Proceedings of the 26th International Conference

July 20 – July 24, 2008
Athens, Greece

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Panteion University
The Hellenic Chapter of the
System Dynamics Society

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Brian C. Dangerfield
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WELCOME

Dear Colleagues,

Welcome to the 26th International Conference of the System Dynamics Society.

Last year the conference returned to Boston, the birthplace of system dynamics, to celebrate fifty years of research and practice in the field. This year, the conference pays tribute to the land of the field's intellectual foundations and philosophical roots: to the place where the systems/holistic way of thinking and living was born, to the place where the systemic approach of inquiring into the natural and social worlds started to be practiced 2500 years ago.

But Athens is not only history. Historical sites and monuments are well embedded into a vibrant modern city with a way of life where the flavours of East and West are mixed into an almost perfect combination. A short walk in the centre of Athens will uncover its multi-cultural character and tradition imprinted in images of ancient Greece, the Byzantine Empire and the Ottoman occupation, but also in the everyday life of many diverse communities. Conference attendees may also be surprised by Athens' modern infrastructure, a heritage of the last Olympic Games.

In fact, one of the highlights of the Conference is associated with the 2004 Athens Olympic Games. At a plenary session, there will be a presentation of the system dynamics modelling work which was carried out to facilitate the logistics of staging the 2004 Athens Olympics. This will be in addition to papers and presentations of the usual high standard that we all expect to stimulate debate and discussions that will open new horizons for the next fifty years of system dynamics. In this way, we hope that the 26th International Conference of the System Dynamics Society will be a landmark for the system dynamics community. But most of all, we really hope that all conference attendees and their accompanying persons will have an unforgettable time in Athens.

Best wishes from the chairs and the conference organizing committee,

Emmanuel Adamides, Nicholas C. Georgantzas, Brian C. Dangerfield,
Jack B. Homer, George-Michael Klimis, George Papaioannou, Patroklos Georgiadis,
George Papachristos, Nikolaos Pomonis, Yeoryios Stamboulis, and Roberta L. Spencer

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What is it? The *SD Career Link*, started in 2000, is hosted by the System Dynamics Society. It includes on-line information and links to organizations that employ candidates with system dynamics and systems thinking backgrounds. The *SD Career Link* provides a valuable forum for the exchange of information about organizations, positions and people in the field of system dynamics. Please visit the *SD Career Link* bulletin board at the conference.

Career Link Allows Companies and Universities to Describe General Career Information as Well as Specific Job Opportunities. The *SD Career Link* web page of the Society web site has two subsections: (1) specific job listings, and (2) company/university profiles. In the job listings section of the career link, employers advertise their current openings. These are for any level of required expertise located in any geographical region. In the profiles section, company and university employers provide general yet descriptive information about how system dynamics fits into their organization, typical jobs, career paths, and other aspects of employment. This subsection allows employers to provide information about system dynamics opportunities within their organizations to supplement the more general information contained on their corporate or academic websites. Such career information is valuable to current as well as future system dynamics students, academics, and practitioners, and we urge companies and universities to describe the use of system dynamics expertise in their organization even if they do not have job openings at the present time.

How to participate? Please refer to the *SD Career Link* page at the System Dynamics Society website at http://www.systemdynamics.org/sd_career_link.htm or send an email message to the Society office at <office@systemdynamics.org>. All information about access to and use of the site will remain confidential. We look forward to your participation.

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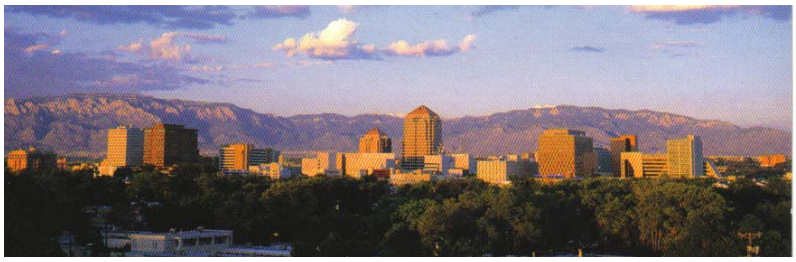

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Supporting Material files can be found by clicking on the appropriate link in the *Paper Index*, found on the conference website. Papers are listed alphabetically by the last name of the primary author.

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

Supporting materials will contain either a single file, or a PKZip format file which can be opened with a number of utilities or directly on some operating systems. File types that may be contained with supporting materials include plain text files or commonly used files types such as .doc, .ppt, .pdf, .htm, .html and .jpg. In addition, models may be included and these will have file extensions that depend on the software used to create them. Below, find information on how to access freeware/demo/trial versions for regularly used software from several system dynamics software manufacturers. Follow the links within the descriptions below to the software needed to view the files.

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

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

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The Vensim Model Reader can be used to open Vensim models which are files with extension .vmf, .vpm or .vpa. This is free software which will allow you to view and simulate models changing the assumptions but not model structure. Many models (.vmf, .vpm, and .mdl) can also be opened using Vensim PLE which is free for educational use. Both PLE and the Reader are available from:
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Parallel and Poster Session Papers

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Analysing Grading and Promotion using System Dynamics Modelling

Most organizations feel the need to predict future human resource levels in order to forecast recruitment and training needs and to ensure that sufficient experienced people are rising through the ranks to fill vacancies at higher levels. This paper described how system dynamics may be used a tool to model and analyse the human resource planning HRP problems associated with staff shortages, staff promotion and progression between different salary grades within an organization. The case of three salary grades is considered and the model produced extends work already completed by the authors on the use of Skill Pool Model (SKPM) in human resource planning. The model is mapped onto an overseas petrochemical company's staff recruitment and attrition situations and subsequently tested using real data. Strategies for HRP. The model involves several control parameters, whose value affects the behaviour of the promotion and progression situation. By simulating different combination of parameters optimum design guidelines are provided to reduce unwanted scenario of staff surplus and/or shortage. We anticipate that system dynamics modelling would help the decision maker to devise medium to long term efficient human resource planning strategies. Keywords: human resource planning, system dynamics, simulation, Promotion and progression.

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Planning for a One Day Group Modeling Workshop: Eliciting and Representing Feedback Dynamics Using Group Explorer

Over several years we have been working to bring together Group Model Building using System Dynamics (Richardson and Andersen, 1995; Luna-Reyes et al, 2007) with Strategic Journey Making (Eden and Ackermann, 1998). The intention has been to develop a more powerful strategy making approach that combines the more naturalistic and speedy processes encompassed in Journey Making with the policy testing attributes of simulation modeling. An emerging literature on Thinklets (Kolfschoten et al, 2006 and Briggs et al, 2003) and Scripts (Andersen and Richardson, 1997) has sought to analyze and to support the design of small group processes. We decomposed versions of Strategic Journey Making and Richardson and Andersen's version of Group Model Building into over 20 interconnected scripts and products. When combined with an additional 10 joint scripts and products that link

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the two approaches, we arrived at a map of 52 scripts and products that fuse the two related approaches into a single view. Using this merged view, we present several powerful designs for a one day group modeling workshop that elicits and represents feedback dynamics using Journey Making processes.

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System Dynamics Modelling in the Development of Management and Organisational Theory

This paper explores the contribution and the influence of system dynamics in the development of management and organisation theory. It begins with a brief discussion of the contribution of computer simulation in theory development for the above areas. It then discusses the practice of theory development using Bourdieu's concepts of Field and Habitus, and places the system dynamics methodology in their context by considering the influence that system dynamics scholars can have in these fields. The resulting conceptual framework is then demonstrated by presenting two different cases of operation strategy theory development using system dynamics modelling and simulation.

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Modelling Integration and Responsiveness for Supply Chain

A key feature of present day business is the fact that it is the supply chains that compete, not companies and the success or failure of supply chains is ultimately determined in the marketplace by the end consumer. Getting the right product, at the right time to the consumer is not only the linchpin to competitive success, but also the key to survival. Hence, customer satisfaction and market place understanding are critical elements for consideration when attempting to establish a new supply chain strategy. Based on the literature review, survey results, and discussion with experts, causal relationships among supply chain performance variables have been developed. On the basis of these causal relationships, a framework has been modeled using system dynamics approach to capture the dynamic impact of performance variables on the supply chain integration and responsiveness for a period of eighteen months. This framework is useful in analyzing the dynamic impact of different policies towards integration and responsiveness of a supply chain.

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Effect of Judges on Court Delay

A common problem through many judicial systems is the court delay. Delay weakens the performance of courts. A long court delay increases the cost of legal procedure and leads to a low quality of judgment and loss of confidence of people in judiciary. As a result, all judicial systems

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tend to reduce the court delay. There is a consensus between experts that the most important variables which affect the court delay are the quality and quantity of judges. In this paper, we build a system dynamics model of judicial system to see how the interaction between quality and quantity of judges determines court delay. The results show that employing more judges is not necessarily the best solution. Also, simulations show that employing policy plays an important role in system behavior.

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Augmenting System Dynamics with Genetic Algorithm and TOPSIS Multivariate Ranking Module for Multi-Criteria Optimization

System Dynamics like other simulation methodologies is basically descriptive, in that it does not search for optimized set of policy variables. To render it an optimization capability one may augment it with a Genetic Algorithm (GA) input machine with a multi criteria objective function evaluator such as TOPSIS. Starting from a random population of policy variables, different simulation run will be performed one for every member of the population. Using GA operators and the evaluation motor a new population of policy variables will be constructed. The procedure is automatically repeated until the best combination of policy variables is formed. This paper presents this as an idea and gives an example of how this can be performed in practice. Key words: System Dynamics, Genetic Algorithm, Optimization, TOPSIS.

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Roadmap for Adopting New Technology in the Utility Industry

We present an end-to-end solution framework for addressing the various analytical challenges that are involved in developing an optimal deployment plan, from a business case development perspective. Our solution framework uses a judicious combination of system dynamics modeling, econometric modeling and mathematical programming based optimization modeling. A system dynamics model is used to estimate the dynamics of user adoption of the new technology, relative to deployment, which results from marketing effectiveness for the new technology, as well as the viral effect of word-of-mouth interactions among users. The model is also used to estimate the lag in benefits realization from the new technology deployment, arising from the above dynamics of user adoption, coupled with a lag in the maturity of the supporting Information Systems that enable effective functioning of the new technology. These estimates are then subsequently used in a mathematical programming model, which solves a multi-period, resource-constrained optimal deployment planning problem that is subjected to the lags in user adoption and benefit realization, which are estimated by the system dynamics model.

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Exploring the Dynamics of Full Information Product Pricing Networks: the Case of Fair Trade Coffee in Mexico

This poster describes research in progress undertaken by the Research Group on Comparative and Transnational Digital Government in North America, which is supported by the National Science Foundation Digital Government Research Program as well as by institutions in Canada, Mexico, and the United States. This research explores distribution networks that attach non-price information to products as a differentiation mechanism. Often this non-price information is transmitted through trusting networks or certifiable labels such as "Organic" or "Fair Trade." We call such networks Full Information Product Pricing (FIPP) Networks. Major objectives of the research are to explore how government policies and investment in information and communication technology can be used to promote FIPP networks and to assess what impacts on economic and local development will result. The first fair trade FIPP network selected for simulation is a coffee cooperative in Mexico, Tosepan Titataniske. Current modeling efforts are aimed at eliciting dynamic insights from the case by the application of established system dynamics knowledge related to commodity models and supply chains.

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Asymmetric commodity cycles: Evidence from an experimental market

Laboratory experiments of commodity markets have used the Cobweb design to investigate market dynamics. The predicted cycles of the Cobweb theory did not occur. Arango (2006) adds complexity and realism to the Cobweb model and observes stronger fluctuations and autocorrelation. He shows that these fluctuations are quite symmetric and similar to the behaviour observed in one category of markets. However the fluctuations are different from the asymmetric price behaviour observed in other commodity markets. We hypothesise that asymmetries could be caused by non-linear demand, different from the linear demand curve used by Arango. Consequently we replicate his experiment using a demand structure with constant price elasticity and dynamic adjustment. Similar to Arango, the supply side is complicated by capacity lifetimes and investment delays across treatments. Compared to the previous results, this experiment gives rise to larger fluctuations and stronger asymmetries.

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The System Dynamics Italian Chapter (SYDIC) community on the web: an online scientific community

The Italian Chapter (SYDIC) of the System Dynamics Society, needed a valid tool to support its member activities, and to support the diffusion of the System Dynamics methodology in Italy, by encouraging the contacts between scholars, researchers and professionals making use of this discipline. Among the existing tools, we identified the web community idea as the most suitable. By carefully searching the available sources and by analysing examples of existing communities, it was possible to identify the characteristics and features of a successful community, and then which are the main aspects and strategies to build a scientific community. It has been found that an IT-system named "groupware" (that is, a platform to support collaborative work or CSCW – Computer Supported Cooperative Work) generally provides most of the desired features for a scientific community. Based on the main features available in a CSCW groupware, we then developed our idea of what the Italian system dynamics scientific community website should be like and which tools and services it should provide to its members, and thus ultimately designed and implemented it based on these concepts.

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Analysis of economic impacts and evolutions of the italian cultural event "La Notte Bianca Romana": a system dynamics approach

We recently assisted to a net increase in discretionary policies by Local Governments relative to their objectives-resources relationships, which moved them far from previously used operative models, while favoring a general promotion of land in terms of a socio-economic growth. Moreover, a strong opinion about the relevant role of culture has arisen: great attention is dedicated to the relationship between territorial socio-economic development and cultural properties. In this context, we analyzed the cultural and artistic event "La Notte Bianca Romana", which has been designed and realized by the Municipality of Rome, consisting in a territorial marketing tool to promote the "Eternal City" in the world. This manifestation has revealed itself as an important incentive to the economic and entrepreneurial development of the city, relating important issues like "economic growth", "quality of life", "social development". Our work aims to show that, by correctly implementing the strategies designed by the Municipality of Rome (the strategic coordinator of the event), the actors of the system may have good chances in successfully developing the potentialities of this cultural event, both in terms of participation and territorial and temporal expansion, with positive social and economic downfalls on the territory.

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A new system dynamics model for the analysis of the paper dematerialization process in the Italian Public Administration

This study deals with a System Dynamics analysis of the paper dematerialization problem during the transition to an all-digital society. The efforts are focused on the description of the situation in terms of the relationships between systemic variables that define the underlying structure of the problem. The referring context is the Italian Public Administration. The central spots of the analysis are the diffusion of the "new technology" and the problem of the archives' dimensions, which have been formalized, by means of the creation and the study of a casual loop diagram, into a dynamical hypothesis. The systemic approach that we used through the whole study, allowed us to consider many collateral aspects that are crucial in this issue, and provide a rich analysis that also shows how social and psychological factors may in the end determine policy resistance and great obstacles to organizational change.

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Physician's burning out and Human resource crisis in Japanese Hospital: Management for sustaining medical services in Japan

Human resource crises by collective retirement of hospital physicians are a critical issue in Japanese health care systems. System Dynamics modeling is a feasible way to understand these phenomena. Japanese health care system is confronted with not only exogenous environments but also endogenous feedbacks to build up the situation. Increasing busyness by physicians and risk of medical lawsuits and decreasing average productivity and quality of physician by hiring new physicians reinforce retirements of physicians and the retirements change the situation for the worse. To keep sustain level of physician we could find essential policies by simulation. First strategy is changing desired number of physicians with increasing of number of patients per physician. Second way is decreasing delay between retirement and hiring. This was accomplished by early recognition of physicians' busyness by hospital managers and abundant of physicians in a health care system.

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Association Between Neural Network And System Dynamics To Predict Dialysis Dose During Hemodialysis

The total dialysis dose, expressed as Kt/V, has been widely recognized to be a major determinant of morbidity and mortality in hemodialyzed patients. Many different factors influence the correct determination of Kt/V, such as urea sequestration in different body compartments, access and cardiopulmonary recirculation. These factors are responsible for urea rebound after the end of the hemodialysis session, causing poor Kt/V

estimation. In this work, system dynamics model was combined with a neural network (NN) method for early prediction of the Kt/V dose. Two different portions of the urea concentration-time profile provided by the system dynamics (on-line urea monitor) were analyzed: the entire curve A and the first half B, using an NN to predict the Kt/V and compare this with that provided by the system dynamics model. The NN was able to predict Kt/V is the middle of the 4h session (B data) without a significant increase in the percentage error (B data: 6.65%±2.51%; A data: 5.62%±8.65%) compared with the system dynamics Kt/V.

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Biofeedback Control Of Ultrafiltration For Prevention Of Hemodialysis-Induced Hypotension

Hemodialysis-induced hypotension is still a severe complication in spite of all the progress in hemodialysis treatment. Because of its multifactor causes, hemodialysis-induced hypotension cannot be reliably prevented by conventional ultrafiltration and sodium profiling in open-loop systems, as they are unable to adapt themselves to actual decreases in blood pressure. Therefore, it is the ultimate goal to provide automatic control in hemodialysis. Furthermore, the treatment should improve patient comfort and be carried out without use of additional body sensors and without additional medication. Automatic control of hemodialysis has the potential to provide a better treatment to the ever increasing number of ESDR patients who present with more complicated co-morbid conditions.

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System Dynamics War Stories

Eighteen cases of applied system dynamics modeling over the last 20 years are described in retrospect. Two cases are described as very highly successful, three as highly, but also five as unsuccessful. The cases are grouped in four categories; military personnel aging chains, defence economics, market sector and academic. Their topic range from organizational resistance, via Russian industrial growth to e,g. real estate dynamics. Six critical success factors are used to describe the cases; client acceptance, client change, client success, model simplicity, publications and spin-offs. Statistical analysis finds that client change is the only significant predictor of overall case success. The retrospect finds that overall case success can be explained by evoking an inverted u-shape relationship between such success and client comfort with new insight; too little or to much comfort with the insight cause low success, medium comfort causes success. Further research should include a review that includes all involved parties' subjective assessments.

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Hydrogen Production Scenarios in Italy

Hydrogen, an energy vector, displays remarkable versatility with regards to the ways it can be produced. State-of-the-art technologies allow almost every energy source to be converted into hydrogen. What is more

challenging, however, is the feasibility of building a new infrastructure to overlap with and, possibly, substitute existing one. This investigation aims to assess what it would entail to add 5% of hydrogen fuel to road transport energy consumption through 2050. The comparison spans five technologies: steam methane reforming, coal gasification, and water electrolysis where power is generated from wind, solar, and nuclear sources. The simulation provides two sets of estimates: calculations on physical infrastructure requirements and its related variable and fixed costs. With regards to facility requirements, the considered technologies show different degrees of feasibility. Coal and nuclear power are not as land-intensive as solar and wind power, but bear problems with pollution and waste disposal, respectively. Economically, coal is least expensive, followed by wind. Natural gas loses competitiveness because of high hydrocarbon prices. The sheer economic rank of preferable energy sources for generating hydrogen should be put into question when internalizing environmental impact of the considered options.

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Testing Dynamic Decision Making Under Real-Time Pressure: A Scuba Diving Simulator

Experimental decision making studies are typically done in environments where subjects have plentiful time before making decisions. In this research, a scuba diving simulator is developed for experimental analysis of decision making under real-time pressure, in dynamic feedback environment. In our clock-driven scuba diving simulator, subjects make decisions in real-time, continuously, which enables us to study effect of game speed (time pressure) on performance and learning. Results show that game speed has significant effect on subjects' performances. Material and information delays are further incorporated to evaluate effects of delays. Both information and material delays are found significantly influential on performance. However, performance differences between delay and no-delay games decrease with practice. Since games attempt to simulate experiential learning, subjects having real diving experience may be expected to perform better than inexperienced ones. Interestingly, no significant difference is found between those with scuba-diving experience and those without. A feature of the game is the fact that the control problem that subjects face is under strong influence of a positive feedback loop. Combined with delays and nonlinearity, the game illustrates how complex the control problem can become even for a small model. Performances of subjects in most trials are strongly oscillatory.

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Improving Strategic Thinking in Management Education with System Dynamics based ILEs: Reflections on a Case Study

Over the past few years there has been an increasing interest in using computer simulation models in order to create learning laboratories (Interactive Learning Environments - ILEs), for management education. Particularly when combined with System Dynamics simulation models, ILEs have proved their validity in a variety of different fields. Starting

from the previous considerations, this paper focuses on the use of System Dynamics based ILEs for processes of individual learning. In particular, the paper presents and discusses the main features of an ILE based on a case study related to service quality management. The effectiveness of the ILE in fostering individual learning has been assessed through a computer based experiment run in a master course classroom. Additional comments and data were gathered through a feedback questionnaires that was delivered to the participants. Among its findings, the paper shows that the ILE supported players to learn to: a) balance the growth of demand-side and supply-side resources; b) simultaneously control tangible and intangible resources; c) take into account the presence and the effects of time-delays; d) develop and apply policies, understanding the short and long term consequences of their decisions.

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How to Approach New Industries and Gain Insights Into Their Development Dynamics

In today's business environment it is essential to be able to gain insights in a yet unfamiliar industry under tough time constraints. The 7 step framework we suggest addresses this issue. Following the standardised sequence of steps will direct the user to identifying the industry's main influencing factors. The historical development of the industry's output variable will be approximated by model simulations. An analysis of the peaks in relative deviations between real and simulated data will spotlight the industry's significant events and influencing factors. Compared to traditional market and environment analysis techniques our framework takes the particular industry's development dynamics into account. Thus we choose System Dynamics as underlying methodology which has already proven useful for understanding market dynamics and gaining structural insights. The 7 step framework will be illustrated with the development of passenger traffic at German airports.

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Closed-Loop Supply Chain Stability under Different Production-Inventory Policies

Product returns from market to the manufacturer can happen because of the motivation to capture the value content of the product after use or the obligation from legislation and the environmental concerns. A manufacturing system capable of integrating both the manufacturing and remanufacturing activities can help the recovery of value content in the products after the end of product's use life. Ordering policy designed for a production system with unidirectional flow of materials i.e., up stream to down stream only), when applied to such an integrated system involving manufacturing remanufacturing can create dynamics in the system. Our investigation into this problem has revealed that these dynamics can be avoided if a well defined production-ordering rule that explicitly account for the returned products, is adopted. We do the analysis by modifying the well known automatic pipeline inventory order based production control system (APIOBPCS) to achieve this goal.

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Introducing in a Non-Profit Organisation a CSR Strategy through a Learning Oriented Perspective: the Emssanar case-study

The purpose of this paper is to analyse the concept of Corporate Social Responsibility (CSR) and to understand how it can be effectively introduced in a non-profit organisation. This analysis aims to disclose the feedback loop relationships underlying the design of a CSR strategy through a Balanced Scorecard (BSC) and to explore the benefits of such an approach on the sustainability of an non-profit organisation performance. The paper through a real case-study tries to demonstrates how a CSR strategy could fail in the long term if a open-loop logic is adopted. On the contrary, by making explicit the feedback loops structure underlying a CSR strategy, it is possible to better understand the mechanisms that foster a sustainable and long term organisation growth and those processes that could prevent the attainment of desired outcomes. After discussing the main benefits and limits of the CSR concept reported in literature, a case-study is introduced and the approach used to implement a CSR strategy through a BSC logic is examined. After reviewing such an approach, a feedback loop analysis is presented with reference to the case-study. Finally, conclusions and further remarks are drown.

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Explaining Women's Careers at a Dutch university: Model building as a method for knowledge elicitation in gender analysis

This paper presents a qualitative causal model of the factors explaining the delay in Women's Careers at a Dutch university. By focusing on the role of image shaping about women's ambitions and performance, it fills in theoretical gaps identified in earlier research about gender processes in organizations. The causal model is based on analysis of 45 interviews, five focus groups and policy documents collected at five faculties of a Dutch university. The research team involved in this analysis used model building to integrate their knowledge and reach a shared definition of relevant variables. Model building proves to support the qualitative analysis of gender processes by supporting the identification of main processes and showing the feedback processes at work. Women's careers are stimulated by the presence of female academics at higher positions, while masculine norms and the lack of visibility of female academics slow down women's careers.

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The effect of multi-incentive policies on the competition of drivetrain technologies

Facing global climate change and the oncoming shortage of fossil resources, it is necessary to reduce overall primary energy consumption. There is a strong need for action concerning car traffic as a main originator of greenhouse gas emissions by use of fossil energy. For a strong mitigation effect, the technological improvement of today`s petrol and diesel engines has to be accompanied by the promotion of alternative vehicles, still being sparsely represented in most carfleets. The spread of one or more new drivetrain technologies throughout the transportation sector represents an innovation diffusion process, which is needed in order to achieve long-term climate and energy policy goals. However, there exist no adequate innovation diffusion models that accurately explain the main driving forces between competing alternative drivetrain technologies and their diffusion rate. This work contributes to the understanding of the fundamental diffusion processes by developing, analysing and applying a model for the market penetration of competing alternative drivetrain technologies.

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Jared Diamond's Collapse again: a re-appraisal based on the system dynamics approach

Reviewing the Jared Diamond’s influential book - Collapse - Page (2005) states that the author's extensive argument can be actually summarized in a very simple model used by economists. Accordingly to that model, societies can enter collapse paths for extracting renewable resources faster than their natural environment’s regeneration rate. The explanation of why several societies chose tracking such an irrational path in the past, by summarizing the argument, is that they did not realize that they were exploiting their physical environment at an unsustainable pace, due to the complexity involved in natural processes. This paper argues that Page’s summary excessively simplifies the Diamond's argument and for that does not give the due weight to important issues, such as the crucial role of the institutional loops play in the environmental collapse process. Using the system dynamics approach, it will be suggested that the process that leads socio-ecological systems to collapse is actually much more complex than that was described by Page. Specifically, it will be shown that, although the model he proposes can be in essence correct, its dynamics is not that simple as he seems to believe.

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Working with "living" models: Emergent methodological contributions from modeling for critical infrastructure protection

Critical infrastructures are increasingly automated and interdependent, subject to possibly cascading vulnerabilities due to equipment failures, natural disasters, and terrorist attacks. The government seeks to ensure that disruptions are infrequent, brief, manageable, and cause the least harm possible. The system dynamics (SD) approach is particularly promising in understanding these complex systems, interactions, and issues. Problems in critical infrastructure protection are being investigated with a collection of SD models developed expressly for these concerns, including agriculture models. This paper discusses the technical and social modeling context that makes this SD modeling effort seem uncommon. It involves a modular approach, a model reassembling technology, a formal process for testing and evaluation, and a social process to manage the development and use of "living" models.

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A Field for Interactive Learning on Climate-Energy Transition: Concepts and structure

This paper discusses the concepts and structure behing FILCET, a field for interactive learning on the climate-energy transition, designed to improve awarness on the climate-energy crisis (CEC) macro- problem, and communicate the structure and dynamic complexity of key policies available to face this transition. This work present FILCET's basic concepts and their application to the communication and collective learning on the energy transition, and its potential use in understanding the interrelationships existing between climate change, energy policies and innovation strategies in the pursue of sustainable development. This paper describes FILCET, its learning targets, the overall structure and mechanism and the elements of the policy game dimensions and the system dynamics model supporting it, which focuses on the dynamic complexity of CO_{2} abatement policies for a power market, such as cap and trade. We include comments and observations drawn from the preliminary testing, reflexions on its potential use as a communication tool for sensitizing policy makers, educators, and energy innovation networks.

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Reducing the impact of demand process variability within a multi-echelon supply chain

Forrester(1958) analyzed Supply Chain and the different levels existing) in it, as well as the participant companies and the role played by each of them inside the chain as a global group, and observed that small variations in end item demand caused oscillations that are amplified throughout the chain. This phenomenon, called the Bullwhip effect (Lee et al, 1997a), has detrimental consequences on inventory levels and on all kind of inventory costs that may affect the added value of the activities throughout the logistics chain and ultimately affect the Net Present Value of all the activities in the chain. There is a set of collaborative supply chain structures (Disney et al. (2004)) which reduce these harmful consequences within the supply chain. The study presented in this paper quantifies how collaborative supply chain structures reduce the Bullwhip effect in terms of demand variability and inventory cost.

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Integrating System Dynamics with Predictive Learning: Measuring the Reliability of a Passive System in a Nuclear Power Plant

Design of future generation nuclear power plants must adhere to three fundamental principles: safety, economics, and non-proliferation. Safety systems serve to mitigate nuclear accident consequences. A special subset of these is passive safety systems, which operate autonomously – without human intervention or external sources of energy. Passive systems rely entirely upon natural laws rather than mechanical moving parts to function. Passive System Reliability (PSR) is not easily measurable because it requires understanding how physical natural laws fail and deals with the uncertainties associated with modeling physical phenomena. In this work, a passive safety system is modeled and a methodology is established to detect the parameters most likely leading to plant failure. A System Dynamics model is chosen to simulate the system; the methodology is built around two techniques: screening of parameters and learning machines for classification. Their union yields a learning algorithm capable of identifying and classifying failure patterns as a function of the model's key parameters. This iterative methodology reduces the simulations required to compute the PSR by 25%. Implications of this benefit, extended to thermo-hydraulic codes, are discussed via an example. This paper contributes to the development of risk-informed procedures for power plant designers and regulators.

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Exploring the Underground Economy to support Public Decision Makers to tackle the Growth of Irregular Workers

The search for new resources to finance the necessary investments for fostering the economic growth led many States to adopt policies to tackle the underground economy and, in particular, to struggle the phenomenon of irregular workers. In most of the cases, such policies failed to strongly reduce the percentage of irregular workers because they were based on a linear and static approach. Based on a research project conducted in Sicily Region (Italy), this article aims at investigating – through the System Dynamics (SD) methodology – main causes-and-effects relationships underlying the phenomenon of irregular workers at both firm and self-employment level. In particular, through the developed SD model, different potential policies will be analysed in order to identify a systemic strategy that could hinder the phenomenon of irregular workers.

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The role of goal setting practice on sales and on the broader commercial system: a case study

The Goal Setting Theory is by many researchers considered one of the major motivational theories. The theory is based on the assumption that setting challenging goals, hard to reach (goal difficulty), yet well described (goal specificity), contributes to a general improvement in working performances. The main purpose of this work is to demonstrate the power of a model in which tangible and intangible elements are integrated: processes underlying the goal setting practice together with processes underlying other business functions, such as commercial, financial and organizational ones. This paper is the result of a research project conducted with a firm operating in the Household Electrical Appliances industry. The firm has its registered office in Sicily, but operate in all Italy regions. In the first part of this paper, an analysis of Goal setting theory and the role of goal setting practice in enhancing individual performance is remarked. In the second part, the case-study, the evolution of the business, feedback analysis of adopted management growth policies, first step for model validation are discussed.

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Pension funds governance: combining SD, Agent based Modelling and fuzzy logic to adress Dynamic Asset and Liability Management

The governance is a system composed by a great number of interdependent entities, with different degrees of relationship. This article considers the governance of a social-economic and political environment under a pension fund's perspective as a complex system in

which the interactions among the actors influence the governance and the governance can influence their interactions, in a recursive way. In order to cope with the peculiarities of complex systems, a system dynamics (SD) model, combined with an agent-based model is proposed to analyze population dynamics and the influence of credibility as a subjective factor over the expected adhesion of new participants. The behavior of the agents is modeled using fuzzy logic. This way, the article aims to evidence the power of a multi-paradigm model to study complex environments and to offer a way to address a dynamic ALM problem in order to manage solvency and liquidity risks in pension funds.

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Framework for Modeling Technology Policy: Renewable Energy in Abu Dhabi

This paper presents a framework for modeling technology policy for Abu Dhabi, an entity of the United Arab Emirates (UAE). Abu Dhabi's general objectives are to maintain a level of economic and sustainable development and to increase skill formation and capacity building. The immediate dilemma is to meet future energy demand for electricity and water desalination but at the same time reduce C02 emission. This paper presents a modular approach using system dynamics to determine the best technology strategy policies to meet these objectives.

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The roles of System Dynamics in environmental problem solving

The present paper contains a short critical description of the roles System Dynamics (SD can play within a framework for the definition of mediated solutions to complex environmental problems. Its main aim is to show how SD can be either a valuable tool for the definition of shared and consensual solutions to such problems or a burden and a hindrance since it closes any discussion and the search of creative solutions owing to its presumed objectivity and neutrality. The paper presents very briefly some basic concepts of SD and then discuss some key concepts (actors, experts and stakeholders) and their roles in the search for solutions to environmental problems. Then we examine with some details the various roles SD can play within the sketched framework and discuss both the various arenas where it can be used and the range of roles it can play, from the worst case (a hindrance) to the best ones, decision support and knowledge sharing. The paper highlight the use of SD as both a cognitive tool and a meta tool in the sense that it both serves as a guide of the planning process and helps the unveiling of hidden assumptions and purposes and the diffusion of common knowledge for the solution of collective environmental problems.

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The Endogenous Perspective: Using Systems Thinking and System Dynamics for Teaching Courses in Public Administration and Policy

This paper shows how systems thinking and system dynamics can be used to compliment concepts and lectures for an introductory graduate level course in public administration and policy. The material outlined in this paper can be used to facilitate discussions, structure lectures, and establish exercises for students in a graduate program. Our goal is to take a first step towards a textbook or series of articles that provides an endogenous perspective on themes covered in today's U.S. based public administration and policy programs. We hope this work follows in solid tradition that uses the endogenous perspective in other fields: business (Sterman 2000), environmental Studies (Ford 1999), systems thinking for management (Senge 1990), and the philosophy of systems theory (Richardson 1991, 1999).

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Maintenance performance improvement : A Corrective Maintenance showcase

This paper presents a case study of an analysis of a Corrective Maintenance process to realize performance improvement. The Corrective Maintenance process is supported by SAP, which has indicated the performance realisation problem. System Dynamics is used in a Group Model Building process to structure the problem and to develop a dynamic business model with which the process is analysed. This is performed by the evaluation of changes in external factors and interventions in the process on performance indicators compared to a reference run. The case study has shown that modelling this maintenance performance problem is possible with System Dynamics, but the method is more suitable on an aggregated level. Although the results of this simulation study are significant, one of the conclusions is to not automatically assume that System Dynamics is suitable for problems that are structured with Group Model Building. It is recommended to select another modelling method after the problem is structured, if that method is more suitable.

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Making the value chain work – analysing the impact of Intellectual Property Management on seed sector development in West Africa

The role of Intellectual Property Management in facilitating the agricultural transformation process in developing countries is unknown and discussed in a very controversial way. This paper conceptualises a

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framework for assessing the impact of Intellectual Property Management on the seed sector in West Africa. At the core of such assessment is a system dynamics model that describes the dynamics of a seed value chain. We use data from interviews with multinational seed companies, research institutions and private sector actors in Ghana for developing a conceptual simulation model and for specifying the impact assessment framework. Different scenarios are to be established to test a variety of Intellectual Property policies. The interviews we conducted suggest that there is local demand for such an overview analysis and the discussions we had about our approach indicated an immediate contribution to the understanding of the entire seed system.

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Renewable energy in Italy: scenarios to 2030

The study represents an exploration of the Italian energy situation, which is characterised by huge energy imports, strong dependence on fossil fuels, and carbon emissions well above the Kyoto target. Certainly, in such a situation, given the nuclear energy ban of the Italian 1987 referendum, renewable energy could help the country. Nonetheless, its high costs could be an obstacle that strongly limits its expansion. One of the main results of the analysis performed with the IRED (Italy's Renewable Energy Development) model is that an increase of the renewables' share up to 20% in 2020 represents a striking change in the structure of the Italian electricity system, which, under certain conditions, is not feasible. Italy faces a sort of triangular challenge, involving fossil fuel prices, renewables production costs, and carbon prices. The trends in these variables will decide the destiny of renewables in the country. IRED is a model based on the system dynamics approach, which encompasses econometric forecasts, technical assessment, and cost estimation. IRED is able to generate a large number of scenarios and sensitivity analyses on a set of elements, such as primary energy demand, electricity demand, renewables mix, investment and operation costs, fossil fuel costs, and carbon prices.

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Rethinking the Conflict Trap: Systems Dynamics as a Tool to understanding civil wars - THE CASE OF COLOMBIA-

This paper presents the first phase of a work in progress which aims at building a System Dynamics model around two theories concerning internal conflict. In particular the model will asses the particular case of Colombia. The different theories around the economics and causes of war can be separated in two trends. The first one argues that wars are economically motivated, and the real objective of armed groups is the quest for money; this theory is characterized under the term greed. On the other side, there are the social, political and historical factors that

allow and facilitate the emergence of armed groups (grievances). This investigation aims to develop a better understanding of the complex interactions around the Colombian conflict, considering both theories and seeks to build a better comprehension of this conflict in order to study how to generate development during an internal conflict.

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Reducing income volatility in multi-product companies through better resource sharing policies

This paper examines the effect of competition on internal resources on income volatility of multi-product companies. Therefore the two-shower model of Morecroft et al is tested and analyzed in symmetric and asymmetric situations. After discussing the opportunities and limits of the shower model's translation into a company context, a stylized company model is presented and analyzed. As was expected, the stylized model preserves the shower model's dynamic behaviour in principal. Optimization of the policy parameters, however, turns out to be sensitive to the objective function. Minimizing the gap of desired income and maximizing total cumulated income produces different outcomes, which is explained by an incomplete cost sector and can easily be avoided. Finally, by changing the equilibrium model into a growth model, it can be shown, that the amplitude of oscillations will increase, making it more difficult for decision makers to allocate internal resources in the most effective way.

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System Dynamics Approach to Modeling Risk in Complex Healthcare Settings

Risk is an inherent part of healthcare, particularly in large referral centers, where some of the most complex cases are managed. While risk cannot be eliminated from the clinical activities, it is believed that some practices involving unnecessary risk can be mitigated without impacting overall performance. Our ability to identify these vulnerable practices, and develop durable preventative or mitigating strategies, however, is hampered by outdated models of risk and an inadequate approach to the analysis of risk. In an effort to develop more realistic models of risk in complex healthcare settings, we applied a system dynamics framework to model how features of the environment (e.g., time pressures, resource shortages, etc.) and human attributes (e.g., risk tolerance, confidence in existing safety policies, etc.) combine to influence safety. The models have enabled us to study, through simulation, the complex interactions between production pressures, historical experience with adverse outcomes, inherent risk tolerance/propensity, confidence in and compliance with safety controls. We present here the modeling strategy and the results of a series of simulation experiments studying these phenomena.

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Statistical Thinking Tools for System Dynamics

Statistical thinking is a well-established approach that involves the application of the scientific method to solving real-world organizational problems. The premise behind statistical thinking is that a disciplined approach to gathering facts can be used to identify the root causes that act as a barrier to successful performance. Once these root causes are identified, corrective action can be planned, and implemented, in order to change the underlying system. At a practical level, the Six Sigma methodology is the most widely known statistical thinking approach. Its structure involves a multi-stage methodology that starts at problem definition, and ends at implementation and consolidation of change. Throughout the stages of Six Sigma a number of practical tools – both qualitative and quantitative – are used to help formulate the problem, create a shared understanding of the problem amongst the different stakeholders, and identify policy levers that can improve system performance. This paper highlights the main parallels and differences between statistical and systems thinking, and illustrates how a number of tools from statistical thinking can also be used throughout a systems thinking consulting intervention. The paper concludes with a case study.

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Human Perceptions of Climate Change

This paper presents an interactive simulation of the effects of emissions and absorptions of anthropogenic carbon dioxide (CO2) in the atmosphere. The interactive simulation based on the "bathtub" metaphor, was built using the Dynamic Integrated Climate Economy model (DICE)-1992. The interactive tool allows participants to make decisions on the anthropogenic CO2 emissions, observe the consequences of the decisions and try new decisions. In a laboratory experiment, we tested the participants' ability to control the CO2 concentration to a realistic amount in the atmosphere over a period of 100 to 200 years. Participants worked on one of two extreme conditions: one rapid, where transfer rate of carbon dioxide was 1.6% per year with CO2 emission decisions made every 2 years, and other slow, where transfer rate of carbon dioxide was 1.2% per year with CO2 emission decisions made every 4 years. Due to human incapacity to handle feedback delays and their use of faulty heuristics, we expected participants to find the slow condition harder to control as compared to the rapid condition. Results show that participants had more difficulty achieving control of CO2 concentration to goal in face of slower dynamics than rapid dynamics. Implications and future of our research findings are discussed.

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Feedback analysis of speculation in a foreign currency market

This paper investigates the impact of speculative trading on foreign currency markets. A review of economic literature reveals that there is

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still no agreement to whether speculators amplify or tame fluctuations of exchange rates. Relevant system dynamics literature suggests that trading by speculators contributes to the formation of price bubbles. However, very few system dynamics papers exist that analyze financial markets at the micro-level of traders. Hence, we turn to the field of computational economics and adapt a well-known heterogeneous agent model. Our new system dynamics model is used to analyze the role of speculation in foreign currency markets.

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Group Model Building Wins: The results of a comparative analysis

This paper presents clear evidence of the value of group model building for supporting group decision processes. It responds to Rouwette et al.'s (2002) challenge to take GMB assessments beyond unstructured single case descriptions that cannot be easily compared. This paper compares two parallel, real-world problem solving teams examining urban growth issues in Las Vegas, Nevada over the same two-year time period. One followed a system dynamics group model building process. The other used a more traditional group facilitation process. Data about the dynamics of discussions and the outcomes were collected from meeting transcripts, participant interviews, written documents and direct observations. The results reveal a marked difference in the content and timing of discussions over the life of each group project, strongly supporting the hypothesis that system dynamics provides a better foundation for structuring discussions, eliciting mental models, and generating sound decisions.

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Genetic Algorithms for Multi-Objective Optimization in Dynamic Systems

This study uses parametric search to meet multiple goals in the behavior of dynamic systems. Parameters are searched using genetic algorithm. Main aim of this study is to discuss how multi-objective parameter search gives essential information about the system. A nonlinear electric circuit is one of the two dynamic models in this paper used for parameter optimization. The electric circuit model shows oscillatory behavior. A fitness function which evaluates period and amplitude and compares it with the desired oscillatory pattern is proposed. It is shown that time horizon for simulation based optimization can be crucial. The second model is a generic System Dynamics model, the stock management problem with second order supply line. The policy parameters are weight of stock adjustment and supply line adjustment. A fitness function that evaluates the settling time, overshoot, and steady state error is proposed. The search results provide some insight on both the fitness function and the system. The obtained results are satisfactory and they show that the response time of the system can be decreased by small overshoot. The paper is a step towards simulation based parameter search becoming an essential support toolbox for model building and policy design in System Dynamics.

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Fuzzy Logic Approach to Mimic Decision Making Behavior of Humans in Stock Management Game

System Dynamics methodology aims to model real complex dynamic systems for understanding them and coming up with policies to change the problematic dynamic behavior. In most of the dynamic systems of interest, humans play an important role. Hence, human behavior modeling is one of the goals of System Dynamics. This paper proposes Fuzzy Logic as a new tool to model human behavior. The paper uses the existing data from an experimental study on Stock Management Model and comes up with Fuzzy Logic players to mimic the behaviors of three different types of players. We believe that Fuzzy Logic will be useful in modeling decision making behavior as it also gives an understanding of why humans decide as they do which is in consensus with System Dynamics modeling.

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A Systemic Analysis of Energy Efficiency in New Zealand's Residential Sector

The problem situation related to energy efficiency in New Zealand's residential sector is quite complex since several factors affect this problem and they change with respect to time. This paper presents the results of a study undertaken to systemically analyse this problem situation. In this study, the problem situation was structured systemically by analysing the behaviour of the main variables related to the problem situation, and then analysing the stakeholders. Further, a participative systems model of the problem situation was developed using a group model building process. The analysis of the model found different feedback loops operating in the system responsible for the complexity of the problem situation relating to energy efficiency in New Zealand's residential sector. The paper concludes by highlighting some of the long term structural changes suggested by the stakeholders involved in this study to change the behaviour of the system.

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The Sky is Full of Good Intentions

The aim of this paper is to illustrate how System Dynamics can beneficiate small and medium international nongovernmental organisations (hereafter NGOs). As the majority of small NGOs are based on voluntary work, few adopt strategic and professional management to enhance and guarantee their sustainability. Such context rises several challenges which NGOs must learn to recognise and to face. A System Dynamics model will be presented and used as a decision-making-tool to help these organisations understanding part of the complexity surrounding them as well as some long term consequences of their actions. A case study will be presented.

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Coupled Contagion Dynamics of Fear and Disease: Mathematical and Computational Explorations

We model two interacting contagion processes: one of disease and one of fear of the disease. Individuals can "contract" fear through contact with individuals who are infected with the disease (the sick), infected with fear only (the scared), and infected with both fear and disease (the sick and scared). Scared individuals--whether sick or not--may remove themselves from circulation with some probability, which affects the contact of individuals and thus the disease epidemic proper. If we allow individuals to recover from fear and return to circulation, the coupled dynamics become quite rich, and include multiple waves of infection, such as occurred in the 1918 flu pandemic. We also study flight as a behavioral response. In a spatially extended setting, even relatively small levels of fear-inspired flight can have a dramatic impact on spatio-temporal epidemic dynamics.

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Modeling the Dynamics of Electronic Health Records Adoption in the U.S. Healthcare System

The adoption of Electronic Health Records (EHRs) moves slowly despite a near consensus in the healthcare industry that their use could be a critical factor in addressing quality and cost issues. Barriers and benefits of EHRs, the adoption process, and potential remedies to speed up the process are subject to numerous studies. In this study, a casual loop diagram of the EHR adoption process is developed and discussed. Through this model, factors influencing the process and the relationships between them are examined. The model is intended to be the backbone of future stock-flow models which will provide a test bed to explore an understanding of the EHR adoption process and to evaluate various policy options.

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A Model for Overreaction to EPS Shocks in the Stock Markets

Standard finance hypotheses (of which market efficiency hypothesis has been derived) have left no room for human emotions or cognitive errors in financial decision making hence the decision-making human in standard financial models is an economically rational human. It is the knowledge of the consequences these very emotions and errors in financial researches and price and restitution trends in different markets which brought about a movement in financial and investment management which soon became known as Behavioral Finance. Behavioral Finance attempts to identify and explore the anomalies of financial markets. One such anomaly is “overreaction” to news

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announcement in financial markets. In the model proposed in this paper we have divided the traders of financial markets into two groups of rational and behavioral (momentum) and then have studied the overreaction to the corporations' newly announced EPS. In this model rational traders cause the stock price to move toward the intrinsic value and behavioral traders bring about the fluctuation of prices.

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Modeling Spiral of Silence Process: A Case-Study of Iran Presidential Elections 1997

System Dynamics has already proved useful in modeling various social phenomena and processes. As perfect examples of such processes, we can mention elections which are effected by many different social, economic, and political factors in every country. Often those factors are so interrelated and the pre-elections situations are so complicated that even the best political analysts not only cannot predict which party would win the competition, but also, after the elections, are unable to fully explain what factors contributed the most to one party's success in the elections. In this paper, we turn our attention to Iran's presidential elections held in 1997 whose outcome was unpredictable even a few weeks before the elections day. Few people could believe the result of the elections, yet many politicians, analysts, economists, and sociologists tried to describe the sequence of occurrences that led to such a huge win for the Reformists party. Among all the explanations proposed by different people, we focus on a sociological analysis which considers various important factors in Iranian society. The high compatibility of the results of our model's simulation with what happened in reality shows the great help that modeling can provide us in understanding social happenings.

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Building Slightly More Complex Models: Calculators vs. STELLA

If students are to develop the potential to effectively manage ubiquitous complex systems it is becoming increasing important to develop systems thinking concepts and model building skills formally at the pre-college level. This paper describes an experiment conducted in two secondary school classrooms in the Pacific northwestern United States to determine the importance of access to a relatively new modeling tool for students to enable them to successfully create and analyze simple models that are slight extensions of traditional models, as compared with using graphing calculators to build an analyze the same extended model scenarios. Does the modeling tool make a difference? If it does, access to such tools must be addressed before a broad spectrum of formal curriculum can incorporate the system dynamics method, at the pre-college level.

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How Price Fluctuations are Influenced by the Response of Intermediaries to Different Sales Methods

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

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An Investigation into Iran's Auto Industry and Analyzing the Effects of Importation on its Growth:A System Dynamics Approach

Nowadays Iran is going to become one of the major auto producers in the Middle East. Although Iranian car industry is reaching near 1,000,000 annual productions, the quality of the products is not comparable with global standards. Iranian auto industry, passing a period of maturation, is now in a situation, in which domestic car producers are supported by strict governmental laws, and import is severely limited. Thus there are not sufficient requirements to form a competitive market. In this paper, we will present a system dynamics model which maps condition of Iran's auto industry in the recent years. The model is then used to provide insights for the current status of the industry, as well as testing some policies for simulating the auto industry's growth.

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Virtual Software Project Dynamics - The Human Resource Managment Sector

Virtual teams are fast becoming the norm in organizations and strategies are needed to deal with the new challenges that they create. Software Project Dynamics is a field of research that uses system dynamics simulation to explore software engineering issues. The objective of this research effort was to enhance systematically the understanding of virtual software engineering by using the system dynamics methodology and existing software project dynamic models. To accomplish the

research objective, the following tasks were accomplished: First, an extensive literature review was done. Second, a Software Project Dynamics model was reproduced. Third, the model was used as an experimentation vehicle. This paper suggests that system dynamics is a viable tool in the exploration of virtual software engineering challenges. A new field of research is recommended to deal with additional challenges of virtual software project teams by using system dynamics with the proposed name: Virtual Software Project Dynamics.

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System Dynamics: A Tool for Predictive Microbiology

One of the most important concerns in food industry is safety. Predictive Microbiology is the application of mathematical models to describe microbial behavior based in experimental data in order to prevent both food spoilage and food-borne illness. Because of both complexity of microbial behavior and food systems, Predictive Microbiology presents some limitations. System Dynamics could be an alternative and useful tool to predict and simulate food microbiological behavior providing a graphical interface and structures linked with a series of equations, to clarify and improve quantitative model descriptions.

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Beijing 2008 Olympics ad dynamics

The Beijing 2008 Olympics glamour presents a unique profit opportunity from advertising for entertainment and media firms worldwide. Poised to benefit from this prospect, the European Union Television Network (EUTV Net) formed a system dynamics (SD) modeling team to carve its ad traffic system during and around the Beijing 2008 Olympics. EUTV Net's objective is to maximize monetary gains by making its ads play on time, error free and with minimal duplication effort. A seven-sector SD model shows ad traffic system structure and computed scenarios identify the dysfunctional effects of the lack of information systems (IS) integration at EUTV Net. The SD modeling process can help organizations respond to their IS integration problems in order to significantly and sustainably improve their business performance.

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Effect of Conditional Feedback on Learning

Formal studies of decision threshold learning assume full feedback conditions, that is, no matter what the decision is (positive or negative), the decision maker will be provided by feedback. However, in the real world feedback may be conditional on the decision made. In this paper,

we investigate how conditional feedback can result in biased decisions. First, based on signal detection theory, a dynamic model of threshold learning is proposed. Then, the model is adjusted to examine effects of conditional feedback on learning and decision making. Then, the model is used to replicate some empirical findings. The results suggest conditional feedback can be a barrier to learning. Further, this study warns about problems of the current assumption of full feedback condition in most dynamic decision-making studies.

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

In the modern era, the advancement of Information technology requires improvement in other fields such as communication technologies, management of human resources, business environments, legal background and so on. Indicators that measure the growth of ICTs in different societies have also pointed out this importance. National legislators are always seeking means to improve ICTs and use them as enabler of industry in their countries. a number of developing countries have devoted a considerable effort in this area, but they have not achieved what they were expecting for. In recent years,Iran has made a desperate attempt to get engaged in similar activities, but according to e-readiness indicator nothing has achieved. In this paper, we take a system dynamics approach to model changes in the progress of information technology in Iran. Sources of many of the problems show up, after the simulation of the model. Also we outline a policy required for reaching a steady growth in the future.

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Real Estate Cycles: A Theory Based on Stock-Flow Structure of Durable Goods Markets

In this paper by means of a simple system dynamics model, we have addressed a cycle-producing mechanism in the owner-occupied real estate market which has not been discussed in the real estate economics literature before. This mechanism is based on accumulation of supply and demand which arises from specific stock-flow structure of a durable goods market like the owner-occupied market. Comparison between our model and a famous model of rental market (Wheaton, 1999) shows that despite the rental market, in the owner-occupied market an increase in durability of buildings leads to more intensive oscillations. Also the effects of price elasticity of supply on the cycles in the owner-occupied market is much more complex than that of the rental market. Furthermore a model integrating the two markets is developed. Model analysis reveals that the interrelations between the two markets make the effect of some parameters on the rental market cycles different from what is suggested by the rental market model. Our work uncovers the rich dynamic complexity of the real estate system and can serve as a good example of applying systems thinking principles to complex real world problems.

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Model on Food security in development countries: A systemic perspective

Abstract: The scientific community has had increasing concerns for strategic understanding and implementation of food security policies in developing countries, especially since the food crisis in the 70s. The process of decision-making in the public sector is becoming increasingly complex due to the interaction of multiple dimensions related to food security. Policy makers normally use models to support their decisions. This research explores the food security process from a national approach for developing countries through the study of its three main components: The availability of food, the access to food resources and the stability of food security. It bases its study on a systemic perspective through the use of systems dynamics as means of understanding the complexity of this phenomenon as well as the (interrelation) linkage and interdependency of its factors. The study will empower the planners of local regions in the decision making process, to foresee future treats, to alleviate partly the scarcity of food and handle the mismanagement of food resources.

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Improving Strategic Management of Hospitals: Addressing Functional Interdependencies within Medical Care

To better understand the performance of hospital operations in response to IT-enabled improvement, we report the results of a system dynamics model designed to improve core medical processes. Utilizing system dynamics modeling and emerging HIS data, we demonstrate how current behavior within the hospital leads to a 'stove-pipe' effect, in which each functional group employs policies that are rational at the group level, but that lead to inefficiencies at the hospital level. We recommend management improvements in both materials and staff utilization to address the stove-pipe effect, and estimate the resultant cost-saving. We believe that the major gains in health information systems use will accompany new information gathering capabilities, as these capabilities result in collections of data that can be used to greatly improve patient safety, hospital operations, and medical decision support.

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Business Model Analysis: A Multi-Method Approach

A business model is a set of assumptions about how an organization will perform by creating value for all the players on whom it depends, not just its customers. This paper discusses a multi-method approach to consistently analyzing the structure, the behaviour and the dynamics of business models in order to identify possible optimizations. The method utilizes object-oriented analysis for analyzing structural and behavioral aspects and system dynamics to analyze value creation dynamics.

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Energy Equipment Diffusion & Touristic Competitiveness: Building of an SD Model for the Greek Islands

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

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Dyadic Communication to Monitor Project Scope: Social Construction of Meaning in an Aerospace Program

This research uses a case study of a large system acquisition program to explore communication dynamics among a US government system program office, a general contractor, and a subcontractor, as they interact to negotiate scope (baseline) changes. Informed by a theory of symbolic interactionism, this research explores the dynamics of dyadic communications within which meaning is socially constructed. Constructing shared meaning in large aerospace programs is critical to delivering a complex product on time and on budget and to avoiding the now common "Nunn-McCurdy breach" (cost exceeding 25 percent of current baseline or exceeding 50 percent of original baseline). Based upon our case-study investigation, we constructed and analyzed a dynamic model of dyadic communication behaviors. Previously reported findings indicate that networks of dyadic communication paths demonstrate instability which can lead to failure, usually three to five years from project start, due to divergent understanding of objectives by the interacting organizations. Analyses suggest that leverage in reducing divergence lies in managing the boundary objects used by project participants and in monitoring relative intra- and inter-organizational attention and pacing. This research builds on previous studies examining the role of boundary objects and relative expertise in vehicle manufacturing and medical imaging.

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Innovation Diffusion in the Building Construction Industry: Empirically-Based Theory Generation

The paper focuses on diffusion of energy-efficient innovations. A conceptual model is developed that integrates relevant variables and mechanisms to describe and explain innovation diffusion in the building construction industry – an exemplary case of a large fragmented, socio-technical system with slow transition characteristics. A considerable amount of literature has been published about innovation diffusion. However, only little attention has been devoted to integrate relevant knowledge from different disciplines to explain the complex phenomenon of innovation diffusion in the building construction industry. This study draws on accepted theories as one source of information; others are existing empirical research, expert interviews, and workshop results. The latter two are based on a case study to obtain insights from a regional industry cluster. We use the grounded theory approach for data collection, analysis and modeling. The result is a validated conceptual model including mechanisms that explain the diffusion phenomenon. The first contribution is the description and explanation of innovation diffusion in a consistent model developed by inductive and deductive analysis. Second, the model provides first insights about policy levers and hypotheses about relative importance of underlying mechanisms. Third, the model can serve as a conceptual frame for a future quantitative simulation study.

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Unconscious Processing of Information in Dynamic Decision-Making – An Experimental Approach

The purpose of the paper is to investigate the effects of unconscious versus conscious ways of making decisions in a dynamic decision-making task. An experimental setting is used to study this question; three experimental groups are distinguished: immediate decision-making (only limited time for cognitive processing), distracted decision-making (time for unconscious processing), and considered decision-making (time for conscious processing). As experimental stimulus, a simulator based on the Kaibab Plateau model is employed. Findings are not yet clear, since so far only pre-test have been conducted; the actual experiment will be run in April and May 2008. Implications might comprise the usefulness of rational methods for decision-making, for instance modeling and simulation. The value of the paper lies in the fact that it connects to a recent discussion in psychology and transfers it into a domain in the core interest of the system dynamics community: decision-making in situations with dynamic complexity.

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Product Diffusion in 'the Long Tail'

Products distributed over classical sales channels serve local markets and have relatively high distribution and storage costs. However, when products are sold over the Internet and distributed directly to the end customer by specialized logistics service providers, the geographical scope of the products (and, thus, the number of potential customers) increases, while at the same time storage and distribution costs decrease (or are even zero, when digital products are considered). In addition with intelligent search and rating mechanisms, customers are able to identify products that fulfill any special needs. This phenomenon, called 'the Long Tail' by Anderson (2004), allows to serve market niches, when before only products of mass interests were profitable for firms to produce and to sell. Employing a conceptual system dynamics model, this paper identifies factors and behavior modes that distinguish the diffusion of products in classical versus in 'Long Tail' contexts. Implications for successful strategies in 'Long Tail' markets are derived from the analysis.

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Overgrazing Behavior and Rationality: A Dynamic Perspective

Although humans are assumed to be rational beings, there has been little consensus regarding the criteria for distinguishing rational from irrational behaviors. For example, overgrazing that often results in a tragedy of the commons is usually considered irrational. A subsequent question may be why there are always some rational people engaging in irrational overgrazing. Based on rationality theories and related research findings, this research analyzes the overgrazing behavior in the National Health Insurance system of Taiwan. The research findings indicate that system sustainability, the effectiveness of control, and the possibility of jumping out of the system are the critical factors that have effects on overgrazing behavior and the rationality orientation. If system sustainability is not a question, rational and opportunistic agents tend to be driven by greed, and the effectiveness of control is crucial in determining the behavior of the agents. However, once the system is perceived to be unsustainable, the motive of fear may dominate and the possibility of jumping out of the system becomes critical for the agents to choose between self-restrained and overgrazing behaviors. In addition, it is suggested that the "it won't me effect" may be responsible for the eventual collapse of the system.

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A Model for Upgrading Fleets under Constrained Conditions

This paper begins with a general discussion of the dynamics of maintaining a fleet of vehicles in a high state of preparedness against high level and ongoing demands on the fleet. The paper presents a model that was used to simulate and evaluate three strategies for a major upgrade to the fleet. The paper concludes with some observations about the general conditions under which the model can be used.

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Women with HIV/AIDS in Malawi: The impact of anti-retroviral therapy on economic welfare

In this paper, we provide a preliminary, in-depth qualitative analysis of the plausible feedback mechanisms contributing to the high HIV/AIDS rate among young Malawian women by examining the relationship between HIV/AIDS infections, HIV risk categories, economic welfare (and productivity), and the potential impact of increased access to antiretroviral therapy (ART). Additionally, to obtain greater clarity, test assumptions, create a roadmap of data for ourselves and others, and to provide more opportunities for future use, we further distill the qualitative analysis into a simplified preliminary quantitative model. For each model structure (qualitative and quantitative), we review the formulation, testing, and evaluation processes involved. We hypothesize that ART is fundamental to increasing economic welfare of young, HIV-infected women in Malawi and show that our models do provide useful information and feedback for future discussion on social policy and problem-solving.

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Surfacing the hidden demand for opioid dependent treatments for drug policy makers

Illicit drug policy has been the subject of important SD studies addressing the interaction between policing and medical treatment and estimating the prevalence of national cocaine use. Here we modeled the impacts of policy changes associated with wider use of newer opioid pharmacotherapies besides methadone. These newer drugs allow less supervision of dosing and changes in the mix of prescribing and dispensing arrangements. Key aspects of the model were estimation of potential demand for the enhanced range of therapies and the cost and treatment impacts of changes in cycling on and off treatments due to pricing and service configurations. Here we describe the use of SD models to provide a logical consistent framework for stimulating debate

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about incomplete and ambiguous data and clarifying the differences in expectations and goals of treatment among broad groups of policy makers. Our methodology included incorporating key concepts accepted from previous economic equilibrium Markov models and control phase plots from previous modeling in the area. Funded by the Australian National Council on Drugs (www.ancd.org.au) This material is yet to be released.

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Bringing distributed software development to SD modelling with Vensim

Maintaining one of the most complex System Dynamics model – ASTRA – with a group of more than 5 economists, we were facing two main problems. First, collaboration was difficult because all developers had to work with different files and changes had to be manually transferred into one model. Second, calibration was time consuming, since the complete model needs various minutes for only one run even on high end computers. We found a solution to these problems in transferring techniques from distributed software development to SD modelling. We split our complex ASTRA model into more than 40 modules, developed standards for these modules to be able to run them inde-pendently and to enable automatic merging of any amount of modules to one model, developed a tool for automatically executing this merge in order to run the complete ASTRA model and we set up a version controlled repository accessible by all developers via internet to manage the simultaneous development work of our modelling team which is spread out over three institutes in two countries. In this paper, we would like to present in detail the individual task as described above and conclude with our experiences after this major transformation of our ASTRA model.

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Applying Fuzzy Delphi Method to Select the Variables of a Sustainable Urban System Dynamics Model

A system dynamics model is composed of many variables. These variables simplify complex phenomena and provide a description of a system's current state or problems. Basic variables that describe the real-world urban development can be established from the elements that make up a city's different dimensions such as industry product, population growth and vacancy rate. The urban development framework takes a system-based approach by systemizing the city's internal elements. The systemic variables then provide not only a clear reflection of the interactions between all of the sub-systems but also how they relate to the overall system. It is therefore very important to select the appropriate variables. Most variables of system dynamics models are, however, set up by the designer, served as a subjective and unscientific approach. This study therefore applies the Fuzzy Delphi Method to the selection process of system variables to increase the confidence of the model. This was accomplished by first examining the system

relationships as well as the intent and meaning of the sub-system variables to be created. After establishing the criteria for variable selection, an empirical case study was used to devise the evaluation variables for each sub-system.

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Local Interventions for Reducing Cardiovascular Disease Risks: What Can They Achieve?

Public documents identify broad strategies for reducing the burden of cardiovascular disease in the U.S., but they do not specify how best to allocate limited resources. Such specific guidance is lacking in part because of gaps in data on intervention costs and effect sizes, but also because the many factors contributing to cardiovascular risk interact through pathways and stock-flow structures that defy simple calculation. The U.S. Centers for Disease Control and Prevention (with support from the National Institutes of Health) is using SD modeling to better understand these complexities and to evaluate potential intervention strategies in terms of their impacts on adverse events and costs over the coming decades. The project considers interventions that might be undertaken at a city or county level, including interventions to improve health care, physical activity, nutrition, mental health, tobacco control, and indoor and outdoor air quality. Construction of the model has involved working with subject matter experts as well as collaborating with the Austin/Travis County, Texas, health department, which has gathered a broad spectrum of local data on population health and interventions over the past several years. This collaborative effort is helping to translate the science of cardiovascular disease into a form that is policy relevant and that can help many communities do a better job of allocating their public health resources.

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Assessing the Effectiveness of Systems Thinking Interventions in the Classroom

This paper presents an analysis of systems thinking interventions in educational settings. Although these interventions have been implemented in K-12 classrooms since the mid 1980s, there is still no clear definition of systems thinking or identification of the best method to test the effectiveness of interventions or methods for teaching systems thinking The goal of this paper is to answer the question: how can we best assess the effectiveness of systems thinking interventions in education? This question begs three sub questions: (1) what is systems thinking, (2) what systems thinking interventions are being used in education, and (3) how have the effect of interventions been measured? The purpose of answering these questions was to propose methods for assessing systems thinking interventions. The analysis of systems thinking interventions in the classroom yielded an initial set of guidelines for measuring and raising a person's level of systems thinking.

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Breaking the Vicious Cycle of Poverty: Micro-Lending

Micro-lending has been introduced as an effective antipoverty tool in recent decades. However not all of micro-lending institutes are successful both in accomplishing their mission and in loan recovery. According to World Bank's focus note (2006), less than a quarter of its projects that funded micro-lending were judged successful. This paper describes a specific type of micro-lending (Grameen way of micro-lending invented by Mohammad Yunus, Nobel Peace Prize winner 2006). Then it summarizes the differences of conventional bank and Grameen Bank. Also this paper illustrates the important loops that make the Grameen successful both in the loan recovery and in accomplishing its mission. The final contribution of this paper is to develop a system dynamics model to test some Grameen policies that researchers believe are the key elements of Grameen's success. I find support for the fact that small loan size which is designed to match the client's knowledge maximizes Grameen's capital. Also the model finds that investing some portion of Grameen's capital, giving loan to groups of people and choosing appropriate interest rate are crucial for Grameen Bank.

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Science Meets Policy Practice

Recent discussions in system dynamics have raised questions about the scientific acceptability of system dynamics and impact of system dynamics on social problems. This paper describes two different projects in the area of mental health services research—a research study recognized for its science and consulting project making an impact on the policy process—and the institutional structures forming the university-agency-state partnerships. Together, the two projects helped create a community with greater awareness of system dynamics, interest in asking new questions from a system dynamics perspective, and motivation to pursue additional system dynamics projects related to research and policy. Key features of the individual projects, Center for Mental Health Services Research, Alliance for Building Capacity, and the community are discussed. The paper concludes with implications for future work in mental health services research and system dynamics in the nonprofit sector.

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Financial Performance of Mental Health Nonprofit Organizations

Mental illness is a major social problem. In the United States, the vast majority of mental health services and supports are provided through nonprofit organizations. Recent changes in the field of mental health such as the implementation of evidence-based practices, funding cuts, and statewide policy initiatives such as transformation have increased financial pressures on these nonprofits. Yet few dynamic models exist for understanding the impact of these changes on nonprofit mental health organizations and their performance. This paper seeks to address this gap by presenting a model of financial performance of nonprofit mental health organizations. The purpose of this model is to identify some of the key mechanisms driving nonprofit financial performance. The model is based on the longitudinal financial data of 65 nonprofit organizations providing mental health services or supports in a large metropolitan community, and key informant interviews with executive leaders from a subset organizations participating in a three-year longitudinal study. A simulation model is presented along with implications for state policy makers, managers of nonprofit organizations, funders, and organizational scholars.

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System Dynamical Analysis for Interdisciplinary Research on Human Resource Development

With respect to the career decisions of IT professionals around 2000 a system dynamic model using real data demonstrates how individual market orientation leads on the whole to high unemployment rates in the IT labor market. In the context of the gender equity program of the Civil Service in Germany system dynamic analysis elucidate – likewise using real data – the significant difference between the institutionally and the individually perceived reality.

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Falls prevention from a system dynamical piont of view

Falls are a serious problem for older adults, often causing severe injuries leading to loss of independence and high cost. Although high effort was already put in research, the situation concerning prediction and prevention is unsatisfactory from practical point of view. A small interdisciplinary team attempt to address the issue in a holistic view using a system dynamics based approach. A simple model was developed based on workshops with experts, which is able to simulate commonly observed circumstances. This leads us to the opinion, that limited success of research up to now is caused by the fact, that modelling approaches used in common are not sufficient for the complexity of the underlying problem. A system dynamics approach would cope much better with this challenge, leading to better predictions and case specific interventions.

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An Interpretive Approach to Drawing Causal Loop Diagrams

Causal loop diagram largely influences the effectiveness of system dynamics. The complex interpretive nature of management problems makes it difficult to recognize all the existing causal loop relations. In order to build system dynamics models for ill-defined problems, "Group Model-Building" is developed. As discussed by Vennix, one source of these messy situations is different perceptions of individuals. In this paper, we develop an interpretive approach to drawing causal loop diagrams assuming that there are different perceptions about same concepts and the analyst is closely engaged with finding most agreed causal relationships.

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Dynamics of Autonomous Control in Production Logistics

Due to increasing market dynamics, Production Planning and Control (PPC) has become more challenging for manufacturing companies. Production plans have to adapt quickly to changing market demands. It is often stated that (1) conventional PPC methods cannot satisfyingly

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handle unpredictable events, disturbances and market dynamics and that (2) in practice the complexity of centralised architectures tends to grow rapidly with size, resulting in deterioration of fault tolerance, and flexibility. To manage the increasing dynamics inside and outside a production system, autonomous control (AC) of shop floor logistics is a promising approach. The paper gives an overview of the modelling and analysis of AC strategies for production logistics. A universal shop floor model, built with Vensim DSS, is introduced. AC strategies are discussed and implemented. The particularities of modelling a production logistic scenario are presented. Based on the simulation results the logistics performance as well as the influence on the system's behaviour is assessed. The main focus lies on the comparison of the effects of the different autonomous control strategies on the logistics performance of the system and its behaviour. To achieve this goal, sensitivity analysis is used to compare the robustness of the logistic system while interchanging the AC strategies.

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An Analysis of Residential Energy Intensity in Iran, A System Dynamics Approach

substantial development of counties needs to use the resources in an efficient way. One indicator that shows the degree of efficient use of energy resources is energy intensity. Statistics show that Iran's energy intensity was in a bad situation during past years and if this manner of using energy resources continues, it will get worse. In this study a system dynamics approach is used to model changes of energy intensity in residential sector in Iran. By implementation and simulation of this model we found some reasons of this problem in Iran. Then we tried to introduce some policies to make steady improvement in energy intensity in the future.

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Overshooting alcohol intoxication, an experimental study of one cause and two cures

Juveniles becoming overly intoxicated by alcohol is a widespread problem with consequences ranging from hangovers to deaths. Information campaigns to reduce this problem have not been very successful. Here we use a laboratory experiment with high school students to test the hypothesis that overshooting intoxication can follow from a misperception of the delay in alcohol absorption caused by the stomach. Using simulators with a short and a long delay, we find that the longer delay causes a severe overshoot in the blood alcohol concentration. Behaviour is well explained by a simple feedback strategy. Verbal information about the delay does not lead to a significant reduction of the overshoot, while a pre test mouse-simulator experience removes the overshoot. The latter policy helps juveniles lessen undesired consequences of drinking while preserving the perceived positive effects. The next step should be an investigation of simulator experience on real drinking behaviour.

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Economic Growth, Pollution, and the Accumulation of Abatement Capital in a System Dynamics Framework

This paper develops a model of economic growth when emissions are generated as a byproduct of the production process. The production of goods yields income that can be used either for consumption or investment. The production of goods also induces an undesired byproduct – emissions. The emissions accumulate to a stock of pollutants which in turn impairs the economy. The consumption of good, in contrast, leads to an improvement of societal well-being. The positive impact of consumption utility and the negative impact of pollution are measured by a welfare function. In this setup of the problem there are two basic intertemporal control problems to solve: First, the society has to decide how much to consume today and how much tomorrow. Second, it has to decide how much of GDP should be invested in pollution abatement over time. The SD model developed in this paper allows simulating the consequences of policy choices and searching for optimal policy strategies. Several simulation scenarios demonstrate the scope of the modeling approach.

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Leveraging Dependency Structure Matrix (DSM) and System Dynamics in Combination to Reduce Project Rework

Planning and managing large-scale projects is non-trivial, as evidenced by the large number of projects that exceed budget and schedule targets. In many cases, rework is a key factor in project delays. Accurate rework prediction is challenging – even when the tasks responsible for rework can be identified, the likely project impact is difficult to determine. The work described in this paper examines how Dependency Structure Matrix (DSM) techniques can be leveraged to support and improve System Dynamics applications. It demonstrates how the DSM can be used to identify tasks that are likely to drive rework within a project and exploits System Dynamics to quantify the associated financial and schedule downsides. Using the context of current oil and gas projects, the challenges of managing dependencies between multidiscipline teams working to identify, evaluate, and select a development concept are examined. An overview of DSM fundamentals and approaches used to help with the management of these dependencies is presented. Next a discussion of how System Dynamics can both benefit from DSM analysis and resolve known limitations are considered. The natural integration of DSM and System Dynamics for management of project dependencies is summarized and used as a basis for suggesting new research agendas.

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Effects of Gas Subsidy on the Behavior of Power Stations in Iran:A new policy to reduce energy intensity in electricity section

Presently in Iran, gas-driven power stations and combined-cycle power stations compete as they share a common budget allocated by the government for their establishment. With the government offering gas at subsidized rates, the cost price of electricity production at gas-driven power stations is comparatively lower, thereby enhancing their attractiveness for the investor. Therefore, despite their decreased efficiency, the establishment of such power stations is on the increase which in turn imposes additional costs for the government. On the other hand, it would be in the best interest of the government to help increase investment in combined cycle power stations which are far superior in terms of efficiency, and which, in the long run, would be profitable. In this paper we present a model and suggest policies for the government through which a decrease in energy intensity can be achieved without incurring additional costs for the government. We suggest practical ways to optimize existing methods of power production by diverting subsidies offered by the government.

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Workforce Management Strategies in a Disaster Scenario

A model of the repair operations of the voice telecommunications network is used to study labor management strategies under a disaster scenario where the workforce is overwhelmed. The model incorporates overtime and fatigue functions and optimizes the deployment of the workforce based on the cost of the recovery and the time it takes to recover. The analysis shows that the current practices employed in workforce management in a disaster scenario are not optimal and more strategic deployment of that workforce is beneficial.

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A Taxonomy of System Dynamics Models of Educational Policy Issues

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

investigations are briefly described. The taxonomy classifies the completed investigations into seven specific areas of concern and five hierarchical levels.

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A Taxonomy of System Dynamics Pedagogic Techniques

A number of papers have been published describing various pedagogic techniques for the dissemination of the System Dynamics (SD) approach at various Education institutions and academic levels ranging from schools (K-12 in the US) to higher education. This paper builds on previous papers by this author that provided a partial catalogue and classification of this work in order to highlight potential areas of research in this field of study and to identify system archetypes at different hierarchical levels and discover new ones. This paper therefore presents taxonomy of System Dynamics Pedagogic Techniques. This paper builds on the earlier taxonomy by widening the scope of the survey of SD Pedagogic Techniques. The findings from these investigations are briefly described. The taxonomy classifies the completed investigations into specific areas of concern and hierarchical levels.

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A Case Study in Application of Vee Model of Systems Engineering to System Dynamics Modelling of Dryland Salinity in Australia

This paper describes an application of the Vee Model of Systems Engineering in developing a System Dynamics model of dryland salinity in the Murray Darling Basin. A modular approach was adopted. Simple modules of salt affected land were developed using Powersim Studio following decomposition, definition, integration and verification processes. Individual modules were verified, integrated and provided with options for policy testing. The use of Vee Model provides a structured way for developing computer simulation model with a top-down approach for requirements elicitation and ensures that the computer model meets requirements and limitations elicited through qualitative System Dynamics and defined at the start of the modelling exercise. It also provides rigorous verification processes. The results of this research provide an avenue for further exploration of the synergistic use of the two approaches to improve model quality.

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The Dynamics of the Government Supply Process for High-Value Spare Parts

Supply chains providing high-value parts to the Government have been plagued by both shortages and excess inventory. In many of these supply chains, a computerized government process calculates recommended

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orders for both new and overhaul parts. A research effort was undertaken to understand the mathematics of this process and its impact on supply chain performance. A system dynamics model of the supply chain was developed that incorporates the equations of the requirements determination process. The model revealed that the process worked appropriately for constant demand and responded well to a ramp-up in demand. It was found, however, that in the face of varying demands substantial bullwhip was produced in the supply chain. Moreover, it was shown that the ordering process is extremely sensitive to common data errors such as the production lead-time and that production constraints, not included in the ordering algorithms, created deep and prolonged shortages. On going research is developing improvements to the formulation of the ordering process and developing supply chain strategies for the next five years under differing demand scenarios.

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Broadening boundary perception in a multi-organizational context: Study of a community mental health program in New York State

This paper reports how systems perspective and simulation modeling method can help healthcare administrators and practitioners broaden their boundary perception and create shared understanding of their system. The case used in this study involves a community mental healthcare program in New York State where Systems Thinking and System Dynamics are used to uncover misalignment in the system boundary perceived by the different levels of healthcare administrators. The difference in the perceived system boundary can have a critical impact on the success of a healthcare program if the perception drives planning and assessment of the program implementation. More specifically, this study looks at how the perceived system boundary influences assessment of workload and capacity issues in the program. The study finds that without a systems perspective, unintended consequences of disparate boundary perception can persist without being recognized at the system level, as the local efforts—or solutions that are not necessarily globally optimal—are arranged to alleviate the unwanted pressures in the system.

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Market development of airline companies: A system dynamics view on strategic movements

The airline industry is characterized by strong dynamic developments. Concentrating on the smallest possible market for an airline company to develop, in this paper we want to demonstrate the effects of entry and exit on city pairs, i.e. the routes between two airports, by presenting a System Dynamics model to simulate and analyze strategic movements on airline markets. By varying the preconditions, e.g. distinct business models and initial entry setups and calibrated with the data of German Antitrust law suit between Lufthansa and Germania, we will show the

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various consequences of different market scenarios, comparing the results with hypotheses from a literature review. Additionally, we will show the effectiveness of a policy of predatory pricing against market entry under different conditions.

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Business Dynamics of a Record Company As Influenced By Online Channels

In this study, it is aimed to investigate the business dynamics of a hypothetical record company. The recent declining trend in musical industry in many countries has brought up the issue of free sharing of musical content. A system dynamic approach was taken to imitate a setting where there are both legal and illegal ways of obtaining an album. Special attention was paid to the self-marketing effect of the musical content present in the market. The life cycle of a particular album that is assumed to have a high potential of being popular is simulated. Despite the outstanding self-marketing effect of the shared content, the record company's profits decrease following the decline in sales due to diversion of people to illegal ways of obtaining the album in the mid-phases of the life cycle. Scenario analyses showed that the company's benefit from free sharing depends on how the increasing illegal content affects the market. If the diverting effect of illegal content is low, the demand generated is realized as legal sales to a satisfactory extent and thus the company actually profits.

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Development of Barbiturate Tolerance and Dependence: A Systems Modeling Approach

A system dynamics model is constructed to study the development of tolerance and dependence to phenobarbital in the long-term. Phenobarbital is a regularly used sedative drug. Its target is the brain. As a side effect, phenobarbital enhances the synthesis of metabolic enzymes in the liver and thus increases its own metabolism rate. Furthermore, in regular use, the brain adapts to the presence of the drug and its sensitivity decreases with time. These factors decrease drug effectiveness and urge the user to increase the dose during continuous use. A feedback loop results as the increased dose affects enzyme and neuroadaptation dynamics. Because adaptive changes persist even after drug intake stops, upon abrupt discontinuation of the drug, the patient experiences rebound effects such as hyperexcitability and seizures. The model incorporates enzyme induction and neuroadaptation dynamics and serves as an experimental platform to study the behavior of the drug user as he/she develops tolerance. Additionally, it is possible to evaluate dosing regimens in order to facilitate gradual withdrawal from the drug so that rebound effects are avoided. Our simulation experiments revealed that whether dependence is partial or complete, the duration of a successful regimen is more than half the duration of regular use.

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A system dynamics model of learning and innovation process profitability

In this paper we will introduce a system dynamic model that aims to identify the mechanisms how learning in innovation process converts to profit. This model is built on a single firm level from a strategic management approach. The model is built with modular structure that is in-line with different theoretical aspects that are covered with-in the simulation. In this research 3 main feedback loop groups are identified that offer different approaches in innovation process performance improvements for the manager. These options and their effects are evaluated with the help of the model and the initial data is presented in this paper.

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A Dynamic Simulation Model of Academic Publications and Citations

In academia, the two main measures of research performance are publications and citations. These two measures in a sense quantify the research success of scientists and academic units. Perception of these performance measures can create pressures on researchers and cause different behaviors in different conditions. The aim of this study is to examine the behaviors of researchers in response to the dynamics of publication and citation pressures. A model including faculty members in a department, their publications and citations has been constructed by using system dynamics methodology. An important factor that determines citations for a paper is the quality of the paper. Reputation of an academic unit is established as a result of citations that the unit receives over time. There is an important feedback loop so that the reputation in turn influences the citations the units will enjoy. A researcher, who has citation pressure on him, would be forced to produce higher quality papers for getting more citations. On the other hand, publication pressure would cause the researcher to produce lower-quality papers in higher numbers, in shorter times. The main decisions of researchers are thus modeled through allocation of researchers' time in research activities and time devoted on each research. The results obtained agree with our dynamic hypothesis and qualitative information about the behavior of actual academic units.

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Modeling of Network Dynamics: From Dynamic Nodes to Dynamic Structure

The paper presents a conceptual framework for modeling of dynamic systems with variable structure. A practical motivation comes from analysis of value networks – complex systems of stand-alone business entities that bond together, more or less tightly, through exchange of

goods, services, and money. The existence of bonds between certain businesses, and their strength, are determined by the relative performance of individual businesses in terms of a value they add along the network. The collection of effective bonds defines the structure of a network. As the performance of businesses changes over time, so does the network structure. Better performing nodes are more likely to get bonded, and nodes with stronger bonds are better positioned to further improve their performance. Having an operational model of the value network behavior, with the capability to predict the changes in the network configuration as a result of the changes in the individual node performance, is a crucial prerequisite for effective management of the network performance. We propose a stochastic model of the dynamic behavior of a value network, which combines probabilistic graphical modeling with stochastic extension of system dynamics to model a network configuration and individual node performance, respectively.

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Building a car market share model of Alternative Fuel Vehicles: from generic system archetypes to system dynamics modelling

This study investigates the market barriers in increasing the market share of Alternative Fuel Vehicles (AFVs) and possible policy options to overcome them by using a system dynamics model. In particular, this study first conceptualises the AFVs market model by aid of generic system archetypes suggested by Wolstenhome (2003, 2004). Among four generic system archetypes suggestd by Wolstenhome, the market structure of AFVs and conventional cars can be explained by 'relative achievement'. Starting from the generic system archetype, this study extends the model to take account of various model assumptions. According to the AFVs market model of this study, if there is a significant network effect on vehicle operating costs, it is difficult to achieve the shift to AFV even in the long term without a policy intervention because the car market is locked in to the current structure. There are several possible policy options to break the 'locked in' structure of car market, such as subsidy on vehicle price (capital cost), subsidy on fuel (operating cost) and niche management policy.

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Interacting representations – how students discuss, construct and use representations within a System Dynamics framework

When students learn to master system dynamics methodology they are introduced to tools and conventions for representing systems and the dynamics in them. This study explores how students collaboratively construct models of dynamic systems in the form of Causal Loop Diagrams (CLDs). Our focus is on the role of the graphic representation in the students' interaction and communication. The work process, comprising both the students' discussions and physical actions, reveal

their process of making meaning. The results show that the evolving graphical representation serves as a major resource in students' meaning making. It is also shown that preconceptions are influential, but sometimes hard to incorporate in a new representational format. Different representational formats interact. For example a phase graph, showing static optimums, influences the process of developing CLDs. Our study also reveals how students recurrently check and validate their CLD by using counterfactual conditional statements.

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Evolution of HIV/AIDS in Southern Africa

This paper presents a system dynamics model to study the spread of HIV/AIDS in Southern Africa. The HIV/AIDS model includes important feedback mechanisms of the spread of HIV/AIDS, and partly explains the dynamics of the epidemic in a representative Southern African country. The HIV/AIDS model indicates that prevention to reduce risk behavior is crucial in all stages of the epidemic, but is most efficient in an early stage. Financial relief is most appropriate in a more advanced stage of the epidemic.

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Dynamic Changes in Creative Manpower and R&D Technology Level in the Culture Industry

Based on various employment and technology data in the cultural sector from the mid-1990s to the mid-2000s in Seoul, Korea, this research examines whether technology- and human resource-oriented programs exert significant impact on creative manpower and R&D technology level. After briefly introducing Seoul's trends in the culture industry, it tries to explain major reinforcing and balancing loops. The stock-flow diagram of the culture industry in Seoul is applied to estimate relative effectiveness of major cultural programs. Judging from a series of simulated experiments, technology-oriented cultural programs are essential to increase creative manpower and R&D technology level in the short term. For the first half of research period, this research finds that human resource-oriented cultural programs put forth minimal impact, if they even exist at all. The trends, however, are reversed in the long term: Both size of creative manpower and R&D technology level absolutely depend on human resource-oriented cultural programs in the second half.

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Dynamic Simulation of Construction Waste in Macao

Abstract: This paper is the analysis for the behavioral tendency of the construction waste (CW) volume in Macao from 2006 to 2025. Four sources of CW are selected to be the objects of study, which are assumed to constitute all the CW in Macao. Some related factors, such as area of Macao, the average stay time of tourists, population density are also taken into consideration. STELLA 8 is used to perform the analysis, and correlation analysis of parameters will be carried out by a statistic software SPSS (SPSS Inc., Chicago, Ill.). The simulation result shows that the total CW will reach 530128 cubic meters in 2025. The sum of total CW from 2006 to 2025 will have a volume of 13,818,250 cubic meters. From the results of the simulation, the largest portion of CW is generated by casino and hotel projects, which is the main source of CW in the entire simulation period. This research was supported by the Science and Technology Development Fund of Macau (No.022/2007/A2), Macao Special Administration Area, China.
Keywords: Macao; Construction Waste; Systems Dynamics; Simulation; Stalla; SPSS.

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Dynamics of Interventions - Relationship between Scale of Change and Performance

Research, as well as three decades of working with managers across diverse cultures, nationalities, and industries, revealed consistent patterns of counter-productive decision-making in their organisations. Managers appear to exhibit an unmistakable tendency to “over-intervene” in the systems (companies, organisations, communities, etc) they are responsible for. This indicates an inadequate level of understanding and appreciation of the complex dynamics, hence generating unnecessary fluctuations and instability in their organisations. Maani et al. (2004), Sterman (1989), and Sweeny (2000) have studied these phenomena in experimental and simulated environments respectively. Anecdotal evidence, as well as research results, highlight a number of mental models and assumptions commonly held by managers. One of the most apparent assumptions observed is the notion of “the harder you push, the faster it goes”, and thus, larger-scaled interventions should result in better performance. This research uses empirical evidence elicited from realistic simulation models of organisations (Microworlds) to shed light upon the relationship between scale of interventions and performance. The results showed that even though large-scaled interventions are effective in the start-up phase of systems, they are generally counter-productive for mature systems operating in steady states. Such results confirm findings from recent research, including the multi-year longitudinal studies of organisations by Collins (2001).

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Modeling Access to Information and Communication Technology (ICT) for Assessing a Penetration Policy

This paper develop a model to access to Information and Communication Technologies (ICT) on development and to assess policy for the penetration of such technologies in Colombia. The model is based on concepts of bounded rationality, i.e. the mental processing capacity and information availability are limited. The model is used for increasing our understanding the complexity of the problem and for policy assessment. It is shown that some policies may increase the penetration of ICT when based on people's opportunities and desires.

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System Dynamics Models as Theories: What Can We Learn from the Virtues of Good Theory for Model Assessment and Evaluation

On the basis of developments on evaluation of system dynamics models and the virtues or characteristics of "good theories," we identify in this paper areas of opportunity for research on model assessment tools. Our initial exploration reveals that current developments on the area of model evaluation are particularly strong to assess the relevance of system dynamics models, finding areas of opportunity in the assessment of models in terms of characteristics such as uniqueness of a model, parsimony, conservatism, generalizability, fecundity and abstraction. We finish the paper suggesting some feasible paths to develop assessment tools in these areas of opportunity. These initial suggestions constitute a starting point to involve in a conversation other members of the system dynamics community.

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Resolving Performance Measure Conflicts in a Supply Chain using Systems Thinking Methodology

Performance measurement and management have received a great deal of attention in the literature in recent years. However, to date, there is scant attention to dynamics and trade-offs amongst performance indicators in theory and in practice (Santos, Belton et al. 2002). Thus, performance management systems (PMS) have remained static, fragmented, and backward looking (Bourne et al. 2000) leading to adverse outcomes, often unknown to managers and organisations. The systems view of performance, on the other hand, requires for a holistic approach to performance measurement integrating multiple dimensions, functions and time horizons across the enterprise. A systemic performance measurement would take into account the interdependencies of functions and their dynamic influence on the performance of the organisation as a whole. The paper reports on an action research within a multinational company where through real case scenarios we demonstrate how KPIs influence, contribute or impede one another in a manufacturing/supply chain setting. The paper reveals how the use of systems thinking concepts and causal loop models by novice users facilitated an open environment for cross-functional communication and collaborations, leading to team and organisational learning and enhanced performance. Keywords: performance measurement, team learning, mental models, systems thinking, cross-functional management.

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Understanding the Dynamics of Declining Disability Receipts in New York State

Under the auspices of the New York State Office of Temporary and Disability Assistance (OTDA), the Division of Disability Determinations (DDD) adjudicates New York's Social Security Disability (SSD or Title II) and Supplemental Security Income (SSI or Title XVI) claims according to the requirements of the Social Security Administration (SSA). Over the past few years, DDD has moved from a demand environment to a planned environment to facilitate a responsive rather than reactive approach to workload changes. This report presents the findings of a study that was conducted to examine why the number of initial disability receipts received by DDD has been decreasing since 1998. To accomplish the study, a system dynamics computer simulation model was built to explore various theories that have been put forth as reasons for the decline.

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Very Large System Dynamics Models - Lessons Learned

This paper provides lessons learned from developing several large system dynamics (SD) models. System dynamics modeling practice

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emphasize the need to keep models small so that they are manageable and understandable. This practice is generally reasonable and prudent; however, there are times that large SD models are necessary. This paper outlines two large SD projects that were done at two Department of Energy National Laboratories, the Idaho National Laboratory and Sandia National Laboratories. This paper summarizes the models and then discusses some of the valuable lessons learned during these two modeling efforts.

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Interactive Simulations to Enhance Understanding of Climate Change

Studies show many people, even those with extensive education, have poor understanding of the basic processes involved in global warming and climate change. Building on prior work we describe new interactive management flight simulators that allow individuals to explore these processes themselves. The simulators cover issues such as the stock and flow structure governing the accumulation of greenhouse gases (GHGs) in the atmosphere, the dynamics of the carbon cycle including feedbacks regulating the removal of GHGs from the atmosphere, with explicit consideration of sink saturation and the potential for positive feedbacks to cut net removal through thawing of permafrost, enhanced bacterial respiration and wildfire. The simulators also examine the delays in the response of GHG emissions to changes in policy. We report results of an experimental test of the simulators with highly educated business school students and discuss extensions and future uses.

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A Feedback Theory of Trust and Confidence in Government

A feedback-intensive theory of trust and confidence in government is presented. In this theory, a distinction between trust and confidence is proposed, which links trust to behavior (action) and confidence to performance (outcomes). In addition, on the basis of findings from the literature on cognitive psychology, a perception-formation process that includes the role of attention, memory, and expectations is used to enrich the understanding of the evolution of trust, confidence, and learning under conditions of uncertainty.

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Effectiveness of Group Model Building in discovering hidden profiles in strategic decision-making

A hidden profile is said to exist when (a) information relevant to the decision at hand is distributed over different members of a decision-

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making group in such a way that each of the group members possesses unique information and (b) group members will need to pool these unique pieces of information in order to select a superior decision alternative. Hidden profiles give rise to inefficient sharing of information, therefore leading to suboptimal decisions. Strategic decision-making is hampered by difficulties in gathering, sharing and integrating information. Information feedback that is dispersed over group members is often ignored. This reflects the existence of hidden profiles. Group Model Building seems capable of discovering hidden profiles in strategic decision-making. The methodology needs investigation in controlled settings to further ground its value. We have conducted an experiment to test the effectiveness of Group Model Building on its contribution to enhancing information sharing and decision quality.

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Linking clinical workforce skill mix planning to health and health care dynamics

Current health workforce planning methods are inadequate for the complexity of the task. Most approaches treat the workforce supply of individual health professions in isolation and avoid quantifying the impact of changes in skills mix, either planned or unplanned. The causes and consequences of task delegation and task substitution between or within health professions is particularly important in handling workforce shortages in developing countries and understanding and planning possible responses to both rapid catastrophic health demands and slower background trends in their social and political environment. As well as the contextual environment, interactions and delays in supplying and balancing health resources and configuring clinical services are required to address the geographic, profession-specific and quality imbalances. These supply side resources include knowledge and research, skills and attitudes of clinicians, buildings and equipment, medications and medical technologies, information and communications technologies and any other methods and models to improve the provision of clinical services. The interaction between demand and supply could adjust for feedbacks of health services outcomes, policies and governance on population expectations, funding, political and social supports and explicitly link these to clinical workforce supply in a useful, rigorous and relevant tool. The challenge is capture the relevant essence of the dynamic complexity of health and healthcare for this purpose.

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ACT Water Management: A System Dynamics Based Learning Intervention

Since the inception of System Dynamics aims to foster in-depth understandings of complex, dynamic problems with the aim of improving learning and decision making at the individual and organizational levels. Whilst considered by many to be a mature

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discipline, SD still falls short of being universally accepted as a decision making tool. Arguably wider acceptance is inhibited by; how decision makers think about complex problems, and challenges in demonstrating the validity of the developed models, and hence building confidence in those models and the strategies developed from them. Evaluative research is necessary to further investigate the ways decision makers think about complex problems and the utility of SD interventions. This research uses a two-phase methodology to test, at both holistic and feature levels, a SD intervention designed for investigating how managers and consumers make decisions which impact upon the limited water resources of a confined geographical territory. At the holistic level changes to patterns of water consumption arising from re-framing the mental models of the stakeholders will be investigated. At the feature level, an experimental study will test how model transparency affect understanding the problem structure.

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A Multi-methodology Approach to Addressing ICT Skill Shortages in a Government Organization: Integration of System Dynamics Modeling and Risk Management

This paper describes a multi-methodology approach used to reveal feedback dynamics operating in supply of, and demand for, skilled information and communications technology (ICT) employees. It describes how a large public service organization has had difficulty in adapting to rapid technological change, and how this has been exacerbated by employee shortages. The impacts of changing demographics of the workforce and society are investigated, along with how these factors impact upon attracting, recruiting, training, and retaining employees. The paper is as much about what is needed to achieve implementation success as it is about the effective application of tools and techniques in the development of strategy. It describes the lessons learnt when a system dynamics model of the supply of ICT skills was combined with a tool that enabled analysis of the risks that shortages would arise, and the consequent cost of those shortages to the organization.

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How to Deliver Multi-phase Software Development Projects: System Dynamics Simulation of Alternate Project Strategies

This paper examines what differentiates multi-phase software development and integration projects from other complex projects. It argues that effectiveness in identifying defects in the early phases of a project results in early rectification (rework) and initially slows down the project. But, this is necessary to improve likelihood of successful delivery of subsequent phases. Lower levels of effectiveness in identifying defects early, creates the need for higher levels of subsequent rework, raising the possibility of rework of rework. The need for

seemingly indeterminate amounts of rework is examined. The key drivers of successful reduction in amounts of rework are investigated through the use of system dynamics modeling and simulation. Most importantly for managers of projects involving software development is that scenario planning can be used to identify where management and engineering efforts are best directed. Through the use of system dynamics modeling and simulation, this can be done before committing to a particular software development project.

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From fossil fuels to renewable energies

This paper describes the model of an industrial society based on fossil fuels whose supply decreases and the society is forced to develop alternative energy sources. It is conceived as an abstract model that captures the basic aspect of such a change, but in a simple and schematic way. Despite this, most of the important dynamics of this problem are included in the model. The results show interesting trends: the transition is possible but not straightforward. The technological change requires time and investment, and the dynamics of such investments are of vital importance. The system can also fall into a stage where no technological change is possible and the industrial ability of the society is lost.

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Evaluating Strategies for Controlling Attrition Rate of Canadian Air Force members

The Canada's Air Force (CAF) has been faced with a challenge of retaining skilled, qualified, and trained members. It is common that every year approximately 10 to 15 percent of members from almost all occupations leave the CAF at various ranks. Due to such consistent loss of members, shortage of members has been causing a multi-dimensional undesirable impact (such as work overload, imbalance between work and family life, delays in training and promotions) on the existing members. The researchers at the CAF have identified factors such as low pay and benefits, undesired postings, work overload, and more engagements in non-job related activities. This research explores the underlying structure that drives attrition rates. A formal simulation model is developed that replicates the attrition problem of the CAF. The development of the model uses the data collected through interviews of subject matter experts, and reports of previous work carried out by the CAF staff. The parameters of the model are calibrated based on numeric data of last seven years. The model results are quite promising and consistent in replicating the historical data. The simulation model presented here demonstrates the capability of evaluating the relative benefit of polices aiming at controlling the attrition rate.

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The Efficiency of Alternative Control Mechanisms in a MTO three-stage tandem Production/Inventory System

In this work we develop a SD model for a make-to-order (MTO) three-stage capacitated production/inventory system. We employ a production order release mechanism affiliated with the automated pipeline inventory and order based production control system (APIOBPCS) policies family. The production rates at each stage are defined under alternative policies. One of the policies considers the human behavior in the decision making process. The robustness of the alternative policies is investigated through the dynamic response of the system under step and pulse changes in demand. Finally, the efficiency of the alternative policies is examined by means of six performance criteria.

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The Diffusion of System Dynamics in Academia

The paper analyzes the geographical diffusion of system dynamics in academia using information on the affiliations of authors who have contributed to the System Dynamics Review. The paper develops and interprets a set of descriptive indicators that allow the identification of sustainable adoptions of system dynamics in a particular country. Longitudinal analyses indicate difficulties in the diffusion process and point at policies potentially advancing the further dissemination of SD.

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The ``Unknown'' And ``Unknowable'' Description

The general mathematical representation complex system is investigated on the base of multilevel hierarchical systems theory (MHST). The formalism of this structures description is proposed. The mathematical properties of the social systems models is investigates on the base Aed representation of MHST. It is shown that this models based on the non-archimedean analysis. Transition to “unknown” and “unknowable” region is investigated. Transition between both regions is investigated. The origin of chaos in the social system is studied. The presence and growth of the chaos follow from the properties of elementary unit (free will of homo) and mathematically linked with the halo of monad. Volume of indeterminacy found. Conditions of controllability are formulated.

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Diverging Incentives and Evolutionary Dynamics within Supply-Chain

The relationship between a supply-chain and a main contractor within a local cluster of production unveils elements of complexity. While fates of supply-chain and main contractor are often interlaced, as the relationship unfolds dynamically incentives may diverge dramatically. This paper addresses a dilemma main contractor faces in taking decisions concerning technology transfer towards local suppliers. On the one hand, main contractor has an incentive in transferring technology with the aim at increasing technological content of input supplied locally. On the other hand, as the technological content of the supply-chain increases, local suppliers may have an incentive in diversifying their sales towards global clients thereby increasing their bargaining power. Grounding on formal modelling and computer simulation, this paper explores different scenario emerging by the matching of different policies of technology transfer and different attitudes of supply-chain towards diversification of sales towards global clients. We explore the circumstances in which cooperative behaviour leads to more efficient scenario than non-cooperative behaviours.

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Minnesota biofuels policy: analysis of the existing renewable fuel standard and a potential low carbon fuel standard

The scientific community agrees global climate change caused by anthropogenic sources of greenhouse gas emissions (GHG) is occurring, and the projected rise in average global temperatures as a result of climate change could lead to serious consequences for human health, economies and the environment. The transportation sector is a significant source of CO2 emissions, and in the United States accounts for 28 percent of GHG emissions. Because of transportation's considerable contribution, the federal government and states have explored and continue to consider ways to lower CO2 emissions from this sector. Biofuels in particular are a popular option for addressing climate change and two main types of biofuels policies have received much focus recently for their potential to reduce GHG emissions from the transportation sector: the renewable fuels standard (RFS) and the low carbon fuels standard (LCFS). It is important to analyze and compare these two policies with regard to their potential contribution to the overarching goal of reducing CO2 emissions. By assessing the RFS and LCFS specifically for the state of Minnesota, this project seeks to address the question: How can Minnesota maximize the contribution of biofuels to CO2 emissions reductions through state-level policy?

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Reducing regulatory burden: Integrating Total Pollution Load Management System and Total Industrial Site Volume Control

The purpose of this paper is finding ways to integrate Total Pollution Load Management System (TPLMS) and Total Industrial Site Volume Control System (TISVCS) in capital region, Korea to reduce regulatory burden on businesses. The TPLMS is a policy adopted to improve air quality in capital region while the TISVCS was adopted to control population concentration in capital region, Korea. TPLMS and TISVCS have different objectives, but they have a common ground because both policy regulate location and size of business. Under the TISVCS, the government sets the maximum limit on the total industrial site volume to control population concentration in capital region. On the other hand, the TPLMS is the environmental policy newly adopted in 2007 to control the total amount of pollution emission in capital region. The TISVCS has been criticized for many years for its weak regulatory rationale and for excessive regulatory burden on businesses. One alternative solution to this problem is replacing the TISVCS with the TPLMS. Using system dynamics model, this paper explored its possibility and conditions under which the integrated policy could operate successfully.

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System Dynamics, RBV and Behavioural Theories of Firm Performance: Lessons from People Express

In recent years several scholars and practitioners have proposed that a combination of system dynamics and the resource-based view of the firm (RBV) can help to explain anomalies in firms' competitive performance over time. For example why do some firms, despite initial success, subsequently falter and even fail spectacularly. This article provides a practical example based on the well-known rise and fall of People Express in the highly competitive US airline industry of the mid-1980s. The contribution of RBV and system dynamics to understanding the changing fortunes of the firm is discussed and also critiqued.

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Dynamic Complexity in Military Planning: A Role for System Dynamics

Military strategists are increasingly recognizing that planned interventions sometimes fail to achieve their goals, especially in the long term, because planning is done with a limited view of possible outcomes rather than a whole-systems perspective. The systems modeling methodology of system dynamics is well-suited to address many of the dynamically complex problems that arise in the context of military planning issues. The purpose of this paper is to highlight key features of

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the system dynamics method as it might be applied to military planning. The paper develops an illustrative model of a stylized military planning situation and uses it to illustrate typical characteristics of system dynamics models and their use to understand system behavior. The example highlights basic structural features found in system dynamics models including stocks and flows, balancing and reinforcing feedback loops, nonlinearities, and time delays. The example shows how structure causes behavior and identifies several characteristic aspects of the behavior of dynamically complex systems, such as the basic dynamics of stocks and flows, dynamic equilibria, paradoxical patterns of behavior over time (e.g., better before worse), shifts in loop dominance, and tipping points. The paper closes with some thoughts on using system dynamics to improve military planning.

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Biomedical Applications of System Dynamics

The absorption kinetics of subcutaneously injected soluble insulin is unusual in that clinical experiments show that a slow initial absorption after a couple of hours is replaced by a significantly faster absorption. Moreover, experiments with different injection volumes and insulin concentrations demonstrate that there is both a volume and a concentration effect. The slow initial phase disappears if either the injected volume or the concentration of the injected insulin is reduced. On the other hand, in the limits of very low concentrations or small volumes, a tail develops on the absorption curve, representing a new type of slow process. A System Dynamics model of this absorption scenario was original developed in collaboration with the Steno Memorial Hospital. In spite of the fact that the insulin concentrations have increased by an order of magnitude, the model continues to correctly predict the absorption curves, and we are presently using variants of the model to explain the absorption curves for other insulin forms, some of which are bound to protein as they are injected or bind to protein as they enter the blood vessels while yet others are injected in crystalline form or precipitate immediately after the injection.

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Catastrophe Archetypes - Using System Dynamics to Build an Integrated Systemic Theory of Catastrophes

We propose an Integrated Systemic Theory of Catastrophes (ISTC) using System Dynamics to model and to understand common systemic structures and behaviours of catastrophes. Current catastrophe research concentrates on a specific field and does not capture complex multi-field catastrophe scenarios that cannot be reduced to a single scientific field. For example, when looking at famines the elements of the relevant feedback loops belong to different fields of science (climate, precipitation, soil conditions, population density etc.) and no single of these sciences alone can identify the systemic structure generating famines. In this paper we introduce the concept of catastrophe archetypes that function as a central element of the ISTC. Catastrophe archetypes describe systemic structures responsible for catastrophes to occur and make underlying catastrophe dynamics visible that are

normally not directly seen. Within the ISTC the catastrophe archetypes will be used as diagnostic-, planning- and theory building tools to explore catastrophes systemically.

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Modeling the Diffusiondynamics of a new Renovation Concept

This paper reports on a preliminary version of a System Dynamics model of the diffusion dynamics of an innovative retrofit concept in the residential construction sector. The diffusion process is conceptualized as depending on the actions of two types of agents and the results of their interactions. The focus of the paper is on the positive feedback processes fueling the diffusion across the two groups of agents and on the negative feedback processes capable of shutting the diffusion process down. After exploration of the model's feedback mechanisms, the results of three simulation scenarios are presented and discussed in view of societal policies and business strategies in support of the innovation's diffusion.

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System Dynamics Simulation Modelling of "Kastela Bay" Regional System

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

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The Impact of Firm Knowledge Strategy on its Competitive Knowledge: A System Dynamics Approach

Recent movements towards a 'knowledge-based' view of firm have emphasized the importance of knowledge in enabling the firm to gain

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competitive advantage. Different dimensions of knowledge are explicated in the knowledge management literature such as explicit vs. tacit knowledge, internal vs. external knowledge, etc. Based on SECI model, firms create knowledge through social interaction between tacit and explicit knowledge. It is important for them to acquire external knowledge and combine it with internal knowledge to create new knowledge as well. Acquiring external knowledge is a very complex process and several scholars have considered this process from different perspectives. In this paper, we try to integrate these perspectives and propose a System Dynamics (SD) model for knowledge transfer and creation dynamics within an industry. Using this model, we can test the impact of knowledge strategy adopted by a firm on its success in different knowledge situations.

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Increasing Mobile Operator Revenue Out of VAS, A System Dynamics Approach

Telecommunication industry is not comparable with many industries in view of rapid market and technological change. In this industry, Mobile Communications is one of the most attractive segments. The new and novel trends can be seen in Telecommunication industry from time to time which suggesting various dynamics and relationships in this industry development. In this article, we will examine and analyze existing trends in mobile operators' services to find out the position of Value Added Service (VAS). Then, existing dynamics in delivering Mobile VAS will be deduced through VAS value chain analysis and its market characteristics. We will simulate and execute the proposed dynamic model and get acquainted with the behavior of model elements and analyze them. Finally, two policies will be suggested and with the analysis of results of these two policies, some recommendations will be made for mobile network operators to maximize their revenues out of VAS.

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Application of Non-deterministic System Dynamics for Construction Quality Management

This paper presents a system dynamic based approach for construction quality management. The dynamic process of quality management is modeled using system dynamics technique. It is shown that the effectiveness of system dynamics as a methodology for modeling and simulating construction process can be significantly increased if it is extended to deal with imprecise variables as well as the vague interdependencies. For this purpose, the imprecise variables affecting the quality management process may be treated as fuzzy sets and the vague and imprecise dependencies between the variables may be considered using fuzzy logic. The additional expenditures caused by the quality defects are simulated and quantified using the proposed non-deterministic system dynamics approach.

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The Dynamic Analysis of a Simplified Centralised Supply Chain and Delay Effects

This paper presents analysis of the behaviour of a model of a centralised supply chain. The research was conducted within the manufacturing sector and involved the breathing equipment manufacturer Draeger Safety, UK. A simplified model of the Draeger Safety, UK centralised supply chain has been developed and validated. Long lead time impact has been simulated as additional production delay. Uncertainty in forecasting has been represented in terms of information delay. Simulation and analysis have been performed using System Dynamics, non-linear dynamics and control theory. The findings suggest that destructive oscillations of inventory could be generated by internal decision making practices. The primary route to the instability depends on the structure of the system.

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Simulation of Drainage Systems in unsteady state condition, using system dynamics

The system dynamics technique is one of the object oriented approach that studies and manages complex feedback systems. Its merits include the friendly and easily development and improvement of model. It's also used as a decision tool for engineering problems.In this paper, the system dynamics technique was used to simulate the performance of a drainage system in unsteady state condition. The model is capable to predict many hydrological parameters such as water table fluctuation, drainage discharge, upward flux, evapotranspiration, deep percolation, infiltration, runoff, soil moister content and unsaturated hydraulic conductivity on the basis of variation of soil moister content. All above parameters were investigated theoretically and their trends were found to be legible. The model was validated using observed experimental field data collected from amirkabir unit in sugar beet development plan located at khozestan, Iran. The observed data were water table level and drainage discharge. The standard error index was calculated to determine the agreement between the observed and simulated values of water table and drainage discharge. The results indicated that S.E. for water table and drainage discharge were 10.2 and 0.13 centimeter per day respectively.

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The Effects Of System Dynamics Approach In Science Education In Middle School

The aim of this study is to 1) apply system dynamics approach in 7th grade middle school students in science and technology course, 2) determine the problems in field application, 3) improve the students' attitude against course and some skills such as problem solving, understanding the causal relationship and graphing with analyzing the relationship, 4) provide an effective learning and teaching tools for

students and teachers. Another aim of this study is to investigate how system dynamics approach help constructivism. The experimental design with pre-post test with control group is applied in this research. The study was applied with 81 students in middle schools in Istanbul / Turkey. Five assessment tools are used: "Science and Technology Course Attitude Scale, "Scientific Success Test", "Cause-Effect Relationship Scale", "Graphing and Analyzing Skills Scale", "Problem Solving Skills Inventory". Improvements due to system dynamics are observed in the tests that measure: scientific success, perceived problem solving skill, ability of undestanding graphics, ability of understanding causality relationships. However in the boundaries of the research, no improvements were observed in the following attitudes: perceived understanding of causality relationships, perceived graphics drawing and reading ability, perceived interest into science and technology course.

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A System Dynamics Model for Studying the Structure of Network Marketing Organizations

The importance of social structures in analyzing a diffusion of ideas and innovations is widely acknowledged. This paper presents the first step in the construction of a system dynamics model to study social diffusion phenomena using network marketing as the specific structure through which products and services are spread. Network marketing organizations are direct-selling channels that recruit new distributors and form a particular type of social network which is shaped through time and based on preferential attachment. The paper presents a way to generate the topology of such a network so as to have the basis for analyzing the diffusion of products and services through such channels; a variant is introduced to an existing model developed with systems dynamics for generating scale-free networks with preferential attachment. We found that the resulting model generates an adequate network topology for analyzing essential characteristics of the way network marketing organizations are formed. This structure is the base for exploring the diffusion of products through such a business model; exploration of these processes constitutes the next step for this project.

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The Power of the Stock: Accumulations in the Colombian Accusatory System Reform

The criminal justice apparatus is an example of a complex system; it can be conceived as a purposeful arrangement of heterogeneous and loosely interrelated actors whose missions are to enforce the law and to prosecute and rehabilitate offenders. This article explores the problem of the growing congestion of criminal cases in a recently implemented reform introduced by the Colombian government; in particular the focus is the criminal process as stipulated by the new accusatory system formally implemented in 2005. A simulation model of this new criminal process system was developed for the Corporation for Excellence in

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Justice (Corporación Excelencia en la Justicia). The paper depicts the main aspects of the model. It also offers selected analyses focused on the way that criminal cases are accumulated and evacuated through the main stages of the new accusatory system. The model shows that this system is largely driven by accumulations which provide a pervasive inertia. But what is more important is that such distinctive characteristic seems to be unnoticed for decision making processes. The paper underlines the importance of understanding the significant dynamics associated with accumulations and how this learning can be promoted through simulation.

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Modeling Exploration Dynamics and Uncertainty of Natural Gas Discoveries

Reserves estimations in natural gas markets are fundamental for decision making of private and public agents. When markets are mature, market signals such as demand growth, costs, and price expectations activate exploration and new reserves are continually added to the proven reserves base. We can describe the process of discovering new reserves in a market with a simple dynamic hypothesis in which investment in exploration eventually leads to increase proven reserves while probable reserves decrease. The simple dynamic hypothesis, however, does not seem able to explain the large reserves additions occurring in immature markets. In immature markets it is frequent to discover large natural gas reservoirs independently of the degree of exploration activity. Instead of rejecting our simple dynamic hypothesis, we broaden it by including discoveries as a stochastic component, aiming to capture some of the major uncertainties observed in immature natural gas markets.

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An Exploratory Study of Applications of SD and AB Modeling

Theory can inform us of the differences between principles and methods used to build System Dynamics and Agent Based Models. However, little is known about how the paradigms are applied in practice and the subsequent difficulties encountered. In order to assist the model developer in applying currently established methodologies, it is first necessary to examine what occurs in practice. This paper reports the conclusions of an assessment study of four different simulation projects, two of which used System Dynamics, and the other two Agent Based Modelling. Results highlight the methodological issues faced when building models with both paradigms. Furthermore, the results suggest that the more mature modelling paradigm of System Dynamics can assist in improving Agent Based Model building processes.

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The Basics of System Dynamics: Discrete vs. Continuous Modelling of Time

System Dynamics deals with modelling processes over time. In this paper we discuss two ways to model changes over time: finite vs. infinitesimal. This leads to two different concepts of time: discrete time as a succession of time points and time intervals vs. continuous time. Although the System Dynamics concept of distinguishing between stocks and flows suggests a discrete modelling of time, SD is considered mostly a modelling technique based on continuous time. In the paper we argue to see SD modelling compatible with both the continuous and the discrete concept of time. We will show that this "hybrid" potential makes SD a superior technique for modelling time, which combines the advantages of continuous and discrete time concepts.

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A System Dynamics Tool for Higher Education Funding Policy Analysis

Conceptually, the level of funding of higher education activities is directly proportional to its strategic directions/implementations and hence quality. In developing countries, these dependencies are far from straightforward due to ad-hoc reactions to reduced funding. This paper contributes to the development of tools for this management challenge. We investigate the dynamics of higher education funding and ensuing impact on part-time teaching, staff to student ratios, staff development, research productivity, and ultimately the perceived quality, using a system dynamics simulation model. The model developed is based on higher education literature in the developing world in general and Uganda in particular. We use the resulting model to review policies on funding and quality in higher education, and ultimately envisage that the model can easily be adapted to higher education in other environments.

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Sensitivity Analysis of a Real Estate Price Oscillations Model

In system dynamics methodology, formal output analysis can create a basis for improving the structure, so it is important to determine the variables to which the model is sensitive, by using a formal experimental design method. Moreover, such a research can allow comparing different methods for parametric sensitivity analysis. The purpose of this study is to understand different reactions of real estate prices to changes in different input factors. The study is carried out on a system dynamics model previously developed by the authors on real estate prices in

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Istanbul. The sensitivity of period, amplitude and mean of price oscillations to the changes in some selected variables of the model are analyzed. Two experimental sensitivity analysis designs, namely fractional factorial design and Latin hypercube sampling are used to measure the sensitivity of the model. The study shows that the factors that turn out to be most significant in the two designs are not the same. But the factors and interactions found significant by both techniques can be safely assumed to be highly influential.

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New Planning Methodologies in Strategic Management; An Inter-Paradigm System Dynamics Approach

The main concern of strategic management today is the controlling of the interactions between the organization and its environment as this constitutes a highly complex system of interrelated parts. The solution to this problem lies on understanding the underlying structure of the organizational-environmental system with all its possible observable manifestations in constructs and quantifiable variables as well as the steering possibilities or decision rules that this structure allows. This requires the drawing of the patterns of interaction of a large number of important variables. In this paper we argue that by combining the strengths of two prominent planning methodologies, which belong to different and to somewhat conflicting paradigms and modeling schools, we may indeed produce a single more effective planning framework. We proceed by outlining the strengths and limitations of the two approaches namely PIMS and System Dynamics and then drawing on the complementarities we integrate them into a single composite strategic planning framework. The PIMS/SD inter-paradigm composite planning model is finally evaluated across theoretical conditions and practical relevance criteria.

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Imposing Tax and Rebate Policy for Addressing Game Addiction Problem

Massively Multiplayer Online Games (MMOGs) are popular worldwide. Especially in Korea, there were about 19 million gamers in 2006. Some players have become seriously addicted to online games, causing a serious social problem. However, studies and/or trials to address game addiction problems have rarely been performed. In this paper, we discover the relationships among interested parties in the game industry and propose a base model to explain them. From the base model, we can expect that casual gamers increase until some time, but decline afterward. The growth rate of total revenue of online game decreases due to a reduced number of casual gamers over time and a negative image of online games. To resolve game addiction problems, we implemented a self regulation policy and a tax and rebate policy in the base model. After applying the policies, we found that a tax and rebate policy is preferable to a self regulation policy. The total revenues of online gaming increases contrary to the concern of game companies, the social image of online games is improved and the number of game addicts decreases.

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¿To produce or to import? That is the question: A System Dynamics approach to the auto-parts industry in Mexico

The Mexican auto-parts industry nowadays has a high dependency from the importation of raw materials and auto parts made in USA, China and Japan and some other countries from which it get supplied for the development of productive processes. Many of this importations can be substituted is the necessary mechanisms to produce in a national level get established, bringing an increase of the auto-parts industry and more competitiveness from Mexico in global scenarios. This paper presents the modeling of the Mexican auto-parts industry, designing scenarios that allow observe the viability of imports reduction.

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Generalised Loop Deactivation Method: An Extension on Ford's Behavioural Approach to Loop Dominance Analysis

This paper presents progress on the conceptualisation and implementation of an extended version of Ford's behavioural approach to feedback loop dominance analysis. The need for the extension of the original method is discussed, as are the methodological consequences of changing and implementing the method. The changed method presented here is referred to as the Generalised Loop Deactivation Method. The automated version of this method is tested on three models. The first of these is used to verify the results of the method, the second to discuss several methodological changes and the third model is used to demonstrate how to detect superfluous structure in a larger model. Significant findings include recommendations on how to eliminate loops from a model, a fully automated version of the loop deactivation method and an extension of its use into model simplification, moving the method beyond loop dominance analysis.

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Production Planning and Control in Flow Shop Operations using Drum Buffer Rope Methodology: A System Dynamics Approach

This paper aims to introduce System Dynamics (SD) in applying Drum Buffer Rope (DBR) methodology of Theory of Constraints (TOC) in a three-stage flow shop system that produces a single product. To the best of our knowledge, although there are a lot of TOC applications using discrete simulation in production scheduling with DBR methodology, there are not any TOC application of DBR methodology in production scheduling using System Dynamics. We firstly present a conceptual model of the production planning and control and raw materials procurement processes of a flow shop, based on the concept of the Capacity Constraint Resource (CCR), which is the corner stone of the TOC philosophy. Then, we present the stock and flow diagram of the system under study. According to the results of an illustrative example, it reveals that the driving force of the production and raw materials procurement processes of the flow shop is its CCR. The system response to pulse and wavy changes in demand is examined as well. Moreover, by means of the simulation results, the efficiency of DBR production scheduling approach is contrasted with the well known anchoring and adjustment approach of Sterman.

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Adventures in Open Source: Collaborative System Dynamics

Open source software has caused a modest revolution in the computer software market over the past ten years. In this paper we introduce OpenSim, a new system dynamics modeling toolkit released under the open-source GNU General Public License, version 3. OpenSim includes two major components, a graphical model editor with an eye towards collaboration and a simulation engine. The simulation engine is used by the model editor to turn the model's equations into a form the computer can understand, perform simulations, and provide the results in a variety of formats while being designed for speed. The model editor allows people to visually create models, but also allows for several people to collaborate in real-time on the same model. OpenSim demonstrates that creating a high quality open-source modeling tool is now both possible and practical, and will yield significant benefits for the SD community.

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Food or Energy? Is that the question?

Bioenergy currently draws worldwide attention and investments. Proponents argue that the large-scale development of bioenergy could be (part of) the solution for diversifying energy sources, enhancing security of energy supply, and meeting environmental and rural development

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objectives. Opponents argue that it could threaten agricultural food prices/production/security, wildlife areas, and international trade flows. System Dynamics models of the EU27 bioenergy/biofuel sector are developed in this paper in order to investigate these issues.

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Dealing with Multiple Perspectives: Using Cultural Profiles in System Dynamics

Many important dynamically complex issues are also characterized by a large number of stakeholders. Stakeholders often have different (incompatible) world views, value systems, lifestyles, interests, and perspectives. One way to deal with this diversity in System Dynamics modeling is to use different (cultural) profiles. Cultural Theory offers five profiles that could be used to take this diversity explicitly into account in System Dynamics modeling. This will be illustrated with a System Dynamics modeling study concerning the development of a residential district in which cultural profiles are explicitly taken into account.

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Northern Rock plc: A case study in banking policy during times of duress

This paper explores the events that engulfed Northern Rock plc, a UK publicly listed company, during the latter part of 2007. The background to those events that took place is illustrated together with their consequences for Northern Rock. A model of the Northern Rock liquidity situation is produced and tested using the System Dynamics paradigm and methodology. The resultant model is verified and validated with reference to known behaviour and data. Hypotheses are constructed resulting in conclusions which centred on the need for co-operation between the Tripartite Authorities and Northern Rock together with a need for active, coordinated management action. Within the limitations of the model different means of coping with banking credit problems are illustrated and remedies postulated. The model presented could be further developed to produce recommendations for automatic triggering of interventions. A variant of the model could be adapted to model contagion risk. These, together with others, are areas for further work. Methodological conclusions are that the model correctly exhibits linear behaviour if not actively managed, that the model contains both continuous and discrete elements, that there is scope within the model to adapt it for use as a teaching/study aid in finance and/or System Dynamics.

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Learning Control Policies in System Dynamics Models

Advances in artificial intelligence and optimal control provide increasingly better algorithms for controlling dynamical systems. These algorithms can be applied for policy design in system dynamics models. In this paper we introduce some basic solution concepts and apply the Q-learning algorithm to a simple dynamic model from system dynamics literature to demonstrate potential value of such cross-fertilization. We also extend a state aggregation and partitioning algorithm that may increase the efficiency of basic reinforcement learning models in application to continuous time and space problems. Simulation analysis demonstrates the value of this approach and offers guidelines for future research.

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Modeling rework cycle: comparing alternative formulations

Rework cycle is at the heart of modeling projects, one of the major application areas of system dynamics. In this paper we introduce a new formulation for rework cycle in which multiple defects may exist in a task. We compare the performance of this formulation with three others, two adopted from the system dynamics literature and one agent-based formulation. This comparative study illustrates the impact of assumptions about the nature of defects and the homogeneity of tasks on behavior of alternative models and provides information necessary for selecting rework cycle formulations effectively. The new formulation we introduce allows for capturing significant schedule over-runs due to a few tasks, with multiple defects, that may cycle through rework process multiple times. Its perfect mixing assumption, however, over-estimates final project quality. Sensitivity analysis informs the robustness of results to multiple project parameters. We discuss the implications for selecting robust formulations in modeling project dynamics.

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A System Dynamics Approach on Post-Disaster Management: A Case Study of Bam Earthquake, December 2003

In December 2003, a 6.7 earthquake struck the city of Bam in southeastern Iran. The city lost over 45,000 inhabitants and the historic citadel of Arg-e´ Bam was destroyed. High number of casualties in this disaster has encountered it among most recent hazardous natural events in the world. Although the old structure of the city was the main reason for the massive destruction of the city, but the outcome of so many dead people has other important reasons as well. The most important one is

that no scientific study has been on dynamical behavior of disaster management in Iran. In this paper a dynamic system is proposed in order to simulate the activities in the zone after the earthquake has shaken the city. Based on that, key parameters are chosen in order to establish some post-disaster policies which are applied on the model and their effects are studied.

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Modelling the Demand for Renal Replacement Therapies: Challenging Assumptions and Influencing Policy

Renal services comprise a growing and costly part of the health system. They provide life saving dialysis and transplant services for patients with kidney failure. Howewver, demand is increasing, costs are rising and there is an increasing shortage of the staff and facilities needed. The response is often to call for more resources The paper describes two case studies which used dynamic modelling to challenge assumptions about the implications of rising demand and to influence policies designed to repsond to it. The key impact of this work was to show that the future demand is as much determined by provider polices as they are by population and disease characteristics. Not all the problems are caused by rising demand and shortage of resources. In these two cases historical investment patterns and clinical practices are key drivers of current problems. Their future is not predetermined by external pressures but modifiable by internal policies.

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An attempt to automate the analysis of complex system dynamics models: an example of WORLD 3

Even the simple run of a medium size system dynamics model can be a cumbersome process, since the uncertainty of the parameters forces the modeller to consider many runs before being confident of how the model behaves. System dynamics simulation packages include some analysis tools, but in many occasions customized tools are desired. For example, one would like to be able to program iterative running of simulations and perform mathematical operations with the results, use analysis techniques such as PPM or screening, or even use fuzzy logic to automate the revision of graphs. In this paper we explore the possibilities of a programming language, Matlab, and its simulation tool, Simulink, for those possibilities mentioned. These languages come from the fields of engineering, but offer many interesting possibilities because of their programming ability. They enable the development of customized analysis tools at a very low programming cost. The World 3 model has been programmed in this languages and some examples of application programming runs, screening and fuzzy logic are given.

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Multiple Cue Threshold Learning Model of Selection and Detection: A system dynamics approach

This paper seeks to understand and build on earlier attempts to model a selection and detection environment, and to devise a simpler, yet more comprehensive, structure that can replicate a decision maker's knowledge and learning of cue judgment and threshold learning. System dynamics modeling will be used as the simulation tool, illustrating not just its capacity for complex system study, but its ability to simulate events that are both discrete and continuous. The task has three important characteristics: this model will have the ability to simulate the effects of changes in base rate, uncertainty, value structure and degree of outcome feedback; it will build on earlier modeling attempts, and include such effects as confidence and implicit learning; and it will replicate the behavior from empirical study of multiple cue threshold learning.

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How Partnership Behaviour Evolves in Networks: Path Dependency, Social Figuration and Life Events

Networks have become the dominant life form in many organizational settings. Most studies of relationships in networks focus on the dyadic interaction between two agents. However, work on enactment, sensemaking, path dependency, and social figuration processes (e.g. by Weick and Elias) suggests complex networks cannot be exclusively understood in terms of dyadic relationships. This paper therefore explores, first, whether emergent processes of enactment and sensemaking in large networks can be represented and simulated in an agent-based model; and second, what can be learned from simulation results obtained with this type of model. We develop an agent-based model of a two-tiered supply network of ten firms with heterogeneous dispositions towards partnership. This model serves to explore the interaction between disposition, sensemaking and behaviour in a network setting. The simulation results exhibit strong path dependency effects and capture, in a highly stylised manner, the emergent process of enactment and retrospective sensemaking. An important finding is that path dependency effects occur in response to life events (e.g. a calamity disrupting the flow of products). Our findings also suggest that inner dispositions may not determine the actual behaviour in complex and turbulent (supply) networks. This raises questions regarding network research that exclusively draws on cross-sectional data.

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Collaborative systems modeling and group model building: a useful combination?

Client involvement in modeling is the hallmark of simulation-based methodologies and applied fields such as information systems development, environmental modeling, and biological systems. Unfortunately, comparison of assumptions and exchange of practical guidelines has failed to take place takes place between methodologies and fields of application. We hope to work towards such an exchange by making an initial comparison between collaborative techniques from information systems development and system dynamics. Collaborative systems modeling refers to client involvement in IT systems development. The field has decades of experience in developing formal models of business processes, a range of methods and tools to involve clients in modeling and ample evidence on the usefulness of alternative approaches. A large part of the literature on group model building covers similar topics. Recent discussions that raised attention in both fields point to further similarities: repeatability of the modeling process (versus dependence on skill of the modeler), quality of modeling and implementation of results. In this paper we explore whether both approaches to client involvement can learn from each other. Thus we look at differences and commonalities between goals, modeling languages, procedures and methods and tools and techniques.

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Human Resource Planning in an Integrated Steel Plant - A System Dynamics Approach

Business success increasingly hinges on an organization's ability to use employee productivity as a factor in the shaping of business strategy. Alternatively, the success of any business organization depends upon the whole-hearted commitment, creativity, competence and initiative of human resource available. Thus, human resource planning is a crucial factor affecting the performance of a business organization. In this paper, we elaborate a model of HR supply and demand as it affects the productivity for a shore-based integrated steel plant using the system dynamics method. This study examines the HR scenario in the steel plant, which is being operated with one-third of the personnel existing in other comparable steel plants in India, over a period of ten years. It looks at the optimal level of human resources necessary to ensure enhanced efficiency and productivity levels, with a view to containing personnel, redeploy existing surplus personnel through retraining and relocation. The key parameters taken up are non-executive/executive ratio, personnel productivity and total workers. More precisely, it identifies policies such as (i) downsizing personnel, (ii) to decrease non-executive/executive ratio, and (iii) to improve labour productivity and its effectiveness. Keywords: Manpower Policy, Downsizing, Labour Productivity, System Dynamics.

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Modeling the Dynamics of Immunization Healthcare Systems: The Ugandan Case Study

Due to low immunization coverage, epidemics such as measles still occur in many countries in the world. Various approaches have been applied to understand immunization coverage problems, however, there are still acknowledged deficiencies in these approaches and this has given rise to research efforts for alternative solutions. To better understand immunization health care problems and to generate insights that may increase the immunization coverage effectiveness, the paper applies system dynamics modeling and field study research methods. Causal loop diagram representing the immunization system is presented out of which a model is designed with the intent to show how particular variables influence immunization demand and coverage. The paper builds on earlier papers by the same authors. Model analysis demonstrates the need to upgrade the health system in proportion to the growing population, and how this can lead to improved immunization coverage rates. The paper suggests key leverage points which could substantially improve immunization demand and the effectiveness of the health system as well as vaccine management.

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Building Understanding of Organizational Change

This article presents some insights from ongoing implementation of BP's Operating Management System (OMS) in Alaska. BP aspires to improve the way it operates and become a sector leader in personal safety, process safety, environmental management and operations excellence. In this paper, the OMS implementation is examined as a process of organizational change. One of the early stages of that process is to build understanding of the organizational change among those responsible for implementation. For that purpose a System Dynamics model and model based simulator were used. The article presents an overview of the model, which is based on established theories of transformation. Some simulation scenarios were examined to illustrate the results of various policies, and to test ideas thought to increase the probability of sustainable change. Implications for organizational learning are discussed.

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Supposing a Control Law of Capital Accumulation for the Modern Italian Economy

This paper formulates a hypothetic law of capital accumulation (HL) for modern Italian economy mainly owing to three analytical devices. The first handles the so-called Verdoorn law. HL reconciles a direct relation

between growth rates of net output and labour productivity with an inverse relation between growth rates of employment ratio and labour productivity. The second advances a 'Ricardian' view of an inverse relationship between growth of employment and returns. The third transforms constant profit investment share into a secularly declining endogenous variable. This paper explores analytically and numerically inertia Scenario I and two stabilising Scenarios II and III of the Italian economic development in XXI century and beyond. In inertia Scenario I, capital accumulation is marked by long swings with a period of about 20 years. Decelerating adjustment of profit investment share to its stationary magnitude depending on profitability would be stabilising for long swings without altering a non-trivial stationary state. Establishing an inverse relation between profit investment share and capital-output ratio in a control law (CL) not only smoothes long swings but slightly raises stationary profitability in stabilization Scenario II above stationary profitability in Scenario I. Stabilization Scenario III exposes fallacy of the neoclassical golden rule of accumulation.

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Modelling changes in medicine use following the introduction of IT-based health policies

Medicines use involves the prescription, transcription, dispensing, administration and monitoring of medicines. These processes are prone to error resulting in the misuse of medicines. Medicines misuse associated with prescription errors and poor compliance by the elderly living at home is a growing concern. This problem will worsen with the ageing population, development of new drugs and drug indications, shortage in the general practitioner workforce, poor communication between patients and healthcare providers and poor information management. Electronic health records could improve the use of medicines by improving access and management of patient and drug information, making work processes more efficient and reducing the workload on general practitioners. The use of medicines and electronic health record systems vary demographically. Current evaluation methods, such as pilots and trials, fail to capture these differences and changes over time and are inadequate in terms of time, cost, resources and transferability. This paper will investigate multi-scale and multi-method modelling to describe the use of medicines and evaluate alternative health record systems across different demographics over time.

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The Role of Goal-Setting and Commitment in Continuous Improvement Processes

One obstacle in the way of enduring process improvement is the necessity to gain and sustain a momentum towards change in organizations. Building upon previous work in the field of operations management and system dynamics, a generic model is outlined that mimics the implementation of several process improvement programs in an industrial organization. For this purpose, the model exhibits a conceptual distinction between particular improvement programs (e.g., total quality management, total productive maintenance) and the overall improvement process. The latter is represented by a continuous PDCA-cycle that connects organizational capabilities on process improvement, development of commitment towards change on different hierarchical levels, and managerial improvement goals with several improvement programs. Among other findings, the simulation experiments show that goal-setting is a crucial aspect in continuous process improvement processes that—if wrongly applied—can stall the organizational commitment to change. Furthermore analyses reveal that plants should strive for process improvement patterns that exhibit higher organizational rather than technical complexity. The value of the conducted approach lies in the explicit analysis of the interplay between goal-setting, organizational learning, program commitment, and process improvement programs.

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Modeling Of The Interactions Between Sectoral Co2 Emissions And Energy Efficieny Under Emission Restriction Policies

The purpose of this study is to understand the dynamic effects of carbon dioxide (CO2) emission restrictions and energy price policies on two highly energy intensive sectors of industry; iron&steel industry and cement industry over a 12 year period. Model is designed so that critical decisions such as growth and efficiency investments are based upon profit and extra costs incurred due to CO2 emissions. The profit margin, CO2 cost over revenue and Energy Cost Share in Total Annual Production are important key variables in the model. This study, giving attention to the economic and energy-emission policy aspects, aims to analyze the causal relationships and the feedback structures among industry's production capacity, investments on new and energy efficient technologies, financial burden, and CO2 emissions.

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A Parameter Estimation Method to Minimize Instabilities in System Dynamic Models

This paper introduces a new method that facilitates the stability analysis of system dynamics models. The method is based on the concepts of asymptotic stability and Accumulated Deviations from Equilibrium (ADE) convergence. We prove several theorems that show that ADE convergence of a state variable will make its trajectory approach asymptotic stability. Achieving ADE convergence requires the solution of a policy optimization problem. We use an approach called Behavior Decomposition Weights (BDW) to reduce the search space associated with that optimization problem. We also demonstrate this method on two examples: a linear "inventory-workforce" model and a non-linear "mass business cycle model". These examples illustrate the features of this method and the potential for the development of efficient tools to improve the quality of the optimization policies.

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Simulation-enhanced descriptions of dynamic problems: Initial experimental results

System dynamics models are built to assist people in understanding and solving complex and dynamic problems. However, the actual outreach of the models is limited as there is still no effective way identified to present dynamic problems and the associated models to a broader audience. Experimental data as well as cognitive load theory suggest that learning about and performance in complex dynamic systems could be improved by enhancing problem descriptions with simulation elements facilitating interactive exploration of dynamic features of the problem. We replicate experiments by Moxnes (2004) on management of reindeer lichen winter pastures, extending the task instructions by an interactive applet featuring dynamics of non-linear growth rate of lichen. In contrast to previous observations when the subjects misperceived gravely the system's dynamics at the outset, our results suggest that with the interactive applet the misperceptions of dynamics can be reduced already in the first trial.

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How much can be learned by exploring an existing model? The concept of guided rediscovery

System dynamics has been developed around the process of modeling and simulation as a means for improving human judgment and decision.

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Due to the high requirements of the process, interactive learning environments have been developed to allow users to learn in a less time consuming manner. However, there is fear that simplification may precisely take away what makes system dynamics so strong. We have inquired the process of modeling and ants activities in search for the activities particularly relevant for learning; we find that much can be learned from exploring existing models – without creating them. One can rediscover the important insights by asking the important questions to the simulation model, elaborating the responses and interpreting them. The developers of a model can articulate the questions that lead to these insights and thus the model user can be guided to rediscover them. We present a prototypical process for this exploration work. We hypothesize that this process leads to more accurate mental models than exposition to a more traditional transparent-box learning environment; we present the research design to be carried out during the first semester of 2008. We also propose to revisit the current taxonomy of computer based learning support.

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Why business and socio-economic models often do not live up to expectations

Looking back critically at about 30 business and socio-economic dynamic simulation models developed over the last 40 years I notice that many of them did not quite live up to what was expected of them. Very often this was caused by organizational shortcomings during the implementation process. Other reasons were discrepancies between thinking and reality ("known known"), insufficient treatment of uncertainties ("known unknown") and/or the occurrence of events neither expected nor anticipated ("unknown unknown"). Based on the analysis of these shortcomings and on references in relevant publications, this paper presents some suggestions on how to avoid them.

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The need for a System Dynamics Based Open Source, Online Interactive Learning Environment Creation Tool.

System Dynamics needs a tool which allows modelers to create Interactive Learning Environments that represent not only the behavior of the model they interface with, but the structure as well. Open Dialect is a free and open source tool which does just that, plus it allows modelers to create ILEs for the web. Open Dialect does not require any previous knowledge of programming. The purpose of this paper is to introduce the reader to Open Dialect, and to show the reader that Open Dialect allows modelers to create effective, intuitive, modern, aesthetically pleasing, online ILEs that will help the System Dynamics community reach out to a broader audience.

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Modeling as Theory-Building

The purpose of this contribution is to make the idea of modeling as theory-building operational. We conceive of the modeling process as a theory-building process, thereby opening up a new perspective on the methodology of modeling in the social sciences. By reconceptualizing the notion of modeling, we hope to convey the advantages of more conceptual thinking in management. Practitioners could gain effectiveness in dealing with external complexity if they would espouse the modeling task as a disciplined reflection and communication geared toward the elaboration of theories. This contribution is based on projects in which System Dynamics models for real-world issues were constructed together with corporate partners. One of these modeling ventures is described in detail to make transparent the isomorphic nature of theory-building and formal modeling, and illustrate the approach of modeling as theory-building.

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Comparing different approaches in teaching System Dynamics in Italian Universities

There has been two main objectives with which the idea to write this paper was started. First of all, to exchange, and hence put in common, the knowledge of different experiences in Italian academic context dealing with teaching of a consolidated but still innovative (at least in Italy) methodology. Secondly, to put in evidence possible pros and cons of each teaching approach in order to better face (at least be aware of)the next teaching years (learn one from the other!) . The paper will describe four teaching experiences in four different university contexts; three are so called hard faculties (Sciences, Statistics and Engineering), and one could be considered soft faculty i.e. Communication Sciences. Two are sufficiently consolidated courses (more than five academic years) and two are less experienced (both three academic years).Three are placed in Master programme and only one (but this one is related to, maybe, the “hardest” faculty-Engineering) is collocated in Bachelor programme. A final synthetic comparison table is sketched and an overall general common consideration is suggested.

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Strategy for organic farming model development

Organic farming represents strategic action for many European countries. Although the subsidies to organic farming sector are present there is no desired level of conversion from conventional to organic farming. System approach was applied in order to analyze the problem state. In order to provide proper strategy to achieve desired level of conversion the simulation model was build. By analysis of different simulation scenarios several propositions for strategic actions are proposed. Further model development guidelines are proposed.

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Does learning to reflect make better modellers?

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In this paper we address the role of reflective skills in the development and training of new System Dynamics modellers at the tertiary education level. Over the last two years students at the Delft University of Technology have written a reflective essay on their experiences with the conceptualisation, formulation, validation and use of a System Dynamics model in addressing the fictitous, but realistic, problems of a public policy maker. The degree to which they apply the cursory reflective training that they receive and the effect of this intentional reflection on their acquisition and application of modelling skills is evaluated. While some students do attempt to address the added value of a modelling approach to their client and their role in actualising this, the majority of students focus their attention on the strengths and weaknesses of their model and the dilemmas they face in executing the modelling cycle. By presenting the metaphor used in teaching these reflective skills and analyzing the questionnaires completed by the students, we are able to gain further insights regarding the views held by the aspirant modellers of the choices they face in building and using their models. This then feeds back to improve our teaching.

Influence of variable catch factors on sardine population level in eastern Adriatic tested by System Dynamics

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System perspective can be applied to the fishery management. Therefore investigation of sardine population behaviour dynamics by system dynamics methodology is presnted in this paper. The model is based on Schaefer production model and available biological data was used for sardine in the Adriatic Sea. The Schaefer production model is often applied in order to submit behavior dynamics of fish population and particularly to manage marine natural resources efficiently. Alegria-Hernandez (1983) used Schaefer and Fox production models for sardine population in Eastern Adriatic. Initial value for catchability coefficient of 3,99E-5 is taken from Alegria-Hernandez (1983). According to the same author value of the optimal fishing effort is between 4115 and 5292 effective fishing days in one year for the sardine in the Eastern Adriatic. Those values are tested using developed model. Simulation

scenarios were made in Powersim and DYNAMO. Although model can be applied for all other species and many of different regions, sardine population was chosen due to its great importance to Croatian fishing.

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Portfolio Implications of Combining Banking with Commerce In the Korean Context: A study based on System Dynamics Approach

The policy of separating commerce from banking has been strictly enforced in South Korea. However, with the passage of the Capital Market Integration Law of 2007 that allows banks to engage in other non-financial activities, the debate now shifted to the final barriers separating banking and commerce. The goal of this paper is two-foiled. First, we examine the possible impact of mixing banking and commerce on earnings and risk diversification. Using a portfolio approach, this paper investigates the risk-return characteristics of the industry mix to analyze the potential benefits from banking diversification into commercial sectors. Second, we also test implications of our results to understand how the specific industry mix leads to the diversification effects using a System Dynamics (SD) model. For this purpose, key variables identified are incorporated into the SD model to simulate feedback structure of the industry mix. The result indicates at least some commercial sectors generated the synergic relationship with banking enterprises. It suggests that increasing returns could have been accomplished with minimum risk by combining banks with either one of manufacturing, transportation, or information technology industries. A further analysis of the particular industry mix using the SD will provide ways of explaining why some commercial industries produce the earning diversification effects.

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The influence of subsidies on economic development: a system dynamics model

Many governments across the world put into practice different policies of subsidies to achieve goals of economic progress in spite of economic theory's arguments, which claims that subsidies hamper the efficient allocation of resources. But if a government decides to implement such policy, what type of subsidy has a higher impact on economic growth? This paper examines the issue constructing a system dynamics model in which the effects of two types of direct subsidies are analysed: production and research and development subsidies. The model is based on feedback processes, non-linear relationships and delays that explain the decisions taken by different economic agents in a generic economy regarding physical capital accumulation, technological development and size of an intermediate sector. Using a system dynamics simulation the conditions under what either the use of each subsidy separately or a certain combination between them have a higher impact on economic development are characterized. Key words: Subsidies, Research and development, Economic growth, System dynamics, Computer simulation.

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Socio-Economic Development Projection Of Malatya Supported By EU Regional Development Programme: A System Dynamics Approach

Socio-economic and regional development models are among the examples that encompass the aforementioned sophistication in their structure. Although outside interferences have certain impacts on the system, fundamental changes emerge within the internal structure of the socio-economic systems. These systems change over time and these changes have a tendency to be non-linear with regard to the developments within the system. System dynamics is one of the best approaches in the development of socio-economic system models, hypothesize and the identification of policies that would provide improvement in the system. System dynamics approach offers easy access to possible outputs under different scenarios. System dynamics is an interdisciplinary approach and it uses the tools and models employed by the related disciplines. Because of the aforementioned reasons, system dynamics approach will be used in the study the socio-economic structure of Malatya in TRB1 where is supported EU Regional Development Programme, will be put in a model in order to monitor certain developments and changes under different scenarios through 2008-2030. This study is supported by TUBITAK.

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Exploring the System Dynamics of Innovation Systems

The innovation system is perceived as an ensemble of resources committed to interrelated innovation activities. The question arising is how the innovation system becomes one (a system), i.e., what are the mechanisms that govern the alignment of resources and activities in innovative directions. A system dynamics framework of analysis is presented where alignment stems from institutional arrangements and strategic intent. These operate as mechanisms of stretch and leverage within an environment of co-opetition and connexity. Central amongst them is the evolution of cognitive-cultural elements that, in the form of mental models (worldviews) and intangible assets (such as trust and co-opeting competence), drive economic action and interaction. A system dynamics modelling approach is proposed that facilitates the quantification and exploration of policy alternatives.

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Investigation and modelling framework of biofuels as a new socio-technical regime

The advance of a biofuels future involves a set of interconnected changes across the value system that amount to a techno-economic regime transition. Within such a process occur various situations of

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co-opetitive games which take place in a dynamic concurrent manner. Systems dynamic modelling is proposed as the core of a policy development methodology in order to facilitate the participatory investigation of policy alternatives.

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Strategic Dynamics of the Project Based Organization

Project management is one of the most important and demanding fields of management. Cost and time overrides are more than common, while more organizations are becoming project-based. Through a systems perspective we develop a holistic view of the project-based organization as a structure of resources committed to activities and the strategic decisions that involved in the operation of the organization. A systems dynamics model is developed in the fashion of a balanced scorecard.

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Zero Waste by 2030: A system dynamics simulation tool for stakeholder involvement in Los Angeles' solid waste planning

This paper describes a strategic level simulation model developed to help stakeholders understand the Los Angeles solid waste system. The model structure is based on a “recycling loop” incorporating five interconnected sectors: consumption, collection, processing, disposal, and production. The user interface includes eight strategic decision levers (product durability, waste in products and packaging, recycled content of products, product recyclability, consumption, consumer diversion rates, diversion processing capacity, alternative disposal capacity) and shows six output measures (waste sent to landfill, material diverted, diversion rate, relative greenhouse gas emissions, relative cost, and relative effort). Model analysis shows that maintaining the status quo erodes diversion rates, reducing upstream inputs to the waste stream (by reducing consumption, increasing product durability, increasing recycled content of products) yields the greatest improvements in waste reduction and lower greenhouse gas emissions, and that achieving desired changes with downstream levers requires using several levers in combination. The model also shows significant tradeoffs between reducing waste and the relative costs and effort required.

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System Dynamics Model of Southwestern New Mexico Hydrology to Assess Impact of the 2004 Arizona Water Settlements Act

Water resource management requires collaborative solutions that cross institutional and political boundaries. As key technical contributors to solving critical resource and security problems on a national scale,

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Sandia National Laboratories are well positioned to team with federal, state, and local water experts to model growing water concerns in the country. Unlike the traditional approach of compartmentalization of tasks and expertise, Sandia utilizes a collaborative modeling approach that is inclusive, multidisciplinary, quantitative, and transparent to all interested parties. A system dynamics (SD) approach forms the basis for the models. We illustrate this process with a water balance model of the Gila-San Francisco River Basin (Gila Basin) in southwestern New Mexico. Teaming with key stakeholders over a course of eighteen months, a system-dynamics hydrologic model is built in response to the terms of 2004 Arizona Water Settlements Act to assess the existing use of water in the region and the potential impact of additional withdrawal based on the legal requirement of the settlement. The model has enhanced the overall understanding of the intricate coupling between water resources and demands and helped structure dialogue around potential the human and ecological impact on the river health in the context of the new settlement.

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The Access Problem

An important problem for system dynamicists, indeed for researchers in general, is how to gain access to empirical data sources. The issue of access is important to consider in judging the validity of theory created from empirical data. In this paper we review the scarce literature on access and create a System Dynamics model to explore the problem.

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Low External Input Strategies for Sustainable Small-Scale Farming in Kenya - A Systems Dynamic Approach

This study sets out to assess the significance of the implementation of low external input strategies on small-scale farming households in rural Kenya. Data collected on two surveys was used to develop a conceptual model of the system and establish links between different internal components within it. This enabled relationships to be made between changes in soil nitrogen (a limiting physical factor to agriculture) and household incomes (a socio economic attribute). A system dynamic

model was developed and used to test the influence of low external input strategies on small-scale farming under different scenarios. It is found that adopting low external input strategies or optimizing its practice could create several positive reinforcing feedback effects on small-scale Kenyan agriculture, and improved sustainability, on the expense of less cash crop cultivation and more food crops.

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Model building in System Dynamics and Discrete-event Simulation: a quantitative comparison

This paper presents an empirical study on the comparison of model building in System Dynamics (SD) and Discrete-event Simulation (DES). We study the model building process of 10 expert modellers (5 SD and 5 DES modellers), who talk aloud while building prison simulation models. The transcripts were coded based on 7 modelling topics: problem structuring, conceptual modelling, data inputs, model coding, validation & verification, results & experimentation and implementation. Our results suggest that all modellers switch between modelling topics, however DES modellers follow a more linear progression than SD modellers. Model coding is a central topic for DES modellers, while conceptual modelling followed by model coding interest SD modellers the most. Interestingly, the combined verbalisations on conceptual modelling and model coding account for the same percentage of SD and DES protocols. The quantitative analysis of expert modellers' behaviour presented in this paper contributes towards the comparison of SD and DES.

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A Systems Dynamics Approach to Assessing Policies to Tackle Alcohol Misuse

This paper proposes a systems approach to tackling alcohol misuse based on System Dynamics modelling. The problem of binge drinking in the UK is first described along with its negative impact on health, society and the economy. A review of the current literature follows, and the systemic nature of the problem explained. System dynamics is proposed as a holistic approach to investigate the problematic situation. The paper describes the development of an initial influence diagram for alcohol misuse that captures the significant factors affecting the problem. The utility of this approach is demonstrated through a simulation model built based on the influence diagram. The simulation model acts as a vehicle for experimentation and testing of several possible policy options. This is shown through the several scenarios of possible interventions by the government to compare the potential impact and costs of each scenario. The paper concludes with a review of the findings and directions for further research.

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Investigating the Effectiveness of Various Crowd Confrontation Strategies Using Vensim and the Phoenix Integration Suite

Crowd confrontations are a common occurrence. In the free World, peaceful protest is a human right. However, when a crowd becomes violent, control forces need to step in to restore order. They should do this with minimum yet sufficient force. The use of non-lethal weapons has been promoted to ensure a continuum of force between the simple presence (show of force) of the control forces and the usage of lethal means. However, the strategy and tactics for the employment of non-lethal weapons is not well developed. A System Dynamics model of crowd confrontation has been built (using Vensim) with the purpose of investigating the effectiveness of various strategies for crowd control, including non-lethal weapons. The model has been calibrated and optimized based on an extensive data collection exercise of a Canadian crowd confrontation event (The Summit of Americas, Quebec City, 2001). Besides details on the processes of data collection and calibration, this paper also provides a proof of concept regarding the use of the Phoenix-Integration software suite (that provides a Vensim 'Plug In') to determine optimal sets of strategies that would allow for successful crowd control using minimum force.

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The Diffusion of System Dynamics analyzed with System Dynamics - A Diffusion Model Considering Network Externalities

This paper investigates the diffusion of system dynamics as research paradigm. It deals with the question whether the diffusion of system dynamics is influenced by network externalities. Assuming the existence of such network externalities the so called penguin and bandwagon effect must be considered regarding the diffusion. Based on a system dynamics model considering network externalities leverage points will be derived enforcing the diffusion of system dynamics.

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A Control-Driven System Dynamics Architecture for Supply Chain Management

As System Dynamics is more and more used in supply chain study, the system architecture for this application becomes various. However, most of the models put emphasis on system simulation, not system control, causing the model unilateral. This paper proposes a control-driven architectural structure in System Dynamics, and relates it with control theory. The architecture includes control module, operation module and output module. An application in the procurement division of an enterprise is introduced with these three modules. And a following

simulation is performed to observe the effectiveness of the three modules. This architecture appropriately connects the controls, states and performances of a system, realized the complete control to System Dynamics models.

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Dynamic Performance Measurement and Evaluation: Will Bridging Paradigms Lead to Improved System Design

Within the domain of systems engineering, conceptual frameworks are used to assist engineers, managers, and policy makers to determine new or modified system designs (Blanchard and Fabrycky, 2006). The designs are driven by requirements set typically by the users and are monitored using technical performance measures (TPMs). System designs are considered effective if they meet the pre-determined TPM values along with life-cycle cost and schedule targets. Therefore, in terms of measuring and assessing system design, one would expect synergy between the systems engineering and the performance measurement literatures. One possible synergistic thrust between these two bodies of literature is the modeling and assessment of dynamic system performance. An approach to that can directly account for dynamic performance measurement and evaluation during these transitional periods is the dynamic performance measurement model (DPEM) (Vaneman and Triantis, 2007). The primary objective of this paper is to present this approach and review it in relation to other dynamic measurement approaches found in the literature. Two examples are discussed that illustrate the implementation of the approach. Another objective of this paper is to discuss why dynamic considerations can potentially lead to improved system designs. A tertiary objective is to outline specific future modeling and implementation challenges that require further research.

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Collapse of Easter Island:A Study to Understand the Story of a Collapsing Society

This study aims at explaining the collapsing behavior of collapsing populations using system dynamics methodology and using Easter Island as a case study. This work is triggered by Jared Diamond's (2005) popular book and Brander and Taylor's (1998) economic model of Easter Island. A system dynamics model representing the resource and population sectors of Easter Island has been built based on allocation of labor. First, base cases have been considered for the hunter/gatherer society and the agricultural society. Later, sensitivity analyses have been run to see the behavioral changes with respect to the parameters used in the model. It is found out that the erosion is the main natural process yielding the collapsing behavior. An interesting finding of the study is that differentiation between a forest and an agricultural sector is crucial while studying the decline of agricultural societies because the dynamics implied by their replenishment rates differ considerably.

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Citizens' Choice: Modeling long term technology transition in the automobile industry

The transformation process towards sustainable road transportation implicitly requires that household's car choice is not only influenced by individual or household specific objectives but also by societal objectives such as mitigating climate change. Hence the car purchase decision is seen as a citizen choice process, also including societal and ecological aspects in the decision function. The automobile industry is already in the process of changing its research and development paradigm towards energy-efficient drive-train technologies – but the process of how and how fast citizens will respond to this paradigm change is still unclear. Based on theoretical and empirical evidence the paper suggests firstly, a conceptual technology transition framework explaining changes in citizens' choice process. The framework highlights why traditional choice models (such as logit models) may not be able to simulate the transformation process towards sustainable road transportation correctly. Secondly, a simple dynamic choice structure will be suggested that is able to simulate nonlinear change in citizens' car choice pattern.

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Strategic Assessment of Transportation Demand Management Policies: Tehran Case Study

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

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When accuracy matters: Prevalence, incidence and mortality rate in an Agent Based model of dementia management

An agent-based (AB) model of dementia management required that an accurate number of virtual patients be initialised at the beginning of the

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simulation, that new patients are added as time progresses and that some groups of patients are gradually removed from the simulation. This is the equivalent of prevalence, incidence and mortality in demographic analysis of the disease. We built a model in which these required parameters were taken from static look-up tables containing average data published in the literature. Our test results revealed that due to the probabilistic nature of the AB model it is difficult to accurately calibrate the model using average estimates of these three parameters over time. The proposed solution is based on implementation of a System Dynamics (SD) model that can drive the agent-based model. The possible benefits of such approach are further discussed and include the implementation of a feedback loop between the AB and SD parts of the model.

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A System Dynamics Model of the Chicken Meat Supply Chain faced with Bird Flu

System dynamics methodology is widely applied in modelling and analyzing supply chain behaviour under uncertain environment. However, there are only few applications in food supply chain in a context of sanitary crises. In this paper, we are accordingly interested in studying the behaviour of the entire chicken meat supply chain coping with sanitary crises effects. A model is proposed to study the SC behaviour dealing with the shortages in upstream supply capacity and downstream unpredictable consumer behaviour disturbed by the crisis as well. This model will be simulated and analyzed to investigate the behaviour of the chicken meat SC under bird flu crisis during the period from October 2005 to March 2006 in France. We then use a sensitivity analysis to study the supply chain stability under different environment uncertainties. Our model should be helpful to decision-makers for other fresh food supply chains when they are facing such crises.

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Limiting motor vehicles' CO2 emissions - a manufacturer's challenge

Due to ever stricter emissions regulations the automobile industry struggles to reduce their products' emissions of carbon dioxide. There are several technical options to solve the problem, all of them equally effective. A manufacturer could decide for minimum cost and move on. However, the problem should also be considered from a long-term perspective. Changes in the products' characteristics or the whole product line may lead to unintended consequences. Changing market conditions should be taken into account. A model is presented that has been developed in cooperation with a German OEM. It takes a broad view on the relevant parts of the market and allows structured planning activities.

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Building on Shifting Sands: The Structure of Repetitive IT Project Escalation, Crisis, and De-escalation

This research examines a case of extended failure to complete a critical and complex IT modernization effort in a US government organization. The project has been revamped, stopped and restarted several times, and as of the writing of this paper has not completed. From the system dynamics perspective, the problem appears to be related to a dynamic and repeating decision and management process with an embedded project management model. We hypothesize that the cyclical project escalation and abandonment is due to the continuous introduction of new requirements during the project lifecycle. A simulation model is developed to test the hypothesis and the results support the proposition that scope creep resulting from the introduction of new requirements may be a causal factor in the cycles of project escalation and de-escalation. The model is then used to test a series of policy options that are aimed at mitigating these cycles. Conclusions, recommendations, and limitations are discussed.

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Emerging Opportunities for System Dynamics in UK Health and Social care- The Market-Pull for Systemic Thinking

The field of health and social care in the UK has been very receptive to systemic thinking in recent years and has been extensively and successfully modelled. This paper describes two trends in health care thinking in the UK which build upon this receptivity and are creating market pulls for whole systems ideas. These are the related areas of health needs analysis and service-line reporting, two concepts that are in search of a language and methodology to help deliver their potential. The paper describes how system dynamics is being applied to both these trends. The work is creating a natural progression for communicating system dynamics models and improving their impact on the thinking of clinicians and managers, particularly in mental health as epitomized by the.

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Open Macroeconomies as A Closed Economic System - SD Macroeconomic Modeling Completed -

This paper completes the series of macroeconomic modeling that tries to model macroeconomic dynamics on the basis of the principle of accounting system dynamics developed by the author. Money supply and creation processes of deposits were modeled in the first paper, while the second paper built dynamic determination processes of GDP, interest rate and price level. In the third paper, these two separate models were integrated to present a complete macroeconomic dynamic model consisting of real and monetary sectors. The fourth paper presented a model of a dynamic determination of foreign exchange rate in an open macroeconomy in which goods and services are freely traded and financial capital flows efficiently for higher returns. This fifth and final paper in the series tries to expand the integrated model in the third paper to the open macroeconomies according to the framework developed in the forth paper. It provides a complete generic model of open macroeconomies as a closed system, consisting of two economies, a foreign economy as an image of domestic economy. As a demonstration of its analytical capability, a case of credit crunch is examined to show how domestic macroeconomic behaviors influence foreign macroeconomy through trade and financial capital flows.

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Contractor Selection Systems Review: Price-Based versus Qualification-Based Systems

For decades, competitive bidding has been extensively used for selecting contractors. Governments utilize this price-based selection (PBS) system for its simplicity and fairness and expect to obtain economical benefit through price competition. However, many researchers have pointed out that the price competition itself is not sufficient to guarantee an economical and quality product. The qualification-based selection (QBS) system has been increasingly considered as an alternative to find competent contractors. This paper broadly adopts the findings of previous research and explicitly depicts the causal relationships between different contractor selection systems and contractors' competitive behaviors to demonstrate the benefits and concerns of a PBS system and a QBS system. Several managerial policies for promoting project success are proposed correspondly.

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Assessing The Level Of Unity And Integration In Malaysia Using The System Dynamics Simulation Model

Social capital plays an important role in enhancing the efficiency of political institutions and the economic performance of nations. Malaysia is a multiracial country wuth a population of 22.2 millions. The four

main ethnic communities are the Malay, Chinese, Indian and the indigenous people of Sabah and Sarawak. The indigenous people account for only about 12 per cent of the population but they comprise of nearly 37 ethnic groups and sub-ethnic groups. As such the importance of maintaining close social bond which encompasses national unity and integration is an important social agenda needed for a successful transformation of the Malaysian economy both economically and politically. This study attempts to assess the level of unity and integration among the diverse ethnic communities of Malaysia on the basis of the hard economic variables extracted from the 1991 and 2999 Population and Housing Census Reports of Malaysia and a sample survey on the social capital of the ethnic communities. A System Dynamics model which integrates both the hard economic variables and the perceived social capital of the ethnic communities is constructed to simulate the scenarios based on different policy options of the government, in terms of affirmative action plan. From the results obtained, strategies are suggested to address issues relating to unity and integration in Malaysia.

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When does it really make a difference? Experimenting with the actor-heterogeneity in modeling socio-technical transitions

This study constitutes a methodological inquiry in a larger research context on transition dynamics, and it focuses on the issue of actor heterogeneity in modeling such processes. On the one hand heterogeneity at the actor level (i.e. heterogeneity among actor groups, heterogeneity among actors in a particular group, etc.) seems to be a very important source for complexity in the observed dynamics, on the other hand introduction of that heterogeneity into the models has a cost of losing some potential of the models to lead to insight development, since they become hard to comprehend in the detail level needed to incorporate mentioned heterogeneity. Hence, as a sub-topic in our wider research objectives regarding transitions, we conducted an experiment on the potential consequences (i.e. gains and losses) of ignoring or recognizing the actor heterogeneity. Three models of the same historical transition case with different types of actor heterogeneity are used in the experimentation procedure. The conclusions include direct outcomes of the experiments, as well as experience of the authors during the process of constructing these three different models that bring about differing challenges.

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Implementing Electronic Trading at the New York Stock Exchange: A Case of Organizational Change

Over the course of the last few years, the New York Stock Exchange quickly changed its trading mechanisms from floor-based to mainly electronic trading. This paper analyzes the exchange's move towards electronic trading from an organizational point of view, with particular emphasis on the following three factors. First, two exogenous

developments—a change in the customer base as well as technological developments—will be analyzed in their co-action to create pressure for adaptation. Second, endogenous reactions and the impact of trading floor-based stakeholders and their culture will be important. Examining the effects of these stakeholders helps gain a more general understanding about the possibility of internal groups to pressure for the retention of the old system. Third, inertial dynamics of the management and of the whole organization constitute a further crucial factor for the New York Stock Exchange's adoption manner of electronic trading. Different scenarios are outlined under which the different forces are able to create a smooth adaptation of the organization to external pressures, punctuated equilibrium, and organizational death.

Developmental Session Papers

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Using a "Dynamic Balanced Scorecard" in Management Education: a Comparison with Alternative Educational Methodologies

This paper focuses on the development of a Dynamic Balanced Scorecard, i.e. a Balanced Scorecard developed on the basis of the principles and tools of the System Dynamics methodology. The paper aims to demonstrate that the use of a dynamic scorecard in management education is suitable to increase students' strategic thinking and system thinking abilities and is able to foster processes of individual and cooperative learning. To validate this research question and in order to compare the effectiveness of a dynamic scorecard in comparison with other traditional teaching methodologies, an experiment has been organized. The experiment is based on the use of a System Dynamics Balanced Scorecard-based Interactive Learning Environment in a master course. The assessment of the performance of the students and the evaluation of the level of knowledge gained in the experiment are two relevant goals of this work. Therefore, the main features and expected results of the experiment are a key element this work aims to discuss.

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The Dynamics of Information Systems Development

The paper explores the dynamics of the information systems development organization within a wider business. We argue that the alignment of information system development with a business is particularly challenging due to the project-based nature of IS organizations. The interactions between software projects carried in an organization may exert a destabilizing influence on IS-business alignment. The research aims to examine how current IS management practices exacerbate this destabilizing influence.

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Legitimacy Crises and Organizational Behavior

Organizations depend on a variety of stakeholders in order to survive. One key influence on stakeholder support is the organization's perceived legitimacy. This paper presents a model of the interaction between an organization and its stakeholders under the conditions of a legitimacy

crisis. The organization's discretion in gaining legitimacy is restricted by the level of available resources. Results indicate that an organization facing a severe legitimacy crisis may not only to fail to restore legitimacy; it may even destroy the remaining constituent support through a vicious circle of overacting and mistrust. Results also suggest that a threshold of legitimacy not only exists for new ventures, but for organizations of all ages, because a legitimacy challenge may push the organization back below the threshold, ultimately leading to its demise. Moreover, the ability to conquer legitimacy crises depends heavily on the organization's initial resource endowment.

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Four Grand Challenges for System Dynamics: Initial Work and Needed Evolution

The author identifies four "grand challenges" (in the DARPA tradition) for SD, and characterizes the problem domain and the methodological evolutions necessary to bring the solutions into widespread understanding and implementation: 1. Development politics and economics 2. Global warming 3. Harmonious Chinese growth 4. Crises of financial interdependency Five methodological advances seem needed: A. Equal footing of political and physical dynamics B. Explicit simulation of foresight and strategy choice C. Pervasive dissemination D. Use of extensive validation and data E. Use of an ecology of models and purposes.

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An Analysis of Energy Intensity in Iran, A System Dynamics Approach

Substantial development of counties needs to use the resources in an efficient way. One indicator that shows the degree of efficient use of energy resources is energy intensity. Statistics show that Iran's energy intensity was in a bad situation during past years and if this manner of using energy resources continues, it will get worse. In this study a system dynamics approach is used to model changes of energy intensity in Iran. By implementation and simulation of this model we are trying to find some reasons of this problem in Iran. Then we try to introduce some policies to make steady improvement in energy intensity in the future.

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Developmental Paper: Corporate Communication: An SD Perspective

Corporate Communication is a strategic management function for directing an organization's planned internal and external communications towards its key audience: customers, investors, employees, suppliers and society. As such, it is a complex system and an important part of the present day corporate dynamics. This present work, following system dynamics approach is an attempt to understand the correlation and interdependency of the organization with its key audiences; identify the indicators and their interdependency; and suggest methods for policy evaluations. The data used for analysis is from major Public Sector companies in India.

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Cognitive Decision-Making Processes

Decision-making is a common aspect in system dynamics literature. The change of existing policies and decision rules is at the heart of the method and a big advantage of the modeling practice. But how is it about the decision-making process itself and the underlying behavioral assumptions? In its early stages decision theory dealt with rational models, drawing on a homo oeconomicus being confronted with optimizing problems. SIMON is one of the great critics of that approach and many researchers have adopted his findings of bounded rationality since then. The analysis at hand is dealing with behavioral problems, decision makers are facing in a dynamic and uncertain environment. The vast amount of information available in a complex and dynamic decision situation is too much for an individual to handle. Hence, decision-making activities, like information-processing and risk-taking, are influenced by unconscious processes in the mind of the decision maker. For example, simplifying heuristics and routines are known as reactions to the cognitive overload. Biases are often the consequence of such behavior. The effects of prior decisions, incomplete information, confidence in decision quality, and risk-taking behavior related to aspects of prospect theory are considered to build a model of "cognitive decision-making processes".

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Combining Qualitative Models and System Dynamics to design the Strategy of a Region

The design of strategies for social systems requires the use of qualitative information owing to the fact that quantitative information can be insufficient to solve the problems involved. The information that the specialists and the decision makers often obtain is incomplete and unsure. Nevertheless, leaders have to make strategic decisions despite these deficiencies. The author has been working in the design of tools to help these decision makers to improve their decisions. In this paper, a methodology elaborated to design the strategy for the city of Santa Cruz (of Canary Islands) is presented. It combines the elaboration of a

qualitative model and the application of System Dynamics and permits an understanding of the structure of the region that allows decision makers to improve their decisions. These results have been obtained working with scarce quantitative information. Key words: Qualitative models, System Dynamics, Social Strategies.

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A Simulation Model for the Automobile Cluster in Puebla, Mexico

This is a developmental paper. Summary The purpose of this study is to build a Systems Dynamic (SD) model to assess the dynamic interrelationships of the most relevant variables of an industrial cluster; and to develop a learning tool for improving decisions to support the cluster's performance. The industrial cluster is integrated by the automobile industry, including the Volkswagen (VW) assembly plant and firms manufacturing autoparts. An initial SD model has been built and early runs have indicated that the model will be potentially useful to assess different levels of investment in labor training; research and development; and infrastructure, among other relevant variables to the development and performance of this industrial cluster.

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Exploring State Space Using Eigenvalue Elasticity Analysis

In current demonstrations of Eigenvalue Elasticity Analysis, the analysis on points in state space along a particular model run. While this approach helps in explaining that particular model run, additional information about the structure-behaviour relationship could be gained by exploring more of state-space than a particular trajectory. Instead of running the model and analysing based on the points in the trajectory associated with one particular model run, the analysis proposed in this paper directly manipulates the state of the model, exploring how influence change according to the position in that space.

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Financial performance analysis of an integrated steel plant- A System Dynamics approach

Proper analysis of the financial statements of any company is necessary to assess the financial health of the company, as it provides valuable insights into its financial performance. The principal tool of financial analysis is the financial ratio analysis. Financial ratios reflect company's ability to raise external financing and the cost of external financing. In the present work detailed System Dynamics (SD) modeling and analysis of the financial performance of a local integrated steel plant is undertaken. The financial ratios considered for simulation and analysis are (i) Liquidity ratios (ii) Turnover ratios and (iii) Profitability ratios over a period of 20 years from 1994. SD model has been successfully applied to portray the dynamic behavior of the financial system of the plant.

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Developing a Candidate Methodology for Managing Nano-Scale Capability Statements

The emergence of nano-scale technologies requires a methodology to measure the consequences of nano-scale items. System dynamics offers a flexible approache to account for the unique considerations of nano-scale technologies, devices, and products that may not be apparent in existing assessment methodologies. Unique aspects of nano-scale items include test and measurement requirements, standardized ontology of nano-scale terminology, and readily applicable management techniques to ensure the full range of requirement, security, health, production, test, and disposal aspects are considered as part of the decision process. The developing research outlined in this paper proposes to craft a methodology for an executive-level management approach for nano-scale product capability definitions, offering a systematic structure for defining, documenting, assessing, and tracking relevant considerations through the entire development, acquisition, deployment and follow-on life cycle of nano-scale programs.

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Qualitative System Dynamics and the Bullwhip Effect

This paper highlights the potential for cognitive mapping to facilitate a deeper understanding of the Bullwhip Effect causes and their interaction. The Bullwhip Effect occurs whenever the variability of demand is magnified through the supply chain. Four causes of the Bullwhip Effect have been discussed in the literature, namely: demand signal processing, rationing/shortage gaming, order batching and price fluctuations. There have been numerous papers investigating these causes individually, but little attention has been paid to their interaction. A critical element in any model that deals with the Bullwhip Effect is the variance of upstream orders. In this paper we present a generic or archetypal map showing some of the most important factors that influence the variance of orders. Two distinct behavioural factors are highlighted: i) judgemental changes to the forecast and ii) judgemental changes to the order. This distinction has been neglected in much of the academic forecasting literature, but is important in practice. Our cognitive map is generic and would require adaptation for individual circumstances. Other avenues of more research, the findings from which will be presented at the System Dynamics Conference, are also discussed in our extended abstract.

Plenary Session Papers

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Why Don't Well-Educated Adults Understand Accumulation? A Challenge to Researchers, Educators, and Citizens

Accumulation is a fundamental process in dynamic systems: inventory accumulates production less shipments; the national debt accumulates the federal deficit. Effective decision making in such systems requires an understanding of the relationship between stocks and the flows that alter them. However, highly educated people are often unable to infer the behavior of simple stock-flow systems. In a series of experiments we demonstrate that poor understanding of accumulation, termed stock-flow failure, is a fundamental reasoning error. Persistent poor performance is not attributable to an inability to interpret graphs, lack of contextual knowledge, motivation, or cognitive capacity. Rather, stock-flow failure is a robust phenomenon that appears to be rooted in failure to appreciate the most basic principles of accumulation, leading to the use of inappropriate heuristics. We show that many people, including highly educated individuals with strong technical training, use what we term the "correlation heuristic", erroneously assuming that the behavior of a stock matches the pattern of its flows. We discuss the origins of stock-flow failure and implications for management and education.

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A Behavioral Model of Hurricane Risk and Coastal Adaptation

Studies of households have shown a poor perception of natural disaster risks and potential disaster severity, typically overreacting to a disaster event but underpreparing and underinsuring after periods of quiet. Many estimates of disaster response and their economic impacts haven't taken these sub- optimal household perceptions into consideration. Here I build a model of a coastal community to understand how household perceptions are important to modeling a particular natural disaster, hurricanes. ``Population Overcrowding" and ``Household Motivation for Insurance" are shown to be important feedbacks to the model, necessary to understanding the data. Overcrowding of a community because of limited housing discourages population and inhibits economic growth. A household's desire to insure against a disaster drives insurance coverage, though their desire wanes after several years. While the behavioral decision-making literature and other studies support the relationships between model variables, the model process identified important gaps in the data, suggesting directions for future empirical work.

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Towards an improved understanding of free-riding in collective irrigation systems: proposition of a basic system dynamics model

A basic system dynamics model for collective irrigation management is proposed, which is aimed at improving the understanding of dynamic processes in collective irrigation systems. In particular, the problem of free-riding on water in irrigation systems is addressed. A feedback system is introduced, which builds on the concept of a critical mass and integrates a number of influence factors that have been identified to play a key role for farmers' motivation for co-operation in irrigation. The base run corresponds to the relatively frequent situation of deteriorating irrigation infrastructure and unsuccessful co-operation. Yet, by varying initial conditions and parameters, the model also describes successful co-operation. Lines of further development are suggested, including a generalisation of the proposed model for collective natural resource management.

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The Importance of Feedback Loops Designing Environmental Policies for Sustainable Development

This article examines the impact of environmental legislation on sustainability that manifests through the conservation of natural resources and landfills. The developed model is implemented to a real world closed-loop supply chain with recycling and Design for Environment activities of electrical and electronic equipment in Greece. The motivation behind this research is twofold: first, to examine whether the environmental legislation should be considered as an endemic process of the system under study or introduced externally without taking into consideration the rates of the natural resources' usage and the used products' disposal and second, to examine the efficiency of different types of environmental legislation on sustainability in order to direct the policy at the right mix of regulatory measures. We adopt System Dynamics methodology applied to many environmental systems. Numerical analysis illustrates that the consideration of the endemic process and the expansion of the environmental regulations in order to include also measures for the products' recyclability and recycled content improves significantly the efficiency of the environmental legislation on sustainability.

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Does system dynamics or control theory help you to strike a balance?

The performance of laymen on tasks testing for knowledge of basic dynamics, such as the bathtub tasks, is consistently weak. There are some reports of beneficial effects of introductory courses in system dynamics or a strong mathematical background. This study investigates

the effects of a system dynamics background beyond the introductory level, and strong mathematical background including courses in differential equations and control theory, on the strategies applied to, as well as performance in, the rabbits-and-foxes task. The task objective is to establish equilibrium in a predator-and-prey system. These well-educated participants performed no better than social science students. The strategies applied differed however, and the dynamic systems educated participants did not demonstrate as much misconceptions about the system as social science students have been found to do. The weak performance raises the question if there are better ways to develop a mature concept of equilibrium.

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The Dynamics of Multi-Tier, Multi-Channel Supply Chains for High-Value Government Aviation Parts

Multi-tier, multi-channel supply chains are now common in many industries including aviation. Such supply chains provide high-value aviation parts to the Government, and many have been plagued recently by shortages. A system dynamics model has been developed of an aviation supply chain producing a major sub-assembly composed of eight components, each component coming from a three tier supply chain. These components are used in new production as well as overhaul of damaged parts. It was found that in the face of varying demands substantial bullwhip was produced and that it became especially pronounced at the lower levels of the supply chain. Moreover, it was shown that the government ordering process is extremely sensitive to common data errors such as the production lead-time and that production constraints, not included in the ordering algorithms, created deep and prolonged shortages. On going research is developing improvements to the formulation of the ordering process and developing optimum inventory strategies for creating push-pull boundaries in the manufacturing process.

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Reflections on the Use of System Dynamics for the Athens 2004 Olympic Games

Planning, designing, and implementing systems to support venue operations at the Olympic Games is a complex undertaking. The organizing committees must create designs that result in reliable, high-quality venue operations at reasonable cost. The organizational backdrop is unique. The organizing committee has a limited lifetime, it has no organizational memory, any learning disappears with its dissolution, and during its lifetime it must change rapidly from a function-oriented entity to a process-oriented one. We developed the Process Logistics Advanced Technical Optimization (PLATO) tool for the operational planning of the Athens 2004 Olympic Games. The PLATO tool contains a rich library of System Dynamics models that is directly transferable to future Olympic organizing committees and other sports-oriented events. The use of the PLATO tool helped ATHOC to examine trade-offs between level of service provided and associated costs. Internationally, the PLATO legacy of its Olympics knowledge base will enable future organizers of large-

scale events to reuse and customize the knowledge to gain benefits and reduce the financial burdens on governments and society. In this talk we will describe the venue operational planning problem, the PLATO approach and its application to venue planning, and reflect on the value of System Dynamics as a modeling tool to engage multiple stakeholders in addressing a complex organizational problem.

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The Dynamics of Diagnosing: Virtuous and Vicious Cycles in the Operating Room

We develop a formal model of dynamic problem solving motivated by an example of doctors handling a medical emergency. The model links interpretation and choice, usually separated in the sensemaking and decision making literatures. Three insights emerge: (1) dynamic problem solving includes acting, interpreting, and cultivating diagnoses; (2) dynamic feedback among these processes opens and closes windows of adaptive problem solving; and (3) reinforcing feedback processes, usually considered dysfunctional, are essential for adaptive problem solving.

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Does Technology Disruption Always Mean Industry Disruption?

In 1997, in his best-selling book The Innovator's Dilemma, Clayton Christensen made critical observations about the conditions under which established firms lose market to entrants with disruptive technology. His work became highly influential, making disruptive technology a buzz word, "thrown around" by the popular media in contexts far beyond Christensen's original claims. Fearing that such over-zealous use of the phrase could lead to inefficient strategic decisions; in this paper we broaden the research agenda around industrial disruption by asking: do potentially disruptive technologies always displace the existing industrial order? We first analyze media sources in conjunction with industrial statistics to demonstrate that several technologies proclaimed by media to be disruptive have failed to displace the industry order. We then offer a general model of industry disruption based upon field research. Our analysis shows that three types of uncertainties – technical, market, and organizational – may explain why such potentially disruptive technologies fail to displace the existing industrial order. Our work should not be misconstrued as a contradiction of Christensen's work. Our general model, perhaps the first differential model of industry disruption contributed to innovation literature, in fact builds upon Christensen's conditions, and argues for broadening the research agenda for understanding industry disruption.

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Regulatory Impact Assessment for the Transportation Sector – Case Study Germany

Currently, there is a discussion on introduction of legal instruments for reduction of CO2-emissions within the transportation sector. However, several instruments – on threshold as well as on economic basis – exist. While some general information on advantages and disadvantages of these instruments is available, the impact of such measures on very complex systems like the transportation sector is not known in advance. In order to anticipate intended and especially unintended impacts and to avoid trial-and-error approaches when implementing legal measures, a model is developed aiming at an analysis of several legal instruments from a political point of view. With help of this model, political decision makers are able to analyze impact of their decisions, and thus the decision making process can be improved. The model consists of several modules: a module of the vehicle market, the vehicle stock and its aging chain, the resulting emissions as well as a management simulator for political measures. The developed model is applied to the case study of the German transportation sector. Several scenarios are analyzed, and recommendations are deduced for political decision makers.

Special and Convened Sessions

Listed alphabetically by Session Name

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Business Roundtable and Business SIG Annual Meeting

Is there a need to understand system dynamics in the business world? Don't just count the numbers - as seen from the stakeholders point of view. What future benefits are there for businesses that apply systems thinking today? There are firms that have used the system dynamics approach for decades - perhaps even unaware of it themselves. Almost nobody in the business world has realized that - besides noting the global profits they are achieving. The Business SIG Roundtable will provide a platform on how to connect system dynamics approaches (from causal loop diagramming, mental model surfacing to simulations). The fields of interest will not be limited to manufacturing, but any business that creates value for customers or clients. Imagine as you travel to the conference, the number of countless sub-processes (buying tickets, checking luggage, waiting at the gate, flying, getting through customs). All processes appear linear - but what are the feedback loops that hit you and involved companies? How could the complete value stream be improved, giving a win-win-situation for companies and customers alike? These are the questions and future seeds for growing understanding and using system dynamics in the business world. Everybody is heartily invited to come.

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Conference Debriefing Meeting

All are welcome to attend to talk about what worked and what needed improvements at the Athens Conference.

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Conference 2010 Planning Meeting

This meeting time will be used to continue to develop the 2010 conference planning process.

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Education Roundtable / PK-20+ and Education SIG Annual Meeting

This Roundtable is the place to come to discuss substantive education issues, whether you are part of the Education SIG or simply exploring possibilities. The Ed SIG is establishing an agenda which embraces both elementary and secondary education and high education. We also deal with both management and public policy issues. We will continue working on the intellectual and operational challenges to system dynamics of the PK-20+ concept of lifelong learning from pre-kindergarten to continuing adult education, reaching beyond the usual silos separating the domains. Come tell us what you are working on, or just ask questions.

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Energy Roundtable and Energy SIG Annual Meeting

An Energy roundtable will be organised gathering the SD-practitioners active in the energy sector to discuss potential SD-applications in the energy sector and specifically trends within the energys sector where SD-applications would be of highest added value.

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Environmental Roundtable

We'll go around the room and introduce ourselves to each other, describing a bit about our SD work. Then we'll do a group modeling exercise.

Exhibitor Demonstrations

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

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German Chapter Annual Meeting

The meeting provides the informal opportunity to meet up with colleagues, peers, and friends interested in the work of the German Chapter. Brainstorming for future projects, ideas for the exchange with

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other Chapters, and suggestions for the advancement of the field in Germany may be the major issues participants may want to discuss, drawing on the fresh impressions got at the conference.

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The Global Economic Outlook: A Roundtable Discussion and Economics Chapter Annual Meeting

In Athens, the Economics Chapter will hold another Roundtable discussion, with this year's topic being "The Global Economic Outlook." Panel members from different continents will make brief presentations on conditions and trends in their regions, followed by Q&A. All conference participants are invited to attend and participate in the discussion.

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HPSIG Health Policy Discussion and Business Meeting

2008 is a special year for the HPSIG with the announcement of the first Lupina Young Research Awards. Peter Warrian from the Lupina Foundation will make the presentations which will take place at our Sunday session. The winning papers will provide an exciting start to our session discussions, which this year, will focus on health inequalities and disparities. These sessions involve short presentations with most time being set aside for discussion in the light of the presentations and individual experiences. Health is an international business and having input from practitioners from many countries leads to interesting informative debate. We will also announce details of the Lupina Prize for the best paper in healthcare dynamics which will be awarded for the first time in 2009. Other developments being planned will also be presented at the session. The HPSIG now has over 200 members and the Sunday session is well attended. So, if you want to be at the forefront of thinking about the dynamics of health systems then you won't want to miss this session.

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Information Science and Information Systems Roundtable and iSIG Annual Meeting

The Information Science and Information Systems Special Interest Group (iSIG)will meet at the Conference to discuss progress in the last year, and also to develop a plan for the comming year. Besides this roundtable, iSIG is hosting this year the SMILE/XMILE/Open Source roundtable, where we plan to continue current conversations in the Listserv.

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Inter- and Intranational Conflict Roundtable

The Special Interest Group: Inter- and Intranational Conflict was approved by the Policy Council of the System Dynamics Society on 3 March 2008. The SIG is concerned with the application of systems dynamics to understanding inter- and intranational conflict, e.g. military and political conflict, terrorism, insurgency, etc. There is a wide range of interested individuals, both academics and practitioners, currently applying the system dynamics approach to this area. Much of this work has not been published or is difficult to obtain. The purpose of the roundtable is to attract more interest and to frame how the SIG can interact, for example, in paper reviews, attendance at non-system dynamics conflict conferences. etc.

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Introduction to the System Dynamics Society

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

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K-12 Open Discussion

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

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Latin America Chapter Annual Meeting

During the 2007 Annual Meeting, we have met many Spanish-speaking members living outside the Spanish-speaking countries and the wider group has grown. Different topics about sponsorship and future joint activities had been talked about. This year's meeting is the opportunity to take up these issues, but also to welcome new members. Any topic members feel relevant for the development of the Latinamerican Chapter (whose mission is to spread system dynamics in the Spanish speaking world) are welome. Durante la reunión del 2007, nos encontramos con muchos colegas nuevos desde países fuera de América Latina. Muchos de los temas conversados – el auspiciado y actividades conjuntas para el futuro – podrán ser retomados este año. Todos los temas que los miembros del Capítulo (en el sentido amplio) sienten relevante podrán ser discutidos.

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Military Roundtable

This roundtable is a meeting point for people in the defence and related fields. Participants are excpected to give a brief oral presentation of their current activities and concerns.

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Model Analysis Roundtable and SIG-MA Annual Meeting

Attend this roundtable to share your opinions on formal model analysis techniques, their use in applications and their value in communicating with clients. We will briefly cover available techniques and demonstrate some of the results and displays that you can now obtain. We will then solicit your ideas and opinions on the value of formal model analysis methods, how these assist you (or not) at present and how their value to you can be enhanced. The outcome of the roundtable discussion will be captured using questionnaires.

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Eighth Annual Modeling Assistance Workshop

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

articles, books, or laptop computers. Spectators are welcome to observe, and even contribute their own ideas, during the scheduled modeling assistance sessions.

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Newcomer Orientation Session

This is a special event for newcomers, scheduled for one-half hour on Sunday afternoon. Newcomers and veteran attendees (guides) will be brought together based on their topics of interest. The guides will provide information to help newcomers maneuver through the conference resourcefully and get the most out of the conference experience.

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Participatory Modeling SIG/Chapter "To-Be"

Meeting of the community of scholars and practitioners interested in participatory System Dynamics approaches to model development and use, to explore the possibility of forming a SIG or Chapter.

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Peer Review Dialog Meeting

Since 2005, there has been an opportunity for joint reflection about the quality of the peer review process at each conference. Last year, for the first time we talked amongst reviewers, thread-chairs, the program committee and the society's head office and policy council. Some points are worth being reminded for this year's discussion: -- shall thread-chairs

give feedback to their reviewers? -- shall there bey types of papers? -- shall there be a reviewer-workshop? Beyond this, one might ask if the conference proceedings should be a publication on their own (ISI): surely there are pros and cons. Every other question relevant to members may be raised during this session.

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PhD Colloquium

The PhD Colloquium is a whole day event for Ph.D. students to present and discuss their current research about foundations, techniques, and applications in the area of system dynamics. Junior and senior system dynamics practitioners and academics meet here every year to exchange ideas about students' projects in an inspiring international and open-minded atmosphere. The forthcoming 9th PhD Colloquium will take place on Sunday July 20th 2008 at the 26th International Conference of the System Dynamics Society in Athens, Greece. Plenary presentations by PhD students at the Colloquium will identify common problems encountered by thesis researchers using system dynamics. Each presentation will be followed by an extensive discussion session, providing a unique opportunity for learning among all attendants, and particularly for young researchers. Combined with a poster session, we expect the all-day colloquium to be an exciting and insightful event. To conclude the day, attendants will be invited to join for an informal and friendly social event. More information is available at www.sdstudentchapter.org Any questions about participating in the colloquium can be directed phdcolloquium@systemdynamics.org.

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Prospective Conference Host Meeting

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

AND

Conference Budgeting Workshop for Hosting a Society Conference

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

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Psychology Chapter Annual Meeting

The Psychology Chapter is devoted to integrating important psychological processes into system dynamic models and to use system dynamic principles in developing new psychological theories. Currently we have started developing a bibliography of papers and models that include psychological variables and social processes In addition, there is an strong interest in studying the role of "soft" variables in system dynamic qualitative and quantitative models.

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Student Chapter Annual Meeting

The Student Chapter brings together students who are involved in system dynamics research, and it gives them the opportunity to raise key questions and discuss concerns related to their research in a constructive and enjoyable atmosphere. Following the PhD Colloquium on July 20, 2008, the Student Chapter will hold its annual meeting. Here, the current situation as well as new ideas for the future will be discussed. Students as well as everybody else who is interested are invited to participate.

Chapter and SIG Poster Presentations

Listed alphabetically by Chapter or Special Interest Group name

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Australasia Chapter Poster Presentation

Members of the Australasian Chapter have been working on a variety of research projects and consulting assignments over the past 12 months. Much of this work was presented at the Chapter's annual research colloquium in Sydney in February. The research projects that members worked on reflect the issues that are currently facing the nation. These include: - constraints in the workforce; - water resource use; - education (agent based & system dynamics); - health and the aging population; - clinical reasoning and pain management. Much of this work will be presented at the Athens conference. Apart from research and consulting projects, members of the Chapter have been working with universities and the business and government communities to continue to educate people as to the uses and advantages of system dynamics. Mark Heffernan and Tim Haslett have been working with the University of Technology, Sydney in developing and running a Systems Thinking Course. Mark, Geoff McDonnell and Derek Burrows ran an introductory SD course in Sydney in February, attracting over 30 participants from Australia and New Zealand. Alan McLucas continues to support SD in Canberra. Over the coming year it is hoped to build the Chapter both in size and recognition. Working with the major Australian business schools is seen as paramount importance in achieving this goal.

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Business Special Interest Group Poster Presentation

Does your company use system dynamics modeling? Would you like to learn how other businesses are applying system dynamics tools? Would you like some help bringing these tools into your business? The Business Special Interest Group was formed in 2005 to provide a forum for the exchange of ideas, methods, and lessons learned in the use of system dynamics in the corporate world. The SIG has grown substantially in the number of interested members since then. Our members represent a cross-section of industrial, consulting, and academic organizations, offering tremendous depth and breadth in relevant expertise. Our goal is to encourage the sharing of system dynamics best practices in business. Our approach is three-fold: (1) Development of the system dynamics

modeling competence of business users through training and consultancies, (2) Sharing recommendations around effective tools and methodologies with immediate applicability to policy and decision making in business, and (3) Encouraging and inviting presentation tracks and speakers to present applicable work and case studies at the annual International System Dynamics Conference. We will provide several examples as part of this presentation.

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Economics Chapter Poster Presentation

The Economics Chapter promotes the use of system dynamics to study and improve economic systems. The chapter maintains a website (http://www.systemdynamics.org/chapters/economics/) and a mailing list with over 70 subscribers. Members of the chapter have organized system dynamics threads for various economics conferences and coordinated the economics thread during annual meetings of the System Dynamics Society. Last year's Economics Roundtable discussion on "Using SD to Teach Economics" was well received, and this year's Roundtable will focus on the "global economic outlook." We encourage anyone interested in economics to visit our poster to learn about the activities of the chapter and its members. We also want to hear about your interests and invite you to join the chapter.

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Energy Special Interest Group Poster Presentation

The Energy SIG was created in October 2006 and currently includes more than 50 members worldwide. The objective of the SIG being an information exchange platform for all SD-practioners active in the energy sector though as well to attract energy experts to get to learn system dynamics. Next to the annual Energy SIG meeting during the SDCs, the Energy SIG also hosts a public website and a members-only Portal Site to facilitate the exchange of information between the members and is planning to hosts regional workshops to get the members togethers and to advance the use of SD in the energy sector.

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German Chapter Poster Presentation

Eighteen months after its foundation, the German Chapter is still on a stable growth path. Having attracted another 25 members since the Boston conference, the Chapter currently counts 70 paying members and is pleased to keep another 70+ interested individuals updated through its newsletter. The Chapter advances networking and collaboration among system dynamicists in Germany with the frequent organisation of SD roundtables and other meetings in various German cities. On June 09th and 10th, the 2nd German System Dynamics Workshop will be held at Mannheim University. The event brings together modellers from both the scientific community and corporate practice. Combining talks, presentations, and modelling exercises, the workshop offers a wide array of opportunities to exchange ideas and opinions. A workshop on logistics and traffic management is organized in cooperation with the German OR society. Drawing on the complementarities of the research paradigms of OR and SD, the workshop aims at the advancement of a joint perspective on complex problems from the logistics, aviation, and general traffic domain. The workshop is to be held on November 13th and 14th at Frankfurt Airport. Submissions are welcome. More information on the activities of the German Chapter is available from our website at http://www.systemdynamics.de.

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Health Policy Special Interest Group Poster Presentation

2008 is an exciting year for the HPSIG. We now have over 200 members and thanks to support from the Lupina Foundation of Canada we will not only be presenting the first student prize in Health System dynamics at the Athens conference but also announcing a further prize for contributions to the field. We are a truly international SIG with active collaboration across the world, utilising SD to tackle major policy issues. We conducted a survey of members in 2007, the results of which will be discussed at our regular Sunday working session, and will be using the results to help plan further developments for the SIG. Some current initiaves include more on-line teaching materials, international collaboration on projects and a library of SD health models. Come along and hear more about how SD is being applied and making a real differnece to policy and practice in health around the world.

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Hellenic Chapter Poster Presentation

The last two years have been of great significance to the Hellenic Chapter. The hosting of the 26th International Conference in Greece was of great importance and honour to all the members of the Chapter. Several meetings were held in order to review the status of the

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conference organization, and mobilise and organize local resources. The Athens Conference, as well as system-dynamics related presentations at the annual national conferences of the Greek OR Society and the Hellenic Society for System Studies, have stimulated interest in the Chapter. Two long-standing projects, the creation of Chapter's website and the publication of an edited volume with domestic applications of system dynamics modelling, are finally very close to completion.

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Information Science and Information Systems Special Interest Group Poster Presentation

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The Information Science and Information Systems Special Interest Group (iSIG) is interested in supporting two different threads of work since its beginning. The first thread of work is associated with the promotion of quality system dynamics work in the areas of Information Science and Information Systems. The iSIG has promoted the creation of a thread on Information Science as part of the International Conference in System Dynamics. The second thread of work is related to the promotion of a common interchange modeling language. Both threads are holding a Roundtable during the Conference this year. Work and conversations among iSIG members takes place in a Yahoo Group and a wiki page.

Inter- and Intranational Conflict Special Interest Group Poster Presentation

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The Special Interest Group: Inter- and Intranational Conflict was approved by the Policy Council of the System Dynamics Society on 3 March 2008. The SIG is concerned with the application of systems dynamics to understanding inter- and intranational conflict, e.g. military and political conflict, terrorism, insurgency, etc. The purpose of this poster is to: (1) Point out some of the historic work in conflict analysis using system dynamics; (2) Indicate the areas of current activities; (3) Encourage membership and search for a way to exchange ideas/paper drafts/strategies for recognizing and promoting the applicability of applying system dynamics thinking to inter- and intranational conflict.

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SYstem Dynamics Italian Chapter (SYDIC) Special Poster Presentation

Poster presentation of the 2007-2008 activities performed by members of Italian Chpapter of System Dynamics Society (SYDIC).

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Japan Chapter Poster Presentation

System Dynamics history in Japan commenced in 1960s; several textbooks of Industrial Dynamics were published in those days. After that, many researchers used System Dynamics in their own field individually for about 30 years. Thereafter, System Dynamics researchers gathered and founded Japan Chapter of International System Dynamics Society in 1990. Since then, Japan Chapter held The International System Dynamics Conference 1995 hosted by Gakushuin University in Tokyo. The chapter members assembled their best minds and finished it successfully. In 2006, Japan Chapter had over one hundred chapter members. As Research activities, Japan Chapter publishes an annual journal and holds regular research meetings and symposiums. In 2007, we held three research meetings including one conference. In particular, the conference was the most important events not only for the chapter but also for the public. The recent theme of the public symposium is “Internal Control and System Dynamics” The conference had many participants including public people. We always welcome System Dynamics members or users who visit Japan. Several System Dynamics researchers have already had meetings hosted by Japan Chapter. Contact with our office is greatly appreciated.

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Latin America Chapter Poster Presentation

The Latinamercian Chapter has the mission to help the SD-community grow in the spanish speaking countries. Founded in 2003, it has latinamerican members from Mexico to Chile, from Spain and a growing number of spanish speakers living in other countries. Since 2003, the annual meeting allows practitioners to gather and newcomers to get in to touch; we have been in Mexico, Chile, Colombia and Argentina so far. Since 2005, the spanish “Revista de Dinámica de Sistemas” publishes two numbers per year. The “sisTEMAS” newsletter and a mail list allow to keep in touch. During 2007, a joint effort lead to edit a book was undertaken. Also, a new textbook is to be released soon. For the future, the production of spanish language materials, the reinforcement of SD in education and the strive for high quality standards in applied work are our priorities.

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Psychology Chapter Poster Presentation

The Psychology Chapter was created in 2005 as a venue for discourse and learning about ways of integrating psychological processes into system dynamics models and to apply system dynamics methodology to the formation of psychological theories. Currently the Chapter has 40 members. Members of the Chapter are currently developing a bibliography of articles that are relevant to these to aims, an updated version of which will be disseminated at the Athens meeting and electronically (via e-mail).

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Russian Chapter Poster Presentation

The Russian Chapter (SDRus) had another successful year. We launched a new website www.systemdynamics-russia.org, which is more interactive and user-friendly. In November of 2007 our chapter held a meeting at the Moscow State University. Eight members made reports at the meeting and we produced the plan of action for the upcoming year. Five new members joined SDRus recently. MSU hosted "The Winter School on Simulation Games and Modelling" in December of 2007. It was a very successful event attended by Russian and international participants. The goal of the winter school was to introduce participants to learning managerial processes through the use of simulation games. Another emphasis was on demonstrating capabilities of simulation games in teaching. The full report is published on our website. In May of 2008 system dynamics projects and papers have been presented at the annual MSU conference "State Management in the 21st Century". One of our members is the chief editor of the Business Informatics Journal, published by the Higher School of Economics, Moscow. This publication welcomes SD articles in Russian and advertises upcoming events in system dynamics. Active work continues at MSU, State University of Management and other centres in Russia.

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Security Special Interest Group Poster Presentation

Security is a broad field that can affect to several systems. However, Security presents some common features in all these systems: It is a system that evolves over time, including technical and social variables. These characteristics make System Dynamics a very powerful methodology for its analysis and research. The incipient Special Interest Group on Security is still immature, but has already provided its first promising results, through the edition of several collaborative papers and project proposals. We should now concentrate on establishing a more robust cooperative network, which allowed us to get a critical mass to undertake more ambitious objectives. The recently developed wiki has to become the meeting point to achieve this goal.

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Special Interest Group on Model Analysis (SIG-MA) Poster Presentation

The Special Interest Group on Model Analysis (SIG-MA) focuses on the development, use and advancement of formal model analysis methods in System Dynamics. These methods currently include: Pathway Participation Metric, Ford's Behavioural Analysis and Eigenstructure-based methods, amongst others. The focus of this group is not so much on the validity of model equations as, given the equations, how can they best be analyzed and interpreted back to reality. Brief History During a workshop on formal model analysis in Delft in 2006, and follow-up discussions at the 2006 and 2007 conferences, it became apparent there was significant interest in formal model analysis and sufficient critical mass to form the SIG-MA. This was approved by the Policy Council late in 2007. Present Activities The activities of SIG-MA include facilitating communication amongst model analysts by moderated listserve discussions. These focus on theoretical developments as well as improving the means of communication of analysis results. We plan to expand our activities to the further development of tools for model analysis and clear communication of their use (and benefits) in applications. Open Membership The SIG-MA is open to all system dynamicists interested in formal analysis. Please contact Willem Geert Phaff (h.w.g.phaff@tudelft.nl) to join our listserve (sdsigma@listserv.tudelft.nl).

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Student Chapter Poster Presentation

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

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Swiss Chapter Poster Presentation

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

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UK Chapter Poster Presentation

The UK Chapter was one of the first regional Chapters to be formed. We have regular meetings in the UK and annually at the international conference venue. This year we held our 10th Annual Gathering. Formerly held in Harrogate, this year we switched it to London South Bank University. The event format consists of a Thursday afternoon of talks, presentation of the newly-inaugurated Steer-Davis Gleave Prize, the UK Chapter Student prize and a business meeting. A convivial dinner follows in the evening with further sessions on the Friday morning. This year's event was a huge success with an attendance at nearly 70. See our website (www.systemdynamics.org.uk) for more details of what took place. In Spring 2006 we inaugurated an evening networking event in London and over 40 people attended. The second was held in December 2006. More of these events are planned and another is expected to be held in May 2008. If you are based in the UK and not already on our membership list (membership is free) then please do join us and see what we have to offer. If anyone would like to see a specific type of event taking place then please make your idea known. We look forward to hearing from you.

Workshops

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Creating Multiplayer Online Simulation Games

This workshop will teach you how develop your own online simulation game using existing system dynamics models and technology readily available online. Massively Multiplayer Online Games (MMOs) such as Second Life and World of Warcraft have tens of millions of users worldwide and have dramatically increased the popularity and awareness of online games and simulations. The problem is that blockbuster games like these require blockbuster movie-sized budgets. However, there is now an opportunity to create smaller multiplayer games on a limited budget. Instead of a massive multiplayer worlds, system dynamics-based business simulations can be transformed online into small multiplayer simulation villages that teach specific lessons to participants through a web browser. During the workshop, Michael Bean will demonstrate how to create multiplayer web simulations, discuss commonly occurring web simulation design challenges and potential solutions, and show examples of web simulations that have been used by thousands of users. Michael will also provide a series of guidelines for creating simulations online. Michael will provide handout booklets, sample simulations, and sample HTML pages that can be used to create your own first web simulation.

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Getting Started at Building Web Simulations using Forio Broadcast

Forio Broadcast allows modelers to develop and present dynamic simulations on the Web with no programming. Although Broadcast makes creating web interfaces to system dynamics models relatively simple and inexpensive, model developers still face hurdles developing web simulations because of the design expectations of Web users. During this workshop, Michael Bean will demonstrate how to create web simulations, discuss commonly occurring web simulation design challenges and potential solutions, and show examples of web simulations that have been used by thousands of users. Michael will also provide a series of guidelines for creating simulations online. When simulations are used in workshops or facilitated by the model creator, modeling experts can compensate for user interface design problems by directly interacting with the users. But on the web, this is impractical. Usability design is critical to create simulations that will be used by a diverse, global audience with limited knowledge of simulation, short attention spans, and unarticulated use objectives. Michael will provide handout booklets, sample simulations, and sample HTML pages that can be used to create your own first web simulation.

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Getting Started with Agent Based Modeling in AnyLogic

After a short introduction to Agent Based Modeling we will show how to build a simple model using that approach in AnyLogic model development environment. We will then add a model component built with the System Dynamics approach and combine it with the agent based part. CDs with AnyLogic trial version will be given to everyone. Participants can bring their laptops and build models with us, or just watch. Everybody is welcome to join the discussion on where AB modeling should be applied and how the two methodologies can successfully work together.

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Getting Started with STELLA and iThink

This workshop will be an introduction to building and communicating system dynamics models using STELLA or iThink software. The workshop is intended for people who are relatively new to the field or do not have experience using the current version of STELLA or iThink. The session will be conducted as a hands on workshop and demonstrate basic techniques for building, analyzing and communicating simple simulation models. Participants should bring their own computers with STELLA or iThink Version 9.1 installed or arrive 15 minutes early to install the software.

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Modeling Dynamic Systems: Lessons for a First Course

"Modeling Dynamics Systems: Lessons for a First Course" provides a set of materials that enable educators at the secondary and college levels to teach a one-semester or one- year course in System Dynamics modeling. These lessons are also useful for trainers in a business environment. A new chapter dealing with material and information delays will be discussed. Developed for beginning modelers, the lessons contained in this book can be used for a core curriculum or for independent study. Systems thinking software like STELLA offers an opportunity to create visual models that actively engage students in the study of a wide variety of problems. Creating a model allows for "real-time" analysis of dynamic behavior and a more stimulating environment in which to glean insight. The lessons include some of the classic System Dynamics problems (population change, resource sustainability, drug pharmacokinetics, spread of an epidemic, urban growth, supply and demand, and more). Developed over 15 years, the lessons in this book

provide an easy-to-use set of teaching materials that are paced gently enough for novice modelers. Students learn to create progressively more sophisticated models, testing their structures as they proceed. Feedback analysis is integral to the lessons.

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Teaching Your Children System Dynamics/System Thinking

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

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How to Write a Good SD Paper

Too often, submissions to the System Dynamics Review reflect considerable hard work that has missed one or more of the basics of doing good research and describing it adequately, such that the reviewers say "do it all over". The workshop supplies preventive measures: It examines all the phases of conceptualizing, executing and writing up research. For each phase, the workshop uses discussion of examples, metrics, test questions and "sure signs of an effort in trouble" to allow the author to detect and correct the big flaws well before submission. "War stories" supplement the brutally simple guidelines.

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Sharpening Soft Skills for Better Modeling

It has often been noted in publications and at conference that as a field, we could do more to increase our “soft” skills as modelers. Issues range from working effectively with groups and being better listeners to dealing more effectively with conflict and issues related to power differences within groups and human diversity. While these issues are arguably present in some way within every human interaction, they become more pronounced when we focus on persistent social problems and begin to work with more diverse stakeholders. Drawing on the diversity of participants attending the session, this workshop aims to develop skills for facilitating and managing group conflicts. The workshop will be highly interactive and focused on preparing and expanding the range of system dynamicists in working with groups.

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Very large system dynamics applications with Powersim Studio

Although large models are not the preferred modeling practice within the SD community there are times when it is necessary. The purpose of this

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workshop is to discuss the lessons learned from developing very large SD applications. There are some valuable lessons to be extracted from the work we have done over the past 6 years. It is important to justify why a System Dynamics model develops into a large model and to separate it from the tendency for inexperienced modelers to develop large models. SD models that become very large are large because they include a lot of detail complexity. We sometimes label this dichotomy, scope versus scale. It is important to understand the difficulties and time necessary when developing a large detail and dynamic complex model and to plan accordingly. It is also important to continuously manage the customer's expectations.

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SMILE/XMILE/Open Source Software. Workshop Roundtable

Since at least 1995 system dynamics software users have expressed an interest and have proposed solutions to system dynamics modeling software incompatibility. Earlier in this decade several conference papers have addressed this issue from a technical and business strategy standpoint. In addition, and related to this, there have been calls for an 'open source' system dynamics modeling tool. Activity related to these two topics occurs frequently on the system dynamics list server. This workshop/roundtable has invited participants from the three major system dynamics modeling tool software firms, plus any other interested parties, to meet and discuss these issues. Our goals will be: a better understanding of issues related to the interchange language and open source and steps forward to pursue these options.

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Adventures in Open Source System Dynamics

Currently under heavy development are two free and open source system dynamics tools, OpenSim and Open Dialect. OpenSim is a new modeling program designed with an emphasis on collaboration. While individuals can use it to create models on their own, its strength lies in its support of multiple people working on the same model at the same time, collaboratively. The second tool Open Dialect allows users to easily develop and maintain aesthetically pleasing online learning environments to OpenSim and other models. Simple ILEs are easy to create and more complicated ones (with multiple people interacting in a simulation, for example) can be created as well. This workshop will showcase these new tools and demonstrate their features through creating a simple model and online interface package, followed by a discussion to guide future development.

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Embedding SD Into Existing University Courses

Workshop proposal: Embedding SD into existing university courses: The aim of this workshop is encourage and enhance the use of SD in existing, traditional university courses. To help ensure a quality experience for students not acquainted with SD, it would be helpful for professors to have a defined approach to introducing SD. That is, there

are several pragmatic problems that create obstacles to a high quality integration of SD in traditional classes. This workshop will attack these problems by facilitating a review and discussion, by the workshop participants, of the following issues: What are the SD concepts that MUST be covered ((SDRMS) System Dynamics Required Minimum Set)? How should the SDRMS be introduced? What should we assign as SDRMS required reading? How should we verify learning of the SDRMS? What should we list as SDRMS "learning objectives?".

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Teaching Strategy Dynamics

If System Dynamics is to help improve the professionalism with which management is practised, it needs to become an integral part of management education, whether in Business Schools, or via other channels. To do this, it needs to pick up, and build upon, what is already being taught, and be accessible to instructors, who may have a large investment in other teaching methods and materials. Several factors suggest there may be demand for what SD can offer. Strategy teachers are looking for better concepts and tools. In addition, increasing teaching loads and the demand for novelty and engagement from participants are both pressures to which SD can readily respond. The workshop will cover how SD can contribute to management teaching, developing and using learning materials , adding 'dynamic' elements to existing courses, use of small-scale, SD-based exercises, and how to deal with executive education situations.

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