since 1995 developed new mathematical and technological solutions for analyzing and visualizing dynamic aspects of SD models. This paper concentrates on some technological results of this research. Our approach is based on modes of behavior, loops and links (influences) of a model, as well as extensions to the causal loop diagram (CLD) representation of models. The overall behavior mode of a model is determined by the sum of all the elementary modes at any time. Each mode describes growth, decay or linear development, and it can in addition have an element of oscillation. By sorting the elementary modes according to strength, the dominating behavior of the model is quickly identified. The paper also describes how loops of a system can be identified and sorted according to contribution to a given behavior mode. Diagrammatic display of contribution to behavior modes (and loops) is performed using line styles and colors of links in a CLD. This creates a visual link between the structures of a model and their relative contribution to selected loops as well as the overall behavior of the model. This special

way of dynamic coloring creates a "heat map" that identifies the most active structural parts of a model at any time.

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ByggSim: An Interactive Learning Environment For Construction Management Students

ByggSim is an interactive learning environment which is developed at the department of Building Economics and Management at Chalmers University of Technology. The model generates seven different types of construction projects each requiring nine activities to perform. There are five construction methods to perform each construction activities. Construction methods are weather sensitive. Since projects randomly generated for four different climate zones, construction method selected by the participants should be good enough to reduce risk of overruns. Participants are divided into five to ten teams and interact for five to six rounds. They compete with each other by submitting a bid for available projects for the round. In the next round they receive results from the last round and based on the progress of the awarded projects and available projects to bid in the round, participants submit their new strategies. The model is developed in Powersim ILE and provides a wide range of learning possibility in construction cost estimation, resource allocation, project scheduling and planning, cash management and risk management.

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Model Of Infrastructure Management: The Case Of Swedish Road Transportation System

Infrastructure exists for the interest of the society and is mostly financed with the help of public taxes. In most of the industrialised countries question of new construction of infrastructure is diminishing. The effectiveness in the rehabilitation and routine maintenance, however, is sought by the infrastructure management authorities. A generic model is developed to analyse different rehabilitation and maintenance strategies over the life span of the infrastructure system. The simulation model can help authorities to understand the complexities of infrastructure system by providing several what-if types of solutions. System dynamics methodology is used to develop a model in Powersim. The proposed generic model is customised for the Swedish road infrastructure and several maintenance policies are tested. Simulation results are analysed and discussed.

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An Account Of A System Dynamics Course Held For High School Students And Teachers, And Community Sustainability Activists

Over the 1999-2000 academic year, an introductory evening and weekend course in system dynamics was held at the high school in Sturgeon Bay, Wisconsin, USA. The students consisted of high school students, high school teachers, and community members. This paper documents some of the attributes of this experience, in the hope that our story may benefit others interested in attempting something similar.

The belief that system dynamics modeling capacity could help support community sustainability projects in Sturgeon Bay and Door County, Wisconsin drove the course. Our hope is that, with proper education, some community members, especially from the ranks of high school students and retirees, will be interested in serving their communities by providing system dynamics consulting to community business, government and charitable organizations. To achieve this vision, K-12 teachers must learn to use system dynamics in their teaching. And community organizations must be aware of the potential of system dynamics to address organization and community problems. This class was a first effort at bringing these groups together to develop community system dynamics modeling awareness and capacity.

This paper discusses several aspects of our experience, including:

- How the course got started…illustrating how community sustainability can be a mechanism for introducing system dynamics in a community.
- Curriculum and process
- Inexpensive distance education techniques used
- Some initiatives undertaken by the students on their own volition
- Some reflections on our experience

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Evolution Of Civil Society And Government In Development Process

The literature of Social Sciences has widely discussed the impact of Government and Civil society on the development process. However, in addition to these impacts, the interaction between Civil Society and Government has a substantial effect on development, which has not been discussed widely. This paper

develops a System Dynamics model to analyze the dynamics of the interaction between Government and Civil Society –which is parted to the Industrial and Commercial sections. In the first phase of development, which is called "Growth" Government has the main role and increases its power steeply while power of Civil Society increases steadily, but gradually "manageable limit of government" restricts government's expansion and Civil Society starts exponantioal growth. After this phase growth limit which is forced by government ,pushes the society to "Transitional Conflict Point".This phase is highly critical , if the Government and Civil Society make compromises for a balance of power then the "Transitions" will lead to "Sustainable Development", otherwise the growth process ends into a self-destructive social upheaval and returns to its origin. The paper also considers "Industrial" and "Commercial" social forces interaction as the key indicator of Civil Society's capability to continue development process. This paper concludes with some policy recommendations to increase the chance of sustainability in development process.

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Sustainable Energy Planning In A Developing Economy: A System Dynamics (SD) Approach

This research "in-progress" proposes a System Dynamics (SD) framework for developing a model for sustainable energy planning in a developing economy(ies) (DE). The paper first reviews the current energy planning models, highlights their limitations in addressing energy planning issues in a DE. Given the current trends in energy demand and supply in the DE, there exists a complex feedback structure that has significant implications for socio-economic development with reference to sustainable energy planning.

Given the suitability of SD in handling feedback systems and the experiences gained from the wider energy modelling in SD community, this model for energy planning in a DE draws from current theories that have been hypothesised in this important area. The effectiveness of the SD framework is in capturing the well-pronounced socio-economic and technological gaps in DE as compared to member nations of the Organisation for Economic Co-operation and Development (OECD). The use of SD enables the modelling of complex energy issues, and thus enhances understanding of the specific system characteristics of DE.

The advantage of the proposed SD framework for DE over the existing modelling techniques (such as optimisation, econometric

and general simulation models) is the particular focus on feedbacks, delays and non-linearity within the decision-making process of energy policy development for DE. The results of this research will fill an important gap in the literature on energy planning for DE by demonstrating the key feedback relationships that are responsible for the dynamics that must be understood for sustainable energy planning in DE.

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Modeling The Transition From Product Manufacturer To Service Provider

Management literature is almost unanimous in suggesting to product manufacturers to integrate Support Services –warranty, maintenance, reliability, etc.– into their core offerings as a way to extend the revenues from a customer. The literature, however, is surprisingly sparse on describing how this integration should be done or the challenges inherent in the process. Transitioning from product manufacturer into service provider constitutes a major managerial challenge, as services require different organizational structures and managerial processes. Qualitative research has identified three dimensions on which these challenges are manifested:

Metrics: From the traditional metrics that govern most manufacturing processes –throughout and efficiency– to more comprehensive metrics that reflect the fact that value is created through a service interaction, that maximizing value for the organization might require sub-optimizing the performance of individual divisions, and that the customer is whom ultimately determines whether value has been created.

Knowledge management: From centralized knowledge centers (product design labs) and products that are intrinsic recipients of that knowledge (i.e., a car or a printer) to networks of service centers that require extrinsic knowledge to deliver the service.

Economic model: From a once-off product-purchase transaction to a long-term relationship with a continuous revenue stream that is perhaps reflected across several divisions in the organization.

I am interested in articulating the challenges for the transition from product to services –a detailed literature review did not shed any light on these issues. I will collect data through field interviews and case studies. In the future I plan to integrate the main findings into a simulation model to explore the dynamics of the transition, identify the main levers of success for this transformation and experiment with the transition speeds to failure modes.

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Teaching System Dynamics And Systems Thinking In Austria And Germany

This paper discusses the emergence of system dynamics/systems thinking (SD/ST) teaching in different countries. A special focus is placed on efforts made to introduce the Modus software in Germany and on the introduction of systems-thinking ideas in Austria's mathematics curriculum in the early 1990s. In chapter 4 the fascinating relation between systems thinking and system dynamics is discussed in some detail, followed by my own definition of systems thinking. In the final chapters the main results of four empirical studies concerning the development of systems thinking skills through teaching system dynamics are summarized.

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Presentation

In Search For The Improvement Of The Efficiency Of University Graduates In Iran

The interaction between academic institutions and industry in Iran has historically been somewhat weak such that the flow of information, experience and advanced knowledge between the two has been problematic. The presence of feedback loops in the system makes the deviation from the desired situation be deteriorated. Correcting key mechanisms in the interaction can continuously improve the productivity of both universities and industry.

Two important elements of the system are university graduates and faculty members. Assuming the majority of faculty members are themselves graduated from home universities, the important of this element is increased. Re-engineering the university programs in a way that graduates can fulfill the employers' requirements is essential in solving the problem.

In this paper the current situation in the interaction between universities and industry is analyzed. The reinforcing and balancing feedback loops which are critical to the behavior of the system are identified. Describing two successful experiences in this respect, a generalized model for the improvement of university-industry relations is suggested. The effects of the alternative policies on the system's behavior are analyzed.

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Dynamics Of Organizational Change

"Changes in social, economic and political systems do affect organisational structures and practices.(…) Exactly how does change in larger systems affect the forms of organisation in society?"

This question was posed by Hannan and Freeman back in 1989. Since the beginning of the 1980's, organisational scientists have developed many theories to explain the causes and consequences of change.

Research on organisational change has been centred around two important questions:

a) How and why do firms evolve?

b) How does change affect performance?

The first question is related to the causes underlying change and the process of change, while the second is related to the consequences of change.

As can be seen in the questions, organisational change is a process which is initiated due to certain causes and it determines, at least in part, the success of the organisation. In addition, change suggests a dynamic phenomenon. Theories developed by organisation scientists hypothesise dynamic, cause effect relationships between such variables as strategic orientation, performance, incremental change, strategic change, inertia, size to name a few. These theories do remain at the static level however.

Although several system dynamicists have made attempts to come up with models on organisational change, all of these models have important limitations.

This paper will provide an overview of system dynamics models constructed so far and discuss their strengths and weaknesses. Next a new model will be presented, based on theories developed in organisational studies. The aim of the new model is to:

a) bring the relationships hypothesised so far into a meaningful whole;

b) investigate whether these relationships are sufficient to explain the causes of organisational change;

c) investigate the potential effects of organisational change on organisational performance.

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Seviba: Virtual Reality For Learning To Learn And To Develop Systems Thinking Based On System Dynamics Models

This paper presents Seviba, it is the result of a learning process whose main goal was to propose methodological guidelines for the development of learner–directed learning are based software. In order to favour the development of system thinking, SEVIBA bases the study of viruses and bacteria on System dynamics models and computer simulation. As a result of knowledge making, students are prepared to develop thinking skills which let them assume the study of complex phenomena, through the application of system Engineering.
Lastly, a final reflexion presents some guidelines for the development of learner–directed learning based software which favours system thinking.

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How Should The Capacity For Treating Heart Decease Be Expanded?

The waiting time for Heart Decease treatment in Denmark is too high. In the County of Funen they have raised the Health Care budget for Heart Decease treatment by 8 Mio. Danish kroner in order to increase the capacity. They assume that the capacity for treating Heart Decease can be raised by 10 percent.
At Odense University Hospital where heart deceases are treated, they already have done a good peace of work specifying the patient flow program (reference program) for angina pectoris. This project has been stopped due to lack of operational content. It captured too much information and part of it was obsolete even before finishing the description of the program. Because of the opportunity to expand their capacity the heart centre wanted to go through a different
procedure of analysis where eventual bottlenecks could be identified without going into all details in the patient flow.
The heart centre decided to analyse the capacity of their system and the possibilities for expansion based on the ideas of System Dynamics. This paper presents the process, diagrams, models and the achieved results. The evaluation of ten department managers who joined the process without any prior experience of system dynamics is also given.

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College Quality, State Standards, And Domestic Violence: Using System Dynamics To Guide Practitioners To "Better Questions"

Conventional thinking suggests that an academic team of an oceanographer and a religious historian have little useful role in conversations with school administrators searching for answers around the financial and human impact of new state-mandated graduation standards, with college administrators over enrollment and financial management concerns, or with criminologists seeking to stem the tide of domestic violence. Recent experience, however, suggests otherwise. Our use of a full range of systems tools has been enthusiastically embraced by practitioners to productively wrestle with "mental models," to illuminate core issues traditionally overlooked in the conventional definition of the "problem," and, ultimately, to forge a better collective understanding of the factors and relationships which affect their "systems." Positive, productive, and expanding collaborations reflect a conscious desire not to assert expertise or provide answers but rather to build a productive framework within which to challenge experts to identify and contemplate "better" questions.

A common starting point for engaging practitioners asks, "What Stock(s) is(are) at the core of your concern?" This launches discussions about the system's behavior over time, distinguishing the "real" from the "perceived" and "historical" experience from the "future" expectation. Behavior over time graphing, while seemingly mundane, yields tremendous insights into differing mental models: their components, boundaries, behaviors, scales of measure, as well as time frames.

We can then guide the conversations smoothly into simple causal loop diagramming and, more powerfully, into simple stock/flow diagrams. It is, at this level, that unforeseen stocks and relationships can raise questions typically ignored in conventional problem-solving. Facilitation of a discussion involving college administrators thus came to center on a stock of "perceived quality" which transcended the traditional boundaries of finance and enrollment. In the case of state-imposed learning standards, a stock of "newly designated student non-achievers" focused an insightful discussion of unforeseen personal as well as financial costs. Finally, in discussions with academic criminologists and social-service providers in the field of domestic violence, identifying two stocks, "perceived male privilege" and "his new

incoming control" literally redefined how discussants conceptualized the "problem" of accelerating rates of violent behavior.

The model of Jay Forrester, challenging experts in a variety of fields--engineers, urban planners, economists and, most recently, educators, to use the tools of system dynamics to alter the "habits of mind" is one which resonates deeply with us. Our experience in working with practitioners in fields remote from our own specialties, by deliberately refusing to provide answers but by guiding systemic reconsideration of the issues and in identifying better questions, underscores growing opportunities for system dynamics to find its way into a variety of new arenas and, if properly exercised, for engaging the experts in exploring some "better questions" for the 21st century.

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Sustainable Development Of An Historical Indian City

The objectives of this paper is to explain qualitatively the expansion – Geographical & Demographical, the consequences and aftermaths of a beautifully located Historical valley city of Udaipur.

This city which is now into its 500th year of its existence is craving for sustainable development and is under tremendous pressure of the very forces which has led to this developmental stage.

Udaipur is a unique example in sustainable development. The city of Udaipur was established in the year 1551 by the then Manarana Udai Singh Ji of Mewar State. He established this city owing to certain political reasons, and the location of this city - which is a valley and had a large number of water catchment areas around it - was conducive into the settlement of this habitat.

The city is a unique example of sustainability because the very concept of balance development was embedded in the system of this habitat right since centuries. The present write up intends to include the elements which provides the sustainability right since its inception and also to understand the systemic forces which are threatening this very sustainability.

The city which down the ages had witnessed the construction of men made lakes which were built around 200 years back, conservation of all the natural resources and the strong political will to maintain the natural balance along with the co-existence of its people has a large no. of unique examples showing the way in

which this balance development was brought about. It was the foresightedness of the erstwhile rulers of this city that they foresaw water requirement needs of this region 200 years in advance and built a network of water resources which is sufficient even for the next 25 years to come from today.

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Modeling Organizations Using A Hybrid Simulation Approach

We developed a prototype simulation that embodies a hybrid modeling approach derived from both system dynamics and agent-based simulations for modeling complex organizational behaviors and interactions.

In agent-based behavior-oriented simulations, agents are entities (like employees and company) that are endowed with certain behaviors and the interactions among these entities executing their behaviors give rise to complex dynamics. We coupled the vast body of insights from the system dynamics community with the agent-based modeling techniques to develop a hybrid simulation approach. The models in our prototype, called TalentSim, rely on this approach that represents a middle ground between the analog modeling based on differential equations in system dynamics and the discrete rule-based modeling methods common in the agent-based simulation community. At the individual agent-level, the modeling is more akin to system dynamics models. However, at the interaction level, the agents behave more like behavior-oriented simulations of agent-based models.

Agent-based modeling requires that the domain be modeled as a set of behaviors. It is an "interaction oriented" modeling paradigm, where the focus of the knowledge acquisition effort concentrates on defining the behaviors of the entities and the interactions among them[Epstein96]. In this type of simulations, agents are entities that are endowed with certain behaviors and the interactions among these entities executing their behaviors give rise to complex dynamics. Some of the discrete-decision making and symbolic reasoning tied to sense-and-respond behaviors (e.g., if most of my colleagues aren't planning to come to work today, I may take a day off) common in business domains may be more amenable to agent-based modeling.

Agent-based techniques can handle heterogeneity in behaviors and domain descriptions. They are very amenable to data-driven modeling without the need for gross aggregations and averaging. For example, it is possible to feed the profiles, interests and

behaviors of music buffs obtained by extensive data gathering into an artificial agent-based model world to anticipate or forecast the probability of a particular kind of soon to be released album becoming a hit[Farrell98].
In this paper, we discuss our hybrid modeling approach and illustrate our claims using examples from the TalenSim prototype. Then we briefly sketch some of the elements of our model that lies at the core of TalentSim Simulator.

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System Dynamics For Small Businesses

Most of the Small Business Companies in the U.S have no systems in place. System Dynamics' tools and techniques might give new insights and produces new mental models to improve business models for Small Business Companies. The VBM(Value Based Management) approach serves only the big companies. Small Business Companies are in need of an integrated approach for soft OD and hard OD at any stage of development.(Forrester) The strong point of Small Business Companies is their potential in Relationship Management and Corporate Governance. Core competencies and the competitive advantage through quality have to compensate for their poor Knowledge Management, that is needed to master the next step from an infancy stage to a sophisticated level of business growth. A survey of Small Business Companies in Maine will show the significance of using a systems approach to business strategy to create momentum and sustainability at the same time.

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Consultants' Roundtable: Using A Simple Classification Framework To Share The Benefits Of Different System Dynamics Modelling Approaches

One possible method of classifying system dynamics models and their development paths is using a 2-dimensional classification framework: size of model and degree of ‘quantification’. The size of the model simply refers to the number of variables and we can think of models as appearing on a spectrum from ‘small’ to ‘large’. The degree of ‘quantification’ is a harder term to define. Starting at the lowest level of ‘quantification’ we have chosen four categories:
Non stock-and-flow representations (systems thinking diagrams,

causal loop diagrams)

Stock-and-flow representations (sometimes called resource maps)

Quantified models using limited data and/or hypothesised relationships

'Fully calibrated' system dynamics models

Using these simple definitions we have developed a 2-by-4 classification framework for system dynamics models. The purpose of this framework is to provide a common language for the consulting community to discuss the benefits delivered by different approaches to the system dynamics process.

The round table will consist of an introduction to the framework placing it in context, not as a framework grounded in rigorous analysis, but as a tool for facilitating learning from shared experiences. There will then follow five presentations from the consulting community using case studies to highlight the benefits of the development paths in terms of addressing clients' problems. Other participants will then be given the opportunity to use the framework to contribute their own experiences to the round table. In addition, the usefulness of the classification framework will be debated.

To reiterate the main objective of the round table this year is to facilitate learning about the benefits of different modelling approaches.

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Applications Of Linkages In Threshold 21: An Integrated Development Model

The Threshold 21 (T21) Integrated Development Model is a tool for exploring consequences of policy intervention through resource allocation on the long-term development goals of a nation. It's current version has 20 sectors, which can be classified into 3 groups: economic (industry, agriculture, services, technology, finance, military, government, rest of the world), social (population, education, health care, nutrition, employment, income distribution, HIV/AIDS), and resource and environment (energy, land, forest, water, air pollution). These sectors are dynamically linked to each other to form hundreds of feed-back loops. This paper highlights some of the linkages among key variables in T21 (including total fertility rate, life expectancy, and cohort death rates), explains how these variables were quantified, and discusses applications to a selected country, among the ten countries where T21 has been applied with funding from UN agencies, the World Bank, several national governments, and US foundations.

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The Value Cycle Model: Understanding The Dynamics Of Value Based Management

There are studies and models to analyze the value chain of a firm. While they are useful in identifying the main activities and drivers of the value creation process in a firm, they seriously lack in explaining the value activities' internal mechanism and linkage dynamics, which generate value, over time. This study attempts to illustrate the internal mechanism and linkage dynamics of a value chain holistically and builds a dynamic theory towards value based management. The main focus of this work is the development of a framework that delivers a value based management mechanism engrossing from dynamic resource-based view of the firm, systemic leverage, balanced performance measures and decision-making perspectives. By way of examples, the concepts underlying the proposed 'the value cycle model' have been elaborated.

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Presentation

Scaling The Vertical Learning Curve Of System Dynamics With Silicon Valley Managers

Managers in this high technology, fast decision making area called "The Silicon Valley" need to view their decisions through a system-wide lens. Learning how to examine problems, or opportunities through a system dynamics lens takes time. Managers in this valley have little time to attend traditional classes. They are familiar with information technology (IT) tools for gathering information, communicating and collaborating. With this in mind, the College of Notre Dame in Belmont, California offers a Masters of Science in Systems Management concentrated on system dynamics. These classes are designed using a combination of face-to-face (F2F) and online sessions to meet the time restrains and to utilize the IT skills of these managers.

This paper reports on a research study which explores how to better apply technology and other teaching tools to help these students learn system concepts. It specifically examines what helps students to learn how to apply system dynamics in their work environments. We understand that the knowledge students bring to a course will affect how they deal with the new knowledge being taught. Therefore, this research project assesses system dynamics knowledge early in the foundation course for the program. It also encourages students to maintain learning logs to record what they

determine is of value in the materials presented. After the course they are asked to participate in a brief structured interview session to collect their individual statements on what and how effectively the technology and teaching tools were employed and what stood out in their learning process of system dynamics. These interview statements are analyzed to create Q-sample statements, participants perform a Q-sort using these statements. The Q-sort results are statistically analyzed using factor analysis software. The validated findings are used to improve the course delivery for the next session of this course.

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Integrating Dynamic Modeling Into The Strategic Planning Process: A Case Study

This paper discusses how dynamic modeling has been integrated into the new strategic and operational planning process in a privately held conglomerate. This conglomerate consists of a corporate support group that oversees the operations of several different business units (BU) that serve completely different industries. As part of a larger organizational transformation initiative, this work with one of the BU's has faced many challenges. Among these included gaining credibility of the model at the corporate and BU levels as well as seamlessly integrating this methodology with other consultant methodologies.
The benefits achieved so far include creating a shared understanding between the corporate of the business model of the selected BU. Furthermore, the modeling process has raised the level of trust and clear communication between the corporate and the operating company staff. These benefits have paved the way for more effective strategic planning and decision-making between these two groups.

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A System Dynamics Approach To Organization Design: Case Of Talented Students' Center In Sharif University Of Technology

Despite attracting many sharp students of Iranian high-schools, Sharif University of Technology falls short of developing their potentials to the desirable extent. To face this problem, a new organization within the university is designed which tends to fulfill the following goals: 1- Improve the quality of education for highly talented students. 2- Employ these students' abilities in some

useful activities. 3- Provide talented students with better opportunities to continue their education. 4- Enhance successfulness of these people facing the community after graduation. This organization is designed on the basis of internalizing growth and learning structures in the system. Considering the dynamic aspects in the behavior of the organization we tried to design its structure in a way that the limits to the systems growth are wholly or partially eliminated.

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Developing A Model For Paradigm Shift In Service Industry

For a long time service industry has been successfully following a mass production manufacturing model, But in last decade, this strategy has lost its effectiveness, putting many successful companies under pressure. Instead a new model has grown to be effective, taking place of old approach in managing service companies. This paper discusses and models the process of above paradigm shift using a system dynamics point of view.

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Industrial Dynamics To Systems Thinking

Prof. Jay W. Forrester pioneered industrial Dynamics. It enabled the management scientists to understand well enough the dynamics of change in economics/business systems. Four basic foundations on which System Dynamics rest were discussed. The thought process prevailing and their shortcomings are pointed out and the success story of System Dynamics was explained with the help of Production-Distribution model. System Dynamics graduated to Learning Organisations. Senge with his concept of integrating five distinct disciplines of Systems Thinking, Personal Mastery, Mental Models, Shared Vision and Team Learning succeeded in bringing forth the System Dynamics to the reach of large number of practitioners and teachers of management. However, Systems Thinking part of the Learning Organisation fails to reach out because it lacks the architecture needed to support it. Richmond provided the much-needed architectural support. It enables the mapping language to be economical, consistent and relate to the dynamic behaviour of the system. Progression from Industrial Dynamics to Systems Thinking has been slow due to different postures taken by the professionals. It is suggested that Systems Thinking has a lot to adopt from different disciplines and should

celebrate synergies and avail cross-fertilisation or opportunities. Systems Thinking is transparent and can seamlessly leverage the way the business is performed.

Susan Rhodes-Yenowine

A Grounded Theory Of Literacy Learning Based On Systems Analysis

This study was to develop a grounded theory of literacy learning based on systems thinking and the seven archetypes developed by Senge. The introduction of State Standards make literacy learning a high stakes venture for administration. In the United States there remains concerns about student progress and the systemic delivery of reading instruction.

In semistructured interviews with principals and teachers it was found that specific patterns or archetypes often interfered with the literacy success rates of students. Seven archetypes were utilized: (a) Fixes that backfire; (b) Shifting the Burden; (c) Drifting Goals: The Boiled Frog Syndrome; (d) Escalation; (e) Growth and Underinvestment; (f) Organizational Additions; and (g) Accidental Adversaries. These patterns produces the unintended consequence of lack of achievement and success of their students.

The use of systems frameworks and archetypes allowed the participants and this researcher to explain why literacy learning was not successful in some cases, that is, a grounded theory was developed. This new understanding brings a new perspective, or lens to view difficulties, to the issue of unintended consequences that result in low student achievement. The use of organizational archetypes can allow literacy leaders to identify the leverage points in student patterns of achievement. Principals and teachers can then increase capacity for achievement, thus turning the vicious cycle of low achievement into a virtuous cycle of success in reading and achievement for students.

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Can System Dynamics Models Learn?

System dynamics models are tools for reflection. Ideally, they help people reflect on problematic or puzzling behavior and gain understanding, insight, and confidence in complex dynamic situations. Thus, in settings where learning is difficult, they help modelers and their audiences learn.

It is common to assert that while people might learn, system dynamics models do not. Our image of models that learn are

neural net models, or LISP or Prolog programs, which can modify their structure and behavior as they run. 'Models that learn' are seen to be models that can change structure, usually interpreted as 'equations' or 'lines of code.' Since system dynamics models do not rewrite themselves as they run, we commonly conclude that they can not exhibit 'learning.'

This little study probes the question of whether these preconceptions of 'models that learn' are as evidently true as we have thought. The centerpiece of the study is a well-known model of instabilities in a workforce providing services in a noisy environment. To this structure is added a formulation representing the model 'learning' that it requires some internal adjustment to dampen the oscillations.

The presentation reflects on elements of this exercise, suggesting how far we can push this example of a model that 'learns' (and 'forgets'), what it might tell us about models of learning in dynamic situations (such as global sustainability), and what it might reveal about the deep harmonies and dischords between the various kinds of models that appear to display learning-like structure and behavior.

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Learning For Sustainability: The Need For A Conversational System Dynamics

The challenges posed by sustainability generate a pressing need for widespread development of a new learning capacity: the capacity for building shared, systemic understanding. System Dynamics appears to be a natural for addressing this vitally important learning agenda. But given the pace at which our discipline is being taken up around the world, it would seem that System Dynamics has a slim chance of playing much of a significant role. If we do want to contribute to addressing the challenges to sustainability, we must accelerate the uptake of System Dynamics. I believe that in order to do this, we must create what I will call a "conversational" incarnation of our discipline—something quite different than what has come to be known as "Systems Thinking." This incarnation will preserve what's essential for underwriting rigorous, systemic thinking. And it will excise what serves as the principal impediment to widespread uptake.

The principal aim of this paper is to introduce you to Conversational System Dynamics, and to hopefully get you a little excited about it in the process (though I'd settle even for agitated). I will begin by using the context of sustainability to motivate the

need for using an approach like System Dynamics. Space constraints do not permit development of this argument in full detail. I am therefore relying in part on the reader's awareness of the broad variety of System Dynamics applications in the realm of sustainability to bear testament to the relevance of our discipline in this domain. Next, I'll develop an operational definition of Conversational System Dynamics by describing which aspects of "traditional" System Dynamics (what I'll call the "analytical" variety) will be retained in this new incarnation, which will not, and why. Finally, I'll describe what would be useful to have in a new software tool if it is to be effective in leveraging widespread assimilation of Conversational System Dynamics.

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Interactive Panel Discussion - Building A Shared Operational Picture Of Learning

The objective of the session will be to make progress toward building a shared understanding (among the four panelists, and the others in the room) of how to increase the amount of learning going on in schools (and by extension, elsewhere). The type of learning being focused on in the session is not "content learning," but rather "developing understanding" and "building the capacity for developing understanding." We will not focus on "hygiene factors" (i.e., the myriad "influences" on how much learning occurs), but rather on evolving a causal theory of what it takes to build understanding--i.e., how the "building" process actually works. Panelists will open by advancing one or more strawmen stock/flow maps of the process. Session attendees will then have the opportunity to critique, modify, and extend the theory represented in the strawmen.

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Approaching A Model Of Policy Change: A Challenge To Political Science

Scholars in the theory of public policy have asked how can we understand the "incredibly complex" process of policy change? Though many answers have made important contributions to this understanding, they tend to rely on theory that is either 1.) very general in scope or very narrow and specific to a particular agency's decision processes, 2.) reliant on a single or several case studies that are often of limited utility, and/or 3.) derived from multiple regression analysis that usually disregards dynamic

change and any element of feedback despite a foundation in an otherwise complex causal theory. In fact, scientific approaches to the study of policy making processes are ill-designed to confront the apparently tremendous influence of personalities and chance events, the unique features of policies, and the unique and diverse range of environments in which policy is made. But "noise" is not unique to political systems and the goal of policy theory must be to assist in understanding the role of causal elements in policy making whether irregular and diverse or uniform and predictable. This paper summarizes several important causal models in public policy making and suggests ways in which these conceptual approaches, previously the subject of limited testing via case studies or regression models, could be made more rigorous with the use of system dynamics modeling.

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Directions For Information Systems Research Applications Of System Dynamics

Information systems (IS) research provides an exciting, high-growth area for applying system dynamics (SD). Though a few papers have been written on the system dynamics of information systems, none have impacted the leading thinking in IS research today. This paper hopes to motivate SD contributions to IS research, by exploring interesting areas where it could be applied, how it could be applied, and who is interested.

Where and How. This paper demonstrates how the SD paradigm adds rigor to IS research by making explicit: strategic resources (stocks), resource dynamics (flows) and resource utilization (connectors). The paper highlights the following application areas. Identifying and understanding strategic resources (stocks) adds value to current IS research on the resource-based view of the firm, and business value. Explaining resource dynamics (flows) explores the accumulation and maintenance of resources that IS research has difficulty explaining with equilibrium economics. Developing and testing hypotheses of causal relationships (connectors) and feedback between resources and flows adds rigor and explanatory value to the correlational view often taken in IS research.

Where and Who. The paper then surveys some promising current applications in the field, and the leading IS organizations and academics that are supporting these applications. Davis and Ritchie-Dunham explore resource dynamics of the technology acceptance model. SAP supports work by Anderson, Morrice and

Ritchie-Dunham using an SD model to explore the value added by ERPs and the balanced scorecard. Ritchie-Dunham and Barua research the pricing dynamics of the internet backbone. Ritchie-Dunham and Norton are applying the dynamic scorecard.

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WITHDRAWN -- Different Assumptions, Different Methods, And Shared Insights: A Comparison Of System Dynamics And Game Theoretic Treatments Of Sustained Differences In Firm Performance

While many System Dynamics models have addressed business strategy issues, game theoretic modeling is still a far more widely used and accepted approach among business school faculty members. This paper develops two parallel models, one game theoretic and one in the system dynamics tradition, addressing a question central to current strategy research. The question ("how does interaction between firm capabilities and market position affect firm profitability and industry structure?") is inherently dynamic, feedback rich, and poorly handled in the existing strategy literature. Though the topic may seem skewed toward success for the System Dynamics treatment, both modeling methods provide valuable insights. The models are used to clarify fundamental and non-obvious differences in the assumptions and solution methods underlying the two approaches and to link these differences to the types of insights and empirical testing opportunities that each method provides. The parallel use of game theoretic and system dynamics models reveals strengths and shortcomings in both modeling traditions and provides a means to build greater confidence in insights that are common to both models.

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The System Dynamics Approach And The Methodology For Multicriteria Decision Aid As Tools For Organizational Learning

The general objective of the present work is to demonstrate that the joint utilization of the system dynamics approach and the methodology of multicriteria decision aid enable the organizational learning process improving therefore the decision processes in the organizations.
A scientific approach was developed based on real experiences grouped according two categories: laboratory experiences and real

world organizations. The laboratory experiences are simulations done with university students. It was created a controlled experimental environment to use the ''Beer Distribution Game''. The original rules to evaluate the learning process were modified to prove our hypothesis. The real world organizations experiences are based on a pharmaceutical company that is passing a transformation process.

From these experiences we concluded that the joint utilization of the proposed tools present specifics advantages as:

The system dynamics approach helps the formalization and communication of knowledge due to the perception of causal links, exchanges and the simulation tools

The system dynamics simulations make evident the counterintuitive feedback impact in complex systems.

The methodology of multicriteria decision aid allows to make evident and to address scientifically the desires and beliefs of organizational agents (stakeholders) in order to formalize them into the organizational strategy and objectives.

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Bulk Delays In System Dynamics Model

In a supply chain handling fast moving consumer goods one of the most commonly followed material ordering process involves releasing supply orders whenever inventory level falls below a predefined re-order level. There are two difficulties in modelling this process in system dynamics parlance. Firstly events in this process occur discretely whereas system dynamics emphasises continuous change. Secondly the time elapsed between occurrence of two successive events depend on inflow pattern. This violates an assumption that is implicit in the delays that are commonly used in system dynamics models. Delays in System Dynamics are modelled as k–th order Erlang functions which are characterised by two parameters i.e. the average time spent in the delay and the order of the delay. The order is actually the ratio between the square of average holding time and the variance of holding time. One of the important assumptions made here is that the average holding time remains independent of the inflow pattern. In many situations these provide a good representation of the reality. However in the material ordering process described the flow is delayed on number and the assumption does not hold.

In this paper we have tried to find a representation for the process that would not require making compromises either on the modelling accuracy or on the philosophical foundations of the methodology. Based on analysis of behaviour we have

demonstrated that the re-order-level based ordering is equivalent to an Erlang process of order equal to the re-order-level. As a result it can also be modelled as an exponential delay. The average length of delay has to be kept as a variable to represent reality.
The work attains importance because of its utility in modelling supply chains where there has been a renewed interest in using system dynamics. In analysing the delays we have used a framework that is commonly used to analyse stochastic processes. Similar method of analysis could be applied to analyse other kind of processes. This is another important contribution of the paper.

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Causality And Validation Of System Dynamics Models Incorporating Soft Variables: Establishing An Interface With Structural Equation Modelling

Conventional methods and models are based on hard (quantitative, cardinally-measured) information. The problems are different in the analysis of soft, qualitative or categorically measured data. Social scientists have been more and more concerned with measuring qualities in order to grapple with complex configurations and the ambiguities inherent in human perceptions and behaviour. The authors had earlier attempted to model the work climate of an R&D laboratory using the system dynamics (SD) framework. Problems occur at two stages in developing such a system dynamics model incorporating soft variables. First most of the variables encountered in such systems are measure using a quasi-quantitative framework. The question of reliability and validity of such measurement would have to be addressed. Second, the causal relationships among the variables would have to be ascertained in a way that takes into consideration this quasi-quantitative measurement approach. Reliability refers to the stability of replicated measurements. Construct validity refers to whether the measure really measures what it is supposed to measure, as opposed to measuring some similar yet conceptually distinct variable. Causality or causal linkages are central to the paradigm of system dynamics. The causal relationships in the above-mentioned system dynamics model were largely derived from correlations, regression analysis, cluster analysis and multiple classification analysis. But in all these methods of analysis, causality cannot be inferred or verified. Further, there is the critical question of validating such a system dynamics model. Our approach towards soft systems modelling is quite apart from the

methodological thrust of soft systems methodology (SSM) and other problem structure methodologies. For one, SD itself has moved away from the hard system paradigm, with the relativist/holistic philosophy of validation. Secondly, in SSM, the problem situation could be ill-structured and messy whereas the variables in the model need not be so. The central theme of structural equation modelling is the establishments of causal relationships among latent variables taking into consideration the reliability and validity of quasi-quantitative measurement of such variables. It is, therefore, argued that establishing an interface between system dynamics and structural equation modelling could be appropriate to address the problem of establishing causality in and validation of a system dynamics model incorporating soft variables. Data from a sample of 236 research units in the laboratories under the Council of Scientific and Industrial Research (CSIR), India have been used to develop two structural equation models. These models help in probing into the causal relationships among the factors of work climate and the measures of effectiveness of research units in CSIR laboratories.

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Balanced Scorecard In A Dynamic Environment

The Balanced Scorecard has become one of the many buzzwords that has emerged in management the last decade. Many organisations have made great efforts to implement a scorecard in their own organisation, but, as with many other new management concepts, there are only few examples of organisations that have succeeded in their scorecard work. The aim of the paper is to identify the most common mistakes that organisations make and possible ways of avoiding them.

The purpose of the Balanced Scorecard is to describe the organisation's strategy and the way of reaching it. One common mistake organisations make in their Balanced Scorecard process is that they do not put sufficient time in identifying their way to the strategy. This in turn leads to a failure in identifying constraints and delays that stop the organisation from reaching new levels and make the organisation conscious of the areas where delays can lead to unintended consequences. It also leads to difficulties in identifying the factors that drive the business in the long run and thus make up the important measures on the scorecard.

This paper proposes the use of system dynamics (SD) as a tool to support the Balanced Scorecard process. The combination of SD and Balanced Scorecard is believed to lead to an increased understanding of the external and internal business environment

and thus to a more efficient implementation of the strategy. SD is believed to support the implementation process and the continuous work with the scorecard by identifying and making explicit the cause and effect linkages, time-delays and constraints in each Balanced Scorecard perspective and between the perspectives, by enabling testing of the strategy before implementation and by simplifying the communication of the strategy to the entire organisation.

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Capturing Competence In Imaginary Organisations

Organisations cannot achieve its tasks without competence. It is considered as the base for all organisations' survival. Today an increasing number of organisations rely heavily on networking with other organisations to achieve tasks. What impact does this strategy have on the build up of competence in the own organisation? Does networking imply that the organisation risks losing its competence in one area to another organisation? If that is the case, what can the organisation do to capture that competence?
In this paper, which is based on a course project that I conducted at the University of Bergen, I compare the build-up of competence in traditional organisations with competence in imaginary organisations. I have identified a few problems with relying on other organisations for task performance and two possible ways of avoiding those problems. System dynamics is used as a tool for analysing the behaviour in two types of organisations and for testing policies for capturing competence.

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WITHDRAWN — Modelling And Simulation Of A Production Line In An Automotive Company

The goal of this research is the modelling and simulation of a Integrated Manufacturing Line (as it is named in the factory) that produces the third idle gear in the Renault Factory sited in Seville in order to find out the true capacity of the line and to make improvements leading to a better behaviour of the system. The item produced is one of the parts manufactured and put by the company into the Renault car gear boxes. To construct the models two approaches have been used: a continous system dynamics model and a discrete model using a interactive and user friendly simulation package, named WITNESS.

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The Application Of A Hydro Electric Production Simulation Model

This paper presents different applications for a system dynamics simulation model representing the technical aspects of hydro electric production. The base model, developed for a Norwegian utility company, original was designed to improve understanding of a complex, technical system in a group of non technical decision makers. Experience showed that the applicability of the model was more substantial than expected. Based on the original core model a number of applications where developed meeting as different demands as decision aid for daily production planning, learning aid for new operators, evaluation of capacity expansion plans, inspection of system parameters and measurements quality and to assess the value of future production potential

The paper describes the core model and how this core were expanded and used in a number of different applications. The development as well as the use of the applications are discussed.
The model structure can be easily adapted to represent other hydro electric production sites and to support other applications. We are presently in the process of adapting the model for a Colombian utility company to assist them in determining the company's value.

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The Fundamental Equation Of Neo-Classical Economic Growth Reconsidered

This paper offers an original model that enables to reconcile growth and long cycles as well as growth and sustainable development. The theoretical equations generalise the fundamental equation of neo-classical economic growth (FENEG) corresponding to the equation (6) of Solow's (1956) original paper taking account of unemployment, resource rent and natural capital in a closed economy. This model grasps the hypothetical law of motion of advancing capitalism that subsumes multiple historical patterns and enable to project future events. The state variables are relative wage, employment ratio, man-made capital-output ratio, the share of environmental investments in net output, real natural capital-output ratio and desired natural capital-output ratio. This law generates endogenously the long waves (Kondratiev's cycles, in particular). Stylised facts and simulation experiments by POWERSIM support the given analytic presentation.

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An Eigenvalue Approach To Feedback Loop Dominance Analysis In Non-Linear Dynamic Models

The purpose of the System Dynamics method is to study the relationship between structure and behavior in non-linear, dynamic systems. In such systems, the significance of various structural components to the behavior pattern exhibited, changes as the behavior unfolds. Changes in structural significance, in turn modifies that behavior pattern, which, in turn, feeds back to change the relative significance of structural components. We develop a mathematical framework within which we can study the characteristics of this feedback between structure and behavior. This framework is based on a piecewise linearization of the system model, a decomposition of the behavior pattern exhibited using

eigenvalue analysis, and an identification of the relative contribution of each of the loops (links) in the model to each of the elementary components of the behavior and thus to the total behavior. This work is an extension of the work by Nathan Forrester and Christian Kampmann on the use of eigenvalue analysis in system dynamics. The mathematical framework developed has been implemented and tested in the form of computer algorithms.

Using this method, we can classify, at any point in time, the feedback loops (or links) in a system with respect to their relative significance to the system behavior. This allows us to interpret structurally the behavior exhibited. Moreover, the method is a key to managing such systems since we can rank the loops (or links) and identify those that contribute most significantly to the behavior in a favorable or in an unfavorable way. Consequently, we can identify the loops (or links) to strengthen and weaken, respectively, as a basis for our management of the system.

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The Hard Core Of The System Dynamics Research Programme

The idea of this paper is inspired by Lakatos' theory of science. Lakatos calls the set of basic assumptions underlying a research programme "the hard core" of the programme, which is the defining characteristic of the programme. In this paper, we attempted to identify the hard core of the system dynamics program, and illustrated its coherence; through presenting the hard core as a multi-level pyramid of basic assumptions, where each level in this pyramid sets a foundation on which the upper levels rest. We then discussed each assumption in details. Moreover, we discussed the most controversial issue in the programme, which is the validation issue. We found that it is directly related to the incommensurablility concept as defined by kuhn's theory of science. We also identified the principal outstanding problem in the system dynamics programme, which is to fully understand the mechanisms of the hidden meta-loop between structure and behavior.

We think that the research to identify the hard core is very crucial in understanding and evaluating the system dynamics research programme; as many of the criticisms of the system dynamics research programme stemmed from a misconception of the hard core of the programme.

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Simtrans

SIMTRANS (for SIMulation of TRANSport)is a model based on the System Dynamics approach, meant to analyze transport policy scenarios in various economic contexts.
Containing numerous non-linear feedback loops, this model simulates the possible dynamic behaviors of the French transport system of goods and merchandises. It includes and describes the links - both quantitative and qualitative - between offer and demand of such transports.
The tool is well suited for forecasting analysis :
- introducing a very large number of controllable variables,
- showing the dynamic links and arborescence between variables, thus developing a clue to the understanding of the why and the how of the system's dynamic behavior and scenario results,
- permitting a good test and analysis of the influence of qualitative changes.
A thinking tool rather than simply a forecasting one, SIMTRANS gives a new and different look at transport policies. And it opens new paths for research, by developing a deeper knowledge of behavior modes and reactions specific to the world of transports, which could not be apprehended by sheer quantitative data.

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Modeling An Organization From The Knowledge Point Of View

In order to study if an organization´s objectives can be achieved by its actual structure we can build up the model of this organization. Models and simulation clarify the relation between the behaviour of the most significant variables, the structure and the policies that govern the system. This modelling process can be developed from many different perspectives. An organization can be saw as an adaptative system, something that must learn to integrate in new circumstances, where information is acquired, integrated, used and refused continually. All those information processes through the organization´s services or products developing processes constitute the organizational knowledge system. Thus, the model is built from a knowledge point of view.
The first decision done when an organization´s model is built up from a knowledge point of view is which are the knowledge levels or the states that guide organization´s behaviour. And what are the links between those knowledge states and other governing

variables of the system.
In a wide range of cases Acquired, Investigated and Applied knowledge are suitable states to build the first approach of the model.
Simulating such a model can help to study the consequences of different policies: more time to acquire knowledge, more time to investigate knowledge or more time to apply knowledge, different recruiting policies, objectives definition, etc.

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Land, Water, Pollution And Production In Agricultural Development: The Case Of "GAP"

In this research, the potential problems of a regional development project (Southeastern Anatolian Project - GAP) related to land use, land degradation, water resources, agricultural pollution and production are analyzed in systems perspective. For this purpose, the dynamic simulation model GAPSIM is developed. GAPSIM simulates the development rate of irrigation schemes, hydropower production with respect to irrigation releases, water availability on farmlands, crop selection and production, salinization, pesticide and fertilizer consumption, rangeland and forest quality and urbanization and population dynamics in GAP during 1990-2030.
The reference behavior of GAPSIM points to many problems. According to the model reference run, increased intensity of the most evapotranspirant crop cotton on fields causes significant water scarcity, which hinders development rate of irrigation into new acres. Also, water diversions to farmlands decrease and inhibit crop growth. On the other hand, increased monoculture cultivation of cotton leads to increased pest density on farmlands. Pesticide application rates gradually increase in order to sustain yields.
Two factors have considerable effect on water availability, arable land use, agricultural pollution and agricultural production. Both of these scenario analyses related to "attitudes in crop preference" and "rate of land transformation" imply democratization of irrigation through improved infrastructure and farm extension practices. First, a significant improvement in system performance is achieved if those attitudes in crop preference which create bias towards monoculture cultivation of traditional crops are altered and rotations of new crops are stimulated. Secondly, if all farmers are assumed willing to transform their rainfed farm systems whenever water is available, more lands are irrigated and the cropping intensity of the most evapotranspirant crop cotton is hindered as water delivery per individual farm is decreased.

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Engaging Sutdents In Powerful Learning Experiences

For over ten years now, K-12 educators have been utilizing system thinking and dynamic modeling in classrooms across the United States. Applications vary greatly and have been implemented in many areas of the curriculum and at every grade level. No matter the topic or the age of the students, reports of success are consistent. What is basis for these enthusiastic reports? Is it the use of technology? Students certainly enjoy the unique use of computers. However, the attention to task and the learning results seem to occur even in connected activities that do not require the computer.

Exploration of dynamic complexity is a highly motivating learning experience for students. Their learning is enhanced by the "real" nature of the problems that they explore and the sense that they are developing skills that will prove useful throughout their lives. The merging of system dynamics and the characteristics of effective instruction creates tremendous potential for engaging students in powerful learning experiences.

Research shows that instructional settings that optimize learning should be student-centered, experiential, holistic, and authentic. In addition, students should be provided opportunities to utilize many forms of expression, to reflect, to interact with other students, and to collaborate. Learning should be developmental and should involve the construction of ideas and systems. (Zemelman, Daniels and Hyde, 1998) Effective applications of systems thinking and dynamic modeling include all of these characteristics. What appears to be most successful is an essential combination of the powerful concepts and tools of system dynamics with best practice in instructional strategies.

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Mental Models And Decision Making In A Dynamic Health Care Environment

Forty-two senior managers (20 MD trained and 22 MBA trained) from two large managed care organizations were asked to make a series of strategic business decisions in a simulated (and dynamic) health care environment (Risky Business – developed by High Performance Systems). One half of the managers in each group (MD and MBA) were given a stable environment, characterized by constant levels of competition and stable economic conditions.

The other half were given a turbulent environment characterized by aggressive pricing and quality improvements by competitors plus changing economic conditions. Each manager in each group was asked to make decisions that maximized the goals of financial performance and quality of care. In the stable environment, eight of 21 managers (2 MDs and 6 MBAs) using primarily feedforward decision control strategies (Brehmer, 1990) were able to stay in business for the full 20-year period of simulated time. In the turbulent environment, two of 21 managers (1 MD and 1 MBA) using financial mental models, were able to stay in business for the 20 years of simulated time. Mental models (financially-focused, quality-focused, balanced) of both successful and unsuccessful managers constrained task performance depending upon the degree of turbulence and the control strategy employed.

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Learning To Cope With Complexity: Management Teaching Supported By System Dynamics Models

Coping with complexity is at the heart of management. As the environments of organizations have become more turbulent, the question how management can be learned and taught has grown in importance. Given this issue, case-study-based teaching has penetrated business schools all over the world.
The authors propose that
a) Simulation models are, in principle, a necessary and essential component for effective case-study-based teaching on general management, in many domains of operations and strategy;
b) System Dynamics models can and should play a crucial role to improve case-study-based teaching in these areas.
The first proposition is grounded in the Conant/Ashby-Theorem (Conant/Ashby 1981). The second proposition is based on the specific strengths of the System Dynamics methodology, which is particularly suited to the modeling of issues faced in managerial contexts.
In a cooperative venture between The Institute of Management at the University of St. Gallen, Switzerland, and BRB Consulting Ltd., Salisbury, U.K., a case study with a System Dynamics model implemented on the VENSIM software (from Ventana Systems Inc., Harvard, MA) was developed. The case was used in the context of a management course for approximately 250 business school students in their third year of studies. To facilitate the interaction with the model, an interface was designed, based on the

SABLE software (from BRB, Salisbury, Wiltshire, U.K.). However, the students had access to the full model, including diagrams and equations. This paper reports on some of the experiences and insights gathered from this application.

Is The LYNEIS-Model Reproducible?

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A common method of validation in many empirical sciences (i.e. physics) is trying to reproduce the results of other scientists. On the enterprise level this approach is used in system dynamics almost exclusively for that part of industrial dynamics which is embedded in the beer game. We try to reproduce the results of one of the more complex models of business dynamics (LYNEIS 1980). Our paper is structured as follows.
We show that we could get the same results for some building blocks of the model using POWERSIM (whereas LYNEIS used DYNAMO). Next we investigate variables connecting different blocks and discuss some explicit and hidden assumptions. Here we argue that the model equations developed in the chapters of the book (building blocks) are different from that contained in the DYNAMO computer program. Assuming that the real complex LYNEIS model is embedded in the computer program we translated it into POWERSIM. The simulation of the complex enterprise model presents patterns of instable behaviour (a phenomenon similar to national economic models). We discuss some problems and possible reasons. Finally we propose a reduced model structure based on causal relations of the German Betriebswirtschaftslehre (as a more complex body of knowledge than the microeconomic theory of the firm).

CILE: Co-Operative Interactive Learning Environment

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For a company that is looking to engage new managers from outside or to promote from inside white colour personnel and to train them rapidly and efficiently is getting a crucial problem in the high level job mobility situation today present in Europe. In order to make productive, as soon as possible, new managers, specific training courses (held both in classroom and/or at distance) are filled out.
A successful training path aims to achieve the following goals:
- to teach quickly general base management arguments together

with a systemic view of the overall company business area stimulating strategic plan definition oriented to pursue a financial and economic long-term equilibrium;
- to motivate the best actions in order to keep general business management objectives within both stable and changeable organisation environment;
- to promote expertise exchange process encouraging a co-operative management philosophy.
In order to favour successful training process, a Co-operative Interactive Learning Environment (CILE), based on System Dynamics methodology and Flight Simulator concepts, has been developed.
CILE is a multi-users learning environment focused on:
- teaching simultaneously, to different managers, the main concepts of overall company management, putting in evidence the different business area (production, marketing, accounting, ….) variables relationships;
- allowing to assign to learner a manager role (production, marketing, accounting) and so, giving to each role the possibility to evaluate, in co-operation with others, decision impacts in different area of action,
- dynamic and continue mapping of knowledge and changing management vs personnel motivation and needs.
The aim of this work consist both in describing CILE general architecture and in explaining its potentialities within manager training courses.

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The Diffusion Of System Dynamics In Italy

In 1996 S.D. Conference in BOSTON there has been a presentation in which the characteristics of where, when, why and how S.D. is present in Italy was analysed. The paper also presented the objective and activities of SYDIC (System Dynamics Italian Chapter).
In this paper we intend to detail the above research not only with updating the past data but mainly to analyse, through the System Dynamics methodology, the process of diffusion of a methodology (particularly focused in analysing S.D. approach itself) in a country such as Italy.
The process of diffusion of a methodology is complex. Above the tangible variables such as number of university courses in which the approach is taught, number of industrial application successes promoted, creation of work groups and work shops on the argument, etc. there are a number of qualitative variables that

influence the positive or negative trend (for example the general environment culture, the story of the methodology in the specific environment, the real interest of academy corporation on the approach, etc.). The work will try to analyse, in general, main (tangible and intangible) relevant variables concerning the diffusion of SD in Italy, and related feedback loops in order to better focus policy levers on which one can act in order to better enhance the process.

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E-Company: A SD Model To Evaluate Marketing On Line Investment

Electronic Commerce, Marketing on line, Network economy, … seem to be today keywords of success. But how many managers effectively know about the cost and benefits of starting to sell their products and services through the Web ? How much they should invest at the beginning and how long does it takes to have a break-even point of their investment ?
In order to give a support in better understanding the process of web marketing and so to have more elements to decide to "dive" or not in this virtual world a System Dynamics model has been developed. The model has the aim to support strategic decisions, for company involvement in E-commerce, pointed out to guarantee sustainable growth and medium-long term success.
The project of E-Company, which includes also a detailed training course on the argument, analysed the whole process of investment in building and maintaining a web site, taking in to account the main variables of the E-commerce.
Through a case study a SD microworld model has been developed. The model gives the opportunity to users to evaluate different what-if analysis through the simulation period time (2 years) at each model step time (4 weeks).
The paper will explain the overall architecture of the model and will present some results of use of the model with different conditions.

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Presentation

Systems Dynamics Model Of Collaborative Decision Making With Information Technology Tools

How do tools and attitudes affect collaborative decision-making? Information technology provides tools which enhance communication and collaboration for virtual teams working in complex decision systems. A before- and-after survey of virtual teams who designed a distributed decision-support environment identifies two distinct communication tool preferences: pro-information technology and anti-information technology. One participant type showed decreased preference for online tools which automatically create structured archives of data and information; the other participant type showed an increased preference.

If some team members don't prefer (and won't use) communication tools which automatically create structured data, then the development of data, information and propositions leading to team decision making may be slowed. Having a team develop a systems dynamics model of its decision system should improve each member's understanding of the effect tools have on process, and thereby performance of the system. This should improve adoption of those communication tools which enhance the decision process.

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Designing Product Launch And Pull Out Policies For A High-Tech Product Family

Successful management of a multi-product hi-tech business is becoming an increasingly difficult challenge to companies in today's competitive and dynamic business environment. Due to technological improvements, and changes in buyer requirements, products do not remain in the market forever, and, hence, have limited life. As a result, products progress through the typical life-cycle stages of introduction, growth, maturity, and decline. The rate of this progression is significantly impacted by changes in economic conditions, business strategies, and competitor reactions. In the presence of limited life and dynamic movement of a product over its life cycle, the challenge for the company is to formulate robust product launch and pullout policies so as to achieve market performance objectives.

To capture these complex relationships, a system dynamics based model is developed and is calibrated to a hi-tech company that introduces newer product generations (belonging to the same family) in the market, hence substituting for the older product generations. The model portrays very important and practical issues such as “impact of early introduction of a product upon short and long term market performance measures”, and “trade-off between continuing to improve existing products versus introducing new products”.
The paper starts with a brief introduction of the concepts involved, followed by a presentation of the current state of research. In the next section, typical model behavior is discussed and important questions are raised and answered. Furthermore, importance of work to the industry is discussed. Finally, future research direction is set.

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The Bb-Tool Management Flight Director

The BB-TOOL® was presented as a template in the 1994 Stirling conference. Since that time it has developed to a full grown microworld covering quantitatively the business planning of a process-owner. The BB-Tool® is a generalised stock and flow-model of the Process-Chains of a business unit. It allows simulation of dynamic business evolution over as long timehorizons as necessary to support validations of operational planning, including cost. The inherent simplicity of a stock and flow-model supports to simulate business-units with a standard model-structure using mean values instead of discrete order-processing, this allows in addition to delineate a business-unit top-down with free choice of aggregation scale.
The BB-Tool® (BB = basic business) comprises the four basic functional parts of the Process-Chain: Supply_Production_Sales_Control: This generalized concatenation of the main process-chains modeling a business-unit is initialized for a specific business-unit by a total of 41 parameters:
Costs
13 parameters based on available cost-infotmation
Scenarios
orders received and customer-repair-claims as a function of time, 4 parameters
Control
Control-parameters defining dynamic-chaining of process (17 parameters) and initializing values for the stocks (7 parameters) Inputs of the Process-Owners during a simulation run.

Problem diagnosis and validation of alternatives to solutions in an ongoing operational Budget-Meeting would be a vision of the Tool in action. An important part of planning and timing actions is proactive quantitative analysis of problems evolving with their timing. The BB-TOOL® supports such analysis with simulation of the timewise evolution of the business considered for the scenarios (e.g. development of orders received) to be planned for.
The interactive simulation capability of the BB-TOOL® in stand-alone-mode provides you with almost on-line evaluation not only as a backup of plannedm scenarios (usually prepared for e.g. with planning routines on your IT-System) for a meeting, but also for new cases developing in the course of the meeting itself. This flexible simulation capability will support quantitative analysis of problems for a wider timehorizon F235and practically any business scenario considered. What you gain is fast quantitative access to validated what_if_business-development-trajectories, a lot more than the usual what_if_results for business-situations taken at a time-instance.

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Technology Benchmarks For Sustainable Economic Growth

An economic growth theory model is developed in which worldwide economic and population growth is optimistically assumed to be increasing in current population-and-economy size, but degradation of environmental quality can cause eventual population-and-economic collapse. The existence of an environmental technology time path that guarantees sustained growth (dY/dt = 0) is proven. is labeled a technology benchmark, a time path of environmental technology in use that society must achieve to ensure against population-and-economic collapse. The World3 global simulation model, developed by an interdisciplinary team of scientists to analyze global growth and its relation to environmental issues, is used to derive estimates of the requisite time path for several key technologies. The estimated time paths are compared with available information on actual rates of technological change. Such technology benchmarks could serve as measurable goals for national and international policy.

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Business Simulation For Daily Decision Support: A Case Study

This paper will describe a practical way to use System Dynamics as a daily tool in business planning processes. It is a case study paper and shows how we as consultants supported a customer in resolving a number of critical factors in their business plan by doing a number of small and focused models in ithink. This approach was new to us compared to previous modelling processes [1,2,3] having turn-around times for fact finding, verification and joint modelling sessions for weeks to come up with commonly accepted models.
The paper describes our methodology exemplified with a number of critical issues for our customer and the relating models that gave us insight.

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The Dynamics Of Corporate Knowledge Management

The decade from 1985 saw dramatic reform of the Australian federal public sector, including devolution of responsibilities to State and Local Governments, privatisation of government business enterprises and outsourcing of non-core support activities. Arguably, the Australian taxpayer has received improved value for the tax dollar. However, our research and consulting experience with government organizations suggests that there have been substantial losses in "corporate memory", not simply in peripheral areas (which is to be expected given the functions that have been shed) but in core policy development and strategic planning fields. This paper derives from management consulting and applied research for federal government agencies focussing on knowledge management and competitive intelligence in regard to client perceptions. The research and associated dynamic models give insight into the development, maintenance and decay of the knowledge assets of public sector organizations. They build on, inter alia, Thomas Stewart's work on intellectual capital and Paul Strassmann's insights on measuring and managing knowledge capital. The application of system dynamics to this field facilitates a move from a reactive to a pro-active framework for strategic planning and in particular provides insights into the implications of outsourcing proposals. This work has relevance for

the development of public policy in that it enables people to understand the challenges in corporate performance measurement and management by exploiting the causal links between corporate knowledge, customer satisfaction and business processes.

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Educating Business On Sustainability - Why Most Attempts Limit Their Own Success

Many traditional education programs on business sustainability involving provision of pamphlets and case studies have resulted in only minor improvements in the businesses targetted, despite the energy and enthusiasm of Project Officers and the willingness of business to be involved. This paper explores why this is the case and shows that many programs have unintentionally limited their own success. Suggestions of how systems approaches can help prevent this are highlighted. (For further information on the redesign of education programs see related paper presented).

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Why Is The Move To Sustainability So Slow? Understanding The Relationship Between Government, Business, The Public And Its Impact

There is a complex relationship between government, business and the public that results in a drifting goals archetype and little progress towards sustainability. This presentation explores the relationships involved and how systems approaches may assist in increasing the speed at which we achieve sustainability.

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Redesigning Education Programs For Business Sustainability

Traditional programs on business sustainability have had limited success. They have a linear underlying assumption that sets up a fixes that fail scenario and results in serious negative unintended consequences. This paper explores the situation and highlights how systems tools could be used to help redesign education programs for business sustainability.

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Study On The Optimization And Development Of Tanjung Emas Container Terminal (TECT) In Semarang Using Powersim Dynamic Model Simulation

Objective of the study is to provide the management with the tool to control the services of its performance. It can predict and reflect the effect of terminal's improvement to the services performance.
Service's performance of the terminal are affected by many factors such as equipment, manpower, system and procedure, number and size of ship, and many others. To represent the relation between those factors to the services, a system dynamic approach is used. The approach will show the effect of any changes of those factors to services performance, to the whole performance and to the performance of the specific factor.
To run The System Dynamic Approach, a computer simulation application program called Powersim and the cost analysis model are used. The variables used for the model are the piloting and tugging time for incoming and outgoing ships, cycles time for each container handling equipment (i.e. Container Crane-CC, Rubber Tired Gantry-RTG, Top Loader-TL, and Side Loader-SL), Head-truck's headway at each equipment, container loading-unloading volume per ship per type (full container/empty container), container receiving and delivery in container yard, operation cost and invesment of each equipment. These input data are formatted in a distribution function. The result of the research will be the optimal configuration of the whole container handling equipment.
To meet the forecasted container demand of year 2000 to 2010, the optimal equipment configuration and the facilities required will be the basic of the container terminal development program.

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Using System Dynamics And 3-Dimensional Visualization To Explore The Dynamics Of Future Global Protein Consumption

Strategic decision making is particularly difficult relative to research investments, where the uncertainty inherent in research and lengthy time lags requires investments to be made far before outcomes are known. This paper reports upon the development and evaluation of the Protein Consumption Dynamics (PCD) system, a tool created to assist managers to improve their perspective of future protein needs. This research effort was

funded by the Illinois Soybean Checkoff Board to aid them in strategic allocation of research funds.

The PCD system includes a Powersim model, the output of which is displayed using a 3-dimensional visualization software package, In3D. The system dynamics model component relates population and income growth to regional protein needs and malnutrition. The model tracks estimated consumption annually (for the years 2001 to 2025) of six agricultural commodities that serve as sources of protein for humans in eight regions that encompass the world. The system dynamics model is designed so that alternative scenarios of the future can be examined using population and income projections of the World Bank and the UN's Food and Agricultural Organization.

The output of the system dynamics model is displayed using 3-dimensional visualization techniques. The visualization component was developed in collaboration with design experts from the National Center for Supercomputing Applications at the University of Illinois.

Through formal experiments with actual manager in the soybean sector, the effects of use of the PCD system are being formally evaluated. This evaluation documents the effects of scenario modeling and visualization on individual and group decision-making processes.

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Real Exchange Rate And Labor Market: A System Dynamic Approach

The way from a close economy to an open one has several implications about the behaviour of different economic variables. Especially, the influence that decisions of free trade have on the employment is important, if as objective of economic policy is pursued full employment and well-being. In this work, we attempt to analyse how the liberalisation of the markets influences the activity rate of different productive sectors of a small economy, as well as, on the employment. For this, we have built a dynamic model, using system dynamics methodology, that collects different aspects of the labour market. The results obtained by the model are compared with the real data for the Spanish region of Castilla y León, during the period 1980 - 1990, for thereafter, to analyse the impact that on the variables of the labour market could have had other measures.

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A Group Multicriteria Decision Aid And System Dynamics Approach To Study The Influence Of An Urban Toll And Flexible Working Hours On The Congestion Problem

The effect of an urban toll and flexible working hours on traffic crowding in cities is analysed by means of a framework based on a methodology in which system dynamics and group multicriteria decision aid are combined. The basic model, which extends a congestion model described by K. Small, examines the behaviour of driving car commuters with respect to their home departure times to office during the morning rush hours. Several strategies for urban toll combined with working time flexibility are investigated as well as the possible use of the benefits induced by the toll for transforming the vicious circle of crowding into virtuous circles, e.g. promoting alternate transport means.

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Long-Term Individual And Community-Level Effects Of Incarceration Of Drug Offenders: A System Dynamics Approach

The utility and feasibility of a system dynamics approach in guiding incarceration policy for drug offenders is explored. A system dynamics model that examines the long-term effects of incarceration on both the individual offender and the broader community will be developed. The model will study the long-term feedback between incarceration and the social productivity potential of the individual and the effects on the community. Both the crime-inhibiting and crime-enhancing effects of incarceration will be explored. Using a system dynamics approach the interactions between the deterrent, incapacitative, rehabilitative, replacement and social disorganizational ("broken windows") effects of incarceration and the positive and negative effects of incarceration on the community will be explored. We are especially interested in exploring the sentencing policy implications of our model on communities that have been severely affected by drug problems. The methodological advantages of a simulation-based system dynamics approach over standard regression-based approaches in studying the long-term impacts of incarceration policies are discussed. The role of system dynamic concepts such as non-linear threshold processes and feedback in developing a theory of criminal embeddedness will be explored

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Using System Dynamics To Facilitate Stakeholder Interaction In Water Resource Management

This paper discusses a study testing the potential of system dynamics to facilitate stakeholder interaction in the management of the Las Vegas, NV water system. The Las Vegas water system serves one of the fastest growing metropolitan areas in the U.S., located in one of the country's most arid regions. Already at 1.3 million people, the population has been increasing by 5,000 people per month for the last decade. All sewage effluent from the city, shallow subsurface groundwater, and stormwater drains via a 12-mile natural wash to Lake Mead, discharging into the lake six miles upstream from the city's drinking water intake. This physical loop in the water system makes understanding the dynamic connections between urban development, ecosystem change, and water quality trends especially important for water management. Over 20 local, regional and federal entities, as well as local businesses and residents, have interests in this water system, each identifying different system characteristics as problematic. Management challenges include identifying and addressing diverse stakeholder objectives and communicating information about the dynamics of the interconnected urban and environmental system. To test the potential of system dynamics to facilitate stakeholder interaction, we have developed a series of progressively more complex stock and flow models representing the water system. In a series of workshops scheduled for spring 2000, we will evaluate the utility of these models and the effectiveness of the approach. This paper will discuss the findings from the workshops.

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Supply Chain Management: Software Solutions Versus Policy Design

Supply Chain Management (SCM) is becoming more and more popular. In the context of an European Research Project (DELPHI Project No. 26965) a field survey of 644 companies in Europe shows that only 14 % of these companies haven't heard anything about SCM and more than ¾ intended to engage in SCM improvements within the next three years.
As interviews carried out all of the interviewed companies use a

software system supporting production planning and control. However, more than 90 % are not satisfied with it and mention significant weak points. Hence, most of the companies seem to intensify their SCM activities because of their disappointment with the results provided by their MRP or ERP software system. They assume that they will solve all or most of their problems by expanding the existing software solutions with components of SCM software. Although, this belief promises a further increasing business for software manufacturers, it seems to be doubtful whether the solely software solution brings the success the companies hope for.

Therefore a system dynamics model of a supply chain with 4 stages is developed based on Forrester's work presented in his "Industrial Dynamics" (Forrester 1961). Using this model, different strategies to improve performance of the supply chain are implemented in the model and simulated. Assuming that the integration of software systems along all elements of the supply chain will improve the quality and speed of information flows, the simulation shows lower cycle time and cost. SCM, however, has a much bigger success potential as further simulations show. If the elements along the supply chain coordinate their order und delivery policies and stay with these policies, they will outperform pure software solutions easily.

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Rubrics For Understanding

A group of K-12 educators have developed a set of rubrics for assessing the understanding generated by the use of system dynamic tools. These rubrics were used at the DynamiQUEST exposition for grades 5-12 students in May of 2000. This is a presentation of the rubrics which includes standards for behavior over time graphs, causal loop diagrams, stock/flow maps and system dynamic models as well as an over-arching rubric for assessing the understanding generated by the use of these tools. Feedback from those who read the rubrics is sought to enhance efforts to bring standards to the use of system dynamics in K-12 education.

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Building System Dynamics Skills In K-3 (Ages 5-8) Students

Over the course of the last five years, teachers in K-12 education community have gradually developed a series of games and activities appropriate for generating system dynamics understanding in the youngest school-aged children. A number of these activities will be presented along with examples of how they can be used in classrooms and with individual students. The materials presented are available on the Creative Learning Exchange website (http://www.clexchange.org)

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A Study On Process And Conditions Of Business Flotation Model Using System Dynamics

The purpose of this study is to clarify the success process and factors of a business flotation, using system dynamics method. It will be helpful to support the decision making for an entrepreneur if the person should take a step forward to the flotation or not.
Recently in Japan, the promotion of business flotation has been one of the major problems to be overcome the extending recession over a long period. However, the flotation by one-man or small group is very difficult. As the obstacle, it is pointed out the social customs; once someone fails to the flotation, it is hard for him or her to challenge again. Accordingly, it is expected to study this topic now in Japan.
To pursuit those aim, we will show them in the following procedures, exampling one-man enterprise in Japan. They are, firstly to build the model about some business systems and patterns of the flotation process using flow diagram, secondly to describe the mechanism to optimize the resource allocation, and finally to simulate the above models under the various conditions utilizing the database opened on the Internet.

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Bathtub Dynamics: Preliminary Results Of A Systems Thinking Inventory (Workshop)

Educators, business leaders, environmentalists and scholars are calling for the development of systems thinking skills to improve our ability to take effective actions in these times of accelerating change. Through courses in the K-12 grades, universities, business schools, and corporations, advocates of systems thinking seek to teach people to think systemically. These courses range from one-day workshops with no mathematics to graduate level courses stressing formal modeling. But how do people learn to think systemically? What type of skills are required? Does a particular type of academic background improve one's ability to think systemically? What systems concepts are most readily understood? Which tend to be most difficult to grasp? We describe initial results from an assessment tool or systems thinking inventory, consisting of brief tasks designed to assess particular systems thinking concepts such as feedback, delays, and stocks and flows. Initial findings indicate that subjects from an elite business school with essentially no prior exposure to system dynamics concepts have a poor level of understanding of stock and flow relationships and time delays. Through the inventory, we hope to provide a means for testing the effectiveness of training and decision aids used to improve systems thinking skills. We discuss the implications of these preliminary results and explore steps for future research.

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Systems Thinking Story Workshop

As Sir Geoffrey Vickers once said, "System is an old word. The Greeks were using it more than 2,000 years ago to describe `a whole composed of related parts.'" Story-telling, similarly, is the oldest form of systems simulation. Children, in particular, remember what they hear through stories.

This workshop explores how children's stories that embody systems principles can be used as part of systems thinking educational efforts.

It is based on a semester-long pilot study conducted with fifth grade students as part of my doctoral work at Harvard's Graduate School of Education. Through this research, I discovered that many stories embody linear event-and-reaction relationships; the

characters' actions never have unexpected changes, and the plot moves forward from beginning to end, as if "setting us up" for linear, non-systemic, non-ecological thinking. But I also found a growing number of stories that embody systems principles and archetypes. In this workshop, we will review the basic story line of several childrens' stories from around the world, surface targeted systems concepts within each story and identify practical "debrief" questions for educators. Please come prepared to read out loud and to share your own "systems thinking stories".

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Presentation

Complex Issue Structuring And Micro-Strategy Testing In ERP Environments

In the mid 90's, the concept of Balanced Scorecard has spread globally.
In parallel, ERP systems began to interconnect the business system via IT.
There was a need to provide decision makers with a synthetic, visual and structured way of assessing corporate performance and of enabling a better strategy formulation. This was made by extracting information from corporate information warehouses, ad structuring them in 'war rooms', where decision makers could 'live with' key performance indicators and feed their decision processes with them , supported by the corporate IT database.
The author will present an integrative methodology for adding value to those sessions, bringing in systems thinking tools and small system dynamics simulations as cathalysts for issue structuring and micro-strategy formulation and testing processes.

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Facing The Upcoming Crisis In Social Security System Of Iran

The social security system in Iran is facing a serious financial crisis. Whereas both revenues and spending in the system are growing, the growth rate of expenses has become much higher than that of revenues. Experts believe that the expenses will exceed the revenues in the next five years. The challenge in the upcoming crisis is then to put off the break-even-point. This paper reports an ongoing project in the social security organization that aims at how the organization can collectively develop effective policies for avoiding the financial crisis. A system dynamics model is developed to investigate the effect of various policies

such as the pay-as-you-go approach and actuarial system on the dynamics of resources.

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The Diffusion Of Goods Considering Network Externalities: A System Dynamics-Based Approach

The diffusion of goods showing network externalities differs from that of conventional products. In particular, two effects are important: the bandwagon and the penguin effect. An incrementally refined system dynamics model helps to understand this special diffusion process better. Leverage points for the management of such products can be identified using simulation results.

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Object Oriented Design Patterns And System Dynamics Components

The software engineering community uses an Object-Oriented Analysis and Design (OOAD) methodology to define, design and build software systems. The tools and trade of System Dynamics is heavily dependent upon software to successfully model and solve problems. This paper explores the Object-Oriented concepts of “patterns” and “classes” and how they relate to System Dynamic “models”, “components”, “molecules”, and “archetypes”. Specific examples will be discussed with similarities and differences as well as strengths and weaknesses and areas of application.

In the Object-Oriented world, design patterns capture generic solutions that have developed and evolved over time and describe them as structures or objects for reuse. These solutions are the subject of untold redesign and re-coding as software engineers have struggled for greater reuse and flexibility in code. Some design patterns can be used “as is” to form solutions or parts of solutions, while others serve as generic templates that can be refined into concrete solutions.

The term component (cf. Myrtveit 2000) is used for a model “class” that can serve as a building block when creating model “objects”. Components have interfaces defining the variables that carry information between the components and the rest of the model. Design patterns can be used both to implement and to document components.

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Innovative System Dynamics Approach To Sustainable Development

System Dynamics method was reformulated in terms of the dynamic tendency balance in any social-ecological-economic system, associated with the sustainable development problem. It permitted very feasible and efficient use of the standard system module for the transformation of causes and consequences linkages into a set of model's dynamic equations, based on influence functions. Scenarios of the sustainable development were presented as a cumulative effect of external forcing applied to any subsystem and propagating inside the whole system through influence functions. Adaptive stochastic method for the determination of influence functions was suggested. Another one extension of the System Dynamics method was made by observational data assimilation technique, supplementing the set of dynamic model's equations.

These innovations allowed to propose a general informational technology for sustainable development resources management - Adaptive Dynamic Balance method (ADBM). Various practical applications of ADBM were discussed. Among them: the problem of decision-making support in changing market economy conditions, natural resources management, human-environmental interactions and others. General conclusion was made, that ADBM could be used as a conventional operation research tool for sustainable development problems solving.

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A Study On Learning Theory Of Management Flight Simulator

For learners, the learning objective of management flight simulators (MFS) should be to acquire the capabilities of coping with the dynamic complexity situation. Some literature show instructors use this method and tools to do business training or school teaching experiments, but results are that learning effectiveness is behind their technology development. Learning effectiveness is not good enough as researchers expected learners to conceptualize, challenge and improve their mental models.

Some researchers may attribute peoples' habit of try and error learning. What learners got is tacit knowledge; they are not aware of, represent or understand their mind maps. They certainly can not assimilate the systemic perspective and knowledge. Some other

researchers attribute to the limited human cognitive resource. People will develop and execute their cognitive strategy by cost-and-effectiveness analysis, but not by mental model simulation strategy. Therefore, researchers have to change learners' cognitive strategy by designing some learning assists to improve learning effectiveness. We can understand the character of human cognitive activity affects learning effectiveness of MFS significantly.

We can reorganize the before-mentioned explanations by connecting with the Learning Theory. The former explanations are predominated by Behaviorism Learning Theory (S-R Theory). They do not emphasize on the implicit process of intelligence, but focus on the MFS decision performance. Therefore, when designing a MFS learning environment, we must consider that focusing on game scores will partly deteriorate learning effectiveness. The latter explanations are predominated by Cognitive Learning Theory. Through understanding the character of human cognitive activity, we can organize some important designs to enhance peoples' abilities of recognizing, representing, reflecting and inquiring their own mental models.

According to above-mentioned reorganizing works, we begin to explore and understand learning theory of MFS by connecting practical insight of experiments with theoretical perspective. This research connects the MFS learning effectiveness issue with the Learning Theory of Behaviorism, Cognitive Learning Theory, Constructive Learning Theory, and Experiential Learning Theory. Through this exploration, we construct a theoretical framework and will develop a MFS learning program and experiment with its effectiveness in further study.

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Prescription For The 21-Century Population Problem In Japan

The rate of birth in advanced countries is decreasing while the aged population grows. In Japan, such tendency is distinctive. The birth number of 2.1 or more per each woman is said to be crucial to sustain the population in one country. This value in Japan is only 1.38, and this indicates a necessity of immediate response. We present a Japan-Population-Model to show what happens in the next century. Further, we propose the policy set avoiding undesired situations that can be appeared in the future, and introducing sustainability of a social system in the third millennium.

Not only calculating the change of population but also taking an

account of feedbacks it was possible to utilize the power of System Dynamics. We included the following feedbacks in the model: labor force, social activities, and welfare. Decreasing labor population affects economics. Decreasing youth causes lack of social activities. Increasing aged people needs more care. Increasing workingwomen needs supporting systems such as nursery schools. These feedbacks make rich insights and can also present more effective policy set, the best prescription. As a result the model has an important social impact in Japan.

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Some Issues In The Strategic Management In Fast Growing Academic Institutions: The Case Of University Of Yazd

The University of Yazd is a ten year old government owned institution. In many aspects such as the number of students and faculties and infrastructure capacity, it has been experiencing high growth rates during the first decade of its development. The focus of the university administration has been on enhancement of the quality of education and, as a result, it has received a good reputation among the students and other universities in the country. However, to achieve a sustainable growth, the management needs a shift of attention from education to research while preserving the quality of schooling. This paper discusses some growing concern of top management in making such shift to happen and describes how system thinking can help in developing a shared vision within the university for the new mission.

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Structuring Managerial Problem Situations: Assessing The Suitability Of Different Methodologies

From its origin system dynamics has been employed as a tool to find leverage points to im-prove the performance of systems. In a meta-analytic study Rouwette et al. (1999) found that the number of case descriptions of system dynamics model building studies involving the client in the process of model construction has increased exponentially over the last couple of decades. Clearly, system dynamics is more and more being used not only as a research method, but also as an intervention tool in organizations, and quite successful in a number of cases. Seen from an intervention perspective, system dynamics is not the only

methodology that is used to solve managerial problem situations. There is a host of methods and tech-niques, most notably those from the realm of soft operational research, also known as problem structuring methods. All of these methods have proven that they can be successful in structur-ing policy problems. However, it is not entirely clear if system dynamics and other problem structuring methods are equally suitable for each type of managerial problem situation.

In the past some researchers have attempted to clarify the similarities and differences between soft OR and system dynamics and indicated how one could benefit from the other (Lane, 1994). Some have even made an attempt to design a typology of problem situations/contexts and accompanying methods (see for example: Geurts et al., 1985; Flood and Jackson, 1991; Mingers and Brocklesby, 1997). Unfortunately, these typologies are too general in nature and at too abstract a level to be helpful as a guide in answering the question when to apply which methodology.

This paper addresses the latter question in more detail. It takes three different, well estab-lished methodologies which have been used widely as tools to support strategic decision-making in organizations, i.e. Group Model Building, Soft Systems Methodology, and Strate-gic Options Development and Analysis. In order to be able to answer the question when to use which methodology, one needs to systematically compare their similarities and differ-ences first. Criteria for comparison include such things as objectives of the method, origina-tion, operating procedure, the role of models, et cetera. In this paper we will deal primarily with this comparison. Our objective in the longer run is to specify criteria to make an appro-priate selection of a method in a particular managerial situation as well. We will start with a brief description of the three methodologies.

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Group Model Building: What Does The Client Think About It Now?

A recent survey shows that client participation in system dynamics modelling projects has become popular over the last decade. Typically these cases report on the effect of client's insight into the problem, communication, consensus and commitment on implementing system changes as well as a number of other important process and outcome variables. Most cases reported in the literature are descriptions of the modeling process and qualitative statements of modeling results. Authors do not set out

to assess a well-described set of outcomes of their interventions, but rather use a more exploratory approach. However, a few studies do employ a quantitative assessment of expected results. A systematic analysis of reported results would increase our understanding of how a system dynamics intervention changes clients and their organizations, and contribute to more effective design of group model building projects. In this paper quantitative evaluation results of ten cases are analysed, ith a special interest in the contribution of process elements to the overall success of projects. Our findings include the results of a previous study (Vennix et al. 1993) and adds new cases to expand the database so that quantitative analysis becomes more reliable and robust.

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The Dynamics Of Local Rules In Hospital Admission Processes.

This paper reports on research into admission practices at a hospital that provided sub acute extended care. A System Dynamics model of the patient flow through the hospital was built to show the impact of the local rules used by the medical registrar. Local rules are behaviours that are local, and often idiosyncratic, adaptations to the local environment. Such adaptations can have a significant impact on organisational performance.

In the hospital, patients were admitted from two large acute hospitals and from the community sources, into two different streams of care a within the hospital. The process by which they were selected for admission set for up the dynamics of patient flows within the hospital. These dynamics involved the acuity of the patients and the demands they placed on the medical systems within the hospital. Hospital funding in Victoria is based on length of stay and occupancy rate. The types and acuity of patients being admitted had a profound influence of these funding bases. The local rules used by the medical registrar, in turn, had a profound influence on the types of patient being admitted. The System Dynamics model demonstrated the impact of these local rules. During the process of building the model, it became clear that neither the medical registrar, nor senior administrators within the centre understood the impact of the local rules.

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Optimization Under Uncertainty In System Dynamics

The use of System Dynamics modeling and simulation as part of decision-making processes is growing. In areas such as strategy, planning, and budgeting, planners typically search for how to optimize the way organizations meet their objectives. Wallace and others have pointed out that deterministic optimization methods, even in traditional static operational research models, can produce results that are consistently wrong in a world where uncertainty plays a major role. First, we discuss optimization under uncertainty in traditional static operational research models. Then we investigate this issue in the more complex and dynamic type of models, i.e. system dynamics models, in particular with respect to the POWERSIM SOLVER 2.0. We also look at optimization under uncertainty with multiple objectives. Our research evaluates strengths and weaknesses of existing technologies, and identifies areas for further improvements.

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On Methodologies Of Socio-Economic-Eco Complex System

Socio-economic-eco complex system includes two sides of static and dynamic states, which makes it difficult to understand and solve. With this fact, we suppose that comprehensive & dynamic methodology and model sets can be introduced into the problems of large complicated scio-economic-eco system, which is a way of combining qualitative & quantitative analysis.

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The Exploration Of China SD Macro-Economy Model And Economic Cycle

A simplified macro-economy model of China is presented. Like the System Dynamics National Model of the US, the major theory and methodology we based on to create the model are system dynamics (SD) and economic theory. Another important basis of modeling is the national statistical almanacs of China. The functions of the model and its value are explained.

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Human Resource Planning In The Knowledge Society: A Dynamic Experimental Simulation Approach

In the knowledge society, knowledge may become more important than capital. The human resource will become important competition resource base. However, some methods of human resource management may not suit to the need of the knowledge society.

This study proposed that: due to the contingency factors of so call "mature time" and "nonlinear of job load", the traditional human resource planning methods may not suit to the need of the knowledge society. In the knowledge society, the mature time of the human resource may be longer than before. The nonlinear of job load is also increased in the knowledge society. However, the researches of the fields of "dynamic decision making" and "system dynamics" show that: when faced the task with time delay and nonlinear, both the decision performance and the system performance were more worse when increasing time delay and the degree of nonlinear.

This study first uses System Dynamics to build a computer simulation model. The contingency factors of "mature time" and "nonlinear of job load" are manipulated to test the impact and performance of different human resource planning methods. The simulation model is then transfer to the experimental task. The laboratory experiment method is employed to do the research. Subjects are asks to play the role of the human resource manager. That is, the human resource planning equations in simulation model are replaced by subjects' decision. Both the simulation method and the laboratory experiment method are to test the hypothesis.

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Dynamics Of Strategy

We intend that this short programme, for those in the SD community, provides teachers of management, whether in corporate or educational institutions, with the concepts and tools to communicate the Dynamics of Strategy (DynoS) perspective. (For more detail on "DynoS see Warren K, 'The Dynamics of Strategy', Business Strategy Review, Autumn 1999, Vol 10, No 3, pp.1-16 and later articels in BSR (next one Vol 10 No.4)) This perspective is becoming increasingly popular as a means of

helping students and executives appreciate the dynamic issues they face when setting practical strategy for and managing their organisations. The programme will be led by Kim Warren with assistance from colleagues.

It will cover not only the outline, approach and process issues involved in putting on full term or semester courses, but also how the frameworks and materials can be selected and adapted to serve other teaching needs. These include contributions to wider courses in Strategy and other subjects, company-specific events, and workshops focused on audiences from certain functional or industry sector backgrounds.

The programme discusses use of Microworlds, which can be used to give an audience direct experience of the added power that comes from capturing the time dimension of strategy. These exercises explore how competitive advantage builds and declines, how new business can build on the artful accumulation of resources and capabilities, how power and politics of strategic management are manifest in resource-allocation and goal- setting, how the warfare of competitive rivalry plays out over time, and how the evolution of entire industries can be understood by aggregating firm dynamics. "

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A Systems Approach To Virginia's Education Standards

In 1995, Virginia established learning standards for students in four subject areas. Two years later, new accreditation standards were also adopted, requiring each public school to have at least 70 percent of its students passing standardized tests in all four areas by 2007 in order to retain accreditation. Only a handful of schools have reached that goal after two years of testing. Political support for rigorous education standards has fallen due to a gap between expected and actual test results, thereby increasing the likelihood of new policies aimed at diluting or rescinding current standards. Using a system dynamics approach to education policy analysis, this paper critiques the accreditation policy and identifies the systemic feedback causing the unrealistic test result expectations. The study contrasts the intended system (in effect, the collective mental model of the policy makers) with the actual system that has evolved, and develops an alternative accreditation policy aimed at modifying the effects of that feedback. The elementary discussion of cause-and-effect and feedback has been retained in this adaptation of an earlier report as a reminder that the audience for

systems dynamics presentations is often untutored in the basic concepts and will reject out-of-hand solutions based on a methodology they don't understand. Since the original study was published in February 2000, subsequent education policy pronouncements in Virginia are, sadly, consistent with the behavior of the system predicted by the system dynamics model.

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Improving Requirements Engineering Modelling By Integrating Influence Diagrams Into The Unified Modelling Language

This paper proposes improving the modelling of the requirement engineering (RE) process when using the Unified Modelling Language (UML) by extending UML to include influence diagrams (ID). The advantages offered by UML are widely accepted within the software engineering community and use case modelling in UML has been used for requirements capture. The scope of UML as an explanatory tool in Requirements Engineering could be extended if ID could be incorporated within the language. We argue that both UML and IDs are strengthened by this synthesis. The deficiencies of IDs in supporting component-based modelling can be overcome by adopting some ideas from the object-oriented paradigm. UML can also gain from the well-established systems thinking / system dynamic ideas that are encapsulated in an ID.

UML has been widely accepted as a defacto standard for Object-oriented modelling as evidenced by its widespread industrial take-up. Object-orientation (OO) and use-cases are becoming increasingly important in software development but, although IDs are more than 35 years old in system dynamics, this modelling concept is new to many practitioners in the software modelling process in general and requirements engineering in particular. This paper proposes a technique for converting IDs into object-oriented reusable models. It is suggested that as these techniques do not at present exist in software development modelling processes, this 'objectification' of ID technique adds value to UML by adding the acknowledged strengths of IDs to it.

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Towards A Model Of Decision-Making For Systems Requirements Engineering Process Management

This paper presents a model of the decision-making behaviour of stakeholders in the requirements engineering (RE) process. Poorly defined requirements cause projects to fall behind schedule, go over budget and result in poor quality system specification. Many systems (software) development organisations are attempting to increase the effectiveness of the RE decision-making process by incorporating improvements aimed at better understanding, improved communication and more effective management.
Little research has been published on factors that influence the decision-making behaviour of the system's stakeholder in RE process management (REPROM). In developing such a model the paper fills an important gap in both the requirements engineering and decision-making process literature. Research in this area is vital if both requirements engineering managers and software development organisations are to cope with the rapid pace of organisational systems change and reap the benefits of an effective RE process.
The paper concludes that current management and decision-making models fail to make sufficient allowance for the complexity of requirements engineering stakeholders' business goals and aspirations in a dynamic software development environment. The paper suggests that the model provides both a foundation for theory building on decision-making in REPM and a basis for improving decision-making through the use of learning/training environments.

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Management Of The "Skills Inventory" In Times Of Major Change

Times of major change can pose extra-ordinary challenges to any organisation. Case studies investigating how companies had faced the challenges of a major change in the previous 4/5 years, and especially how they attempted to prepare their managers for their new roles, revealed that many were ill-equipped to face the task. One particular result suggested that firms that had relied only on their existing management team and/or on internal promotions had not fared as well as those for whom circumstances permitted the

recruitment of new mangers to key posts.
This observation seems to run counter to the management dictum that firms should always endeavour to hold onto their experienced staff. A simple system dynamics model of a firm's 'skills inventory' can shed light on this apparent paradox. The model indicates that in times of stability or slow/incremental change, retaining existing staff is indeed very important. However in times of major change, as the obsolescence rate of the firm's existing skill base increases significantly, importing critical skills with new recruits may be the only realistic way of boosting the skill-base to the necessary levels.
This situation is likely to have important competitiveness consequences for firms with traditionally low staff attrition rates, where growth is not creating new post opportunities, or in areas where the external recruitment market offers only limited access to new appointees with advanced skills.

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Buy-Back Contract Risk Modeling Using System Dynamics

In this paper ContractSim is presented. ContractSim is a Windows program based on a combination of system dynamics and Monte Carlo simulation techniques that can be used to perform risk assessments. A user-friendly interface has been built around a basic risk model. Before the simulator is put to use in a given project, it must be validated by experts in risk analysis to reflect the specific risk elements and dependencies in the project. The first version of ContractSim was designed to evaluate so-called Buy-back contracts, which is being used by NIOC, the Iranian national oil company when foreign companies are contracted to develop oil fields in Iran. When ContractSim has been tailored for a specific oil field development project, project management can perform risk assessments without the continuous support from risk analysts.

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Dual Economic Development And Degradation Of Ecological Environment Of Lancang River Basin

The development of Lancang River basin has shown the dual structure in that the major development efforts have been paid to the big economic infrastructure projects and mining plants from which the local rural communities can not get the most benefit.

Therefore, although substantial resources have been invested in this region, the well understood vicious poverty and degradation of natural resources cycle can not be broken. Meanwhile, the construction and operation of these infrastructures and mining industries adds new risks to the natural environment. Without preventive and proactive polices and strategies, degradation of natural resources, which in turn will impact on the life expectancies and utilization rate of the infrastructures, will be intensified. A qualitative system dynamics model, focusing on feedback analysis is built to analyzes the effectiveness of the implemented and proposed development strategies in Lancang River Basin.

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Presentation

The Predestined Fate: The Earth Nutation As A Forced Oscillator On Management Of Northeast Arctic Cod

The paper presents a system dynamics theory of the influence of the Earth's nutation on management of Northeast arctic cod. According to this theory the Earth's axis dynamically behaves as a forced oscillator on a non-linear sea system that modulates a set of harmonic and sub harmonic low frequency temperature cycles in the sea system.
The paper reports a correlation between time harmonic cycles of the 18.6 year Earth nutation and the temperature system and the biological system in the Barents Sea. The influence from the Earth nutation is explained by a general systems theory where modulated temperature cycles are forced oscillators on the biological system in the Barents Sea. The system dynamics of the biological system are synchronized to the temperature cycle and amplified by a biological stochastic resonance to the food systems. A stochastic resonance of 18.6/3=6.2 yr between the management and the biomass dynamics introduces an unstable biomass.

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A System Dynamics Approach To The Growth Of Medical Expenses In Taiwan

The National Health Insurance (NHI) program was officially launched in Taiwan on 1 March 1995. The NHI program targets all Taiwan citizens as beneficiaries. The initial balance of revenues and expenditures was stable, but there has been a deficit since 1998. As the problem is mostly caused by the payment system of

fee-for-service (FFS), the Bureau of NHI (BNHI) is gradually implementing global budget (GB) to limit the payments under FFS. This study uses causal loop diagrams and the prisoners' dilemma to explore the interlocking actions and reactions taken by the players in the NHI and their consequences. According to our analysis, implementing GB will keep the benefit payments under control as planned, but the undesired consequence is a reduction in the quality of medical care. Since better quality medical care is also one of the objectives stressed in the implementation of the NHI program, BNHI should consider its consequences befor comprehensively implementing GB.

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Operations Strategy And Environmental Management In Costa Rican Electricity Power Sector: A System Dynamics Approach

The Costa Rican electricity power sector has, up to now, been a totally integrated government monopoly. The power sector is where 35% to 47% of the total government investment has been made. De-regulation of this sector is expected to bring competition at the generation level, greater efficiency and lower prices.

In Costa Rica an electricity model showing the dynamics and feedback relationships among several variables does not exist. This adds to the expectations of how this national sector might operate when competition is introduced.

A System Dynamics model of the electricity power sector is developed in order to show the interrelationships among operations strategy issues (i.e., capacity, technology, vertical integration, quality, production planning), environmental management (i.e., losses, conservation and efficiency programs), investment, debt, prices, costs, demand, forecasts and private generation.

Confidence in the usefulness of the model is built through structure and behavior tests, including summary statistics. This confidence allows using the model to test several policy implications. A System Dynamics software is used for tuning, optimizing and risk assessing the model. Also a microworld of the Costa Rican electricity power sector is developed.

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