Proceedings of the 31st International Conference

July 21-25, 2013
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Robin S. Langer, LouAnne Lundgren,
Erin R. Sheehan and Joan M. Yanni

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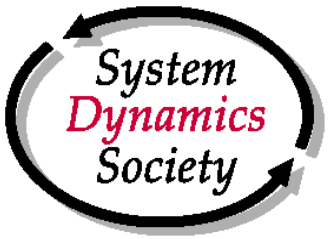

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Welcome

Welcome to the 31st International Conference of the System Dynamics Society. This year, the conference returns to the Cambridge-Boston area, just minutes away from Massachusetts Institute of Technology (MIT) where Jay Forrester conducted his groundbreaking work.

This year's program shows that the field of system dynamics continues to thrive. Conference participants come from 46 countries from all over the world. Starting with the PhD Colloquium on Sunday, through plenary, parallel, and poster sessions Monday through Wednesday, and Thursday's workshops, you will have the opportunity to participate in conversations and presentations discussing system dynamics work of leading academics and practitioners.

The main theme of the conference, **Creating the Future from Within,** highlights the role that endogeneity and feedback have in understanding and effectively managing dynamic systems. The program will consist of invited and contributed sessions and workshops demonstrating the state of the art in the theory and application of system dynamics. This year, we have an enhanced online schedule in which you will be able to see brief author bios, photos, and presentation slides. Furthermore, a Model Expo will take place on Monday providing an extremely interactive hands-on experience with models presented at the conference. The program schedule will also include exhibits, model assistance workshops, panel discussions, special sessions, a student colloquium, and Society business meetings.

During the conference there will also be time for social and professional interaction in a relaxed and fascinating setting; an Informal Gathering on Sunday during and after registration, a University hosted Welcome Reception on Sunday, the Poster Symposium and Buffet on Monday, and the Conference Banquet on Tuesday will provide such an opportunity. Additionally, for those interested in knowing more about MIT, a guided tour, including a visit to the MIT Museum (admission fee paid separately), will be available. Also, the Spouses' Lounge will offer a place for spouses, significant others, travel companions, and family members to meet, gather, and make plans to do fun things in Cambridge-Boston. This will be a great opportunity for them to make new friends and renew acquaintances; we welcome them to the conference!

This year, 28 Thread Chairs, supported by several hundred volunteer reviewers, screened and commented on around 400 submissions. In addition, several dozen volunteers worked many hours to ensure a successful conference; without their commitment our conference would be impossible. A very special thank you goes to all who helped.

In addition to all our sponsors, we are also very fortunate this year to have two conference partners, *PA Consulting Group* and the team of *Ventana Systems* and *Greenwood Strategic Advisors AG*. We sincerely appreciate the enthusiasm and support of all our sponsors.

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

On behalf of the conference committee, best wishes from,

Robert Eberlein, Ignacio Martinez-Moyano, Jack Homer, Hazhir Rahmandad, and Roberta Spencer

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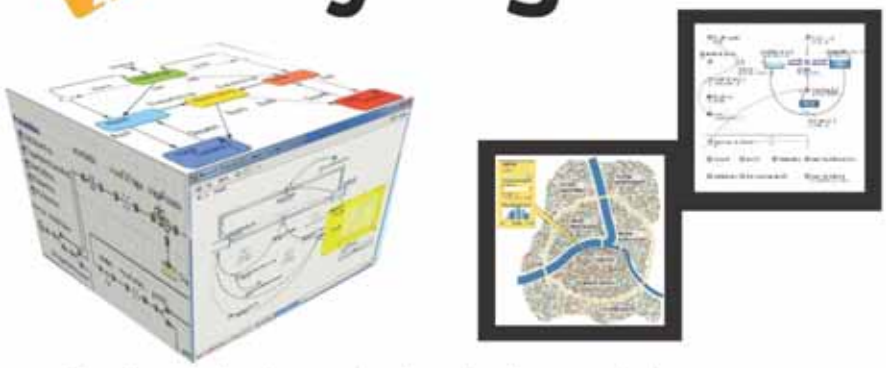

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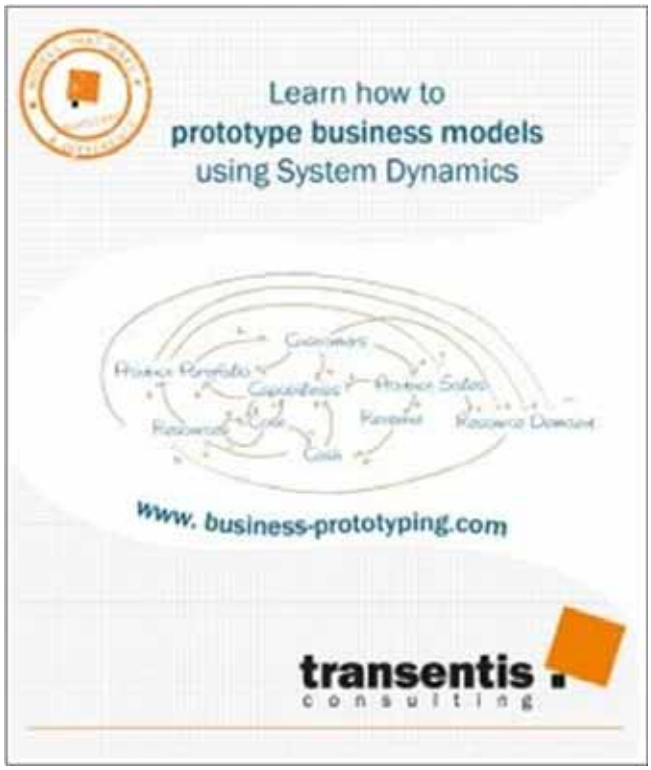

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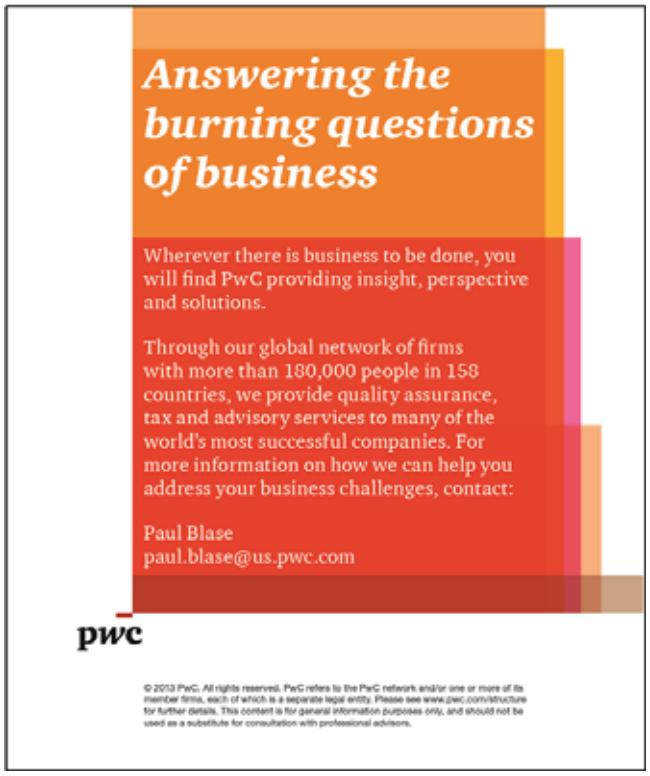
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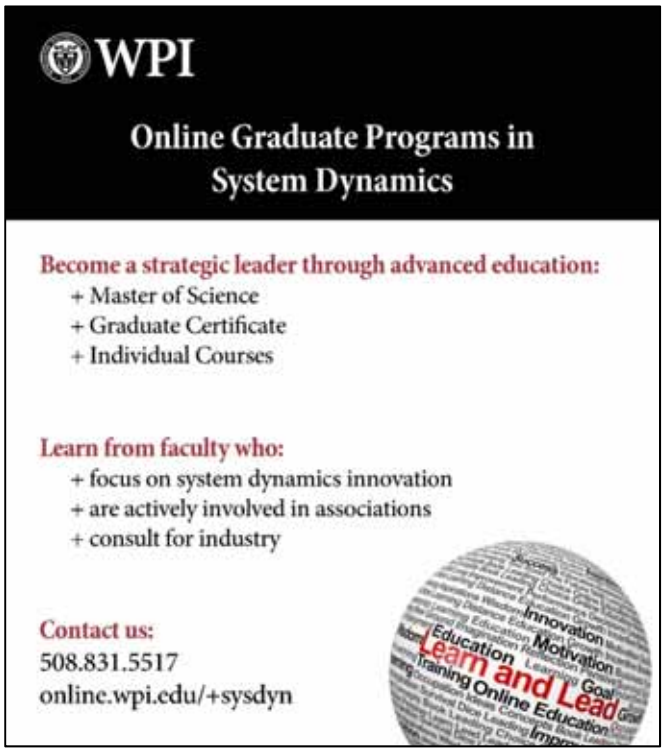
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- **Viewing/Opening/Reading the Supporting Material:**

Supporting materials will contain either a single file, or .zip/.rar or other archive which can be opened with a number of utilities or directly on some operating systems. Supporting materials may include plain text files or other commonly used file types. 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 publishers. Follow the links within the descriptions below to the software needed to view the files.

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

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Ozgur Araz
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Carlos Saldarriaga
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A behavioral model of collective action in artisanal and small scale gold mining

Ben Turner
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Student Initiated Systems Dynamics in the Academic Setting: Opportunities, Challenges and Enjoying the Process

Ranran Wang
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Exploring the Water-Energy Nexus in an Interconnected, Dynamic, and Uncertain World

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Tale of two gardens: Social capital and Community Development in St Louis

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Doina Olaru
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System Dynamics Based Simulation for Airport Revenue Analysis

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Mapping a 15-Year History of System Dynamics: A Content Analysis of Articles Published in its Premier Journal

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System Dynamics Model for Balancing the Formality and Flexiblity of Product Development Project

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System Dynamics Approaches to US-Mexico Border Poverty: From Canonical Situation Models to Group Model Building

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Assessing the Potential of Shale Gas Production on Interregional Energy Geopolitics

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Simulating Urban Transportation in India: A System Dynamics Approach to Explore Alternative Mobility Options

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Active use of quality management system in the construction industry

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Accounting for Dynamic Complexity in a Cost-Consequence Analysis of a Healthcare Intervention

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Optimal Investments in New Low Carbon Electricity Production Technologies

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The Financial Innovation Model to Improve Toll Road Infrastructure Investment Development: Using System Dynamics

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Timeframe for investing in cyber security does matter: A brand value argument

The majority of published studies on the economics of cyber security literature focus heavily on the development of optimal investment strategies in cyber security from a cost / benefit perspective. The focus on investment strategies from this perspective neglects the amplification from potential behavioral response by consumers to a cyber security incident. This conference paper explores the effects of brand value and consumer confidence in the context of cyber security policy implementation. We find that if brand value and consumer confidence theories are applied to a model of cyber security costs and investments, a single or a series of serious cyber security lapse(s) could lead to business failure.

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Improving Efficiency and Capacity in Primary Health Care in Iceland Using System Dynamics

To identify the characteristics of treatments for mood- and anxiety disorders that maximize the effectiveness a system dynamics model was developed by using respective literature and extensive knowledge and experience from specialists in the field. Utilizing system dynamics modeling and existing literature on treatments for those disorders as well as information from working professionals in the field, it can be demonstrated how current treatment with medications can lead to accumulation in the system, with little short term benefits for patients but longer term loss for the health care and possibly the patient too. When it comes to policy changes in health care management regarding treatments for mood- and anxiety disorders, Cognitive Behavior Therapy (CBT) is recommended as an alternative for the primary health care. This evaluation is based on results of modeling the existing system. CBT entails clear benefits and is an optimal choice, compared to the current state of system, when the objective is to help as many patients as possible in the most effective way without increasing the cost of treatments. Increased emphasis on other resources, like CBT, for patients with mood- and anxiety disorders can achieve improvements in patient's quality of life resulting in significant cost benefits for the society.

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Diabetes Learning Lab in Stella 10

In this activity, the body reaction in the intake of food will be simulated: Food amount; type of food; when the intake of food took place; how fast the digestion occurs; reaction time of the pancreas; the connection between the blood glucose concentration and the insulin production. The content will also cover the subject between the coordinated and harmonious functioning of the pancreas (which secretes insulin), the liver, and the body's cells (insulin receivers). The

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Homeostasis: Process that regulates the blood concentration. Together we'll discover the cause-effects cycles that characterize the problem and how they become an important part of the solution. This article will span the effect of pancreas' insulin production in diabetes type I, as well as the cells' glucose uptake and their rejection to insulin, all this with the intention of visualizing how it breaks into the cause-effect cycles that regulates the blood glucose concentration in the body, triggering the imbalance in health.

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The beer game in Stella 10

To develop a learning laboratory or a business game for the supply chain to help us find the leverage points, which are the intervention places where a little change would lead us to a grate change in the systematic behavior. The levers are power points of influence. Since the systems are counter-intuitive, finding these levers is the key as the motor of the sustainable sales growth for all business. Specially, it gives us the power to supervise the impact of our decisions and avoid, as far as possible, the unintended consequences of the intervention in any system. The better way to discover the influence places is through a learning laboratory connected to the supply chain.

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[Pollen learning lab]® to improve the public education system (new)

[Pollen learning lab]® is a methodology, which is sustained upon the system dynamics and the systemic thought to envision sustainable policies to improve the academic performance of the public educational systems for countries worldwide. To achieve this, given the results of public education in the world, we have taken the first steps to develop a new learning lab that helps us to visualize the impact of our decisions to improve the education system, and avoid the possible, the impact of the unintended consequences of changes in public education policy to be implemented in social, cultural, economic and ecological. This methodology can be applicable to improve the performance of a school, a district, the education of a state or country, the learning process and generated knowledge which can be extended as well to the business field in an easy way.

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A system dynamics approach to clarify the impacts of state loans on real estate market in Iran

In this paper, the effect of state loans on real estate market prices in Iran is investigated through a system dynamics approach. Although the government has given loans to the demand side for the purpose of stabilizing the housing price, the price has increased. In the proposed model, the effects of giving loans to the

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demand and supply sides of the market have been studied. The market includes investors as well as non-owner families and constructors in the supply and demand side. The results indicate that granting loans to the supply side for construction will be more beneficial than the demand side. In addition, the monetary policies of the government which influence the liquidity in society can influence the market behavior considerably. Thus, it is suggested that first, the government reduce the amount of liquidity in society and second, the government give state loans to the supply side of the market.

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Modeling the Dynamics of a Bank Issuing Mortgage Backed Securities

In this paper, we dive deeper into the aggregate bank's MBS business model focusing specifically on pass-through mortgage-backed securities. In order to assess the impact from prepayment and default risk for a MBS issuer, we quantify all financial transactions of the MBS issuer with home owners, MBS investors and insurance providers based on the pass-through MBS structure. To achieve a stable cash flow, we also include both business loans and savings deposits, so that both interest earnings and interest costs are included in the system. Two scenarios are presented to qualitatively validate the simulation model. In the first scenario, we demonstrate the dynamics of the aggregate bank's net capital position due to the MBS business both in the presence and absence of interest-earning business loans. The bank uses the cash from MBS investors to fund business loans and strengthens its revenue from interest income. In the second scenario, we simulate an economic downturn that triggers home-buyer default rate and decline in home prices. Against such a backdrop, the simulation model shows that the extent of insurance coverage, whether high or low, leads to very different dynamics in the net capital position of the aggregate bank, as well as in the viability of the MBS business model.

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Towards a Dynamic Theory of Serial Insurgencies

When a government falls to an insurgency, the establishment of the new government is not the end of the story. Often, perhaps even most of the time, the new government will also be faced by an insurgency and quite likely overthrown. Thus begins a domino-like chain of serial insurgencies and overthrown governments, which typically create more harm than the original insurgency. While much has been written on why traditional governments fall to insurgencies in the first place, this paper examines why a series of rapid, successful insurgencies occurs after the initial government has been overthrown. We also examine how various factors, such as connectivity, relative deprivation (the gap between popular expectations for a government and its actual performance), extra troops (e.g. international peacekeepers) and other factors either promote or suppress serial insurgencies. Some findings that stand out are: (1) increased connectivity (such as seen in the Arab Spring) not only destabilizes incumbent traditional governments, but also promotes serial insurgencies; (2) extra troops from abroad can be counterproductive; and (3) often the final stable government in a serial insurgency is not as popular among the citizenry as the initial government that was overthrown.

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Exploring Policy and Initiative Decision Making in a Dynamic Conflict Environment

The need to provide resources to tactical forces requires a long and often vulnerable logistics tail, which draws forces from forward operating areas and exposes support units to hostile action. The additional requirement of securing and transporting resources to tactical forces effectively increase costs, delivery times and challenges the decision making of leaders. This model allows those leaders to investigate energy and infrastructure considerations in a red vs. blue simulated conflict environment. This approach is important as often operations oriented wargames and models discount the requirements for logistics, providing an incomplete examination of the tactical or operational problem. By using System Dynamics, the logistician can investigate those factors that influence and limit operations and identify possible solutions and test initiatives applicable to the logistical problem. The goal of this paper is to outline how a system dynamics model may adequately simulate the battle space such that users may then experiment with logistics policy and initiatives in a gaming environment.

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A Patient Flow Model of Singapore's Healthcare System

Objective: To develop an evidence-based dynamic model to simulate the likely impact of different supply-side and demand-side interventions on hospital admissions, wait times, and bed occupancy rates for acute hospitals and community-hospitals. Data Sources: Demographic and population data and 2012 Singapore Yearbook of Statistics on health from Singapore Department of Statistics, as well as estimates from physician researchers. Study Design: The patient flow model was created using system dynamics methodology and parameterized using available data from reports. Principal Findings: Due to population aging, between 2014 and 2030, the number of hospital admissions in Singapore is projected to increase 65 percent. By 2030, 58 percent of the admissions are expected to comprise elderly individuals 65 years of age and older. Consequently, wait times for admission to acute care hospitals are expected to increase from within a day of referral to two weeks if current healthcare capacity remains unchanged. In addition, the bed occupancy rate for acute care and community hospitals is projected to reach 100 percent by 2023 and 2025 respectively. All interventions tested would either moderate these increases or decrease the bed occupancy rate for all care venues and wait times.

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Policy analysis to boost the adoption of alternative fuel vehicles in the Colombian market

The growing concerns about the climate change, the characteristics of the transport sector and its future trend, have made this sector be considered relevant in the policy analysis that promote the low carbon economy. The development of alternative fuel vehicles is one of these policies. However, although the diffusion of clean technologies has been studied for the academy community, and is receiving major attention of the governments, industries and stakeholders, both the adoption process of these technologies in developing countries and the effectiveness of the policies for boost the adoption in the market are low known. This research presents a conceptual approach that involves a design and use of a system dynamics simulation model based on. Simulations with two different

policies: fiscal and communication were carried out. The results show that the communication policy is more effective than the fiscal policy when we try to impulse a model of low carbon private transport in the Colombian market.

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Proposal of a 'Goldilocks' Methodology for the Assessment of an International Crisis

Through a well-known metaphor in the Anglophone literature, this paper addresses the value of a proposed methodology for the analysis of complex international crisis, by stating that the Systems Thinking and System Dynamics approaches can constitute the common ground between the need to develop a full scale and time-consuming systemic understanding of the area and the pressure to get the action going before is too late: a “Goldilocks” approach (which is just right), that is a phased approach that neither leads to a too linear and simplistic model, which would surely lead to timely, yet inevitably ineffective, courses of actions, nor to a too "brain-intensive" one, which would, eventually, produce a more accurate and detailed comprehension of a crisis but with a high risk of eroding massively the little precious time available for intervention. Also, we will propose a possible Crisis Archetype, which, in our perspective and experience, can easily be recognized in every Crisis Situation and that can thus be considered in order to gain insights into the Crisis being analysed. All this will be operationalized through an applied case of a recent International Crisis, still active today: the crisis in Mali.

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Logistikum - the logistics competence

The development of sustainable transports through the right logistics strategy – a system dynamics approach

This papers purpose is to picture interdependencies between logistics strategies and transportation movements through a systemic point of view. The underlying methodology of this research work is system dynamics. The paper starts with a short overview of developments in freight transport and the definition and parameters of a logistics strategy. Afterwards the developed qualitative part, a causal loop diagram is presented and described. Based on the causal diagram the quantitative model is developed and validated to guarantee plausibility. Afterwards first findings of scenarios and experiments will be presented. The results highlight interesting and important interdependencies between parameters of logistics strategy and freight transport. The most usable identified leverage points will be presented. The developed model is a useful tool for the realization of sustainable transportation movements.

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Dairy Business: Farmer Education Enables Precision Farming

Precision dairy farming is the application of information technologies to dairy cattle farm management and allows increase both the performances and the profit of the farm production processes pursuing objectives of low-input, high-efficiency and sustainability. Recent studies clearly showed that the critical point of adoption rate of precision farming technology in dairy farms is represented by farmer education level. This paper describes the role of farmer education and its constraints on driving the efficacy of precision farming techniques adopted by a certain dairy farm. The paper also describes a possible application to a specific dairy cattle production area of Italy. The conceptual map consisted of 6 causal-

loop named: Precision farming; Reports; Break even; Efficiency target; Farmer background; Education demand. The proposed conceptual model showed as farmer education enables and stimulates the efficacy of precision farming technologies. Further developments must include the stock and flow diagram of the reviewed relationships and the model calibration with existing information on dairy practices and required local information on farmer capabilities.

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(Un)desired Tantalum?

In 2010, the Ad Hoc Working Group, a sub group of the Raw Materials Supply Group, chaired by the European commission, wrote the 'Critical raw materials for the EU' report EU (European Commission 2010). Tantalum, a transition material used in electrolytic capacitors, and as such a principal component for many electronic devices, is mentioned in this report as one of the most critical materials for European industry and consumers, in terms of supply disruptions for modern or emerging technologies. The report gives three reasons for the criticality of tantalum. First, a large share of tantalum production comes from the east of the Democratic Republic of Congo (DRC), and Rwanda. This region, the African Great Lakes region, is a well-known conflict region. Therefore, tantalum mined in the DRC, or more in general, Central Africa, is known as a conflict material (Bannister 2008). Second, tantalum has presently low recycling rates, as well as low substitutability (European Commission 2010, Tantalum-Niobium International Study Center 2010).

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Ageing and the Sustainability of Public Expenditure: SD Based Policy Analysis

Societal ageing is a major issue in many developed economies, with a great chance of leading to unsustainable public expenditure. In this study, we address this issue by testing several policies, separate and in combinations, for their robustness under uncertainty. These policies include changing the retirement age, addressing unhealthy life styles, increasing labour participation, and labour productivity. They are tested for their robustness in ensuring sustainability of government contributions to basic state pensions and public expenditure on health care. The conclusion of this study is that even when uncertainty is taken serious, adaptive policies like coupling retirement age to the life expectancy are still too conservative. Further, even with the policy combinations discussed in this paper, especially health care expenditure may still rise above sustainable level.

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Modeling the Dynamics of Methylmercury Biomagnification

Methylmercury (MeHg), which is a heavy metal, accumulates in the body of species through consumption of food including MeHg or through absorption (absorption of MeHg from water by zooplanktons). The concentration of MeHg in the body of the species in the higher level of food chain is higher than the ones in the lower level. This increase in the level of concentration is called biomagnification. In this study, a dynamic simulation model is constructed to study the biomagnification of MeHg in zooplanktons, small fish (Atlantic mackerel), big fish (Bluefin tuna) and Human. The data is taken from studies held in the Mediterranean Sea. The model successfully replicates the real life situation. There are two essential findings. First, the concentration in humans significantly increases by eating higher amount of tuna per week. Second, the concentration in

water immediately affects the concentration in the body of each species in the food chain. Key words: MeHg concentration, biomagnification, dynamics of food chain.

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Model validation: matching data and structure to behavior through partial model calibration in Group Model Building setting

This paper presents a framework for model validation and calibration, while employing ERP systems' data and expert knowledge of Group Model Building sessions' participants. This framework was applied in the project for a staffing company, and I will use mini case studies from it to illustrate my approach. In order to build this model various sources of knowledge were used: statistical data, market reports, knowledge of company representatives obtained through interviews and group model building sessions, and system data stored in various IT systems. Combining those sources of information it is possible not only to get more knowledge about the system, but also validate and calibrate it. Based on this project experience and related literature some practical recommendations were developed and their applications demonstrated.

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Social Housing in Colombia: A case for Social Systems Engineering

Social housing is one of the deepest felt needs in Colombia. In 2011, the number of families without quality housing reached 3.5 million. Statistics reflect the severity of the problem, yet its real dimension is deeper and much more complex as it interconnects actors with diverse motivations. Unfortunately, the policies that are currently being applied in Colombia follow a simple linear cause-effect type of thinking, for instance simply granting more subsidies or imposing severe minimum laws. Such policies do not take into consideration the complex structure of a social system. Seen from a systems perspective, it is possible to propose structural policies that will modify the dominance of different potential feedback loops to accomplish systemic improvements. Some of the opportunities to empower the virtuous loops are found in the community networks, economies of scale and the quality of the housing as a way to impulse progress. The greatest dangers that should be treated are the high economic and social costs generated by informal and low quality housing. Our proposal thus recognizes the social housing system as driven by motivated actors that form feedback loops, which explain and 'produce' the problem. We understand such type of intervention as an example of social systems engineering.

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Dynamic Impacts of Performance Based Payment System on Public Hospitals in Turkey

The goal of pay for performance (P4P) system in healthcare is to increase the efficiency of healthcare resources by paying physicians and hospitals for performance. Ministry of Health in Turkey has implemented P4P since 2004. The purpose of this study is to investigate the dynamic impacts of P4P on the behaviors of hospitals and physicians. The model includes physicians' interactions with patients, the revenue pressures on physicians, and the resulting impacts on health outputs and quality. In order to increase productivity, physicians are induced to perform more medical activities. Physician, who

experiences revenue pressure, may try to increase his/her revenue by performing more medical activities and give less importance to quality. Resulting inadequate treatments and wrong diagnosed patients would have negative effects on health quality. On the other hand, physicians who do not have any revenue concerns may give the quality of healthcare absolute priority, undermining the productivity. This tendency may result in hospital crowding and high crowding pressures on physicians. Such conflicting pressures are included in model to investigate the impacts of P4P on health outputs in public hospitals. Results obtained concur with our dynamic hypotheses and agree with some of the general behaviors recently observed in Turkish healthcare.

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Using system dynamics to apply syndemic theory to women with and at-risk for HIV

Women in the United States are increasingly affected by HIV/AIDS, most commonly through heterosexual contact. Together childhood sexual abuse, emotional distress, substance use, violence, and financial hardship have been hypothesized to represent a syndemic: a set of mutually reinforcing health and social problems that interact and impose an increased burden on vulnerable populations. To date, models of HIV-related syndemics have predominantly assessed the linear or 'additive' relationships between syndemic constructs and outcomes (e.g., HIV-related high risk behaviors). We applied system dynamics modeling to assess the simultaneous interdependencies and feedback processes among these constructs. Our model was informed by applicable research literature, qualitative input from members of the Bronx Community Research Review Board, and previously collected cohort data describing women with a history of HIV-related high-risk behaviors (n=620). The final model demonstrates the causal influence of violent events and substance use on self-worth, emotional distress, and HIV-related high-risk sexual behaviors. Model output displays behavior of these constructs over a simulation period of 104 weeks (2 years), illustrating hypothetical clinically relevant profiles of women with and at-risk for HIV in the Bronx. Overall, the modeling fostered a critical understanding about patterns of interdependency among the syndemic variables unforeseen by general linear modeling.

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Model for Calculating Operational Capacities in Service Providers Using System Dynamics

In this article establishes the allocation study importance for the workforce in the service industry, focusing on credit companies in the financial sector, given its complexity and the relationship between the operational capacity determination in offices, in relation with fluctuations in transactional demand of system. Based on historical data and system behavior using statistical analysis, was simulated the transactional demand and profitability behavior. Once defined the model for calculating operational capacity, and supported on system dynamics model was constructed a continuous simulation that calculates the resources number (workforce, workstations and ATMs) required to serve the services demand and looking for the maximum use of available capacity, formulated as a proposal not only for credit companies, also for service companies with similar settings and want to evaluate the allocation of these resources with variable demand in a particular or general sector of the system.

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How a CEO Can Create a Sustainable Competitive Advantage by Modeling the Company as a Dynamic System

Modeling a company as a dynamic system is a powerful tool to guide business improvements. Models provide "insight into the physics" of nebulous bottlenecks that restrict growth. This has been demonstrated repeatedly at DPS Telecom, where models have been successfully used to grow the company from $6 million to $13 million with no increase in staffing. Insights into client churn, product quality, company culture, and profitability were all modeled, understood and improved. The final model, dealing with self-regulation within the Sales Department, resulted in a multi-million-dollar decision to buy out one of the partners. This paper starts by explaining why the CEO is uniquely well positioned to lead modeling efforts, and it gives a quick outline describing how to get started. Next, four models are introduced that helped DPS more-than-double sales, double sales per employee, and more-than-quadruple operating profits. Three of the models talk about sales and revenue. The fourth shows how modeling can help in soft topics like staffing and culture. Finally, a simple learning and execution flowchart is given to allow a CEO to hit the ground running and begin using this technology.

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The endogenous genesis of Etruscan proto-cities: System Dynamics as a tool for historians

Around the 10th century BC the rural villages in South Etruria (now Tuscany and Latium, Italy) began to disappear and a number of cities started to arise. The accepted grounds of these events deal with defense and safety reasons. Instead, our interpretation attributes the birth of the proto-cities to a sustainability crisis in the mining villages and asserts that mining technicians imposed such transition on farmers in order to carry out a sustainable reorganization of the whole system of settlements and, as a corollary, to strengthen their ruling role. The objective of this paper is threefold: (i) to illustrate the proposed hypothesis by means of a simulation model roughly reproducing the described event, (ii) to point out the System Dynamics approach potential as an auxiliary tool in the historiographical research, (iii) to provide a further example in literature of how to model a transition phase and to handle discrete events within a continuous paradigm. In addition to a detailed description of the model and its outputs, this paper includes an outline of historical events considered herein, some epistemological and methodological considerations, and an exposition of the next steps of this research path. Keywords: Etruscan proto-cities, Etruscan mining and metallurgy, origin of the cities, processes of urbanization, synoecism, auxiliary sciences of history, modeling, structural change, simulation, system dynamics.

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Cooperation and Learning in Cyber Security Training Exercises

Cyber attacks pose a major threat to many organizations, and cooperation within and between organizations has potential to improve defensive capabilities. Tracer FIRE, a training program for cyber security incident responders, has begun to explore whether cooperation during training exercises can enhance learning. A system dynamics model was created using the Behavioral Influence Assessment

framework, which uses well-established psychological, social, and economic theory to simulate cognition and interactions between people and their environments. The model was used to understand the relationship between cooperation and learning during Tracer FIRE, and to explore methods, using scenario exploration and sensitivity analysis, of increasing participants' learning.

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Critical Issues for Organizational Growth and Success: A Systems Thinking View using Feedback Loop Analysis

In the current knowledge era, organizations are facing tough competition due to the highly uncertain environment. The technological development and change in organizational mindset from traditional resource and asset based to knowledge base thinking further acts as a catalyst for this kind of uncertainty. The future of the organization depends on the extent of organizational knowledge and its ability to use the knowledge for practical purpose. Learning, innovation, flexibility, change process are some of the critical issues which decide the competitiveness of the organization. This study focused on some of the critical issues for organizational long-term growth and success. The study is basically based on the caselets study of about 12 organizations which are discussed with a systems thinking view. Casual loop analysis has been done to summarize the caselets. An innovative idea of interpretive logic explanation of the links, has been done as add on to the casual loop methodology. Keywords: change, learning, innovation, knowledge management, organization culture, top management support.

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Developing a Fair and Robust Energy Policy

We used a system dynamics model and statistical analysis to find an energy tax policy that is both fair and robust for all interested parties based on the assumptions made in this study. Regret analysis techniques were developed and used effectively to find a policy that minimized the losses of both the state and energy producer. The policy worked well under a wide range of uncertain future conditions and is effective when it is difficult or impossible to define or agree upon the probabilities of important events. Our goal in this work was to expand on ideas that were developed in our previous papers, as well as the work of other researchers in system dynamics, petroleum engineering and other disciplines. We focused our efforts on defining a policy development process, rather than on the potential complexities that might arise in real situations. However, we believe the approach described here can be adapted to more realistic situations. That will be the focus of future research. We hope that our techniques may eventually be used to find ways to encourage the development of new energy resources in a way that is both fair and beneficial to all parties.

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Increasing part-time working hours in the Netherlands. Identifying policy recommendations through Group Model Building

With 73% of women and 19% of men working part-time,the Netherlands is known as the champion of part-time work. In order to increase especially the working hours of women with small part-time jobs (less than 20 hours per week) the Dutch government installed a thinktank of employers, employees and goverment. This Taskforce Part-time-Plus commissioned two related studies on the relationship between ambitions, part-time work and gender. Group Model

Building was used to integrate the results of the two studies into a causal loop diagram and to derive policy recommendations from them. This papers describes the results of the Group Model Building process and reflects upon the usefulness of the method for translating research results in policy recommendations.

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Facility Conditions: A System Dynamics Review of the CSU Capital Outlay Program and its Impacts to the CSU, Chico Campus

The California State University, Chico's assets are deteriorating. The existing mechanisms to improve the campus through the California State University (CSU) Capital Outlay program will do little to address the widespread degradation of the campus facilities. Through delegated authority, each campus is responsible for the welfare of its facilities; creating 23 separate approaches to facilities management and enabling a zero sum game for capital resources. The consequences of widespread facilities degradation is impacting student success and preventing both the system and individual campuses from focusing on its core responsibilities and ultimately its mission. While the CSU system appears to be aware of the theory of asset management and total cost of ownership, policies and practices indicate that there is a large gap between comprehension and implementation. This paper will analyze the existing CSU facilities management system utilizing two dynamic models to understand general system behavior, local impacts to the CSU, Chico campus and potential leverage points for improvement.

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Does Modification of Representation Format Affect Stock–Flow Thinking?

Stock–flow systems are poorly understood even though we are faced with them in many, sometimes very important domains. Several studies found that only few participants solved stock–flow tasks correctly and that modifications of the representation format (e.g. changing the flow graphs) did not improve performance. In the present study, we modified the representation in a more extreme way. Because it seems people have difficulty distinguishing between stocks and flows, we wanted to simplify the transformation of flows into stock. We created teaching pictures where the flows were presented as stocks per time unit. We analyzed if such a representation improved stock–flow performance. Participants had to solve three tasks in different representation formats (tub, bus, and line graph). Regression analyses revealed differences in performance. The modified representation conditions led to a better stock–flow performance (R^2 = .389, partial correlations: .557, $p < .001$ (tub), .498, $p < .001$ (bus)). To test for transfer, all participants had to work on two additional tasks presented as line graphs. The modified representation groups did not solve the additional tasks better than the line-graph group. To summarize, the teaching pictures simplified solving stock–flow tasks but transfer did not occur.

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Cities as Complex Systems

Cities are a self-organizing systems, which implies that increasing returns are present and the cause of the evolution of cities. This paper argues this kind of

increasing returns stem from many variables that cause each other so cities can be seen as a complex system. This article also argues that these intricate interactions between many variables can be described using the tools of system dynamics.

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Business Competition as a Complex System: A System Dynamics Approach

The perfect competition paradigm of conventional microeconomics has traditionally been used as a reference to determine the efficiency of markets. However, there are very few industries that can be described with this model. This paper argues that the perfect competition model is based on very unrealistic and restrictive assumption, but when they are relaxed to introduce increasing returns to the growth of the firm, it is possible to think of business competition as a complex system. This paper also argues that the tools of system dynamics can be used to make explicit the way increasing returns cause the growth of the firm and determine the structure of the industry where it competes.

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Key qualitative patterns of systems behavior as a core element of mental models

Mental models of dynamic systems (MMDS) have been an important concept in systems dynamics from the beginning of the field. Yet, it is still unclear how to include MMDS in system dynamics models, mainly because a more operational conceptual structure of mental models is still lacking. This paper proposes that hybrid models, which combine elements of system dynamics, network science and agent-based modeling approaches, allow the refinement of such structure by helping to uncover what we call key qualitative patterns of systems behavior. We propose that these patterns should be considered as a core element of mental model of dynamic systems. The argument is illustrated with a hybrid model created in the NetLogo platform to study a real irrigation system in the semi-arid region of the state of Minas Gerais/Brazil.

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Application of System Dynamics for Municipal Waste Management in China: A Case Study of Beijing

Municipal domestic waste is the most complex one among the solid wastes. Its improper disposal will easily cause serious environmental pollution, occupy substantial landfill and waste the recyclable resources. System dynamics methodology presents special merits in the study of the municipal waste management. In this paper, 16 study achievements of the system dynamics are summarized with regard to the solid waste management in China; studies on the system dynamics models are focused for the municipal waste management in Beijing, covering the relatively detailed structure designs for population subsystem, waste discharge subsystem, waste disposal subsystem, waste charging subsystem, waste pollution/landfill loss subsystem, and macro-economy and green GDP accounting subsystem; the preliminary simulation findings are described and a conclusion is made; finally, it is envisioned that the system dynamics models of municipal domestic waste management should combine with the GIS technology to facilitate the spatial presentation of findings, with the optimization technology to screen the best decision-making plan, and with the safety & early-warning technologies to prepare emergency plans.

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A Dynamic Simulation Model for Insulin Resistance and Type II Diabetes in the Context of Obesity

Type II diabetes, is a common endocrinological disease leading to other serious health problems such as heart disease, kidney dysfunction that may eventually lead to a premature death. Insulin resistance is seen as the starting point of this disorder. Obesity, hyperglycemia and hyperinsulinemia are the main reasons for insulin resistance and type II diabetes. The aim of this study is to construct a dynamic simulation model that can realistically reproduce the long term behavior of developing insulin resistance and type II diabetes related to obesity. Thus a model is constructed which focuses on the interaction between body weight of an average individual and glucose-insulin regulation. According to the available research, doing exercise and changes in diet may reduce the severity of insulin resistance or even eliminate this disorder completely. Simulation experiments show that different exercise levels and dietary intakes have impact on the insulin resistance development. In the long run, insulin secretion and beta-cell dysfunctionality play a more significant role in developing type II diabetes. In conclusion, the significance of obesity effect on insulin resistance and type II diabetes is demonstrated by simulation experiments, supported by available information and data in the literature.

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Assessing policy for mitigating greenhouse gases in electricity

The need for regulation of greenhouse gases (GHGs) sets policy challenges to the energy industries in the XXI century, given the major climate threat that has manifested in recent decades. The focus will thus be on environment-related issues, including emissions, renewables-based technology and change in consumer- use patterns. In this context, policy aims at preserving and maintaining security of supply as well as a competitive environment within both power generation and energy-intensive industries. There are enormous uncertainties regarding the effect of GHGs on climate change in Latin America and on the structure of the electricity sector in the future. In spite of the obvious threats, these conditions also provide opportunities not yet explored. A low- carbon policy aims at changes regarding: regulation, demand, supply, market structure, management and, in general, the competitiveness of the power generation industry. In this direction, it is neither clear what structural changes should be adopted within the electricity sector, nor what are the opportunities that this policy may offer. This article assesses the effect of GHG policy on the Colombian electricity sector, based on system dynamics simulation; it also indicates how emission costs and incentives in the electricity sector induce technology changes leading towards a low carbon economy.

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Assessing the new electricity-market reform in GB with the support of SD

The British government plans to implement an Electricity Market Reform (GB EMR) in the near future. Its objective is to replace the existing nuclear and coal plants by low-carbon ones and deliver reliable and affordable power. Though the

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GB EMR has proposed several policy instruments for meeting its objectives, there is not known simulation exercise that assesses the extent of the consequence of this profound and important initiative. This paper shows a system dynamics model that supports the analysis of the long-term effects of the various policy instruments that have been proposed in GB EMR, focusing on environmental quality, security of supply and economic sustainability. The paper concludes that for achieving the GB EMR objectives, it is required the promotion of low carbon electricity generation through the simultaneous implementation of various direct and indirect incentives such as Feed in Tariff and a capacity mechanism.

Robust workforce planning for the English medical workforce

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This paper describes the use of system dynamics in a major project for the UK Department of Health to inform a review of the intake to medical and dental school. It takes many years to train these professionals (typically 15 years or more for a hospital consultant), so an under or over-supply cannot be corrected quickly or easily. The cost of training and employing an individual is significant so the decisions to be made are highly important. The system dynamics approach meant that robust, evidence-based supply and demand models could be created to test potential policies and their impact. It also meant that the model was "transparent" and enabled the expertise of several hundred stakeholders from the healthcare system to be captured and synthesised. Significant decisions were made as a result of this work, including a 2% reduction in medical school intakes to be introduced with the 2013 intake, with a further review in 2014; no immediate change to dental school intakes because of issues over data quality highlighted by the modelling, with another review in 2013; and a rolling cycle of reviews of medical and dental student intakes should be established; to be undertaken every three years.

Applying the System Dynamics Approach in Evaluating Clinical Risk Management Policies in Three Healthcare Companies

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This paper explores and extends research on the role of system dynamics methodology as a powerful approach to clinical risk management (CRM). We report our preliminary findings on CRM in three healthcare organizations. We use system dynamics methodology for exploring the multi-dimensional facets of hospitals' complex operations management systems. We address theoretical scholarly matters focusing on the depiction of managerial insights to gain more understanding of CRM. We investigate the impacts of CRM implementation on the hospital financial performance along with other indicators. We provide a summary of our findings and their empirical and theoretical implications and contributions.

The Dynamics of the Organizational Culture in a Municipality

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Although the organizational culture is one of the main issue of organizational studies, very few research has tried to explore the organizational culture change process through a systemic and dynamics perspective. This paper explore the dynamics of the organizational culture in a municipality over time, trying to show

that: (1) the dynamics of the four typologies of organizational culture in the municipality can be better described and explained through a causal loop diagram, that allows to put on evidence the hidden structure (feedback loop structure) responsible for the dynamics of the considered phenomenon; (2) the process of the cultural change in an organization is characterized by nonlinear dynamics; (3) a programme of change management focused on organizational culture in such municipality is be significantly affected by the role of the information delay that characterizes the relationship between the exogenous and endogenous variables of the system at a organizational level of analysis; (4) the efficacy of the policies adopted by the management of the municipality could be widely reduced if they don't take into account the feedback loop structure underlying the organizational culture dynamics over time.

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SOA Governance Dynamics for IT Organizations

Service Oriented Architecture and cloud computing provides the IT infrastructure, design patterns and other artifacts to an IT company get intrinsic interoperability between software programs and achieve other benefits like increase software federation, increase business and technology alignment, increase vendor diversification options, increase return over investment, increase organizational agility and reduce IT burden. As SOA governance refers to the coordination of people, processes and technologies involved in each area within an organization, a diagnosis of a governmental IT agency gave many insights over its performance and its SOA Governance problem in order to produce a SD model. Thus, by comprehending the complex interactions between the factors that could influence SOA governance systems, in conclusions it is proposed the combination of SD with other approaches to develop computer based management flight simulators.

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Decision thresholds in developmental-behavioral screening: Gaining insight through system dynamics modeling

To identify and treat young children with developmental disability, physicians use various parent-report questionnaires as screening tools. However, it is unclear how pediatricians use screening instruments in practice, particularly whether they follow recommended decision thresholds or set their own based on their past screening experience. In practice, a high proportion of children with disabilities are not accurately identified until school age or later, indicating a high false negative rate for young children. We developed a system dynamic (SD) model to evaluate factors that influence physicians' decision thresholds when identifying developmental disabilities in pediatric settings. The model was informed by the literature on medical errors and decision-making, regret theory, and a prior SD model of thresholds in social policy. We conducted a series of virtual experiments to simulate interventions to improve detection of developmental and behavioral disorders among children, including introduction of a high-quality screening instrument. Our results suggest that if physicians adjust their decision thresholds based on feedback regarding patient outcomes, then detection rates may be improved not only by improving the accuracy of screening instruments, but also by improving feedback to physicians regarding medical errors or by decreasing regret associated with false positive results.

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Dynamic Strategies for Apartment Brand Management in Korean Housing Market

Apartment brand, which is widely used in manufacturing sectors for many years, has been used as a new strategy of construction companies in Korean housing market since 1990s to survive in fierce competitions and fulfill customer's changing needs. Due to distinctive attributes of construction market and its product, various factors are needed to be considered in order to implement the strategy from other industries. A number of construction companies have succeeded in brand awareness and image building, however, they still struggle to establish brand loyalty and manage brand equity elements in balance. The purpose of this study is to introduce and analyze the brand equity building process of apartment products in Korean housing market and determine causal relationships among variables to propose strategies for long-term prosperity of the construction companies. System dynamics modeling method is applied to describe how variables affect and are linked to each other in terms of building equity and enhancing company profits from customers' brand awareness to brand loyalty. Based on the analysis model, strategies for construction companies were proposed and this may support the company to gain competitiveness among its competitors in the fast-changing market.

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Exploatory Study on Emerging Market Entry Strategy - Systems Thinking Approach

Main topic of this study is ‘the characteristics of emerging markets’, ‘the strategy of entering emerging market’, and ‘the expansion strategy of emerging giant into global market’. Three theoretical frameworks are selected to show the characteristics of emerging markets, Institutional Theory, Transactional Cost Theory, and Resource-based View. This study suggests 5 CLDs, each of which integrates a series of causality drawn from rigourous literature reviews of 55 studies of SSCI Top Journals from 2000 to 2012. It is the unique contribution of this study to draw each causality from previous literature. In sum, political activity and institutional void are critical factor related to characteristics of emerging market, and CSR/CSV and cultural distance should be considered as a leverage point.

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A Framework for Measuring the Value-Added of Knowledge Processes with Analysis of Process Interactions and Dynamics

In the current business landscape outputs are heavily dependent on their use of intangibles and knowledge to produce outputs. This shows the importance that intangible assets have in benefits and value in cases such as project selection which cannot be appropriately managed without considering the role of knowledge. This research develops a framework to measure the value that processes add based on knowledge. It starts by considering current systems and analyzing proposed changes with the Matrix of Change to propose alternative systems in which system dynamics can then be used to model the desired system for behavior measurements. The framework applies knowledge as a way to generate value based on the concept of Kolmogorov complexity, a complexity theory that relates the amount of knowledge required to successfully execute

change as a determinant of the change itself. Criteria for project selection is then based on the amount of knowledge measured to generate change. The framework is applied to a case study in mobile weapon system using Unmanned Aerial Vehicles (UAV).

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Evaluating Scenarios of Capacity Expansion given High Seasonal Variability of Electricity Demand: The Case of Saudi Arabia

The Kingdom of Saudi Arabia (KSA) has experienced rapid growth in peak load and electricity consumption over the past decade. Under current demographic and economic trends, peak load is projected to nearly triple by 2032, which will require massive new investments in both conventional and alternative generation capacity. A unique aspect of KSA is that the electric load nearly doubles in the summertime, which means that high penetration of renewables and nuclear in the future will need to be supplemented by flexible, dispatchable technologies. This paper breaks down the load curve into different categories based on utilization, and then develops a technology-specific capacity expansion model to meet projected growth in these categories, net of future renewable or nuclear capacity additions. This higher-granularity approach is novel in System Dynamics, where previous work has used aggregated measures of demand and grid capacity. The paper evaluates different scenarios of demand growth, renewable and nuclear deployments, and conventional capacity plans across various economic and environmental metrics. Key tradeoffs are discussed to inform policy development.

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Modeling Dynamic Transitions in the Global Air Transportation System

The air transportation system needs to change drastically if it is to transition into a sustainable state. The stakes for the needed technology-driven change – innovation –are extremely high for the lead adopters given the high cost of R&D in manufacturing and the need to change parts of the existing infrastructure and operational procedures if a significant improvement in high energy efficiency is to be achieved. We conduct a quantitative strategy assessment of different transition options using the Global Aviation Industry Dynamics Transition (GAIDT) system dynamics model of the industry and a composite indicator V (normalized strategy value), that combines the economic and environmental benefits of different strategies to test how such changes will cascade through the global aviation system accounting for airline and aircraft manufacturer competition across a variety of aircraft product lines. The GAIDT model exhibits advanced features of dynamic modularity, extensibility, autocalibration and a GUI. We found that the normalized strategy values will highly depend on the fuel prices. However, if the fuel prices continue to rise, any kind of innovation option is beneficial. When decoupled from fuel prices, early transition options are preferred and radical innovation is found more beneficial than incremental.

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A System Dynamics Approach to Modeling the Global Capital Markets

The holy grail of investing is to earn an attractive rate of return over time while avoiding the steep losses that typically afflict conventionally managed portfolios. To achieve this goal, it is essential to understand the causal factors and risks that

impact the global capital markets in a systematic manner that represents the complexity of the real world. In a departure from conventional industry practice, a theory of global capital market behavior has been created in an attempt to describe the economic, fundamental and behavioral interrelationships that drive markets. To guide investment decision making, this theory has been expressed in a computer-based mathematical model that employs a System Dynamics approach. The purpose of this paper is to share the underlying principles and logic supporting the Model, which is employed as the key quantitative driver of an investment management process to construct globally diversified portfolio strategies on behalf of clients. The Model consists of a system of nonlinear differential equations using a System Dynamics approach that describes the causal interrelationships among key global capital market, economic, fundamental and investor behavioral variables. These equations represent research spanning over three decades seeking to identify the key drivers of market behavior of a set of equity, fixed income, hard asset, real estate and currency indices across the U.S., Europe, Asia and emerging markets.

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Pitfalls of Multi Method Modelling: Concepts and Comparisons

System Dynamics is one of a variety of modelling techniques developed to investigate the behaviour of systems. When different modelling techniques meet, either in theory or in practice it is common to compare them. Moreover some recent studies have compared approaches in order to choose between them or as a basis to combine them into a multi-method model. However, comparisons between methods can be problematic . Different modelling systems have different underlying principles and it is important to recognise these in order to avoid the unsafe translation of ideas and prejudices from one system to another. Even systems which are apparently equivalent may differ in important respects. This paper highlights some of the problems in this area which may be regarded as pitfalls for those seeking a multi method point of view. Problems with comparing system dynamic models and analytical differential equation models are examined. Role and concept of randomness as applied in different systems of modelling is explored. The potential for misunderstandings is further underlined by examining a few unguarded examples from the established literature.

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Reviewing the Role of Stakeholders in Operational Research: Opportunities for Group Model Building

Stakeholders have always received much attention in system dynamics, especially in the group model building tradition, which emphasizes the deep involvement of a client group in building a system dynamics model. In organizations, stakeholders are gaining more and more attention by managers who try to balance the interests of various stakeholders. This trend is reflected in management literature where much advancement is made in what is known as stakeholder theory. In stakeholder theory it is stated that the implementation of its principles is one of its biggest problems because tools that facilitate balancing the interests of stakeholders are supposedly lacking. Operational research on the other hand aims to advance these exact tools. Apparently, there is a large gap between management literature and operational research, including system dynamics and group model building. To assess how group model building and other operational research methods help to implement stakeholder theory, we provide a systematic review of 140 operational research applications on the topic ‘stakeholders’.

Content analysis of these articles shows the potential of group model building specifically, as this is a method that facilitates improving the rational, organizational process, and transactional level of an organization's stakeholder management capability.

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Simulation-Based Learning Environments to Teach Complexity: The Missing Link in Teaching Sustainable Public Management

While public-sector management problems are steeped in positivistic and socially constructed complexity, public management education in the management of complexity lags behind that of business schools, particularly in the application of simulation and simulation-based learning. This paper describes our development of a Simulation Based Learning Environment that includes a coupled case study and SD simulation surrounding flood protection, a domain where stewardship decisions regarding public infrastructure and investment have direct and indirect effects on businesses and the public. The Pointe Claire case and CoastalProtectSIM simulation provide a platform for policy experimentation under conditions of exogenous uncertainty (weather and climate change) as well as endogenous effects generated by structure. We discuss the model in some detail, and present teaching materials developed to date to support the use of our work in public administration curricula. While learning and outcome evaluations are not complete, we believe that he effectiveness of this approach will be demonstrated.

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The Challenges of the French Electricity Generation Sector: an Analysis using ESDMA

Nuclear energy dependency, large vulnerability to socio-political factors, high wind and solar energy targets and progressive liberalization of the energy sector; those are some of the main challenges the French electricity sector is currently facing. This paper uses the multi-method Exploratory System Dynamics Modeling and Analysis to explore the future of the French electricity generation sector given its unique specificity and the wide range of deep uncertainties that this market contains. This methodology then allows the exploration of the complex interaction between socio-political parameters and the support for new nuclear energy installed capacity, for example as a result of a nuclear accident. The model used for this research was created by Pruyt, et al. (Energy Transitions towards Sustainability: A Staged Exploration of Complexity and Deep Uncertainty, 2011) and has been adapted to reflect the specific dynamics of the French electricity generation sector.

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Addressing stakeholder conflicts in rural South Africa using a water supply model

A system dynamics modelling approach is adopted to deepen understanding of the effects of operational management on the performance of the Greater Kirkwood water supply system in South Africa. Currently, the interrupted operation of the system has led to perceptions of systemic social injustice on the part of citizens and contention between the municipality responsible for supplying water to the citizens and the Water User Association responsible for delivering untreated

water to the municipality. The model is used as a means of exploring the technical constraints of the water supply system, and of supporting discussions between stakeholders about contentious issues, and the ways they can address these issues. Research on the utility of the model as a means of supporting strategic conversations between stakeholders (cf. Howick & Eden, 2010) is ongoing.

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Muwait: a system dynamics model for municipal waste management in Italy

This paper deals with the management of municipal waste in Italy. The main purpose of the research is to carry out some scenario and sensitivity analysis. In order to achieve this goal, a system dynamic model was built: Muwait (MUnicipal WAste management in ITaly). The model is able to simulate technical aspects as well as revenues and costs associated with waste disposal and potential energy savings which could be generated by waste. The model considers also investment policies through which policy-makers could encourage recycling. In particular, three main policies, characterised by different level of investment, were considered: Business As Usual, Medium Intensity Policy and High Intensity Policy. Policies of deterrence, which could implemented by policy- makers through the imposition of sanction, as well Nimby effects and technological breakthroughs, were also considered. The main result of the study is that the differentiated waste collection represents the most efficient method of waste disposal and high levels of investment in separate collection can give rise to large returns in efficiency.

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A System Dynamics Approach to Data Center Capacity Planning - A Case Study

This paper is a report on an empirical study where the System Dynamics methodology was applied to help a Scandinavian cloud computing company in planning for its future data center capacity. The client's main interest in this project was to gain an analysis tool for estimating the point in time at which the capacity limit of the company's main data center would be reached. A System Dynamics model was built for this purpose, with its structure based on empirical knowledge elicited from the client, generating several important insights along the way. The result is a realistic model which is used for policy and scenario analysis, and ultimately answers the client's main question. To the best of the author's knowledge, no previous System Dynamics work has been carried out in this area. Yet, being dominated by aging chains, co- flows, accumulations, delays, and feedbacks, data center management is in this paper demonstrated to be a promising area for applying System Dynamics.

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A Supply Demand Model for Exploration of the Future of the Dutch Gas Sector

Import dependency and the extent of renewable gas production are two outcomes of interest concerning the future of gas supply in the Netherlands. Due to the complexity of internal mechanisms and uncertainties associated with the natural gas production, the production of renewable gases, and the demand for gas, the future of these two outcomes of interest cannot simply be projected. In this study, a system dynamics model is built to investigate the dynamics of import dependency and the renewable gas production, and an uncertainty analysis is

conducted by using this model to explore the possible futures of these two outcomes of interest in numerous scenarios. The results show that import dependency is above 80% in 2060 in the majority of the scenarios, but there are few favourable cases in which it is below 20%. The ratio of renewable gas to the total consumption is not expected to exceed 10% in short term and to remain around this value although there are cases in which it reaches 40%. In future studies, the import mechanism of the model can be extended, different behavior patterns observed in the scenarios can be identified and analysed, and the results can be used for policy recommendations.

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Using Scenario Planning Data in System Dynamics Model Building

The main contribution of this paper is describing a traceable data analysis procedure for modelling scenarios using the results of a simplified Scenario Planning workshop. We first introduce our project where the ultimate goal is to develop a grounded model-based policy discussion tool for the Australian automotive recycling industry. We review current scenario-based model building techniques and highlight their practical gaps and then present the proposed procedure rooted in Qualitative Data Analysis approaches. We show how to update the Causal Loop Diagrams and Stock and Flow models and how to determine scenario conditions thus enabling a clear record of model building. Using an example from a real project, we highlight the main challenges of the procedure that are dealing with data scarcity, estimating new trends for variables, and deciding on the nature of the changes in the simulation models. The paper concludes by arguing how the procedure may benefit system dynamists that require a coherent and structured modelling trail or when it is more feasible to engage the stakeholders in an abbreviated Scenario Planning workshop instead of Group Model Building.

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Effective Leadership using System Dynamics and the Matrix of Change

The business environment has become more demanding. This has increased the pressure on leaders already struggling with a changing world. The purpose of effective leadership is to increase value and the productivity of teams. Leadership models have been proposed in various aspects to make leaders more effective. However, there are no explicit guidelines for how to effectively manage leadership in different scenarios. As a result, many organizations have faced challenges dealing with ineffective leadership which ultimately has negative impact on overall business performance such as Hewlett Packard and Research In Motion. We have performed interviews and research to create a framework of leadership, that based on the current state and the desired future state, is able to recommend a dominant style of leadership. This is modeled through the matrix of change and system dynamics. The matrix of change helps in understanding the current and future states, their stability, and the transition between them. On the other hand, the essential leadership attributes and dynamics are implemented into the system dynamics model based on the transformational leadership perspective. Preliminary results are being validated using interviews with leaders/experts across different regions, cultures, and seniority levels.

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State Security Dynamics and the Impact of Intervention to Build Country Capacity

Recent history has shown that the armed forces will encounter significant challenges in its future stability and reconstruction efforts that seek to establish a safe and secure environment in the assisted country. In addition to establishing and maintain security, the military will ensure government stability with democratic practices including fair elections rule of law, and human rights; development of a robust economy; and help the assisted country in becoming a respected member of the international community. The military has had some success at affecting the social, governance, and economic fabric of a country. However, as recently demonstrated in Afghanistan and Iraq this has come with a significant price tag in terms of human life and investments. Few will deny that the US has struggled to invest our resources during stability and reconstruction operation in an efficient and effective manner. The Department of Defense must learn to better invest its resources before the outbreak of hostilities as well as throughout the spectrum of conflict and post-conflict operations. More importantly, we must better understand when to invest in building host nation capacity. This paper uses systems dynamics to understand how these investments affect the long-term legitimacy and capacity of a nation.

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Exploratory Dynamic Analysis of the Adoption of Biowaste Separation Behavior in Households

Biodegradable waste (biowaste) corresponds to the largest fraction of household waste in low and middle-income countries. However, very low recovery rates for this material stream are obtained. In part, this is due to the fact that the adoption of source separation at household level is not given sufficient attention. In cases where source separation has been ineffectively introduced, the lack of awareness is named as culprit for the failure. Unfortunately, managers of such initiatives are not cognizant of the need of moving households from a stage of non-compliance to compliance. Furthermore, the feedback effects of social interaction, awareness raising campaigns, financial incentives, and punitive actions have never been studied in this socioeconomic context. Thus, the model presented explores the possible behaviors resulting from these interventions in the setting of Addis Ababa, Ethiopia.

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Model-Based Strategy Design for Biowaste Recovery in Addis Ababa, Ethiopia

In order to improve the performance over time of waste management in cities in low and middle-income countries new strategies need to be developed, tested, and implemented. Biodegradable waste (biowaste) should be the primary focus of any strategic design effort, as it corresponds to the largest fraction of household waste in urban centers, which still remains to a large extent unrecovered. Therefore, applying the Strategy Dynamics framework developed by Warren (2008), which uses System Dynamics to develop resource-based strategies, a strategic architecture has been designed for the case study of biowaste management in

Addis Ababa, Ethiopia. The strategic architecture consists of all the necessary strategic resources needed achieve the desired performance over time, the flows that cause the resources to grow and be depleted, and the factors that control these flows. For this case study, the strategic architecture includes the administrative units involved in implementation, households separating biowaste, the biowaste collection capacity, the compost production capacity, and the market for compost. Based on the analysis of the performance of the proposed strategy recommendations for the city of Addis Ababa are made.

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Connecting Micro Dynamics and Population Distributions in System Dynamics Models

Common system dynamics models capture the mean behavior of groups of indistinguishable population elements (e.g. people, tasks, widgets) aggregated in stock variables. However, many modeling problems require capturing heterogeneity across these elements with respect to some attribute(s) (e.g. weight, errors, price). The representation of heterogeneity could be important for correct characterization of behavior of a system as well as evaluation of policy options. In this paper we develop a method to connect micro-level dynamics (associated with elements in the population) with macro-level population distribution along an attribute of interest. The method enables modelers to efficiently characterize the distribution of attribute of interest without explicitly modeling all the elements in the population. We apply our method for modeling distribution of Body Mass Index and its changes over time in a sample population of 3074 female adults obtained from the National Health and Nutrition Examination Survey (NHANES) data. Comparing our results with the ones obtained from an agent-based model that captures the same phenomena shows that our method offers good precision with computational costs that are significantly less than agent-based models.

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Marketing Effectiveness Improvement Analysis Based on System Dynamics Model

Marketing activities always have been thought to be crucial in the present life and the future survival of the companies and sometimes impose greatest cost on them. Therefore, the investigation upon measuring the effectiveness of these activities is an inevitable fact. Regarding the constant and complex relationships between each of the measures that affect marketing effectiveness, a methodology of evaluating that cannot cope with these sophisticated interactions would not be useful. This paper primarily tempts to establish a system dynamic model of marketing effectiveness that could explain the interactions between factors that effect on marketing effectiveness by causal loop diagram and then, presets several executable scenarios to improve marketing effectiveness. The metrics that have been investigated in this Study are totally applicative and comprehensive which can evaluate marketing effectiveness in various industries. The metrics of the research were generated from 75 marketing executives in the industrial units of East Azerbaijan, one of the most important industrial zones in terms of the number of manufacturing companies in Iran, and an expert panel as well. Results of this study clarify that applying intensive strategies and improving relationships with customers would lead to optimize marketing effectiveness of a company.

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Value and Acceptance of System Dynamics in Business: Business Owner as SD Practitioner Perspective

This paper was written by a mid size business owner and practicing System Dynamics modeler. Using a specific example, this paper describes the acceptance and usefulness of an SD modeling process in business. In the author's experience, using rigorous SD modeling, especially careful use of stock and flow concepts, to describe and gain insight into dynamic business issues is an effective and valuable business tool. These modeling efforts generated several critical insights that were used to alter policy to the advantage of the business. However, communicating these insights beyond a few involved employees was met with significant resistance, especially when "System Dynamics" or "Computer Modeling" was central to the discussion of insight generation and policy formation.

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Using System Dynamics to Inform Scenario Planning: A Case Study

Developing strategy and policy requires some understanding of both the present and the future, but operational environmental change can makes these two vastly different. Defining that which is predetermined and that which is not about the future can provide clarity and decrease the space along which the present system might evolve into its future state. Scenario planning is an approach for exploring these different possible futures. The development of scenarios is about surfacing mental models, testing them, and learning. However, the literature on scenario planning offers little in the way of guidance about how this can be done. System dynamics offers a formal process for surfacing, testing and informing mental models. This paper presents and investigates the use of system dynamics to inform scenario planning. It did this by applying the two approaches to a not-for-profit organisation. While scenarios and a dynamic model were developed, the effectiveness of this application of the approaches is questionable. The dynamic model did address issues that remained unanswered by the scenario planning approach. However, it only addressed one small part of the system explored by the scenarios. System dynamics has the ability to explore systems on a range of different scales, suggesting that this particular application may not have reaped the full benefit from integrating these approaches.

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Global Models from Malthus to C-Roads and Beyond

The World's economy and environment are complex dynamical systems driven by multiple feedback processes, accumulations, time delays and nonlinearities, but research shows that poor understanding of these processes is widespread, even among highly educated people with strong technical backgrounds. Modelers from Malthus to the Club of Rome team to contemporary teams around the world have used dynamic simulations and analysis to address this challenge, arguably with only modest positive results. Indeed, dominant reactions include denial, resignation, and despair. And yet interactive use of a fast-running, decision-maker-oriented System Dynamics models C-ROADS and En-ROADS have shown some progress in helping build understanding and action. Here we describe the history of global models and then share our team's most recent learning and future plans using these global climate and energy simulations to help keep human society within Earth's carrying capacity.

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Simulating the Value of Advanced Electricity Storage: Initial Results from a Case Study of the Ontario Power System

This paper describes the use of system dynamics to aid long-term planning for the power system in Ontario, Canada. Our work focused on the value of an investment by NRStor, Inc in bulk energy storage using GCAES, the General Compression Advanced Energy Storage™ technology. The models simulate the air pumped into an underground cavern when electricity prices are low and the generation from the air released when prices are high. This arbitrage value is combined with other services such as the discplacement of capacity and the integration of wind generation. The models have been used to promote learning among the members of the NRStor/GCAES project team and among the key agencies involved in planning and operating the Ontario power system. The modeling system provides a unique perspective on ways to obtain multiple services from a single storage facility. And from a system dynamics perspective, the system demonstrates a unique way to combine short-term operational models with a long-term planning model. This combination has proved successful in promoting team learning through simulations of short-term and long-term dynamics in an internally consistent and mutually reinforcing manner. The paper concludes with Ontario's plans for the storage project and for the modeling system.

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Maya Apocalypse: Resuts of Varying Productivity, Consumption, Impacts, and Policies

This paper explores the dynamics of population levels in Maya lowlands from the Late Preclassic to Post Classic, roughly 400 BC–1600 AD. Building on the 2007 ISDC paper "Maya Apocalypse: Warfare-Punctuated Equilibrium at the Limit of Growth," it considers the effect of changing productivity, per capita consumption, and per capita environmental impact from constants to variables. It also considers the effect of political paradigm shifts.

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Dynamic Conservation of Money

Money is an information flow often mistaken by a cash material flow, even coins or bank notes do not have value by themselves but by the information written on their faces or face value. The conservation of information flows is different than the conservation of material flows, because System Dynamics' software designed to preserve material flows, does not automatically conserve information, thus money preservation requires coflows. The purpose of the paper is to present the design of sustainable financial policies which requires money conservation to last, because structure determines, but money sustain, behavior. A model of swapping stocks illustrates the use of money conservation to design policies for future stable improvements. Key Words: money, information, conservation, future, swapping, coflows.

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Evidence building for waste prevention: understanding the causal influences that result in waste

Waste prevention can be viewed as a set of practices that reduce the amount of waste generated in the economy; they can be undertaken during the design, manufacture, distribution, use and disposal phases of the product lifecycle. A research project funded by the UK's Department for Environment, Food and Rural Affairs (Defra) applied systems methodologies to support development of new waste prevention policy in England. The project developed a system dynamics model designed to capture existing knowledge on the causal influences that lead to waste generation. The model was developed firstly through several group model building workshops with key experts and stakeholders which produced a set of basic causal loop diagrams, and then through the development of a comprehensive system dynamics model by an expert modelling team. The key structure in the model is a materials flow map of materials and products through the economy; the material flows are driven by the dynamics in seven sub-models. Preliminary results from the project are presented in this paper. Policy interventions referred to in this paper are solely for the purposes of explaining the modelling approach and the views expressed are those of the authors and do not necessarily reflect those of Defra.

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Investigation of Cyberbullying Phenomenon as an Epidemic

Cyberbullying research began in the late 1990s, and was largely in response to the growing use of technology among adolescents, as well as increased instances of cyber abuse among teenagers (Patchin & Hinduja, 2006; Yardi & Bruckman, 2011). Cyberbullying can have a long-lasting psychological impact on individuals; the result of which can include changes in self-efficacy, self- esteem and behavior. This study postulates that not only do these impacts have negative consequences on individuals, but that cyberbullying spreads through communities, societies, and the world similar to an epidemic. The general strain theory, the system dynamics SIR epidemic model, and prior cyberbullying research findings were used to develop a casual loop model to explain the underlying structure of the cyberbullying epidemic problem. Finally, directions for continued research are identified.

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A Global Approach to the Optimal Control of System Dynamics Models

The System Dynamics (SD) methodology is a framework for modeling and simulating the dynamic behavior of socioeconomic systems. Characteristic for the description of such systems is the occurrence of feedback loops together with stocks and flows. The mathematical equations that describe the system are usually ordinary differential equations and nonlinear algebraic constraints. Seemingly simple systems can show a nonintuitive, unpredictable behavior over time. Controlling a dynamical system means to specify potential interventions from outside that should keep the system on the desired track, and to define an evaluation schema to compare different controls among each other, so that a ``best'' control can be defined in a meaningful way. The central question is how to compute such globally optimal control for a given SD model, that allows the

transition of the system into a desired state with minimum effort. We propose a mixed-integer nonlinear programming (MINLP) reformulation of the System Dynamics Optimization (SDO) problem. MINLP problems can be solved by linear programming based branch-and-bound approach. We demonstrate that standard MINLP solvers are not able to solve SDO problem. To overcome this obstacle, we introduce a special-tailored bound propagation method. Numerical results for these test cases are presented.

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Corporate Training Dynamics and Insights

The Catalyst® Virtual Academy (CVA) is a training organization at Computer Sciences Corporation ("CSC"), a global, Fortune-500 Corporation of over 90000 people. It has been a great success over many years with participation steadily increasing. However, certain constraints on time threatened that success. What is causing these constraints on time and what could be done to improve this situation? This paper reports on a System Dynamics approach used to gain insight into this problem and discusses the process followed, the results, and the insights gathered on the journey to the results. This paper may interest anyone who wants to have a clear understanding of the process followed in building and using a system dynamics model to gain insight into a real-world problem. In addition, it may be of interest to anyone managing an enterprise wide training organization.

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Stretch Goals, Managerial Responses, and the Distribution of Performance

Many academics, consultants and managers advocate stretch goals to attain superior individual and organizational performance. However, there is limited research exploring the effects of stretch goals on the shape of the performance distribution. Here, we explore the effects of goal difficulty on performance in an experimental study. Participants were given either moderate or stretch goals for profit in the People Express management simulation. When compared with moderate goals, stretch goals improved performance for a few, while many found the stretch goals too difficult and abandoned them. Consequently, stretch goals led to higher performance variance and a right-skewed performance distribution but did not improve median performance. In complex dynamic environments, discovering and implementing strategies to realize stretch goals is difficult and risky, and, instead, some managers adopt lower self-set goals or focus on survival. Strategy research typically investigates the mean effects associated with different strategic choices but there is limited knowledge about how these different strategic choices–including setting stretch goals–affect performance distributions. Understanding the shapes of distributions associated with alternative strategic choices is important and experiments using management simulations that closely approximate the decision-making environments of executives–by incorporating feedback, delays, and nonlinearities–provide excellent platforms for such research.

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A Strategic Innovation System Dynamics Process Model

The aim of the paper is to investigate strategic innovation through a System Dynamic based process model, built on a qualitative study, that explains the dynamics of innovative strategy generation and implementation within firms. In the model the process of developing strategic initiatives is extensively influenced

by a series of enabling activities that top management put in place to create the desired organizational context, a context that is characterized by an optimal level of entrepreneurial orientation.

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Research Workforce Diversity: The Case of Balancing National vs. International Postdocs in U.S. Biomedical Research

The U.S. government has been increasingly supporting postdoctoral training in biomedical science to develop the domestic research workforce. However, current trends suggest that mostly international researchers benefit from the funding, many of whom might leave the U.S. after training. In this paper, we describe a model used to analyze the flow of national vs. international researchers into and out of postdoctoral training. We calibrate our model to the case of the U.S. and successfully replicate the data. We use the model to conduct simulation-based analyses of effects of different policies on the diversity of postdoctoral researchers. Our model shows that capping the duration of postdoctoral careers, a policy proposed previously, favors international postdoctoral researchers. The analysis suggests that the leverage point to help the growth of domestic research workforce is in the pre-graduate education area, and many policies implemented at the post-graduate level have minimal or unintended effects on diversity.

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Agile Project Dynamics: A System Dynamics Investigation of Agile Software Development Methods

Although Agile software development has many advocates and is widely used for commercial software, acceptance in the government and defense sectors has been limited. This variation may be the result of differing meanings to the term "Agile" or differing effectiveness of the range of methods denoted by those meanings. We examine a range of Agile methods practiced and develop a framework of seven characteristics, which we call the Agile Genome. We gain insight into the dynamics of how Agile development compares to classic "waterfall" approaches by constructing a System Dynamics model for software projects. The Agile Project Dynamics (APD) model captures each of the Agile genes as a separate component of the model and allows experimentation with combinations of practices and management policies. Experimentation with the APD model is used to explore how different genes work in combination with one another to produce both positive and negative effects. The extensible design of the APD model provides the basis for further study of Agile methods and management practices.

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Using Dynamic Stock & Flow Models for Global and Regional Material and Substance Flow Analysis - An Example for Copper

Models of anthropogenic metal cycles quantify where metals are introduced into economies, how they are used, where they are stored and how they are recycled or discarded. Despite the rising amount of publications and research work in the field of Material Flow Analysis (MFA) and Substance Flow Analysis (SFA) in recent years, dynamic modeling approaches of anthropogenic metal flows have

been heavily underrepresented. In this paper, we present a general methodology to simulate metal cycles over time based on a system dynamics approach. Using the example of a global copper flow model, we present the potential outcomes of dynamic metal cycles including the results of a stochastic uncertainty analysis of the recycling efficiency of postconsumer copper scrap. In conclusion, we discuss the potential to enhance the material flow models and to link these cycles with further system dynamics models. For this purpose, we shortly present several ongoing projects.

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Unlocking the promise of patient engagement: the dynamics of patient portal adoption

This paper considers the impact that the active involvement of patients in their health—often referred to as patient engagement—has on health and financial outcomes. The challenge is how best to identify and adopt successful engagement strategies that encourage patients to adopt interventions, attitudes and behaviors that can support their care needs. Many providers consider patient portals—healthcare-related online applications that allow patients to interact and communicate with their healthcare providers—as a key component of their engagement strategy. We develop a system dynamics model of the adoption of portals by patients and providers that quantifies how adoption patterns create costs and benefits for the organization. Our approach builds on existing studies by providing an integrated framework to explain different trajectories of portal adoption. We provide initial insights into diffusion of patient portal use and conclude with a discussion of the potential for engagement in outcome-based health care payment models, such as Accountable Care Organizations.

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Right timing: unseen delays and stocks in implementation of transport systems

Increasing travel demand and motorization rates pose challenges to city planners to design successful transport systems that offer enough coverage and service quality for citizens. These challenges are even more dramatic in developing countries due to poor conditions of their transport system in terms of transport supply, service and infrastructure quality and, accessibility. To respond to this challenge city planners design new transport systems that can improve urban mobility conditions. Nevertheless, implementing new transport systems requires design, infrastructure modifications and teaching the population how to use the new system. In this paper we use small system dynamics models to show that these elements involve delays that produce accumulations that can generate negative consequences on the success of the transport system that is implemented. One of these consequences may affect user satisfaction which can be understood as an accumulation of users' experiences on the transport system. Interaction among these delays and stocks, and the absence of planning and coordination that takes into account these elements may produce congestion and low transport system users' satisfaction. Combating inertia produced by a low level of satisfaction may turn into a difficult and long run task compromising the success of a new transport system.

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The Network Strategy of a Gas Distribution Company

The purpose of this project is to see the gas network system from a new point of view and understand the dynamics of the growth known until now. Until when will we receive request to expand the network? Until when should we follow these request or better stop the expansion? Should we change the expansion decision criteria? What are the impacts of the current decision on the future? What should we take in consideration when we decide to expand the network?

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Elicitation of Mental Models of Dynamic Systems: Do Existing Elicitation Approaches Suffice?

This paper reviews approaches to elicit mental models in general in order to answer the question whether existing approaches to mental model elicitation can be used to elicit mental models of dynamic systems. The latter has recently received attention in research about managerial and organizational cognition. Until today, however, the elicitation of mental models of dynamic systems was not discussed from a conceptual perspective.

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Nonlinear Dynamics of Ghost Busters: Detecting Fraud with System Dynamics

This article examines the extensive practice of cooking the numbers in primary education enrollment with "ghost students" and proposes a System Dynamics model to detect such practice. The model is defined as an endogenous closed system with non-overlapping sectors that complies with the law of conservation of matter; so, the number of students flowing into the education system must equal those who ever flow out. This ensures that, internally, people are not created artificially, as ghost students are in reality. A persistently larger-than-suggested-by-the-model enrollment rate suggests a kited student population and therefore the presence of activities to swindle public funds.

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A Multi-Pathfinder for Developing Adaptive Robust Policies in System Dynamics

Adaptivity is essential for dynamically complex and uncertain systems. Adaptive policymaking is an approach to design policies that can be adapted over time to how the future unfolds. It is crucial for adaptive policymaking to specify under what conditions and how to adapt the policy. The performance of adaptive policy is critically depended on the proper timing of the actions. This paper illustrates that robust optimization can be used as decision support aid for appropriate specification of conditions to ensure adaptivity of policy under uncertainty. Furthermore, multiplicity of divergent objectives of different stakeholders is also important for policy support in dynamic systems. To address this issue, multi-objective optimization algorithms are good candidates for a proper solution. In this paper, we outline how to use multi-objective robust optimization in System Dynamics to support adaptive policy design. The outlined approach results, rather than a single set of conditions, in multiple alternative conditions under which to adapt policy. Thus, better informed policy debate on trade-offs is possible. The approach is illustrated through a SD model about the transition toward renewable

energy systems in the EU. The study aims to propose a model-based simulation approach with multi-objective robust optimization for supporting informed adaptive policymaking.

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Systems Thinking to Understand a Knowledge-producing Triple Helix Innovation Process

A triple helix of knowledge-producing spheres consisting of universities, industries, and government research institutes has recently been proposed to analyse an R&D-driven innovation ecosystem. This paper aims to theoretically expand a typical triple helix model using a system-based approach. By employing causal loop diagrams, we discuss how a triple helix innovation process operates. Our proposed causal loop diagram provides lessons in the process of innovation policymaking by interpreting causality and understanding different time lags for short- and long-term achievements in a knowledge-producing triple helix innovation context. In addition, this study illustrates diverse and complex scenarios (caused by a system's dynamics) that facilitate the implementation of preventive policy measures which may avoid the counterintuitive difficulties faced by triple helix stakeholders. Based on our high-level model, we close this paper with novel avenues for qualitative and quantitative research related to triple helix dynamics analysis.

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The establishment of container-deposit on single-use beverage packaging in Germany

In 2003, the German government instated bottle deposit on disposable beverage packaging as means to enhance the use of reusable packaging. The new law was followed by a short increase of the usage of reusable packaging, but then it continued to decrease. In this paper, the different arguments around the instatement of the deposit on single use beverage containers are summarized and a system dynamics model of this case of policy resistance is derived. This model of the single use container and reusable container deposit system shows that the process of the implementation of the policy itself creates incentives for retailers and producers to supply beverages in disposable packaging instead of using multi-cycle packaging.

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Innovation and Learning in Terrorist Organizations: A Complex Adaptive System Framework

Academics, military strategists, policy analysts, and law enforcers increasingly describe terrorist organizations in terms of complex adaptive systems. While the paradigm is useful as a concept and has generated an abundance of models, in-depth theoretical analyses using first-principles of complex adaptive systems to understand terrorist organizations remain few. Of those that do exist, the majority focuses on understanding the inherent structural strengths and weaknesses of the organizations with the ultimate goal of disruption and defeat. In doing so, most experts acknowledge the key role that innovation and learning play in providing terrorist organizations with the capacity to adapt, yet there is a paucity of systematic treatment of the topic. This paper will review the organizing principles, behavior characteristics, and mechanisms of these concepts; how other authors have applied them to understanding terrorist organizations; and

supplement the existing literature with a theoretically grounded framework for understanding innovation and learning within terrorist organizations, drawing on first principles of complex adaptive system dynamics.

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Future Trends of the automotive Li-Ion Battery Supply Chain in Germany – Dynamic effects on raw materials and employment

Researchers as well as car manufacturers expect a greater market penetration of electric vehicles (EV) in Germany and worldwide for the next years and decades. The Lithium-ion battery represents the core technology of electrically driven cars, because it defines technical and economical limitations. Consequently, the knowledge about this technology and the ability to produce it are the relevant drivers for a successful EV diffusion. Due to the expected great market penetration, the battery supply chain has to grow extremely in future or otherwise the economic potential gets lost. But the prospective impacts of this fast growing demand on the supply chain and its environment can be hardly estimated. Therefore, the aim of this paper is to build up a first simulation model, which demonstrates the development of the automotive Li-ion battery supply chain in Germany over the next decades. By means of various EV diffusion scenarios we want to show expected future trends and their impacts on the battery supply chain, on raw materials, production capacities and on employment effects.

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The Manager as Modeler

In many business SD application applications within business, managers who "owns" the problem are cast as clients of external or internal system dynamics consultants. However, significant benefits accrue when the manager him- or herself is also the modeler.

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From the Archives: Models That Matter: Selected Writings on System Dynamics 1985-2010

This poster provides an overview of my recently published book, with excerpts in the form of text, diagrams, and simulation results. The 16 articles reprinted in the book reflect my work in SD modeling over a 25-year period, from the mid-to-late 1980s when I was a young professor, followed by the 1990s when I consulted primarily to large companies, and then the 2000s when I have consulted primarily to public organizations on questions of health policy. The selected papers span topics in management and operations, psychology, medical sociology, microbiology, disease and drug abuse epidemiology, and health policy. Some offer ideas on methodology and how the field of SD may best move forward, asking how we can be rigorous, how we can be useful, and how we can do both within the real-world pressures of time and budget. Citation: Homer JB. Models That Matter: Selected Writings on System Dynamics 1985-2010. Grapeseed Press: Barrytown NY; 2012.

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Impacts of Knowledge Management on Customers loyalty: System Dynamics Approach

In today's competitive business environment, those organizations are approaching excellence when they achieve acceptable results besides providing appropriate infrastructures and following right processes. The one of these results is customers' loyalty. One of organization infrastructures is Knowledge Management (KM), which is gaining increasing attentions nowadays regarding the soaring significance of knowledge resources. Because Knowledge Management affects on customers' loyalty; in this article, we review the effect of KM on customers' loyalty. In order to review this relation, a comprehensive model is required, which should be able to capture all aspects of KM. One of such models is Knowledge Management Assessment Tool (KMAT). Also, a comprehensive model is required to capture all aspects customers' loyalty. The such models are Excellence models. Excellence models, such as European Foundation of Quality Management (EFQM), try to establish a tradeoff between enablers and perceptions in evaluating organizational performance. This research is an effort to find the relationship between knowledge management and customers' loyalty through system dynamics tool. In other words, this research exploits system dynamics in order to measure the effects of KM on customers' loyalty using mentioned tool based upon a combination of KMAT and EFQM.

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Modeling the Influence of Narratives on Collective Behavior

This paper combines System Dynamics Modeling of group behavior with theory of narrative influence and with data from social-media streams to predict social outcomes. Narrative theory describes how stories help people make sense of their world, and is being called upon to explain behavior in domains such as security, health care, and consumer behavior, among others. The model described in this paper quantifies the time-varying strength of cultural narratives as a degree of belief in the narrative's explanatory power, updated heuristically in response to observations about similarity between cultural narratives and current events. The paper introduces Twitter posts as a proxy variable for measuring narrative-significant observations in the real world. Using this proxy, the research develops a case study of the violent riots in London in 2011, and demonstrates how relevant narratives can be identified, monitored, and included in behavior models to predict violent behavior.

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First Four Years: A Case Study of Starting a Social System Design Lab

There have been relatively few accounts in the literature about the start of organizations dedicated to applying system dynamics. This paper tells the story of the first four years of a university based social system design lab inspired in part by Jay Forrester's 2007 plenary talk at the International System Dynamics Conference. The paper recounts some of the history and environment leading up to the founding, presents the initial strategic dilemma in the form of a system dynamics diagram along with the proposed strategy, and reviews the results after

the first four years. Central to the story is the use of system dynamics and lessons from system dynamics on the challenges of managing growth including some of the pressures from going against conventional wisdom in an organization.

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Using System Dynamics to model the HIV/AIDS epidemic in Botswana and Uganda

Uganda and Botswana present two interesting and contrasting cases in the AIDS epidemic. Systems dynamics models of the AIDS epidemic in Botswana and Uganda were created to examine the future development of the virus in both countries and evaluate existing and future policy measures. The effect of current and new policies such as abstinence only, educational campaigns, increased availability of anti-retroviral therapy (ARTs) and condoms, and circumcision were tested on key social and economic indicators. The most effective policy in both countries is a combination of scaling up prevention of mother to child transmission (PMTCT), condom use and availability, circumcision, and ART coverage. The epidemic in Botswana seems to have leveled out; therefore, alternative policies such as circumcision will be necessary to fight HIV in the future. In Uganda there is great need for improvement in dealing with the AIDS epidemic. The model shows that HIV prevalence will increase without drastic policy measures.

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Inclusive growth and sustainable finance - a system dynamics model

In our paper we present a system dynamics model which we are developing for analyzing the relationship between economic growth and consumer debt from a financial and distribution-political perspective. The recent debt crises in the euro-zone and in the United States have naturally triggered controversial discussions about the cause and effect between the various socio-economic factors. Kumhof and Rancière presented a model that explores the "nexus between increases in the income advantage enjoyed by high income households, higher debt leverage among poor and middle income households, and vulnerability to financial crises". Bordo and Meissner, on the other hand, used "data from a panel of 14 countries for over 120 years" and found "no evidence that rising income concentration was a significant determinant of credit booms". Our preliminary results do not only support the findings of Kumhof and Rancière but may also explain why Bordo and Meissner found no evidence in their work. Understanding stock-and-flow dynamics is a key to understand and thus to prevent or overcome debt crises. Compared to austerity, achieving more income equality seems to be a better method meeting the challenge of the debt crisis. Inclusive growth can be seen as a prerequisite of sustainable finance.

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Modeling Movie Release Strategies

This research examines the impact of release strategies on the diffusion of motion-picture movies at the US domestic box-office. A model is developed that captures consumer choice as a behavioral process accounting for the movie's intrinsic attributes, seasonality, word-of-mouth, network effects, consumer heterogeneity, marketplace competition, and managerial inputs. The model estimates weekly box-office receipts for 137 movies and achieves a median r-squared of 0.98 and fits 91 percent of the movies with an r-squared greater than 0.75. The study demonstrates that accounting for this full range of factors not only

improves the model's fit, but also leads to a parameter set that depicts a richer description of the movie industry. Managerial decisions regarding the selection of a movie's release date and its distribution strategy are found to significantly impact box-office performance.

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Strategic Resource Management under Causal Ambiguity - An Empirical Study of Resource Management Dynamics

The Resource-based view (RBV) of a firm is a stream in the field of strategic management. System Dynamics scholars have made a number of contributions towards the field by seeing a firm as a resource system rather than a bundle of resources. This perspective, known as the Dynamic RBV, emphasizes on the importance of managing the firm's resource system. This paper follows the Dynamic RBV perspective and examines the resource management process under causal ambiguity; the study hypothesizes that systemic understanding towards the resource system helps the management behavior. Then, the paper empirically tests the hypotheses via a behavioral experiment design. Two controlled groups, each with a different understanding of the resource system, are compared. Using a management flight simulator, People Express 2000, 60 participants engaged in a resource management process of a low-cost airline. The study shows that employing system's perspective towards the resource system supports managers to effectively manage their resource system and also improves performance.

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Strategic Resource Management under Causal Ambiguity - The Dynamic Resource-based view approach

The Resource-based view (RBV) of a firm is a stream in the field of strategic management, which sees a firm as a bundle of resources. System Dynamics scholars, under the name of the Dynamic RBV, have employed system's perspective towards the RBV; that is, the firm is viewed as a resource system rather than a bundle of resources. This paper mainly discusses the notion of causal ambiguity, which is one of the theoretical cornerstones of the RBV. The traditional RBV sees causal ambiguity to have a paradoxical effect towards firm performance; a positive effect through providing protection to the firm's strategic resources, and a negative effect which undermines decision makers' decision quality. This paper attempts to disentangle the paradox by using the system's perspective; I identify causal ambiguity as a factor that hinders managers in understanding their resource system, and in turn their resource-developing decisions. The paper postulates that adopting system's perspective towards the resource system can help managers to manage causally ambiguous resource system. Finally five theoretical propositions that discuss potential resource management behaviors under causal ambiguity are presented.

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An Analysis of Post-disaster Resources Supply and Work Environment for Restoration Planning of Facilities

Disaster event causes fatal damage on regional built environment (e.g., residential and commercial buildings, core infrastructures and roadways), which generates their functionality losses. Because economic and social activities in urban area depend on not only residential and commercial but also public services provided by facilities and infrastructures, It is essential to implement appropriate restoration planning for recovering functions of facilities within a limited time. In

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this regard, regional recovery environment (e.g., resource supply chain, debris disposal system, and transportation network) after disaster can have negative impacts on reconstruction operations of individual facility compared to a pre-disaster situation. This research thus develops a system dynamics (SD) model to understand the constraint (e.g., required resource and service availability, and their effects on restoration work efficiency) on restoration efforts of facilities in a post-disaster situation. The results of simulation showed that a better understanding of the surrounding context for individual facility restoration can support project managers to implement more appropriate restoration planning to rapidly recover facility's functionality with reduced wastes of time, cost and resources. This model also has a potential to be utilized for implementing more effective restoration plans for facilities and infrastructures in region with an understanding of regional recovery environment.

Bioenergy market competition for biomass: A system dynamics review of current policy

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Interest has grown in the use of biomass as an energy source and the United States has various policies in place that incentivize the use of biomass for electricity and liquid transportation fuels. However, many of these policies – such as Renewable Portfolio Standards for electricity and Renewable Fuel Standards for fuels – create different economic signals that may create competition for biomass. To date, growth projections of the US biopower and biofuels industries have been performed independently without consideration of the effects of competition. Furthermore, foreign exports of biomass may further increase biomass prices to the point that domestic bioenergy production becomes uneconomical. This paper presents a system dynamics analysis of economic competition for commoditized biomass feedstocks given three independent buyers: domestic biopower, domestic biofuels, and foreign exports. The Bioenergy Market Model simulates the long-term dynamics of supply and demand in these markets by treating biomass feedstocks as a collective commodity, dynamically calculating the market clearing price, and partitioning the feedstock to buyers based on a unique value-comparative algorithm. Results suggest that market dominance by exporters is a realistic scenario, and if a greenhouse gas-limiting policy is enacted, the domestic industries receive adequate incentive to protect them from this exporter domination.

The impacts of biomass exploitation and carbon valuation on boreal forest management

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Over the past decade, the forest industry in Canada's province of Quebec has suffered significant losses in employment, largely due to systemic issues which combined a weaker market for lumber with increasingly limited timber supplies. In response, recent governmental actions have focused on stricter forest management, along with subsidies to promote the lumber industry as well as the harvest of waste biomass for energy. In this context, the goal of this paper is to present an aggregated system dynamics model of the causal links between the traditional forest industry, biomass, carbon valuation, and employment in boreal communities, in order to provide insights into the basic behavior modes of the industry under long-term policy scenarios. Preliminary results from the model show that the cyclic investment patterns caused by lumber demand may limit the effectiveness of employment policies. However, the exploitation of biomass within a carbon pricing framework could potentially be a useful policy to

decouple employment from exogenous demand cycles, by channeling carbon revenue for reinvestment in boreal communities. Further work will apply Exploratory System Dynamics Modeling and Analysis (ESDMA) techniques to test policies under parametric and structural uncertainty.

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Using System Dynamics to Define, Study, and Implement Smart Control Strategies on the Electric Power Grid

The United States electric power grid is the most complex and expansive control system in the world. Control of individual generators is based on unit inertia and governor characteristics, larger regional control coordinates unit response based on unit economics and error conditions, and higher level large-area regional control is administered by a network of humans guided by economic and resiliency related factors. Under normal operating conditions, the grid is a relatively slow moving entity that exhibits high inertia to outside stimuli, and behaves along repeatable diurnal and seasonal patterns. However, that paradigm is changing due to increasing implementation of renewable generation sources. Renewable generators by nature cannot be tightly controlled or scheduled and appear like a negative load to the system with all of the variability associated with load on a larger scale. In response, grid-reactive loads (i.e. smart devices) can alter their consumption based on price or demand rules, thereby balancing this variability. This paper demonstrates how a system dynamics modeling approach capable of operating over multiple time scales can provide valuable insight into developing new "smart-grid" control strategies and new ancillary services for smart devices to accommodate renewable generation and regulate the frequency of the grid.

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A Simulation Framework for Integrated Water and Energy Resource Planning

Affordable electricity and accessible, clean water are fundamental to economic production and human livelihood. In the United States, groundwater aquifers are being drained for agricultural production, electricity generation suffers unplanned shutdowns during extreme droughts, and questions surrounding hydraulic fracturing of natural gas are causing many to doubt the future of their water supplies. In this paper, I suggest that improved water and energy planning can help avoid these negative outcomes. I pose that energy and water planning are not integrated enough, and give examples why. Furthermore, I propose a more integrated process that combines the best of current planning approaches and discuss how it would be structured, with an eye always to managing complexity. I introduce the Water and Energy Simulation Toolset (WEST), which is a collection of system dynamics modeling objects that I developed to aid decisions within this more integrated planning process. I detail how WEST may improve integrated water and energy planning, and discuss how such an approach may be used in the western United States.

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Disaggregation of a Stock Variable Based on Attribute Distribution

A co-flow structure, with built in table functions based on cumulative distribution properties, is used to approximately disaggregate a perfectly mixed stock into two sub-stocks. An implementation of this structure requires a priori knowledge of the

distribution of allied co-flow attribute that is presumed to be a random variable. A user can specify the fractile threshold (Z value) for this attribute around which the stock can be split. This structure is tested for a variety of conditions. The goal of these tests is to examine whether the co-flow based partitioning is robust to variations in (i) different structural parameters (e.g. time needed to adjust the stock) and (ii) distribution properties of the co-flow attribute. Results show that the specified table function based on cumulative distribution functions can correctly separate a perfectly mixed stock, on average, for normal or exponentially distributed attributes. Limitations of the approximation for estimating attribute averages are documented. Implications of these findings for comparing system dynamics models against agent based models, and for inferring the results of Monte Carlo simulations that involve smoothing of flows, are discussed.

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Achilles Can Catch the Tortoise: Alternative Goal-seeking Structures

The standard formulation of a gap-closing heuristic used in system dynamics is computationally simple, but might present problems in particular applications. From a control perspective, it is extremely overdamped, approaching but never reaching its goal, far from the optimal control system. From a behavioral perceptive, it is unrealistic: the initial response is too fast, or the approach too slow, and the controller changes its behavior for no reason. Whether this matters for system behavior would have to be tested in particular models – whether persisting small differences or the pace of response has any important impact. This paper presents some alternative formulations to test.

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Service delivery and service delivery protests in contemporary South Africa: A systems perspective

Post-apartheid South Africa has been characterized by formulation of policies intended to improve livelihood of the previous disadvantaged people in the country. Improved service delivery was one of the ways of through which success of these policies would be manifested. In 2011, however, the country was experiencing at least two service delivery protects per week. To provide some insight into the situation, this paper presents a high level model of service delivery and service delivery protests in South Africa. From a qualitative viewpoint, it highlights the role of service delivery protests on services in the pipeline and on service depletion, and the importance of systemic time delays in determining the levels of government services offered at any particular time. Module simulations reveal that after accounting for the effect service delivery on services in the pipeline and service depletion, long term level of service delivery stabilization will depend on resources budgeted for the service delivery vis-à-vis community expectations of the level of service delivery. The paper recommends that these three aspects should form part of the government's planning and communication strategy to communities as part of its wider effort to reduce frequency of service delivery protests fuelled by improbable expectations.

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Social dimension of bio energy production policy in Africa: A systems thinking perspective

The paper makes a case that bio energy production is a single techno-economic social system. Using a systems thinking approach, it develops a qualitative and a quantitative systems dynamics model to capture bio energy production as system and to demonstrate complex relationships that policy makers have to contend with in coming up with effective bio energy policies in African. From the models' analysis, the paper come to the conclusion that social acceptance will be an important determinant of sustenance bio fuel production in Africa. Moreover, any policy intervention geared towards increasing bio energy production that does not take into account social acceptance and does not articulate bio energy production as a single techno-economic social system is likely to be susceptible to policy resistance.

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Pushing the Limits – Using System Dynamics to Forecast Short-Term Commodity Price Movements

Information derived from forecasts forms the basis for companies' strategic decision-making processes. Forecast accuracy can thus have a significant impact on the bottom line. While scholars discuss the usefulness of System Dynamics for carrying out forecasts in general, it is recognized that it should mainly be applied to provide insight into long-term developments, and not for short-term forecasts. In this paper we challenge these assumptions and propose that when expertly and rigorously wielded it can produce valuable results. To illustrate our point we provide the example of a short-term price forecasting model developed for a large global petrochemical company. We first portray limitations and benefits of forecasts in general and System Dynamics-based forecasts in particular. We then present the challenge posed by the company, and how a somewhat unorthodox yet still rigorous process based on System Dynamics tools, methods and insights delivered value to the client – even if the eventual forecasting model used to do so contained no significant feedback loops. We conclude by discussing the benefits of using System Dynamics outside of what can be considered its typical field of application, and by stressing the extensive and varied use of data that permeated the whole process.

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Electric Power Demand Scenarios – SD Approach

The demand for electric power is ever growing in the world and many countries are struggling to meet the demand. This paper presents modeling of the demand sector with system dynamics. It considers the industrial sector, domestic and commercial sector and also the agriculture sector. It takes up the case of Andhra Pradesh state of India. It generates the basic scenario. The limitation of this paper is that the supply side is not modeled and therefore, the policy experiments are also not shown.

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Limits to Population Growth and Water Resource Adequacy in the Nile River Basin, 1994-2100

The purpose of this study is to examine the potential limits to growth within the Nile River Basin region based on actual and projected estimates of population growth and water resource adequacy between 1994 and 2100. The projected disparity between population growth and water resource adequacy within the region raises serious questions about the adequacy of water resources given current population rates and the timing of potential intra-regional conflict. This study, by employing a system dynamics model for the region, projects extreme water scarcity with potentially catastrophic human implications by mid-century. Egypt is likely to encounter a severe water crisis by mid century and as early as 2020 under conservative modeling assumptions. Averting a potential crisis in the Nile River Basin region will require the formulation and evaluation of plausible solutions to water resource issues. The impact of this crisis can be attenuated only by reducing birth rates, reducing per capita water consumption, or increasing water supply. Desalination, one method for increasing the water supply in Egypt, is not sufficient to divert this potential crisis. Future study is required to examine the internal dynamics water and population in each country in the basin.

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R&D Project Portfolio in Research and Development, Part of a Whole in R&D Strategy

The proportion of research and product development phases play the crucial role in forming the routines of R&D companies. In a such company, it is a strategic decision to focus on each of these phases, as it will affect many characteristics of the R&D operation. This model is an effort to combine a R&D strategy framework and system dynamics methodology, based on the interactions of the authors with an Iranian R&D company. A general model of R&D operation with indication of elements of R&D strategy in feedback loops is developed. Assumptions of the model are mostly based on the real world attributes of the aforementioned company. The model is then used to explain past behavior of the company over time, and examine current policies exploited by the firm.

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Adverse Selection in SME Financing: When Both Bank and Innovative Entrepreneur Lose

SMEs are gaining increasing importance in the global economy. Compared to large enterprises, they suffer many more obstacles, a major group of which are financial obstacles. In the Iranian context these obstacles are even more pronounced for innovative SMEs. According to the Global Competitiveness Report published by the world economic forum, in Iran, it is too difficult to get a loan without adequate collateral and by only a good business plan. In such a setting, firms who have an innovative entrepreneurial idea will suffer the most. In this paper, using a system dynamics model it is demonstrated that despite the fact that banks are using tight measures to reduce their risk, the situation for both bank and SME worsens over time. This leads into larger amounts of Bad-debts for banks and reduced "ease of access to loans" for SMEs. A number of policies which may improve the situation and lead into mutual prosperity for bank and SME have been proposed.

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Systems Analysis of the Impacts of the Great East Japan Earthquake and Tsunami on Energy Supply System in Kamaishi-City

The Great East Japan earthquake and tsunami hit coastal cities in Iwate, Miyagi and Fukushima Prefectures of Tohoku Region devastating the energy supply system in the region. Electricity and fuel shortages caused severe problems in the city of Kamaishi varying from lack of mobility, communication, heating to reduced health conditions. This paper, aims to analyze the impacts of the earthquake and the tsunami on local energy supply system in Kamaishi City by; i) clarifying what energy services were in need when there was a shortage in energy supply right after the disasters by performing semi- structured interviews; and ii) identifying and analyzing causes and effects of the energy supply shortage at local level when the disasters occurred by applying systems thinking approach and causal loop diagramming methodology. Suggested alternative potential measures in tackling energy supply shortages and in preparing future disaster risk reduction plans are expected to be use of policy makers.

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Adaptation to climate change in sub Saharan Africa. A multi-sector impact analysis for Burkina Faso

Several decades of successive droughts and desertification, caused by climatic changes, have made the Sahel region one of the must vulnerable to further climate change. This vulnerability is steadily increasing in scope and visibility and it leads to destroyed farmland, major food shortages, decimated herds, and considerable material and human losses. Adaptation to climate change is the adjustment in ecological, social or economic systems in order to alleviate adverse impacts of change or take advantage of new opportunities. However, well-intentioned adaptations can generate costs when wider issues or longer timeframes are considered. This paper develops a system dynamics model for the case of Burkina Faso. The model serves as a multi-sector impact assessment tool and estimates the vulnerability of different policy sectors to climatic changes. It also quantifies the synergies and trade-offs between different adaptation options. Model simulations show that the most cost- effective combination of adaptation options to compensate for the social and economic losses caused by climate change costs approximately 15% of those losses. The model contributes to building adaptive capacity in Burkina Faso by building awareness of the impacts of climate change, the necessity for a multi- sector adaptation strategy and by exploiting ways for maintaining economic growth.

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Lending to Small and Medium Enterprises: A Novel Approach to Credit Portfolio Management

There is a vast unmet demand for credit from SMEs in emerging markets, while banks need novel ways of approaching their risk strategies. These inspired a pilot project within a major commercial bank. The goal of the project is to investigate in what ways exploratory system dynamics (SD) could support lending decisions and monitoring of a SME credit portfolio. This paper reports on this project as a practical application of SD modeling for a bank. The first stage of the project consists of `quick and dirty' modeling and analysis intended to illustrate the possibilities of this approach. A generic model of a company with debts was

created to explore plausible dynamics given the assumptions about how the company's environment may affect its performance. The 2nd and 3rd stage – modeling of actual companies and aggregating them into a portfolio for stress testing – is work in progress.

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Diversity and Innovativeness in New Product Development Teams – Addressing Dynamic Aspects With Simulation

Various empirical studies investigate the correlation between diversity and innovativeness in New Product Development teams (NPD teams). However, those studies show various and contradicting results. Diversity can be a resource that helps to strengthen the innovativeness of a NPD team. On the other hand, diversity can act as a risk that leads to diminished team cohesiveness and thus obstructs innovativeness. Numerous other factors influence the innovativeness of a heterogeneous NPD team. In this paper, we will discuss if and how simulation as a complementary method to empirical studies can help to shed light on the complex and contradicting effects of diversity on innovativeness of NPD teams. Simulation models can help to analyze the diversity problem and its dynamic behavior as well as to allow insight into the basic underlying structures. Thus, simulation can show, where further empirical data is needed, can help in developing and testing new theory, and can support organizations in gaining a better understanding of heterogeneous NPD teams and implement practical solutions. We will show a highly aggregated and simplified System Dynamics model to illustrate the potential simulation has as a complementary method in the area of diversity research.

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Process Insights from Using Group Model Building to Address Emergency Department Use for Pediatric Asthma Treatment

The rate of emergency department (ED) use for the treatment of pediatric asthma in St. Louis has been four times higher than the rates in surrounding counties for over two decades. ED use for conditions that can be better managed in primary care facilities drains hospital resources, and creates significant stress and strain on families whose children need treatment. Several policies to address this complex problem involving social, health and health care system factors have failed to produce any long-term results. Insights into effective intervention require a deep understanding of the complex system in which the problem is situated. Thus, to address the problem, we organized group model building (GMB) sessions to bring stakeholders involved with various aspects of pediatric asthma treatment, care, and prevention to create a qualitative map of the structure driving persistently high ED use. Insights from the process include a shared understanding of the system boundaries, elements and feedback structures involved in pediatric asthma exacerbation and care, as well as an understanding of feedback and focus on endogenous drivers of system behavior among participants. Using the desired insights to drive the design of the sessions along with frequent reflection kept the GMB process productive and responsive.

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Dynamic Demand Modeling of Freight Fleets

Freight traffic and functioning logistic systems are basic prerequisites for a successful economy. The combination of behavioral changes towards online shopping and the resulting need for high delivery flexibility will lead to a growing demand of light duty vehicles (LDV). Despite already existing models which predict the size of the LDV fleet based on a given transport demand, a dynamic connection between transport demand and vehicle fleet has not yet been realized. A distribution of annual mileages from LDVs, which have a wide range, leads to the assumption that fleet operators could adapt their mileage within set limits. This dynamic mileage adaptation is expressed as a module, which can then be integrated into existing fleet models. The results show that the number of LDVs needed to satisfy the demand is less volatile compared to the use of constant annual mileage. The results can certainly be seen as one step to more realistic fleet forecasting, yet further research in the field of fleet operator behavior would be beneficial.

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Keeping Students with the Curriculum: Using a Systems Dynamics Approach to Elementary Education

A study was performed by the authors as an exploration into the systems dynamics of education. The objective of this study was to analyze which factors help students keep up with the curriculum best in the context of a systems dynamics model. For this study, only factors which can be influenced by professionals in education were considered. The long term vision of this study is to enable professionals in education to see a range of possible results of changes to the school on keeping students with the curriculum (possibly through an online tool). To achieve this, a systems dynamics model of a generic elementary school was built using Vensim. The model was tested under a series of systematically altered conditions and sensitivity analyses were performed. Difficulties in measuring psychological factors necessitated assumptions regarding certain factors such as levels of teacher enthusiasm. The major findings of the study, are that teacher training in an archetypal good school and a combination of policy measures in an archetypal bad school have the largest influence on students keeping up with the curriculum.

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Limits to Planetary Fresh Water Use: A Multi-Model Investigation

There has been a renewed interest over the last few years in limits to various earth bound systems and processes. This has been instigated by the work of Rockström and colleagues on planetary limits. Essentially, the planetary limit concept can be understood as a modern update to the seminal system dynamics work on limits to growth. The central idea of planetary limits is to identify thresholds in various earth bound systems and processes that, if crossed, would push the earth system out of its Holocene state. This work has been criticized for overlooking key feedbacks between the various earth bound systems and the ignoring the uncertainty that is intrinsic to any assessment of these limits. In this paper, we address these issues by using integrated system dynamics models in an exploratory way. We demonstrate this approach by investigating limits to planetary fresh water use using two world water models, namely ANEMI and WorldWater. The initial results suggests that sever water shortage is driven by the

need to dilute waste water, and food demand and production. We discuss directions for improving the overall methodology and the case specific application.

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Teaching Characteristics of Complex Systems in K-12 Education: Lessons Learned

This paper describes lessons learned while completing a pilot project initiated by Professor Jay Forrester through the Creative Learning Exchange. The goal of the Characteristics of Complex Systems Project (CCSP) is to create online curriculum materials for K-12 students and interested adults that will illustrate the characteristics of complex systems first enunciated by Forrester (1969) and appearing repeatedly in the systems thinking/system dynamics literature since then. The pilot project was designed to address the characteristic "The cause of the problem is within the system" through the creation of a family of models that share the generic 2nd order negative feedback loop that generates oscillation. Students can encounter these models in various formats and subject areas. Through repeated exposure to models and materials that incorporate instructional scaffolding principles , students learn to recognize the perceived problematic behavior exhibited is a consequence of the internal system structure. The lessons learned during the pilot project are being used to inform further development of curriculum materials that illustrate Forrester's characteristics for K-12 students.

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Regional Strategic Industry (RSI) Promotion Projects and Their Impact on Regional Economic Growth

This study tries to measure the direct and indirect effects of the Regional Strategic Industry (RSI) promotion projects in Chungbuk Province in Korea. In specific, it critically examines whether there exists policy consistency and connectivity between the hardware-oriented Stage I and the software-centered Stage II RSI promotion projects. Major findings are as follows: Firstly, 'the continuous investment' is regarded as the most crucial policy leverage for the strategic industry promotion and regional economic growth. Secondly, without exceptions, the RSI promotion projects should switch their evaluation criteria to performance-oriented ones. This paper suggests a series of candidates including job creation, patent application, manpower training, and pilot production and sales, all of which would significantly contribute to budgetary efficiency. Thirdly, in selecting their subprojects, the RSI promotion projects should pay due attention to evaluating technology value and marketability. Fourthly, it should put policy priority in strengthening cluster networking and interconnectivity among projects, inevitably supporting a selective number of virtuous network systems. Fifthly, auxiliary projects such as marketing, technology aid, and knowledge-based services should not be overlooked.

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Modelling Sovereign Debt Induced Banking Crises: Theory, Application and Policy Conundrums

The paper examines the relationship between sovereign debt dynamics and the stability of financial institutions using a system dynamics framework. It also explores the effectiveness of various policy options aimed at restoring stability after severe macrofinancial shocks. The model incorporates three main agents: banks, a central government and a rating agency. The banks and the central

government are assumed to be boundedly rational and backward looking interacting via both the local and international capital markets. Further, the credit rating agency is assumed to be rational and forward-looking. The framework identifies the transmission mechanisms linking sovereign debt and financial sector crises when the above three agents interact over time. Although the calibrated model is informed by Jamaican data and the debt situation which has prevailed there since the global financial crisis, the model provides a framework for the consideration of sovereign debt crises in other countries. The model does well in developing a causality driven approach to explain the reasons behind increasingly unsustainable debt-deficit dynamics and how these imbalances can spill-over into the banking sector leading to increased financial fragility. The paper closes with a discussion on the usefulness of this approach in informing regulatory reform within the banking sector.

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The Bullwhip Effect in Hybrid Supply Chain

As the service is becoming the strategic preference of the manufacturing company, more and more manufacturing companies provide customers with total solutions by integrating services into their core product offerings. The hybrid supply chain (HSC), which is formed as a chain by a group of manufacturers and service providers, who work together to offer total solutions to customers. In HSC, customers' responses to variable service levels and interaction between inventory strategy and service capacity strategy have a great impact on supply chain instability, which represents an important concern in supply chain research. To tackle this problem, we establish a system dynamics model, which is grounded in a first-hand study of the HSC for an elevator company in China. First, we analyze the oscillation characteristics of bullwhip effect caused by interaction between manufacturer and service providers. Then, we propose the performance metrics of bullwhip effect in HSC. Finally, based on the model we find that by incorporating service capacity adjustment strategy into the inventory replenishment policy the bullwhip effect of HSC could be smoothened.

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Theories and Models. The Cognitive Significance of System Dynamics Modelling

Simulation models in System Dynamics are not only useful tools for prediction and control, but a very important source of knowledge about the modelled systems. Moreover, sometimes System Dynamics models have a status quite similar to the one of theories. In our paper, we analyse this relevant aspect of System Dynamics modelling. We discuss four general conceptions of the relations between theories and models, and we try to make clear the sense in which System Dynamics models can be taken as theories about the structural features of the real systems modelled.

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Policy Simulation in a Warzone: System dynamics in Afghanistan

The paper describes a system dynamics policy simulation engagement undertaken with the US special operations command in Afghanistan between August 2011 and February 2012 and is organized into three sections. First, the basic mission and motivation for the engagement are reviewed. Second, the results of and lessons learned from the engagement are discussed. Third, a reference mode is

begun to support a more extended system dynamics-based study that addresses the counterintuitive outcomes of the Afghan intervention specifically and of the problems associated with nation building more generally.

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Exploring carbon futures in the EU power sector

The European Emissions Trading Scheme (ETS) in combination with other renewable electricity (RES-E) support schemes such as (premium) feed-in tariffs or tradable green certificates do not guarantee a carbon neutral power sector in 2050. This paper shows that many plausible futures of high carbon emissions exist when no substantial efficiency measures are taken in high growth futures. Using System Dynamics (SD) in combination with Exploratory Modelling and Analysis (EMA), it seems that the main European energy policies might result in high levels of carbon abatement but have very limited guarantees whatsoever. There are potential 'free lunches' for policy makers to reduce carbon emissions but these will probably not suffice when ambition levels remain high. This paper sheds new light on the path to find policy synergies for the European electricity sector with the aim to rule out lurking catastrophic futures of high carbon emissions combined with high costs for society.

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Eramat! A Culturally-Anchored Board Game Simulator for Maasai Pastoralists in Southern Kenya

A culturally-anchored board game simulator named ERAMAT! was created in cooperation with Maasai pastoralists and then piloted with members of Maasai communities in southern Kenya during the summer of 2012. The game provides an alternative to a computer-based simulator, and hence provides a culturally credible simulation of the system dynamics associated with an accelerating boom/bust cycle of drought and hunger in the region. Factors driving the phenomena include greatly increased population densities, pastoralist cultural values, evolving pastoral practices, the ebb and flow of the semi-arid environment in which Maasai pastoralists live, and political and ecological pressures. The game encourages deeper understanding of these dynamics for pastoralists and non-pastoralists alike, and can generate conversations leading to insights on effective strategies for reducing the impact of the inevitable periods of low rainfall. This paper reports on the underlying dynamics, the game design, and the results of the pilot. ERAMAT's rules, symbols and language attuned to Maasai core values and pastoral praxis allowed players to engage in conversations about past experiences and outcomes, as well as explore alternative strategies for livestock and livelihood survival.

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Burnout and Floating Goals in High-Contact Service Operations

This paper explores behavioral issues associated to the management of high-contact service operations. In this type of operations there is a tension between managerial target setting and the well-being of service agents. Target setting and monitoring to maintain overall efficiency, resource utilization, and output rate often leads to burnout and high attrition rates. This paper looks at how workloads and target performance metrics are adjusted in a service operation and explores the interaction of the mechanisms associated to the management of these goals with burnout and attrition. The paper finds that a simple linear relationship between resource utilization, burnout, and attrition is insufficient to explain

observed data. The paper proposes that a feedback non- linear structure is better suited to explore those issues. The proposed feedback structure takes into account agent learning, resource utilization, human agent expectations, and target workload and performance goals. The article explores these issues in the context of a case study of a large high contact service operation.

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Group Model Building to Support Interdisciplinary Theory Building

In this paper we describe the initial steps in the development of a theory of the impacts of governance principles such as completeness, openness, relevance and reliability on the adoption of a large-scale interorganizational system to increase supply chain transparency. The research presented here is in alignment with the use of system dynamics models to develop and test theories. Given the interdisciplinary nature of the project, Group Model Building was selected as the approach to build the theory. In this context, the system dynamics model, and other artifacts used during the modeling process work as boundary objects facilitate conversations among researchers from different disciplines.

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Cellulosic Feedstock Biofuel Feasibility for Automotive Use

The transition of the US automobile fleet to alternative fuels (electricity, hydrogen, ethanol, etc.) will take considerable time. Automobile fleet turnover, technology readiness, and biomass feedstock availability will all play a role. This work examined the feasibility of producing up to 90 billion gallons of cellulosic biomass sourced ethanol by the year 2030. The model contains a high degree of granularity and the modeling process struggled with a 'constraint versus consequence' approach to formulating the model and presentation of results.

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High-Value Outsourcing: Impact of Team Structure and Capabilities on Complex and Uncertain Offshoring Projects

Extant research on offshore outsourcing has largely studied non-core, fairly routinized tasks, such as IT services and BPO. However, companies have recently begun outsourcing higher-end work entailing greater complexity and uncertainty, including knowledge-based services like new product development. We hence investigate to what extent the offshore outsourcing approach can effectively transfer to such projects, by developing a simulation model based on field research of a sample of global software development projects conducted by a leading Indian outsourcing vendor with its customers. We contrast the global delivery model with a so-called consulting model and find that an offshore

outsourcing approach based on distinct strategic complementarities is better at addressing sophisticated higher-end work, given the characteristics of its team structure and capability composition. The results bear implications for traditional notions of firm boundaries and organizational forms.

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Supporting policy analysis in the Dutch rail sector using System Dynamics

With a sizeable expected growth of demand for rail transport in the Netherlands in the coming decades, and limited resources for expansion of the rail network, intensified utilization of the infrastructure is to be expected. To adequately manage this growth, appropriate tools for policy analysis are needed. Additional scrutiny is placed on these tools, because of the unstructuredness of many problems in the rail sector, and decision-making in a network type environment. The possibilities and pitfalls of using System Dynamics for policy analysis in the Dutch rail system have been explored by performing a modelling study into the interrelations of modal split, mobility and operations using System Dynamics. Results show that the reliability of infrastructure is a major component in the extent of delays. Furthermore, the effect of unreliability in a train trip and the characteristics of a car trip are important for the choice between train and car. Although classical policy analysis has proven to be possible, modelling the operational part of the system has proven challenging due to the spatial and discrete characteristics of parts of the system. Recommendations are given to improve the model and model use to better suit the unstructuredness of the problems.

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A Dynamic Performance Management Approach to Evaluate and Support SMEs Competitiveness: Evidences from a Case Study

The role of Performance Management (PM) systems has become crucial for steering Small-Medium Enterprises (SMEs) to successfully compete during the ongoing critical economic transition. To improve decision-maker strategic learning processes, traditional PM frameworks need to be combined with System Dynamics (SD) modeling. This paper shows how to design and use a Dynamic Performance Management (DPM) approach to assess and support SMEs competitiveness. The emerging framework is applied to a real case of a small business to analyze the empirical effectiveness of the approach hereby suggested.

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Analysis of a serious accident emergency drill with a simulation model

Studies of labour risks with simulation models can be categorized into two groups: those which analyze serious accidents to obtain applicable rules in the future, and those which analyze the rules and mechanisms of control of risks to simulate the functioning before potential accidents in order to identify and manage the necessary guidelines of prevention and course of action. Here we have an ex-post approach where we study the chain of events that have caused the accident to prevent it from repeating itself, and on the other hand we have an ex-

ante approach that analyzes the complexity of the relations between the parts of the system that can give place to accidents and it simulates diverse strategies that allow to reduce the risk. Later it is described using a causal graph the system of prevention of labour risks of a generic company, and that same graph transforms itself in a model of simulation - in spite of handling qualitative variables - to simulate the effects that are produced in a serious emergency exercise.

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Understanding the Global Financial Crisis: Lessons Learnt for Developing Islamic Banking and Finance Industry

Why did no-one see the credit crunch was on its way? This question came from Queen Elizabeth, when she visited The London School of Economics in November 2008. This question has been an inspiration to start this paper. The next question emerges "Why does nobody see the financial system as a whole?" Using system thinking, system dynamics paradigm and theory of feedback system, this paper tries to enrich the understanding of how financial systems work: what drives them and causes the behavior. Understanding the role of regulators, mass media, derivative financial products, greedy or unethical people, conflict of interest of rating agency, incentive matters, misplace reliance on risk management model is critical for developing intuition about the evolution of the financial system which simultaneously stimulate the global financial crisis. All those critical factors are relatively recognized and prevailed in the implementation of Islamic banking and finance system nowadays. Many lessons can be learnt from this financial contagion since Islamic banking and finance system has inevitably been a part of the international financial systems. Moreover, since the majority of Islamic banking and finance products are still debt- financing, short-term oriented, Islamic banking and finance are vulnerable affected to financial contagion.

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Critical Success Factors of the Offshore Outsourcing of Software Development Projects: A System Dynamics Approach

This research focuses on the offshore outsourcing of software development projects. Little research has been conducted on the factors that would mitigate risks from the specific contexts of these projects. This study identifies and provides an understanding of the structural causes of issues that can occur and which impact offshore outsourcing projects performance. The main objective of this research is to propose a list of the most important critical success factors (CSFs) in the context of offshore outsourcing software development projects by providing a dynamic hypothesis based on the qualitative modeling principles of system dynamics. The analysis of data collected as part of this multi-case research study was used to systemically model the sequence of three software development projects outsourced to vendors in India by a large client located in North America. The study revealed six CSFs that promote the emergence of behaviors deemed desirable or limit the scope of events deemed undesirable, namely: the level of technical knowledge of the supplier, the availability of technical experts from the client, the level of detail sufficient and low volatility specifications; trust based on objectives, transparency of the vendor's internal processes, monitoring mechanisms for control and project deliverables.

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Exploring strategic responses of the automotive industry during the transition to electric mobility: a system dynamics approach

This paper outlines a model archetype that can be used to assess the effects of future policy making and the future transition towards electric vehicles on the automotive sector, while taking into account insights from innovation, transition literature and the multilevel perspective. In order to show the flexibility of the model structure and tackle the gap on how the automotive industry normally responds on those factors, the approach is then used together with historical data to generate insights on how industry has responded to pressures in the regime in the past. For that a case study approach is taken when a timelines for the automotive regime and landscape are presented and then put in relation to a timeline of BMW's activities. While the study is in an early stage, still it is shown how first quantitative parameters can be identified. The article concludes with an outline of future work.

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A Preliminary Qualitative Model for the Availability of Climate Adaptation Finance in Developing Countries

The large investments required to adapt to climate change in developing countries ask for the involvement of the private sector. For the private sector to participate in infrastructural projects, there needs to be clarity about, amongst others, how and when returns on investments are made and who carries the risks. This may vary by types of infrastructural measure and country's institutional setting. The project Water2Invest under the European Climate-KIC (Knowledge Innovation Communities) programme develops an internet-based tool to support these types of decisions by showing both the effectiveness of supply- increasing or demand-reducing measures under various scenarios and by providing insight in financing possibilities in different institutional settings. To support the latter, this paper introduces a qualitative model of factors influencing the availability of finance for climate adaptation, as a first step in understanding financial feasibility of infrastructural measures in developing countries.

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Individual Performance in the Beer Game: Underweighting the Supply Line and the Impact of Personality

Data was collected from undergraduate students playing an online version of the Beer Game and correlated with data from a personality survey. Several measures of individual performance were developed that loaded into 5 factors: anchoring, weighting of visible inventory, weighting of unseen inventory, inconsistency, and amplification. Results show that personality does predict some measures of performance in the beer game, and more so for the wholesaler and distributor role. A surprising result is that underweighting the supply line inventory is not correlated with demand amplification.

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Transformative quality of doctoral education: the way new standards are negotiated. System dynamics approach

Quality is a concept that is leading every discussion within public policy of higher education (HE). It is common when state external regulation of doctoral educational quality is supported by internal self regulation, when certain level of doctoral education quality is ensured by internal long lasting "common" practice. For instance, doctoral degree awarding (DDA) process is such the case, when state regulates requirements for process and personnel involved. The research goal of this study is to analyse the practice of the doctoral degree awarding in Lithuania (DDA members selection and DDA process) and explain the factors within the practice that stimulate transformation of quality of doctoral education. The research employed the qualitative approach using semi structural interviews. Informants for interviews were selected from the list of DDA committees that were operated in 2010-2011 in Lithuania. Based on qualitative research data, we construct an explanatory causal loop diagram explaining the transformation nature of quality that is a product of negotiation between academia and state regulators. Dynamic hypothesis are based on threefold causal loops: adoption of new state regulation; implementation of state regulation and formation of new tolerance to quality.

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Impact of Flexibility on Risk Management in an Indian Pharmaceutical Manufacturer – A system dynamics approach

Flexibility is a multi dimensional perspective built over the concept of dynamic interplay between thesis and anti-thesis, which facilitates options, freedom of choice and change management mechanism. The freedom of choice is leveraged best when it is backed up with the continuous learning environment. Flexibility is about dealing with diametrically opposite business situations with processes and actors who have the options, change management mechanism and freedom of choice backed up with knowledge, synthesizes and comes up with Learning, Action and Performance (SAPLAP, Sushil 2000). The challenge of today's business world is to transform traditional organizations and their systems so that they can become more flexible. Development of dualistic behavior of business environment has created immense tensions. The environment can be best described by Flowing Stream Strategy (Sushil, 2012) by managing change with continuity. The monolithic either/ or concept has paved ways for multidimensional inclusiveness. It's about dealing with Centralization with decentralization, Continuity with change and Integrity with diversity. The concept of value for money has become a cliché. Customer wants more value with lesser cost. Flexibility, Controllability and Risk sensitivity is gaining increasing importance as organizations strive for competitiveness through enhancing capabilities in three paradigms – people, process and technology.

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Anticipating complex behaviors of coercive actions in international relations

The main goal of this article is investigating complex relations among nations based on basic conceptual framework which covers several influential fields. Extensive and multidisciplinary nature of international relation (IR) problems as

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well as complicated nonlinear behaviors, makes using modern techniques necessary. For doing so a system dynamics model for solving small scopes of IR problems is proposed. The article focuses on investigating relations based on coercive actions in longtime ranges. Iran and US relation is considered as a case which defines generic and extensible conditions and scenarios. Finally the results have been presented.

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Dynamics of the transition towards alternative fuel vehicles in advanced and emerging markets

The global diffusion of alternative fuel vehicles is strongly associated with deep social and technological uncertainties, which result from considering the market differences of advanced and emerging markets, and the technology maturity and potential of alternative fuel vehicles. We analyzed the effect of the interplay of these uncertainties using a system dynamics model characterized by the socio-technical feedback processes inherent to this transition context, and the interdependencies of automakers, consumers and fuel suppliers. We explore a large set of scenarios varying the social and technological factors in our model, and use the scenario discovery method to identify sets of policy relevant cases. We find five policy relevant behavioral clusters associated with the diffusion of hybrid vehicles and the diffusion of electric vehicles. Our analysis shows that the initial transition inertia towards alternative fuel vehicles in advanced economies can be exhausted, and thus threaten the global transition towards alternative fuel vehicles. Emerging markets can offer a complementary market niche that can be used to support this transition. We conclude that the process of diffusion of alternative fuel vehicles can be enriched and strengthened if it is seen as a complementary process between advanced and emerging markets.

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Deduction and abduction in computer simulation: Comparing logics in theory development

The article presents a review of a sample of simulation studies in the management and organization body of literature. The proposed approach to the review hinges upon the analysis of the logic of inference that underpins the selected studies. In particular, I suggest that the two recurring type of inference that, deliberately or unintentionally, inform the use of simulation analysis are: deduction and abduction. In addition, the paper proposes an historical journey that portrays the diffusion of computer simulation studies within management and organisation literature. The presented review aims at two goals. First, the paper strives to contribute a point of view to help researchers to approach the design of a simulation-based study with increased awareness. Second, the reported analysis ought to help researchers who are not familiar with simulation to study to appreciate the possible contribution of simulation studies to theory development.

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A System Dynamics Analysis of the Bottled Water Industry in the United States

The Bottled Water Industry has seen rapid growth since the early 1970's until recently, where a plateau has been seen in the sales of Bottled Water in the US. The purpose of this study was to understand this Bottled Water Industry behaviour by determining its key leverage points. Leverage points being points

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within a system where a small shift in one thing can produce big changes in everything. These 'leverage points' can be revealed by observation and study of the system in focus. They are then able to be used to create a System Dynamic model that replicates the real world behaviour of the system. This was the method followed in this paper, whilst focusing upon the Bottled Water industry in the United States. The model was also used to look at possible behaviour in the future of the Bottled Water Industry. Using these predictions it was hypothesized that that the Bottled Water Market will plateau with oscillation and then collapse.

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Modeling the Evolution of a Science Project in Software-Reliant System Acquisition Programs

Analysis work by the Software Engineering Institute (SEI) on data collected from more than 100 Independent Technical Assessments (ITAs) of software-reliant acquisition programs has produced insights into some of the most common ways that programs encounter difficulties. This paper describes work done at the SEI that is based on these insights, and intends to mitigate the effects of both misaligned acquisition program organizational incentives, and adverse software-reliant acquisition structural dynamics, by improving acquisition staff decision-making. The research presented here uses a preliminary system dynamics model to analyze a specific adverse acquisition dynamic concerning the poorly controlled evolution of small prototype efforts into full-scale systems that is called "The Evolution of a Science Project." The system dynamics model of the behavior is described, along with the results of simulations run using the model. The paper concludes with a set of lessons learned, as well as potential future research directions.

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A System Dynamics Model for Investigating Early Detection of Insider Threat Risk

In many organizations, the responsibility for managing the insider threat falls almost exclusively with the information technology staff. But many of the early indications of problems occur at a behavioral, nontechnical level. This paper describes a system dynamics model for investigating how monitoring the behavioral indicators of insider threat risk can reduce the overall risk of a cybersecurity breach within an organization by promoting early detection. We show how the model could be used for a given set of input data, derived from our insider threat case database, and discuss future work to identify more robust inputs through interaction with partnering organizations.

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From the Archives: The dynamics of action-oriented problem solving: linking interpretation and choice

This poster reprises our paper published in 2009 in the Academy of Management Review. Motivated by a medical diagnosis problem that generates a wide range of problem solving behaviors, we posit a theory of action-oriented problem solving that links interpretation and choice, processes usually treated separately in the sensemaking and decision making literatures. We used an iterative, simulation-based process to develop a system dynamics model grounded in a unique data set of 39 anesthesia residents confronting a simulated patient with a breathing problem. Three insights emerged: (1) action-oriented problem solving includes acting, interpreting, and cultivating diagnoses; (2) feedback and interactions

among these processes open and close windows of adaptive problem solving; and (3) reinforcing feedback and confirmation bias, usually considered dysfunctional, are helpful for adaptive problem solving. (Original paper: Academy of Management Review 34(4): 733-756 2009.).

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Debriefing as a System: Enhancing Reflection in Experiential Learning

Experiential learning settings using simulations offer promising opportunities to help improve performance for trainees, but the quality of the debriefing is of paramount importance. Using the domain of medical simulation as motivation, this paper proposes a theory of debriefing as a system comprising the trainees, the debriefers, and the psychological context or "container" they co-create through conversation and behavior. The paper uses causal loop diagrams to conceptualize the key feedbacks in the debriefing system, presents a system dynamics model , and uses simulation analysis to explore key dynamics, including the co-evolution of context and learning. The results show that the effectiveness of debriefing is rooted in critical interactions among the psychological context, the debriefer, and the trainees.

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Applying System dynamics to simulate Iran's engineering post graduates employment status

Iran's universities have been used to enroll students with out considering market's capacity for university graduates. A fact which has led to problems such as lack of experts in some fields, under employment and unemployment in many others. While, forecasting market's capacity for university graduates and enrolling students based on the predicted capacity is the best way to hinder such problems. In this paper, we aimed to apply System dynamics to forecast capacity of Iran's market for engineering post graduates from one side and number of engineering post graduates from the other side to make it possible to predict post graduates' employment status in country's near future. The results show that there will be ample job opportunities for phd graduates such that they will not face unemployment or under employment in upcoming years. Phd students will have a good occupational status in near future while master students' employment status will aggravate in onward years such that most master graduates will be relegated to jobs requiring less knowledgeable workers such as careers that require a bachelor's degree or non degree jobs.

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Cost of Malaria Elimination in Kenya by Means of IVM Implementation

Kenya is one of the sub-Saharan countries where malaria is still endemic in some of its regions. The interventions to reduce malaria prevalence in Kenya focus on both, case management and prevention. The first type of intervention deals with diagnosis and treatment of the disease. The second type -prevention- includes very diverse methods to avoid mosquito bites. During the last years, prevention in Kenya has been based on the use of Integrated Vector Management (IVM), which is a rational decision-making tool designed to provide intelligent and optimal management of resources meant for malaria prevention and vector control. The present study evaluates the potential impact of different IVM strategies for the future, in order to obtain optimal results in malaria reduction. The analysis has

been performed using a system dynamics model that can simulate and evaluate different IVM interventions under different scenarios of development prospects, climate change or effectiveness of anti-malaria methods. Such scenarios can help to identify adequate interventions to maximize reduction in malaria transmission while observing their repercussions in the other sectors. Finally, the model allows estimating the possible cost of eliminating malaria in Kenya on a mid-term horizon under different scenarios and considering different combinations of IVM interventions.

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Translating Between Laplace Domain Block Diagrams and System Dynamics Stock & Flow Diagrams

System Dynamics and Control Engineering employ different techniques to model complex systems. System Dynamics professionals and Control Engineers do not have a documented technique to relate the two different methods however. This paper first describes the fundamental structures in Stock & Flow Diagrams including stocks, flows, auxiliaries, and connectors. The basic structures in Control Engineering State Space Representations are then discussed. Since both methods are techniques of describing complex systems, parallels are drawn between the two techniques and their structures. Then a succinct method for translating between generic structures commonly found in both systems is described. Examples are also provided that employ the techniques described.

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South African Green Economy Model (SAGEM)

Green economy is a concept that covers several issues of sustainability. It is an economic paradigm that prioritises increasing the well-being and equitable distribution of economic benefits, while at the same time reducing environmental impacts. This paper introduces South African Green Economy Model (SAGEM) that was developed to test the effects of investing in green economy for selected sectors based on system dynamics approach. While the model consist of 14 sectors and 31 modules, emphasis for green economy was on four key sectors namely: natural resource management, agriculture, transport and energy. The baseline simulation (2011 – 2030) and historical trends for specific variables over the period 2001 to 2010 is also presented.

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System Dynamics Model of Residential and Commercial Lighting Markets

System Dynamics models are developed of the residential and commercial lighting markets. Rate of purchase of new systems are related to the installed base of existing systems, system component reliability, and construction. Buyer preferences are assumed to depend only on the characteristics of the lighting systems. Characteristics considered include price, efficacy, life, and color rendering. The preferences are represented by coefficients of a multinomial logit function are are calibrated against decades of historical data in an econometric fashion. Assuming buyer preferences stay constant for a comparable time into the future, projections are made for the market adoption of LED technology. The disruptive impact of lighting efficiency regulation is examined.

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A System Dynamics Model of Salt Reduction at National Level

To reduce salt intake of the population, it is important not only to raise people's awareness of need of salt reduction but to reduce salt content in food products. This study aimed to develop a simulation model for salt reduction at national level. The model combined three sets of a pair of stocks and a flow between them. People's awareness subsystem consisted of stocks of people who are not aware of and who are aware of need of salt reduction and a flow of becoming aware of the need. People's salt taste subsystem consisted of stocks of people with high and low salt taste and a flow of change to low salt taste. Food products subsystem consisted of stocks of products with high and low salt and a flow of change to low salt products. To estimate average salt intake of the population, selections of high salt food by people with high salt taste and of low salt food by people with low salt taste were provided by look-up functions. For lowering average salt intake of the population, it was revealed that making people with high salt taste choose products with low salt earlier is crucial.

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Fuzzy Systems Perspectives on Cognition, Economics and Machines in Organizations

This paper advocates and explains that Fuzzy Theory involves the necessary mathematical and logical foundations which materialize the representation and computation of categories of Jerome S. Bruner and Eleanor Rosch's Theory of Cognition, and also the new model of economic man of Herbert A. Simon Theory of Bounded Rationality (Nobel Prize, 1978); which have an important role in organizational behavior. Based on these premises, this research reviews the roles of cognitive machines in knowledge management and organizations; and from such a perspective, this work indicates that Fuzzy Theory represents the foremost and prior contribution to the concept, representation and computation of symbolic cognitive categories which have an important role in the new model of economic man, bounded rationality and organization behavior.

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Electricity Market Coupling: Latin America vs. Europe

Electricity Market Coupling is spreading all around the world; however, its potential benefits and drawbacks are still open to debate, and regions like the European Union advance quite slowly towards integration. There is no agreement in terms of what are the right policies to implement in order to acquire the benefits of integration without putting reliability at risk, and most countries continue to implement national policies without taking the interconnectors into account. In order to contribute to the discussion, we develop a System Dynamics model that allows us to simulate the integration of two countries and test different scenarios and policies. Two dissimilar cases, one in Latin America and one in Europe, are analyzed, and we obtain some insights into the aspects that deserve special attention when designing policies for interconnected countries. Results of the simulation show that, in the long-term, the amount of investment in generation capacity, as well as the technology mix of new investments, is influenced by the degree of interconnection. Furthermore, the effect of a capacity payment mechanism depends not only on the degree of interconnection, but also on the characteristics of the integrated countries, such as the complementarities, currently installed capacity, resources, load curves, etc.

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Policy in Adaptive Financial Markets—The Use of Systemic Risk Early Warning Tools

How can a systemic risk early warning system (EWS) facilitate the financial stability work of policymakers? In the context of evolving financial market dynamics and limitations of microprudential policy, this study examines new directions for financial macroprudential policy. A flexible macroprudential approach is anchored in strategic capacities of systemic risk EWSs. Tactically, macroprudential applications are founded on information about the level, structure, and institutional drivers of systemic financial stress and aim to manage the financial system risk and imbalances in two dimensions: across time and institutions. Time related EWS policy applications are analyzed in pursuit of prevention and mitigation. EWS applications across institutions are considered via common exposures and interconnectedness. Care must be taken in the calibration of macroprudential applications, given their reliance on quality of the underlying systemic risk-modeling framework. In addition, macroprudential applications should not commence without explicit economic impact analysis of feedback mechanisms involving the new policies. Recent systemic risk EWSs predicate the discussion of potential macroprudential policy tactics and include the Systemic Assessment of Financial Environment (SAFE) EWS developed at the Federal Reserve Bank of Cleveland.

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A system dynamics-based model of the socio-technical systems of household energy and carbon emissions

There have been concerns over sustainability issues around the world, especially when it comes to the way energy is used and corresponding environmental impacts in the form of climate change, global warming, etc. Reduction in household energy consumption is seen as a way to curtail this menace. This paper argues that the issue of household energy consumption and carbon emissions (HECCE) is a complex technical and social phenomenon that needs to be understood from both engineering and social science perspectives. This research used the concept of socio-technical systems as the theoretical framework that underpins the study. The research applied system dynamics as both the methodology and tool to model HECCE. The result is a population of outcomes for the HECCE in the form of space heating, hot water, artificial lighting, appliances, and cooking. The tool produced is an intuitive one with the capability of replicating reality as evidenced from the outcomes of validation done. The sensitivity of different policy levers (occupants' behaviour, insulation level, etc.) is done with the tool. This would go a long way in helping decision makers draw more realistic policies for household energy consumption which is critical to the carbon emissions reductions agenda of the government.

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A system dynamics approach to the expansion of liquefaction capacity in the LNG industry

Capacity and price cycles in capital-intensive industries affect firms' performance and profitability, and there is a need for understanding the mechanisms and dynamics of investment in capacity expansion. We report the main results of the analysis of investment decisions in the LNG industry, specifically in the liquefaction segment. We propose a model in which investors estimate the

capacity needed from their expectations for future demand. This estimation changes as market sentiment encourages or discourages investments. Market sentiment is increased by profitability and is decreased by projects under construction as investors would find stronger competition for allocating their supply According to the results, liquefaction capacity increases until 2030 as a result of increasing forecast of demand and high prices. In the 2010s capacity even overpasses demand expectations due to decisions prior 2011. When investors are driven only by profits of the market, cycles of capacity appear, which agrees with other markets such as electric ones. This result suggests that investors indeed are aware of the likely saturation of the market in the near term. Under low and high prices, industry is still profitable, being those results very similar although model seems to be more sensitive to low prices.

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Evaluation of Alternative Dynamic Behavior Representations for Automated Model Output Classification and Clustering

Automated behavior mode identification and clustering are potentially valuable additions to the analysis toolset of a system dynamics (SD) modeler. The key component for such tools is the feature vector construction; selecting a set of features to represent the dynamic behaviors to be classified or clustered. In this study, we evaluate a set of alternative feature vectors in clustering basic behavior modes encountered in SD practice. As the first case, coefficients of the polynomials fitted to the dynamic behavior are used as the features. In the second case, a given set of curves are fitted to the dynamic behavior, and the degree of fit to these curves are used as the features. The third case constructs feature vectors based on the changes in the signs of slope and curvature of the behavior. In other words, the feature vector represents the original behavior as a sequence of atomic behavior modes. In our preliminary evaluation, the third approach outperformed the former two. Later, we propose a set of extensions to the third approach in order to improve its performance while dealing with oscillatory behaviors. The modified version of the third approach is evaluated to perform better than the original one in clustering both non-oscillatory and oscillatory dynamic behaviors.

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Bayesian Parameter Estimation of System Dynamics Models Using Markov Chain Monte Carlo Methods: An Informal Introduction

While calibration is an important element of the System Dynamics modeling process, traditional calibration techniques exhibit significant limitations. Many such techniques are limited to providing point estimates of calibrated values, sometimes together with information on uncertainty around such estimates. Such techniques also impose assumptions concerning the error distributions and privilege a specific dynamic model structure. Markov Chain Monte Carlo (MCMC) techniques offer a powerful, general, and versatile alternative approach. Bayesian MCMC approaches eschew point estimates, and instead provide a means of sampling from a full ("posterior") distribution of parameter vectors. Such techniques can further express the relative likelihood of different model structures. Finally, MCMC approaches allow a modeler to explicitly specify a general probabilistic model giving the likelihood that observed empirical data would be produced by a certain parameter vector. While MCMC approaches offer strong benefits, it can be daunting for System Dynamics modelers to secure even a basic understanding of the MCMC process, and there is only a small extant

literature concerning applications of MCMC to simulation models, largely using language unfamiliar to most System Dynamics practitioners. Within this paper, we seek to provide a gentle introduction to the use of Bayesian MCMC techniques for System Dynamics parameter estimation.

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Equivalent System Dynamics Model for Reliability Assessment

This paper proposes the use of an Equivalent Systems Dynamics Model (ESDM) to model a Nonhomogeneous Continuous-Time Markov Chain (NH-CTMC). An ESDM represent the Markov Model (MM) by means of the language and the tools of the Systems Dynamics (SD), and the results are obtained by simulation. In this case we used the example of the reliability assessment of a Repairable Multi-State System (RMSS) by means of a (NH-CTMC). In these cases the failure and repair rates are time-varying and the NH-CTMC is needed to be considered. Nevertheless, for these models the analytical solution may not exist and the use of others techniques are required. As an example, an RMSS with three components, failure rates associated with the Weibull distribution and repair rates associated with the Log-logistic distribution is developed. This example serves to identify the advantages and disadvantages of an ESDM to make model a RMSS and evaluate some reliability measures.

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Complexity-Based Gaming Approach to Improve Learning from Simulation Games

This study investigates whether a procedure in which games are played in an increasing order of complexity can improve game performance, conceptual learning, and transfer of learning. Using controlled experiments, we test whether playing simpler versions of a game in increasing complexity improves performance and learning as compared to playing the simpler versions in random order, or repeatedly playing the same complex game without any change in complexity. The results are not in favor of gradual complexity increase in terms of performance and learning, indicating that it is not straightforward to establish a gradual-increase-in-complexity method for improving performance and learning, due to subtleties related to task structure, game procedure and cognitive effects of the playing sequence. Subjects perform slightly better when they are first introduced with relatively simpler versions of a task, and when the complexities of consecutive games are close. Probable factors behind these results are discussed. In depth analysis of factors causing these results is a potential further research topic.

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Flood damage in Bangkok: disaster or an opportunity for creative destruction

We attempt to evaluate the paths to recovery following the devastating floods in 2011 in Thailand, which submerged a large part of the country for five months and severely damaged the infrastructures and the economy. We use system dynamic to simulate the impact of flood and test the performance of post-flood recovery effort. Since most of Thailand's economic activities are located in the capital, we set the boundary of our study to Bangkok metropolitan area. We build on Saeed's model of Schumpeter's concept of creative destruction, which he has posited as fore-runner to Forrester's Urban Dynamics model (Saeed 2010). We

extend Saeed model to subsume the infrastructure aging chains and land constraints of the Urban Dynamics model. We also added to the model mechanisms for taxation and service provision as on ground in Bangkok. We study the damage recovery policies implemented by Thai government as well as those alluded to in Urban Dynamics. We find that encouraging new investment and reducing cost of capital help recovery to some degree. These policies paired with increasing demolition of old infrastructure seem to facilitate the recovery process.

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Perception is more than time delays

In this paper, we look at the way perceptions – a vital component of any decision-making process – are modeled in System Dynamics (SD) models. SD models include perceptions as a factor translating actual into observed conditions. System dynamicists assume that true conditions are not available to decision makers and thus, should not be used directly in decision policies in a model. Instead perceived conditions are used. Typically, perception is modeled by using an information delay that represents time delays inherent in forming perceptions. Perception formation, however, entails more than just time delays. In this paper, we aim to broaden the definition and use of perception in SD models by paying attention to the possible roles heuristics play in perception formation. We present a generic structure that can be used to model several heuristics. We present three examples: availability heuristic, recency/primacy effects, and selective perception. We conclude that this structure may be used in combination with information delays to capture a broader range of perception errors in human decision making, in SD as well as other OR approaches that pertain to model human behavior and decision making.

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The shift to land value taxation: A tale of a different future

In the midst of the current crisis, initially sparked by a housing bubble in the US, tax reform proposals become ever more relevant. The present paper elaborates one such proposal by means of qualitative SD. It makes the case the benefits of shifting tax from property to land value. It presents the current and an alternative land value tax system structure, it compares them and draws practical repercussions for energy consumption of the modern building stock which is a driver of final primary energy.

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A System Dynamics Approach on Green Car Diffusion Strategy and the Korean case

The research is to identify important diffusion factors and their effects on green car diffusion process using system dynamics perspectives and a causal-loop analysis. First, we briefly investigate Korean government's effort to promote green car diffusion and the increase of green car in the country. And then, through a deep review on previous research, we have found the important factors of green car diffusion process. Price, driving range, network effect, recharge system, fuel cost had important facilitation on consumer attraction and green car diffusion. Based on the review, we have constructed a causal loop diagram explaining hybrid car diffusion process. We have found 3 important reinforcing loops in the causal loop diagram. Loop for learning & economies of scale(supply side), loop for network effect(consumer side), and loop for battery development(technology side) had most significant roles in the whole diffusion process. Through a

deliberate analysis on the 3 causal loops, we have found meaningful results. First, there seems to exist a critical mass in the diffusion. Second, of the 3 loops, the battery technology had most significant role. Third, sales, not consumer installed base, must be a standard to decide whether the critical mass is achieved or not. Based on these findings, several meaningful implications are suggested for the government and corporations related to the green car industries.

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Empirical Study of Design-Construction Feedbacks in Building Construction Projects

Understanding project dynamics is one of the core application areas for system dynamics. Despite a long tradition of modeling the interactions between multiple phases in a project model, the strength of these feedback mechanisms have not been rigorously estimated. In this article we take a step towards addressing this shortcoming by estimating the feedback relationships between design and construction phases of construction projects. We estimate the parameters of three hypothetical feedback relations between design and construction with data 15 construction projects. Consistent with previous qualitative evidence, the estimated factors reveal that undiscovered design rework diminishes construction quality and production rate significantly and construction completion speeds up the detection of undiscovered design rework. We also assess the predictive power of our model using another set of 15 empirical cases. The model showed excellent fit to the calibration data calibration and good prediction in validation.

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The Marijuana Market in Mexico: A System Dynamics Perspective

The problem of drug trafficking in Mexico and its side effects has led the government to take serious measures regarding drug trafficking. The results of these efforts on policies, initiated back in 2006, have made it clear that it takes a holistic approach to the cartel-related phenomenon. The present work aims to provide information about the financial dynamics of the marijuana market operated by the Mexican cartels, and the possible impact it could have in both the United States and Mexico strategies related with the market control. A dynamic model is used to identify the financial impact of the cartels, and the results are presented through a set of scenarios.

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An Overview of the Biomass Scenario Model

Biofuels are promoted in the United States through aggressive legislation as one part of an overall strategy to lessen dependence on imported energy as well as to reduce the emissions of greenhouse gases. Meeting mandated volumetric targets has prompted substantial funding for biofuels research, much of it focused on producing ethanol and other fuel types from biomass feedstocks. A variety of incentive programs (including subsidies, fixed capital investment grants, loan guarantees, vehicle choice credits, and aggressive corporate average fuel economy standards)have been developed, but their short-and long-term ramifications are not well known. This paper describes the Biomass Scenario Model, a system dynamics model developed under the support of the U.S. Department of Energy as the result of a multi-year project at the National Renewable Energy Laboratory. The model represents multiple pathways leading to the production of fuel ethanol

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as well as advanced biofuels such as biomass-based gasoline, diesel, jet fuel, and butanol). This paper details the BSM system dynamics architecture, the design of the supporting database infrastructure, the associated "scenario libraries" used in model runs, as well as key insights resulting from BSM simulations and analyses.

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Cycles in Casualty: An Examination of Profit Cycles in the Insurance Industry

Aggregate earnings for the property-casualty insurance industry have exhibited cyclical behavior for decades. I develop a dynamic model of the insurance industry with endogenous premium setting, risk aversion, and other feedbacks; and use the model to identify strategies to mitigate the cycle. In addition to documenting a model, the paper showcases strategies for building confidence in system dynamics models when only some quantitative data is available. Using these tests I suggest that the premium setting process is fundamentally important for determining the stability of insurance industry pro fits.

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Re-Scaling the Parents as Teachers Program in Missouri

The Parents as Teachers program in the State of Missouri has begun a re-scaling effort to serve families through a more holistic approach by ensuring all components of their evidence-based model are implemented by each Parents as Teachers affiliate. Parents as Teachers seeks to help families by training and certifying parent educators who deliver monthly or bi-monthly home visits to families participating in the program. The program is open to families who are expecting a child, and it supports families until the child enters kindergarten. The Parents as Teachers model described in this paper supports the re-scaling efforts by the Parents as Teachers program and offers insights into the complexity of this issue and what the next steps might be for the Parents as Teachers program.

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Developing Capacity for Systems Thinking in Schools

The Systems Thinking in Schools programs, funded and supported by the Waters Foundation, serve to build systems thinking and modeling capacity in teachers and students nationwide. Because the field of systems thinking in education is so new and substantive research findings are limited in scope, there is a need to expand programs to gather evidence of improved learning outcomes. Before more research can be done towards measuring learning outcomes, there is a need to understand the barriers for both new Systems Thinking in Schools movements being initiated, and for established programs maintaining support and capacity. To best address this discrepancy in understanding, the author finds it most productive to create visualizations of the situation with the help of stakeholders and literature. Through a system dynamics framework, the author will be working to construct a case study, series of models, and Handbook for Replicability to address this gap for schools looking to include systems thinking in their curriculum and programs.

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Small SD Models for BIG ISSUES - The Book

This paper presents a new SD e-book with 100 cases and many online resources. It was developed for teaching and testing large introductory and intermediate SD courses and blended collaborative online learning, but could also be used for hands-on self-teaching. It allows anybody determined to acquire basic quantitative SD modeling skills to do so in 50+ hours. From day one on, students are supposed to make models, simulate them, analyze and interpret their outcomes, and use them to design adaptive policies and test their robustness. Models relate from day two on to real current dynamic issues. There is one basic learning path and ten different theme related learning paths (housing policy, energy transitions and resource dynamics, wildlife and ecosystem management, health and drug policy, risk analysis and crisis management, criminality and policing, education and innovation, management and business, and economics and finance). Those interested in just one of these application domains can acquire these skills by practicing only with cases within their domain of interest. The why, what and how questions regarding this e-book are addressed, fully hyperlinked learning paths are proposed, and examples of exercises and cases are provided. The e-book is offered free of charge and provisions are made for others to join this initiative.

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Model-based Policing to Fight High Impact Crime

This paper reports on a System Dynamics simulation project for the Dutch police. The aim of the project was to increase the effectiveness of their fight against high impact crimes, especially robberies and burglaries, through model-based decision support. The model developed for this project is used for multiple uses, namely to (i) support meetings of Chiefs of Police with regard to real world police interventions by allowing them to virtually discover un/intended consequences of these interventions through an online interface; (ii) test the effectiveness of suggested interventions under deep uncertainty, i.e. given thousands of plausible scenarios, as well as to identify real-world pilot studies that would be needed to reduce key uncertainties regarding the effectiveness of police interventions; and (iii) monitor and compare the effectiveness of real world and virtual interventions in order to improve formal and mental models regarding high impact crime system. Additionally, four teaching and testing cases on burglaries and robberies are provided in the appendix.

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Doing more with Models: Illustration of a SD Approach for Dealing with Deeply Uncertain Issues

Many grand challenges are both dynamically complex and deeply uncertain. Combining System Dynamics with Exploratory Modeling and Analysis allows one to generate, explore, identify and analyze all sorts of plausible scenarios related to such issues, and design and test adaptive policies over many scenarios. This paper explains and illustrates different uses of the resulting computational System Dynamics approach by means of an applied case, the outbreak of a new flu strand like the 2009 A(H1N1)n flu. First, we illustrate the use of this approach for generating and exploring different types of plausible pandemic shocks. Second, we illustrate the use of machine learning techniques to analyze contributions and effects of uncertainties, and discover and select scenarios.

Finally, we illustrate the use of this approach for supporting the design of robust adaptive policies in order to be prepared for any new flu outbreak, especially those that really require action.

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Anticipating Future of Android: Role of Quality Gate Keeping

Android is currently the fastest growing mobile platform. But is the growth sustainable? In a platform users and developers feed each other through a virtuous cycle of network effects. Initially, a small number of quality applications attract users. With user growth developers join in to reap benefits. Growth beyond a point activates balancing forces of questionable quality and results in slowdown and bust. To the gatekeepers, quality threshold is a handle to control the speed of growth. This paper builds a system dynamics model of Android platform where growth enabling forces and balancing forces are represented. It is calibrated with real life data. Policy experiments are carried out with different quality thresholds. These demonstrate that a loosely regulated ecosystem enables initial growth. However when users prefer quality to quantity, as applications are available in plenty, the ecosystem needs to be tightened up to ensure sustained growth.

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Study of Information Spreading on Micro-blogging based on SEIR model

Micro-blogging has become an important channel for information spreading nowadays. In this study, we build a system dynamics model to investigate the mechanism of information dissemination on micro-blogging. The model is an extension of the traditional SIR model considering the feature of micro-blogging and its users. We gathered the data from Sina micro-blogging for the case of a school bus accident happened in Nov 2011. Data shows that new posts and forwarding posts outbreak quickly after the accident. The number of new posts and forwarding posts both peaked on the second day, and then gradually reduced. Six days later, the number of posts stabilized at a relatively low level. We use the data to calibrate the SD model and then studied how different parameters affect the spread of information. We found that infectivity not only affects the speed of information spreading but also affects the wide-spread of information. Increasing the hesitation rate (change from infective state to exposed state) greatly hinder information spreading.

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System Dynamics Based Simulation for Airport Revenue Analysis

Under increasing competition and pressure for financial self-sufficiency, airports have adopted various strategies. This paper presents a System Dynamics simulation model exploring relationships between airport, airline, and passengers through fares and fees. The case study is a small to medium size international airport (Perth, WA), fully private and light-hand regulated and the model investigates two scenarios of airport charges for two routes where five airlines operate. The changes in airport fees affect differently the airlines and the cumulated aeronautical and non-aeronautical revenues confirm the two-sided view of airport operation.

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System Dynamics and stock markets

This paper presents an analysis of the behaviour of a stock market; the London stock exchange main market as expressed in the FTSE 100 index. The paper examines the main features of the literature relating to the academic and practitioner views on market behaviour. One of the main pillars of current academic understanding of stock markets, the efficient market hypothesis, is examined and tested. A novel variation on a known flaw in the efficient markets hypothesis is examined; the sub-Monday variation on the Monday effect. Using actual data this variation is tested and found to be in violation of the efficient markets hypothesis. The paper describes two index/market designs; one with actual data and one with hypothetical data. Limitations of system dynamics models in data rich environments are illustrated. The models presented here are put forward as prototypes for the development of further stock market simulations. This paper presents a proof of concept that cyclical behaviours exist in stock markets and that stock markets are therefore amenable to analysis using the system dynamics paradigm.

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Modelling the Raw Water Demand of a Dry-Cooled, Coal-Fired Power Plant: A System Dynamics Approach

South Africa is a country with limited and deteriorating quality of fresh water resources. Eskom, being the key supplier of electricity to the country, is the single, largest user of these precious water resources. Consequently, it is imperative that the organisation fully understands its long-term water supply and demand; with regards to quantity, accessibility and quality; for planning purposes to ensure that the security of water for electricity needs is met and to respond appropriately to the water crisis in South Africa. In modelling the long-term raw water demand, a system dynamics approach was favoured as a result of the ability to model, to an optimum level of complexity, the dynamic trends in water demand over life of the plant, without losing the ability to follow causality between system parameters with time delays. Water mass balances for a 4,800 MW dry-cooled, coal-fired power plant were constructed across every process utilizing water and, every water source and sink. Upon varying rainfall; coal quality; thermal efficiency; auxiliary power consumption; demineralized water recovery and consumption rates; third party water usage and, employing flue gas desulphurization technology and other water saving measures, efficient use of water at the plant to reduce raw water demand was simulated.

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Estimation of Unknown Parameters in Dynamic Models Using the Method of Simulated Moments (MSM)

We introduce the Method of Simulated Moments (MSM) for estimating unknown parameters in dynamic models. The MSM is useful when there are empirical data related to the behavior of different entities and error terms do not follow any well-established distribution. Statistical moments such as mean and variance of empirical data can be matched against the moments of model-generated data in order to estimate some structural parameters of the model. The major value of the MSM for estimating dynamic models is in its flexibility to be used with any type of data, including cross-sectional data, to estimate dynamic models.

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Supply-Chain Transparency and Governance Systems: Market Penetration of the I-Choose System

In this paper we explore the impacts of key characteristics of Supply Chain Governance Systems in the development and diffusion of technology innovations that promote supply chain transparency. The preliminary model presented in this paper was developed following group model building methods. Our current simulation experiments reveal that the market resists "take-off" unless external financial support can be found. Additionally, "take-off" dynamics of the system are dominated by marketing budgets and external support for infrastructure. Marketing budgets drive how fast users adopt the system, and without external sponsorship of system, the final market collapses. Finally, the quality of governance –reflected in information completeness, openness, relevance and reliability– and the resultant trustworthiness of information determines final sustainable market share.

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2052 – A Global Forecast for the next Forty Years Using a Mix of Models

The book 2052 – A Global Forecast for the next Forty Years (Randers, 2012) contains just that: A description of what the author sees as the most likely scenario for global population, economy, climate gas emissions, and resource use over the next forty years. This paper describes the method used to arrive at the 2052 forecast. Building from the original Limits to Growth World3 model, the focus shifted to future climate gas emissions, as this appeared to be the tightest planetary constraint. Because of the likelihood of wildly different developments in different parts of the world, forecasting region by region was done using a spreadsheet model for each of 5 regions, with feedback among the regions done by manual iteration. External models were then used to calculate the resulting temperature change, the effect of climate change on agriculture, and the ecological footprint. Additional manual iterations followed before the results were checked against a World3-like model with explicit energy and climate sectors. The paper elaborates the weaknesses in this procedure, but argues that it is still possible to arrive at a credible forecast for the global development in the climate and resource area over the next forty years.

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Effects of Aging Resources on Firm and Industry Dynamics

Mainstream strategy scholars have long recognized the importance of stocks ("resources") in explaining firm growth and performance. Under the label of the Resource Based View (RBV) of strategy, strategy researchers have been

consumed with several questions about stock accumulation. Surprisingly, the literature has done little to evaluate how the value (not just the amount) of these accumulated stocks rise or fall endogenously over time. In this paper, we show how the simple aging chain model provides a general structure that can extend and strengthen the RBV by organizing existing system dynamics insights about resource aging and by teasing out unexplored implications of resource aging for firm and industry dynamics.

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A new Hybrid formalism that Integrate Different Simulation Approches to Develop a quantitative tools to support Decision Making

Decision Support System (DSS) is a system software to support decisions and to allow an effective analysis improvement. DSS support all people that have to decide about strategy in particular complex contest in which for human may be difficult establish what is the best choose, or what is the best decision-making strategy to carry out to achieve the objective. A fundamental step is the system conceptual model building. In simple problems basic mathematics is enough. In more complex problem it is impossible to manage the mathematic solution and for this reason the simulation is used. Scope of simulation is to schematize reality reflecting it faithfully. It can be discrete or continue. In the first case, dependent variables change discretely for particular time values simulated, in the second case dependent variables can change in continuous manner during the simulation range. Into this article we proceed by steps: in the first section literature review will be shown, referring literatures that have already shown this themes; in the second section we will proceed analyzing the integration among different models and, consequently, the building of model for simulation importance; in third section there will be a focus on simulation concept and difference between discrete and continuous simulation.

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A System Dynamics Study of Uranium and the Nuclear Fuel Cycle

A system dynamics model of the World uranium market for the period 1988 to 2048 has been developed. Analysis illustrates some of the key features of the market for this commodity, including the role that time lags play in the formation of price volatility. Various demand reduction and substitution strategies and technologies are explored, and potential external shocks are simulated to investigate how price and the associated industry respond. Sensitivity analysis of key model parameters indicates that the time constant related to the formation of traders' expectations of future market prices embedded in the proposed price discovery mechanism has a strong influence on both the amplitude and frequency of price peaks. One particularly timely scenario simulated is the possibility of the ending of the "Megatons to Megawatts" program, in which the USA agreed to buy uranium from former Soviet nuclear warheads for use in power production. This agreement has not been formally renewed and we find that in the absence of new substitute sources this could cause a significant rise in uranium prices. Finally, our analysis leads us to believe that uranium resource scarcity will pose a problem until the second half of the twenty first century at the earliest.

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Abstract System Dynamics and its Application to Corporate Governance Analysis

Comparing a decision taken by a group to an elementary feedback loop, the paper proposes a typology of group decision-making, by distinguishing whether the input, output and feedback are provided by individuals or by groups. The paper suggests that this can constitute a framework for evaluating the functioning of the corporate governance of a firm.

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Adapting 'Agility' to Healthcare Service Delivery

Agility is a fundamental characteristic of successful supply chains faced with volatile and unpredictable demand, and has been suggested as a promising new paradigm for improving healthcare delivery. Agility is an organization-wide capability that seeks to improve overall responsiveness to customer demands, synchronize supply to demand, and cope with uncertainty. However, even if many conceptual models of agility are available, extant literature fails to clearly delineate how 'agile' can be applied in healthcare services and to what extent healthcare systems can benefit from these approaches, nor are there comparisons to current healthcare system redesign paradigms. Given the resource constraints in most hospitals, it is useful, if not critical, to develop a good understanding of how, and to what effect, the agile paradigm can be applied in healthcare. We test specific agile operational practices in a simulated healthcare environment using system dynamics modeling, establishing the comparative effectiveness of changes to system structures that promote market sensitivity, demand information sharing, and centralized planning. This study provides healthcare managers and policy makers with concrete guidance to improve system performance through adopting agile practices, and opens a new area for service supply chain management research.

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Simulation of Transitions Towards Emission-Free Urban Transport

This article presents a simulation model that depicts transport user choice in urban areas among different types of private cars and public transport. The model is used to examine the effects of different policies to aid reduction of greenhouse gas emissions. Simulation results reveal that policies directed towards the adoption of new private car technologies and towards public transport cannot be analysed separately. Policies must be designed in unison in a way that they work well together and do not undermine each other's effects. For example, policies targeting electric car adoption may reduce public transport ridership and not advance the overall vision of emission free transport.

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Employment-Centred Stabilisation Policy Propelling the Economy to "Escape Velocity"

The paper refines and generalizes the Fanti and Manfredi Goodwinian model with delayed profit-sharing allowing capital investment lower than profit. Although periodic dynamics arise via simple Andronov – Hopf bifurcation for large "humped" delays, the opponents' proposition that the wage-profit indexation triggers persistent economic cycles is incorrect. The paper reveals detrimental effects of the profit-sharing rule for economic reproduction in the long run even when it alleviates oscillations. This paper revises the equations for profit-sharing and bargained wage terms from the opponents' model in two encompassing non-linear four-dimensional models. The previous model enabled extreme condition tests for them. In the first, before second-order delay is added, a growth rate of profit is proportional to a gap between the indicated and current employment ratios. This policy rule with a great margin of safety stabilises capital accumulation being fuzzier for stretched "humped" delays. In the second model, deviations of employment ratio and delayed profit rate from their stationary magnitudes define net change of relative wage. This proportional control already present in the first model is reinforced in the second shortening a transient to a distant target employment ratio. Parametric optimisation for both models is supported by Vensim.

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Modeling and Comparing a Startup Dynamics in the US and Egypt

In today's world startups are playing a key role to stimulate the economy, and create fulfilling employment opportunities. However, the failure rate of startups in the US, a prominent country in encouraging startups, has been eight out of ten, a very high proportion. In this paper, I explore this topic further with a hypothesis that company's sustained success depends not only on its financial growth, but also its dynamic ability to continuously fulfill its key stakeholders' needs and aspirations, and its ability to adapt to the specific conditions of its evolving ecosystem. This paper provides a holistic, system-driven conceptualization of a startup and its internal dynamics from human resources, product development, customers, and financials perspectives. I develop a System Dynamics model to represent these internal dynamics and simulate it over a period of five years. In addition, I bring in the impact of exogenous factors from the entrepreneurial ecosystem as a "second layer" of variables in the entrepreneurial model. I then compare and contrast the US and Egyptian cases. A significant difference in final Firm Valuation and Job Attractiveness was observed. I conclude with a discussion of the high leverage points in the Egyptian ecosystem based on this analysis.

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Three slices of Jay Forrester's general theory of economic behavior: An interpretation

This paper defines the unique contributions Jay Forrester made to economics through his system dynamics models that emphasize pursuit of operational goals in every day decisions rather than meeting the abstract criteria of rational expectations. In particular, the paper attempts to reconstruct his distinctive explanations of economic cycles over the course of his National Modeling Project, whose details appear in PhD theses, occasional papers, and internal

records of the MIT system dynamics group but have not been published in a succinct form and are not widely known especially by the newer vintages of system dynamics practitioners.

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A Risk-based Evaluation of Policies for Sustainable Water System Design in the Kingdom of Saudi Arabia

Stakeholders in the Kingdom of Saudi Arabia are concerned about the sustainability of the country's water system. The Ninth Development Plan (2009-2014) formulates a number of policy directives to make the water system more sustainable. Assessing whether these policies can improve the degree of sustainability of the water system is a challenge because it is linked with many economic sectors, and characterized by a high degree of uncertainty. Conventional techniques of assessing water system performance do not reveal system wide impacts of water system policies, either on the supply- or the demand-side. This paper presents an approach and some preliminary results in evaluating policies to assess their degree of sustainability. A multi-generational comprehensive wealth framework captures the notion of sustainability across the economy, which the analysis applies partially for water system assessment. By including uncertainty formulations in a system dynamics model, the analysis provides a risk-based view of water system performance showing that policy impacts under uncertainty are likely to be very different than those expected in deterministic planning scenarios.

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Transport, Energy and Emissions Interaction – A Systems Approach

Fuel usage in Transport Sector of India is bound to increase by 87% in 20 years with a decrease in available diesel stock and increased demand. The contribution of Vehicular Pollution to Urban Air Pollution was 90% in 2010. In order to eliminate these risks the interaction between Transport, Energy and Emissions sectors should be studied in detail which has been carried out in this study based on Systems Dynamics principles. The major objective of the work is to study and appreciate the existing Transport demand and supply in Chennai city, to procure data through inventory on energy requirement and emissions from transportation sector and build an SD model using STELLA to determine the Energy requirement and Emission levels from transport sector in the year 2026. When the existing growth trend was assumed to continue over the horizon year it was found that Public Transport and Personalised modes contributed to 18% and 80% of the total trips respectively with about 300% increase in Fuel demand. A scenario of augmenting Public Transportation and simultaneously restricting growth of personalized vehicles showed a substantial decrease of nearly 65% in Energy consumption and nearly 50% reduction in Emission levels from the latter.

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Knowledge analysis in coupled social-ecological systems

Climate change will lead to significant yield reductions in maize dominated farming systems in sub Saharan Africa. Agriculture in this region thus faces the challenge of undergoing considerable transformation in order to adapt to climate change and become more food secure. Stakeholders who are directly affected by the challenge to adapt to changing conditions, however, neither have an overview

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of existing adaptation options and their impacts, nor do they have sufficient knowledge for prioritizing and implementing these options. This paper proposes a methodology for evaluating stakeholders' knowledge of and learning in complex dynamic systems such as agri-food systems. This methodology emphasizes the analysis of how stakeholders affected by climate change and food insecurity perceive the current situation, how they acquire new knowledge in the course of a system dynamics-based intervention and how their existing knowledge hinders or contributes to the acquisition of new knowledge. In a pilot study, we apply this methodology to the case of agri-food systems in Burkina Faso and we report on data about stakeholders' conceptions about the challenges offered by climate change and the effectiveness of different policy options to meet these challenges.

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Freight Vehicle Circulation Restriction Policy in an Emerging Country Metropolitan Area: undesired impacts

The objective of this study is to investigate the long term effects of freight vehicle circulation restriction policies in the Sao Paulo metropolitan area. The analysis will encompass the impacts of this policy in the congestion level as well as the transportation costs. The findings showed that the freight vehicle circulation restriction policies fail to reduce its impacts on the congestion level and causes an increase in the transportation costs. Alternative policies, like the implementation of a urban logistics platform, were pointed as more effective to reduce the traffic impact of freight vehicles and were capable of reducing transportation costs.

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Simulating Government Policies for the Ethanol Market in Brazil

Sugarcane ethanol is now established as an important component in the Brazilian energy matrix. This status was achieved through a long lasting, expensive incentive program that started in the 1970s and with ongoing research and development. But the industry has had ups and downs and during 2011/12 it went through a major crisis with a shortage in supply, surge in prices and a shift in demand from ethanol to gasoline. This paper explores recommended policies by the government to deal with this and future crises. A System Dynamics model is used to replicate the current and possible future scenarios and to test appropriate strategies. The simulations show that a policy to allow gasoline prices to grow, adjusting to international prices, would have a highly positive impact for the industry while also contributing to public savings. The dosage of the policies can be tested under different scenarios with the presented model and flight simulator.

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Case study: Scenario and Risk Analysis in the Pulp Industry using System Dynamics and Monte Carlo Simulation

Similarly to those of other commodities, pulp prices are highly volatile. In such a capital intensive industry, with high operational risk, proper assessment of future possible scenarios for pulp prices is fundamental for investors' financial planning. Building excessive capacity can be dramatically harmful for the entire industry. This paper describes a case study where a system dynamics model and flight simulator were used to generate expected scenarios for pulp prices as a tool to

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support investment decisions. More specifically, a Monte Carlo simulation running on top of the SD model provides a range of expected values for prices in different time horizons with pre-defined confidence levels. Even though the model and specific results cannot be fully disclosed, the paper describes a methodology and techniques which can be applied in several similar problems involving risk analysis and system dynamics applications.

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Absent or distant? On the use of indirect causal links and chains of causal links to compare mental models of dynamic systems

The subject of articulating and comparing mental models of dynamic systems has been present in system dynamics since many years now. Methods have been borrowed from other disciplines and been adapted to the specific needs of system dynamics. They all focus on variables and causal links, and most recent ones include feedback loops. However, this focus has problems to deal with differences stemming from different degrees of aggregation. Here it is proposed to insert chains of causal links as level of analysis. A simple example is used to show how this can be done; first a reference model is defined with a standard length for each causal chain; then a distance matrix representation of causal diagrams is used and two new indicators – relative length difference and relative content difference – are shown to provide useful information for interpreting different levels of aggregation in the causal connection between flows and stocks.

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Learning objectives for successive development stages of system dynamics competency

The system dynamics field has a need for defining what one needs to know and capable of doing to ne a system dynamicist. This paper builds on previous steps taken in order to elaborate a shared definition; it adopts the methodological orientation of stage-wise competency development from beginner to competent. It also uses Bloom's taxonomy – a widely accepted reference framework – to articulate an organized set of learning objectives. A Delphi process has been designed to exploit the knowledge and experience of a set of system dynamics experts use their contribution to obtain a clear statement concerning the learning objectives for beginners, advanced beginners, competent and proficient (practitioner). The resulting ordered and classified set of learning objectives is a necessary, though not sufficient, step towards a shared standard for system dynamics instruction and training. Building on it, standard activities and materials, as well as certification devices can be designed and developed.

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Exploring the mutual benefits of collaboration with Concept Mapping – preliminary results and some puzzles

Concept mapping (CM) is a field which initiated in educational research and expanded into educational practice and knowledge. CM often deals with complex subjects from science, economics and management, where system dynamics (SD) is also present, and its proponents have developed rigorous methods to analyze and compare such maps. We have compared the use, the structure and the

comparison methods between CM and SD and identified conceptual compatibility and some methodical complementarities: SD diagrams of mental models of dynamic systems (MMDS) can be interpreted as CMs and CM comparison methods for large samples can be applied in MMDS research; also the rigour of SD modelling can become a vehicle for integrative reconciliation of knowledge and thus SD can become a relevant tool for educational researchers. We show these aspects on a conceptual level and using a simple illustrative example. We conclude by proposing some relevant research questions.

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Participatory Modeling in Environmental Systems: Learning from the System Dynamics Tradition

Participatory modeling has grown in popularity in recent years as a tool to investigate environmental systems and generate consensus among stakeholders around environmental problems. System dynamics has one of the longest track records of any modeling field of incorporating stakeholder input into model-building, and therefore has much to offer the growing field of participatory modeling. However, there are key differences between organizational and business systems, from which most of the system dynamics literature on participatory (or group) model-building derives, and environmental systems. These differences include: more variation in stakeholders' goals and desired outcomes in environmental systems; less feasibility of assembling relevant stakeholders; greater temporal and spatial scale of the problems encountered and more exogenous drivers; more difficulty in collecting information relevant to the problem; and a greater need for specialized and scientific knowledge about the system being modeled. Participatory modeling efforts around the environment, whether using agent-based modeling, system dynamics, scenario development, or other methodologies, would benefit from the lessons contained in the system dynamics group modeling literature while taking into account the need for longer group processes and more involved data collection efforts that may arise with environmental problems.

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Effects of Illustrations, Specific Contexts, and Instructions: Further Attempts to Improve Stock–Flow Task Performance

Although we face a multitude of complex dynamic systems every day, there is empirical evidence that even simple ones such as stock–flow (SF) systems are extremely difficult to understand. Based on different theoretical approaches and on previous findings in educational and cognitive research, the current study investigated two approaches to improving performance in SF tasks: invoking valid mental models and building new suitable mental models. In two experiments, the effects of net-flow data illustrations, supportive chart representations, selected contextual scenarios, and two adapted educational methods (informative instruction and induced discovery) on SF task performance were empirically tested. Results indicate that none of the approaches led to increased SF task performance. However, gender and mathematical skills were found to be valid predictors of task solutions.

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Evaluating long-term impact of qualitative system dynamics workshops on participant mental models

Several studies that describe group model building interventions assert that these interventions can produce new insight. No previous study has examined whether these new insights are enduring. This paper reports on evaluation of four qualitative system dynamics interventions conducted 12 months after the interventions. The interventions each consisted of a three hour workshop followed by a two-hour workshop one week later, to plan strategy implementation initiatives in a government department. A change of circumstances meant that the workshop conclusions were not implemented. Statistical comparison of work samples from immediately before and after the workshop, and twelve months later, suggest that participants views on the workshop topic changed through the workshop process, and that these changes were enduring even in the absence of reinforcing activities.

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Visual integration with stock-flow models: How far can intuition carry us?

Doing integral calculus is not easy for most students, and the way it is commonly taught in schools has attracted considerable criticism. In this paper we argue that stock–flow models have the potential to improve this state of affairs. We summarize and interpret previous research and the results of some of our own studies to explore how an intuitive understanding of (and teaching) integral calculus might be possible, based on such stock–flow models: They might be used for doing "visual integration" without calculations. Unfortunately, stock-flow tasks themselves seem to be quite difficult to solve for many people, and most attempts to make them more intuitive and easily solvable have not met with much success. There might, however, be some potential in using animated representations. In any case, a good starting point for students to eventually be able to perform visual integration in an intuitive way and to arrive at a deeper understanding of integral calculus seems to be to present flows as a succession of changes in stocks.

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Poultry Supply Chain: A System Approach

Supply chains of individual farms linked with final market via intermediate companies are becoming a normal business phenomenon. Yet at present, it is not clear that how such supply chain networks can achieve stability/sustainability in terms of structured network to gain benefits, meeting demand, supply and highest productivity. This quantitative study investigates these questions using a Poultry Breeder production process simulation model and its forward and reverse chains. The model was developed in a system dynamics simulation environment using design science methodology. Model analysis shows that intricate poultry supply chains behave inconsistently over time to meet market demands. This paper also focuses on poultry unused wastes. The objectives of this study are to find out social, economic and environmental benefits through forward and reverse poultry supply chains.

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A model-based study and policy analysis of Domestic Violence and Sexual Harassment against Women and Children

This paper addresses the pervasive problem of sexual harassment and domestic violence against women and children. Following a brief introduction to the scope and consequences of sexual harassment in different regions, this article focuses on the current situation in Egypt. To gain insight on the effects of the different policies proposed in the Egyptian context, a System Dynamics model is used. First, a policy analysis is performed on the 'quick and dirty' simulation model and then the preliminary results are tested under uncertainty. The main conclusion is that reduction on the side of the offender is of significant importance, but comparatively time consuming and therefore not sufficient.

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Eco-Eco-System Dynamics

The United Nation's promotion of Sustainable Development Goals (SDGs) requires researchers and practitioners in the planning and policy making community to take fuller account of dynamic interactions. Rio '92 and the Millennium Declaration supported "integrated assessment models" for long-term policies. Most work still relies on economic framework (e.g. Stern Report) which incorrectly monetize environmental and social variables and obscure the dynamics of natural resources essential for economies and societies to function. The global economic ecosystem's complexity requires an integrated, multidisciplinary, systemic approach to make better sustainability policies. System Dynamics provides an ideal basis for integrated, multidisciplinary models by incorporating real world causal relations, cross-sector effects, resource stocks in addition to flows, and long-term effects of policies and assumptions. It must be used more extensively to generate sustainable economic policies that take account of externalities, avoid theoretical relations, give politicians an integrated long-term outlook, and take account of the interactions between the economy, society, and ecosystem. System dynamic modeling must address these relations more completely; convince more people to use these models; and convey the results to politicians. The Millennium Institute's Threshold21 model includes analysis of SDGs and sustainable development strategies -- a major step towards eco-eco system dynamics.

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An Analysis of Mental Process within Construction Workforces for Project-level Safety Management

Safety management parts can be classified into Environment-based Safety Management (ESM) and Human-based Safety Management (HSM). To attain a desired safety level, improving both parts is required. The current safety management, however, is conducted focusing mainly on the ESM, not on the HSM. In order to conduct balanced safety management, a mental process model to support the HSM is a requisite. Thus, this study presents a mental process model which explicates how a worker makes a decision on safe behaviors. The model consists of three sub-models: Model for Worker's Decision-Making on Safe Behavior, Model for Optimistic Recovery, and Model for Habituation. This study has provided a better understanding and a logical basis for the HSM.

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Go Big or Go Home: How to Build Large-Scale SD Models

When Dr. Jay Forrester developed System Dynamics in the mid-50's, physical limitations of computer memory and storage necessitated creating simpler models capturing high-level dynamics at the expense of fidelity and realism. Those limitations no longer exist, yet the overriding philosophical view of SD practitioners is on simple models providing "insights" into system behavior. The authors of this paper feel it is time that the community of practitioners turn SD into a true analytical approach and move toward large-scale models capable of representing the true dynamics of the system of interest. Moving from small to large models requires a shift in thinking about how models are constructed, exercised and analyzed. This paper showcases work by the authors that make truly large scale SD models practical.

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A system dynamics approach to assess the impact of policy changes in the Icelandic demersal fishery

Seafood is of great importance in the Icelandic economy and in 2010 the fisheries sector and related industries contributed 26% to GDP. The main stocks in Icelandic waters are controlled with individual transferable quotas. Permanent quota shares in the Icelandic demersal fisheries are allocated into two segments the so-called large ITQ-system that applies to all species and all vessels are eligible in the system which accounts for approximately 83% of total demersal catchers. The other segment, which is the case study presented in this paper, is the small boat hook system where only vessels smaller than 15 gross tons and use longline or hand line as fishing gear and accounts for about 15% of total catchers. In this paper we show how the system dynamics approach is used to model an simulate changes in the management of the fisheries and the impact of these changes on chosen performance indicators.

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Extending Opinion Polls through the Combination of Analytical and Simulation Models

This paper describes a method for extending the accuracy of opinion polls by combining a simulation model with text analysis. Opinion polls are an important tool for gauging how societies interpret issues ranging from elections and policy to uprisings and regime change. While such polls produce detailed data, they are also costly and take time to field. The "Arab Spring" uprisings highlight the challenges this lag creates when governments collapse more quickly than the time required for polling and analysis. In relation to this rapid change is the rise of social networking and the instantaneous information it provides. Yet research indicates that opinions expressed in social media are often not representative of societies as a whole. To integrate these two very different data sources, we use events extracted from media to perturb a simulation of representative agents that were initialized using a prior poll. Agents update opinions using equations developed in a system dynamics model of social identity theory's bounded confidence. We then evaluate the model's performance using longitudinal opinion studies. Preliminary results suggest that the integrated results offer improvements over the sources used in isolation, which may help leaders do better at anticipating important societal changes.

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Third Generation University Strategic Planning Model Development

The paper discusses implementation of a research that is aimed at development of a simulation model which would allow analyzing different development strategies of the third generation university. Small countries' universities have limits of growth. The problem can be solved with a new approach to university role. The third generation defines university as innovation generation, transfer and implementation center, while maintaining the traditional university functions. The 3G university activities change number of innovative companies in the country. With growth of the number of innovative companies, potential researches and innovation customers' amount grow. With time the amount of conducted research and developed innovative products growth. Innovative products and technologies is the basis of university competitiveness in the 21st century. Universities must develop, accumulate, implement and get benefits from innovative products and technologies.

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Organisational Flexibility : a simulation model

Several theoretical and empirical studies identify main components of Organisational Flexibility (OF) and show the relations between most of them. However, comprehensive modelling of these interrelations and the consequent simulation of several strategies of organisational change incorporating the time-varying dimension remains a challenge. This article presents a simulation model of the OF level when change strategies are implemented confronting several states of environmental turbulence. Two models have been developed to allow patterns of behaviours to be analysed in a simulation environment. The first model represents the translation of an existing theory. New understandings about the original theory were generated that are translated to a second model with new constructs to be considered. It incorporates the firm's ability to change conditioned by resistance to change effects, the managers' perceptions of real environmental changes and, the delays originated by the implementation period of concrete changes at organisational level. The simulation experiments conducted with both models allow patterns of organizational change to be analysed and suggest that the impact of change strategies on organisational flexibility at different levels of environmental turbulence is non-linear and complex. As a consequence, a more robust theoretical model in Organizational Flexibility is provided.

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A Dynamic Analysis of Socio-Technical Transition towards Bio-Economy

Bio-economy is a complex socio-technical system undergoing rapid change. There is a significant risk of not achieving the full potential of bio-economy due to suboptimal solutions, and therefore a system dynamics model applied to analyse transformation from fossil based economy into bio based economy is introduced. The model is based on interviews conducted with Finnish bio-economy stakeholders, literature review, and VTT bio-economy experts. The purpose of the model is to act as an interaction and dissemination enabler as well as evaluation and specification tool for stakeholders and a basis for further research. Contribution of this paper is to analyse the interconnections and feedback structures of fossil and bio-economies. These two economies are co-

existing side by side, fossil-economy being currently the dominant one. However, there is significant political will on national and EU level to shift towards bio-economy. This idea is mainly driven by the climate change, i.e. need to reduce greenhouse gas emissions. Interviews show that there is a wide understanding concerning the importance of bio-economy, however, something is lagging or preventing the transition. The purpose is to analyse restrictions hindering and enablers accelerating the transition.

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Public Financial Strategies in Time of Crisis. Building the Global Competitive Advantage of State to Increase its Finances

Governments, in most of the countries, seem to ignore that global competition concerns not only private organizations but also the public ones. While these last operate in a fix location, the first ones move according to the competitive advantage offered by being localized in a determinate nation. From their localization not only depends their competiveness but also finances available for States through profits taxation, and therefore, the wealth of a nation. The present study analyzes and tests, overcoming the short-term Governments' mental model of "tax increase and cut expenditures", a new way to recover economy and public finances based on the strategic approach of collaborating with private firms for co-creating their global competitive advantage. This means to improve the organizational and legal framework in which private firms operate for reducing their overhead costs for compliance of rules, and public facilities' inefficiencies. As counterpart, the economic environment will take advantage of new national and foreign investors and of existing firm's retention. A system dynamics model of an enterprise operating in Italy will show how such factors eventually lead to an increase in financial resources for State organization by taxation of larger profits of private firms and less expenditures for unemployment benefits.

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A System Dynamics Approach to Enhance Tourism Service Delivery Performance through Value Co-Creation

Value co-creation is shown to play a prominent role in performance improvement in various sectors ranging from manufacturing to service. However, its role in creating value and consequently improving the performance of service in tourist sector has not been investigated in the literature. In order to bridge this gap and considering the complex and dynamic nature of the tourism industry, this paper, using the SD simulation model, builds models aiming at developing a tourism engagement based value co-creation mechanism. It targets to improve cultural heritage sector performance in terms of service delivery system. Considering a specific case study, Sicily (Italy), the developed models intend to address the tourist's service delivery experience design. Although system dynamics has been applied to a wide range of problem domains, using it in co-creating value within service delivery design especially in tourism sector is relatively new and is considered one of the main contributions of this study. The main result of this study suggests that incorporating a value co-creation through engagement of tourists, ideation, would enable policy maker to stay in line with tourists needs and invest in accordance with their wishes which leads to significant improvement in quality of the services offered to tourists.

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The Capability Trap and Implementation of Evidence-based Practice in Child Protective Services

Evidence-based practice (EBP) is often heralded as the solution to increasing the quality of services provided by child protection services (CPS) agencies. Yet, little known about how to successfully implement EBP within these agencies. System Dynamics is a method that holds promise for improving our understanding of implementation. In this paper, I apply Repenning and Sterman's Capability Traps model to the context of CPS to (1) determine the model's applicability to implementation in CPS, (2) gain insights into how capability traps may emerge in implementation in CPS, and (3) demonstrate the value of applying system dynamics to the complex problems often encountered in social work.

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When your goals do not address your concerns: Lessons learned from a mediated model to support regional planning in Wellington

Regional planning processes are often based on inconsistent views among involved stakeholders on (1) what the problems or concerns are for the region, (2) what the visions or goals are for the region, and (3) what the scope for a regional plan should be. Such plans will lack commitment when implemented and might fail to address the "real" concerns of the region. It might create additional problems when implemented. To avoid such undesired outcomes, this paper illustrates how mediated modeling, and more specifically a model emerging from such a process, can contribute consistency to views, goals and scope of regional planning. Based on a case study in the Wellington region, this paper illustrates how a mediated model helps to identify and assist with the revision of inconsistent goals among stakeholders and how it can be used to build consistency in a future plan.

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Fearless Use of System Dynamics in Education – How You Can Make a Difference!

For twenty years, individual system dynamicists and educators from around the world have guided students to thinking deeply about complex, systemic issues and potential high leverage action. How can you work within your community to develop relationships within educational settings and share system dynamics resources and expertise as well as learn from interactions within these settings? This session will provide: • stories of how system dynamicists and teachers have interacted and learned from one another while working to build capacity and resources for classroom use. • packets of useful materials, available at cost, with specific recommendations for starting conversations with interested educators and sharing resources. • conversation to identify next steps for you to take within your community and to ascertain what support structures need to be set up to carry the work forward.

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Do People Possess a Global and Ordinal Understanding of Accumulation? An Experimental Study

People's seemingly poor ability to understand accumulation principles is well-documented. We argue for a distinction between understanding of the accumulation principle, e.g. how the behaviour of the stock is related to its flows, and application of this information, e.g. solving an accumulation problem where participants need to numerically integrate the flows. We argue that understanding of the accumulation principle contains one necessary and sufficient condition: having a correct representation of the causal relations between the system parts, and that such an understanding is global and ordinal in nature. We test this hypothesis in an experimental study by systematically varying two dimensions of how one accumulation problem is presented: (a) type of visual search referring to whether people process the information given in a analytical (local) or holistic (global) manner; and (b) type of information retrieved, referring to whether the information people extract is categorical or ordinal in nature. As expected, we find that a problem format that induces both global search and the retrieval of ordinal information enhances people's understanding of accumulation compared to a problem format that induces local search and the retrieval of categorical information.

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Dynamic Modelling of User Satisfaction: the Case of the Bangkok Mass Transit System

Build-Operate-Transfer (BOT) scheme is a key approach in the Public-Private Partnership transportation infrastructure development concept. The private sector obtains concession to develop public infrastructure projects on behalf of the government to build and operate projects and transfer back to the governments at a pre-specified date. The Bangkok Mass Transit System (BTS) SkyTrain is being operated by the BTS Company Limited under an agreement with the Bangkok Metropolitan Administration. Due to the commercial nature, user satisfaction is a major cause for concern. In order to assess the levels of user satisfaction, it is essential to study the user benefits and gauge their levels of satisfaction. The focus of this paper is on the performance of the project during the operation stage and the implications for management. It is proposed to use System Dynamics modelling and simulation to explore the problem of user satisfaction. This research considers ways in which the satisfaction levels of users may be enhanced. Data were collected through questionnaire surveys and interviews to derive causal loop diagram to be translated into stock and flow diagrams for the simulation. The model will be tested rigorously before being deployed for policy experimentation on user satisfaction.

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Teaching top-down modeling to bottom-up thinkers: A report from the initial phase of a collaborative watershed-modeling project

Conducting environmental research that is relevant to the needs of decision makers is an increasingly important goal for academic institutions. There is great potential to develop decision-relevant outputs by integrating process-based watershed models with local expertise in collaborative system dynamics models. This paper reports on a workshop held to teach process-based modelers working

on an interdisciplinary regional modeling project about the potential for representing hydrologic and socioeconomic conditions using a system dynamics model. A revised version of the Idagon, a classic watershed system dynamics model, was employed to demonstrate to researchers how collaborative watershed modeling with stakeholders will be carried out. We collected information about technical modelers' perceptions of system dynamics before and after the workshop. We found that even scientists who have a passing familiarity with system dynamics approaches benefited from a refresher training session and thoughtful discussion of the applications and limitations of system dynamics modeling. Process-based modelers' most prevalent concern about collaborative modeling was related to how uncertainty can be captured and communicated. On the basis of questionnaire responses and group discussion during the system dynamics training, we make recommendations for future efforts to increase collaboration and mutual understanding among process-based (bottom-up) and system dynamics (top-down) modelers.

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System Dynamics Endogenous Mental Models

This article introduces Kahneman's (2011) System 1 and System 2 behavioral economics vocabulary to enrich the discussion of mental models as endogenous to System Dynamics models.

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Assessing Future Carbon Emissions from Fossil Fuels of China

The Chinese government has set an ambitious target to reduce the intensity of carbon emissions per unit GDP by 40 – 45% during 2005 to 2020. The T21 national development model for China was developed for the purpose of analyzing the effects of long-term national policies that relate to carbon emissions, loss of farm land, water shortage, energy security, and food security, and their contributions to this reduction target. The focus of this paper is on the policies that have substantial impacts on carbon emissions from fossil fuels. Four scenarios are developed with the model to simulate the future carbon emissions: 1) the BAU (business as usual) scenario, showing the likely results of continuing current policies; 2) the TECH (technology) scenario showing the effects of more investment in renewable energy sources and promoting more energy efficient technologies; 3) the BEHAVIOR scenario, showing how government tax and price policies, together with public education programs, would instigate behaviour changes towards more sustainable living; and 4) the TECH&BEHA scenario, which shows the results of combining scenarios 2 and 3. The scenario results show that the 40 - 45% carbon emission reduction for the period 2005 – 2020 is achievable.

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A Shock to the System: How can Land Value Taxation change the Face of Cities?

This paper deals with implementing land value taxation in a city. The System Dynamics method is used to gain insights regarding the consequences such a policy would have on the city's growth. The hypothesis that when all taxes except for the land-value tax are suddenly eliminated the construction of new houses and new businesses will be reinforced is tested under different scenarios. The model used is a simplified version of the Urban Dynamics model by J. Forrester (Forrester, 1969), with the urban area being divided in 4 zones. The results

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showed that the implementation of a land value tax and the nullifying of all the other taxes generates results and behaviors, which are almost the same as in the case where all the taxes existed. On the other hand, if the land value tax is introduced from the beginning- with no other tax present- the city gets the most beneficiary results. Finally, the time of the implementation but also the level of the land value tax are two crucial factors, which could generate unwanted results.

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Epidemiology of Cytomegalovirus

Cytomegalovirus (aka CMV) is the leading cause of neurological disabilities among children causing among others mental retardation and hearing losses. This article approaches the uncertainty of CMV with the use of system dynamics to test the effect of existing and hypothesized policies in order to reduce the number of children affected by neurological disabilities because of congenital infection. A baseline system dynamics model built on deep uncertainty reveals that in the case of the USA, the spread of the epidemic can be contained by two measures: developing a vaccine currently under trials and combining existing policies.

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Dynamics of Consumerism and Credit Card Debt under the Influence of Advertising

Consumerism and persistent personal debts as a result of extensive use of credit cards under the influence of advertising is addressed in this paper. A system dynamics simulation model related to consumption behavior of middle-income people in Turkey under the influence of advertising is constructed. Debt, excessive spending, and 'consumption satisfaction' dynamics are investigated via policy and scenario analysis. The results show that i) restricted maximum credit card limit can be an effective policy to prevent high debts but, in the long run, the policy may result in more 'unsatisfied' people ii) in order to provide considerable decrease in debt and increase in satisfaction, average advertising frequency should be reduced substantially iii) a hybrid scenario combining maximum credit card limit policy and reduced advertising frequency scenario is shown to be beneficial for individuals, lowering debts, without sacrificing consumption satisfaction.

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An Investigation into Land Use Changes and Consequences in the Northern Great Plains Using Systems Thinking and Dynamics

From 1997 to 2007, 9.6 million hectares of grassland were converted to cropland and fifty seven percent of these conversions occurred in the Northern Great Plains (NGP). Since 2007, another 9.5 million U.S. hectares have been converted with the majority located in the NGP. Short-term, positive benefits include increased food production and higher financial returns to farmers. However, there could be unintended consequences through loss of ecosystem services. Consequences may include compromised water quality, wildlife habitat loss/fragmentation, and decreased carbon sequestration. The principal objective of this work is to: 1) identify structural features influencing land use decisions through agricultural stakeholder engagement; and 2) to synthesize results into a causal loop diagram through a group model building process. This information can be used to construct a stock-flow model to quantify implications for land management,

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forecast potential unintended consequences from major land use changes, and develop strategies to minimize their impacts.

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Integrating Economics and System Dynamics Approaches for Modeling an Ecological-Economic System

This article describes a collaboration between system dynamicists and economists to model a multi-sector, ecological-economic model of population and resource dynamics that is firmly based on economic theory and leverages the strengths of both fields. The example presented shows how an SD approach allows model complexity to be extended so as to effectively model interactions between an economic system and an ecological system. We show how SD model analysis can help explain the counterintuitive model behaviors that result when the natural resource carrying capacity or regeneration rate are increased. Simulation results also indicate that allowing for out-of-equilibrium states (adaptation) has a non-negligible impact on the dynamics of ecological economic systems.

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On Component Based Modeling Approach using System Dynamics for The Financial System (With a Case Study of Keen-Minsky Model)

The methodology presented will take the modeling to higher level and scale. By using hierarchical component based modeling approach, the model result would be easy to understand and to communicate. We are now able to reconstruct the Keen-Minsky monetary model using system dynamics approach without difficulty. It is because ordinary differential equations and network accounting model can easily be translated into system dynamics form. The resulting model consists of two main blocks, the real sector and the financial sector. The smallest component is exponential growth module in the family of first order system. The price module is created from first order system component. The nonlinear function is encapsulated as a module. The purpose in this modeling is not emphasized on prediction, but more on getting insight by forming an accurate model of the economy's behavior.

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Solution-oriented Systems Thinking Archetypes; examples of the Manawatu River, New Zealand

Most representations of Systems Thinking Archetypes explore problematic systemic causalities. Policy or management guidance from Systems Thinking Archetypes is generally directed toward understanding new and delayed feedback loops, exposing critical connections and revealing invisible underlying structure. This paper explores Systems Thinking Archetypes from a solution-oriented perspective. Instead of identifying problems the focus shifts to solutions generation to achieve a higher level at which to intervene in a system (Meadows, 1999). Recognizing that problems and solutions are interconnected, we argue that language may be important, especially when the goal is to move beyond incremental improvements towards generating a level playing field for more courageous, vision inspired changes (Senge, 1990). For the Manawatu River Catchment, examples of eight archetypical behaviors and a solution-oriented adaptation of the archetype decision-tree (as proposed by Goodman and Kliener

(1994)) are presented. The desired outcome is to support on-going multi-stakeholder dialogues with a positive frame and move beyond incremental problem solving catchment management to a higher level of solutions generation.

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The eye of the beholder: exploring the dynamics of regional differences in cataract treatment

Research into the variance in healthcare practice in general focuses on the regional differences over a period of single year. By this focus it leaves out the dynamic nature of the interaction between demand and supply of healthcare. The dynamics of the interaction between demand and supply of cataract treatment in the Netherlands are explored in this paper. This study was initiated by the Dutch Health Care Insurance Board in order to improve policies for managing the Dutch healthcare system. With the use of group model building, a system dynamics model is created to generate insight into the growing number of cataract treatments and differences in the number of treatments between regions. The main source for the growth in number of cataract treatments is a gradual change in indication criteria. The simulations for the twelve provinces in the Netherlands show comparable behaviour. The timing between the simulations is different. Hence the distribution of the number of treatments over the provinces is different for each year. A possible source for difference in timing is the ratio between the population of a province and the number of ophthalmologists in that province. Hence, for assessing the variation of practice time studies are required.

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Legalization of Cannabis in the USA: A System Dynamics Approach to Drug Policy

Colorado and Washington State have made history by approving measures to make marijuana sale and use legal for people over the age of 21, in direct opposition to federal law. While there is a sizable discussion of the actual repercussions that legal marijuana would entail, no one knows exactly what will happen. Politicians in both states (and the federal government) must now make decisions on how best to implement these policies in a highly uncertain setting. Furthermore, the lack of specific information of existing black market trade makes pure economically driven policies highly speculative. The purpose of this paper is to aid in making such decisions by analyzing the relationship between the legal production of marijuana and the black market trade as well as their effects on the general population using a System Dynamics approach. As there is uncertainty about the initiation of cannabis use, addiction, and the effect of legalization on these processes, further research is needed. Preliminary conclusions can be drawn from looking at legalization from a market perspective, which imply that both that regulating supply through permits is an effective deterrent of oversupply and that heavy taxes may leave room for the illegal market to remain operational.

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Stress-Testing Banks under Deep Uncertainty

Years of turmoil in the banking sector have revealed the need to assess bank performance under deep uncertainty and identify vulnerabilities to different types of risks. Banks are not the safe houses of old. Today, banks are highly uncertain dynamically complex systems that are permanently at risk due to internal and external stresses and uncertainties. Although external uncertainties and stresses

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cannot be controlled, internal design and policies can, and hence, offer opportunities for robust redesign. This paper illustrates a multi-model System Dynamics approach towards financial stress testing in view of making banks more robust, i.e. performing more appropriately in all plausible futures, especially in the most stressful futures. Various System Dynamics models are used to represent the core operation of a bank. This set of models is constantly attacked by all sorts of (combinations of) risks and shocks in order to generate insights into all sorts of plausible bank system behaviour under stress, identify the causes of undesirable dynamics, vulnerabilities and levers. Using these insights, adaptive policies are designed, and further improved under deep uncertainty using robust optimization. Finally their robustness is tested and compared with other promising policies.

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System Dynamics Simulation Models and Points of View

System Dynamics simulation models incorporate points of view in many ways. In our paper, we explain that claim through an analysis of the notion of points of view. Also, we offer an argument going from the non-dispensability of points of view in System Dynamics modelling, and from the non-reducibility of some of the points of view involved, to the non-eliminability of something like System Dynamics in an ideally complete scientific image of reality.

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Implications of The Rate of Organizational Learning on Value Capture in the Digital Economy

Two newly introduced products from the same firm were expected to do well, yet one product failed while the other thrived. Why? To answer this question, we built a firm-level system dynamics model of the adoption of information technology products with a focus on firm-level allocation of investments to marketing, technology and, to the reduction of other switching costs. We also modeled the firm's ability and rate of learning from customers. The firm-level model was validated against revenue data and management interviews. We identified implications of designing a positive user experience and of adopting a culture of relentless rapid business experimentation. The various scenarios supported by the model illustrated that, in order to survive and compete in the digital economy, information technology firms need to shed a comfortable yet myopic focus on existing capabilities and develop business strategies validated through "fail fast, learn fast" experiments. Sustainable competitive advantage also hinges on the capability to effectively disseminate the knowledge gained through business experiments within the firm.

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Exploring Retailer's Ordering Decisions under Delays

When final customer demand exceeds available supply, retailers often hedge against shortages by inflating orders to their suppliers. While the amplification in orders caused by competition for scarce resources has been described in the literature almost a century ago, there is little experimental research examining the factors influencing retailer's order amplification. This paper analyzes retailer order decisions in response to a surge in demand. In an experimental environment based on a formal mathematical model we test subject's ordering decisions under different ordering and supplier capacity acquisition delays and compared them to an optimal benchmark. Our results from different treatments allow us to characterize subjects' performance in this system and formulate a heuristic that closely replicates subjects' ordering behavior in all treatments.

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A System Dynamics Examination of the "Spirit of Capitalism"

Starting in the mid 1990s, scholars in finance and economics have created a body of literature in a sub-field called the "Spirit of Capitalism." Using sophisticated econometric models, authors in this sub-field demonstrated that the search for status seemed to drive stock-market volatility and economic growth and tended to make investors more risk averse. However, much of this work suffers from at least one serious flaw—it lacks operational thinking. The purpose of this paper is to begin an attempt at identifying the operational underpinnings, and the resulting underlying dynamics, of this "spirit of capitalism." The paper offers two causal loop dynamic hypotheses and the beginnings of a stock-and-flow system dynamics model. It concludes with some thoughts about issues raised by the current paper, and with how the authors will address these issues and develop these ideas in future work.

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The Utilization of System Dynamics in Concluding Policies for Greater Cairo Sustainable Development

This paper aimed to build a system dynamic model that would assess the policies that are currently adopted by the Egyptian government and give insight about other policies that can improve the quality of life for Egyptians, especially in Greater Cairo. The main finding of this study is that increasing the government expenditure in Greater Cairo would not improve the living conditions of Greater Cairo residents. The model confirmed that the concentration of economic activities in Greater Cairo has increased its attractiveness. The increased attractiveness has increased population growth in Greater Cairo much more than the capacity of its utilities, which resulted in a degradation of the quality of life in Greater Cairo.

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Modeling opioid addiction treatment policies using system dynamics

Treatment of opioid addiction has historical employed an opioid drug called Methadone that is dispensed in liquid form at treatment facilities. Drawbacks to this treatment include social stigma and relatively high risk due to the pharmacological properties of methadone and also its side effects. A newer therapy uses another opioid drug called Buprenorphine, which is safer and has less social stigma because it can be prescribed and dispensed in tablet form. Policy makers have been cautious, however, and have place a cap on the number of patients that a physician can treat using Buprenorphine, leading to a concern that even though it is safer, people seeking treatment might not be able to locate a physician and access the treatment because of the cap. An SD model was developed to represent the flows of opioid abusers into and out of treatment with Buprenorphine, as well as the number of physicians certified to treat with Buprenorphine. Treatment is constrained by the cap and also by the amount of budget available for subsidizing treatment. The main finding is the treatment budget is by far the most influential policy variable, and that changing the cap would probably not make much difference.

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Systemic Analysis in Legislating: Modeling the "Cash for Clunkers" Stimulus

Legislating often may lead to unintended consequences and fail to achieve intended consequences due to the complexity of political and social environments. In this article, the authors build a system dynamics model focused on the American 2009 "cash for clunkers" legislation. The authors identified dynamic hypotheses of both intended and unintended consequences in legislative history and political commentary. Unintended consequences were suggested: distortions in new vehicle sales and production, used vehicle supply and consumer driving behaviors. Causal loop and stocks and flows models were developed. Using a Vensim simulation, the authors tested for significant statistical differences in automobile related variables with and without the legislation's eight-week sales subsidy. The study found only short-lived effects on used car dealers, charitable donation programs, and sales of new cars. The reasoning and technique presented in this case study suggests a systematic and learning-intended alternative to the prevailing "art" of political decision making.

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Teaching Policy Design, Using a Case Study of Unintended Consequences when the EU Regulates Hospital Doctors' Hours

The purpose of this paper is to encourage readers to help us assess and improve the major project in a graduate level system dynamics course in policy modeling. This year, we modified the project in hopes that it would contribute more to the learning objectives in the course. We have seen both positive and negative effects of the change; the jury is still out. To provide a context for reader reaction, we describe the project in some detail. It is based on a case study of the unintended consequences suffered by UK hospital doctors due to the European Working Time Directive. Thus, despite the pedagogical slant of this paper, it may also interest health policy analysts. We emphasize the process of managing the project and the tasks required of students, and particularly solicit comments and suggestions about certain key features. Three of the authors were students in the course, and some of their work is used to illustrate how students carried out the project.

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An End-to-End Supply Chain Model For Planning In Uncertain And Volatile Times

This presentation describes a real-world application of SD-based supply chain models to a military helicopter program. The objective of the project was to see if the real-world supply chain could actually support the demand forecasts for critical components provided by a demand-generation software tool. Many times demand forecasts are provided and it is assumed that the supply chain will fulfill all requirements on time with no issues, regardless of the shape of the demand forecast. From SD, we know that many supply chain dynamics (e.g., bullwhip effect) can significantly impact supply chain performance. The work on this project validated the baseline case as well as several other possible scenarios.

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The Top 7 Myths About System Dynamics

This paper discusses several myths and major issues with the adoption of SD in the "normal" business world, as well as how SD practitioners can overcome these myths and issues.

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Dynamic Drivers of Successful Social Impact Bonds

Public goods and services, such as prisons, are often underfunded compared to private goods and services. Social Impact Bonds (SIB) are a new financial vehicle to increase the use of private funds for public good. SIB use a pay for performance structure to change a critical reinforcing loop from a vicious cycle of decay to a virtuous cycle of improvement. A a case study model of the Her Majesty's Prison (HMP) Peterborough SIB is developed and analyzed to understand the roles of high leverage parameters and feedback loops in the SIB success or failure for the two primary participants (HMP system and SIB investors). Program effectiveness and unit program costs are found to be two high leverage SIB design characteristics. The analysis and model are used to make recommendations for both the owners and investors concerning SIB design.

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The Dynamics of Indonesian's Currency Crisis in 1997

The exchange rate behavior in Indonesian's recent crisis 1997 caused an interesting phenomenon of exchange rate disequilibrium. The exchange rate rose and fluctuated around its new quasi-equilibrium in damped oscillation behavior. Subsequent speculative attacks by some speculators which created new desired equilibrium generated such behaviors under two consecutive first order delays. Comparing the result with uncovered interest parity framework under a constant and oscillating risk premium revealed that exchange rate behaviors during the crisis was best explained by speculators attacks followed by uncovered interest parity under oscillating risk premium. Uncovered interest parity with a constant risk premium produce unreliable estimated exchange rate. Under some advisable range of parameters, exchange rate model with speculative attacks can explain the general behavior of the exchange rate during the crisis.

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Large System Transformation within Healthcare Organizations utilizing Lean Deployment Strategies

Multiple healthcare organizations have been recognized as successful in sustained, enterprise-wide transformation utilizing Lean deployment methods. A realist review of large system transformation utilizing enterprise-level Lean Deployment methods within healthcare organizations was conducted by Hagg, et al (2013). Synthesis and analysis of the results from this review indicate that there are five primary strategies associated with successful healthcare-based Lean deployments - Respect for People, Strategic Alignment; Strategic Deployment; Large Scale, System Improvement Efforts; and Small-Scale, Local Improvement Efforts. Additional findings from this review indicate that the applications of the specific mechanisms with these strategies are emergent within multiple transitional phases spanning 6-8 years. In order to better understand the emergent

nature of enterprise-level Lean deployment strategies, a more robust understanding of these transitional phases is needed. We have created a dynamic hypothesis and system dynamics model to explore how the mechanisms and context interact to drive phase transitions within healthcare-based enterprise-level Lean deployments. Additionally, we investigate how healthcare-based, enterprise-level Lean deployment programs can be better designed in order to increase rate of success and decrease deployment cycles.

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If the hillock does not survive, the community does not survive: Insights from the SD Winter Institute in Andhra Pradesh

This paper is a documentation of the process and insights from a two-week intensive course in Andhra Pradesh India through the Winter Institute. This course was attended by students from Washington University in St. Louis, and staff members from the Foundation for Ecological Security based in India. The authors will detail the specific village setting in which the work took place. Next, we will elaborate our research and skill-sharing process using participatory rural appraisal, group model building and systems thinking. This will be followed by an explanation of the reference mode, system dynamics model and results of simulation runs. Finally, we will conclude with the pivotal insights we learned throughout the entire process, and ideas for next steps.

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Modeling the Nuclear Fuel Cycle: Agent Based Approach

System dynamics approach was previously used to simulate the dynamics of the nuclear fuel cycle and associated infrastructure deployments. It was found to be a useful paradigm that is appropriate for simulations of this system given the nuclear fuel cycle's inherent mass flows, process time delays, and feedback loops. Agent based simulation approach is currently considered as an alternative or complimentary approach to system dynamics for this type of simulations. The move towards agent based simulations is motivated by the needs to expand the options for fuel cycle simulation and to explore further synergies between the different components and players that affect the behavior of the fuel cycle developments. This paper explores the applicability of both approaches to the nuclear fuel cycle simulation and discuss an agent based model of the fuel cycle, SINDA model, that can be further developed in the future to explore expanded and more realistic fuel cycle deployment scenarios.

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Developing "System Dynamics-based" Flexible Strategy Game-card: Exploring Performance of the Indian Telecom Service Providers

India has emerged as one of the fastest growing telecom markets in the world and witnessed a telecommunication revolution in the last two decades. In the recent time, the Indian telecom industry is experiencing a major transformation with stagnating revenues, declining ARPU's, and stiff competition, which is overall impacting its performance. The present study seeks to explore the future growth perspectives for telecom service providers by identifying other revenue options and their impact on performance. The integration of system dynamics methodology with a recent developed performance management framework helps

to bring the issue further in a case context by developing a system dynamics based performance management model portraying the impact of data based services on the performance with the help of many scenarios. STELLA 10.0 software package has been used for model and scenario developments. The study proves the integration of system dynamics methodology improves the holistic understanding of telecom operating system showcasing the integration of subscribers' view and data based services create the future of telecom service industry in this transforming business environment.

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Does Money Matter on the Formation of Business Cycles and Economic Recessions? - SD Simulations of A Monetary Goodwin Model

The objective of this paper is to explore a role of money on the for- mation of business cycles that develops into economic recessions. As an analytical framework, a simple capitalist market economy is considered, consisting of workers, shareholders and producers. For the description of their budget equations, accounting system dynamics method developed by the author is used. In order to analyze the economic behaviors of the economy, a slightly revised Goodwin growth cycle model is built. These two approaches are, then, integrated to construct our monetary macroe- conomic model called in this paper a monetary Goodwin model, rst without interest, then with interest. The macroeconomic model thus con- structed reveals an important role of money and interest on the formation of business cycles that evolve into economic recession.

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Exchange Rates and Deindustrialization: Japanese Experiences

The strongest yen's appreciation in 2011 made many Japanese companies choose foreign operations. The general public is worrying that this choice may put them out of work. Contrary to this public debate, academic debate argues that deindustrialization is the natural outcome of the successful economic development in advanced economies. However, a regression analysis on the current Japanese economy suggests that the negative deindustrialization or hollowing out has started. Based on statistical findings, this paper develops a system dynamics model and examines the negative effect of deindustrialization. A shift from domestic production to overseas production reduces economic performance little by little. Although foreign direct investment is preferred to exports under the home currency appreciation, this myopic strategy will hollow out the domestic industry in the long run.

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A Case Study of the Value-driven Feedback System for Quality Culture Improvements in the Project-based Organizations

Project-based organizations (PBO) refer to a variety of organizational forms that involve the creation of temporary systems for the performance of project tasks. In recent decades, PBOs have received increasing attentions as an emerging organizational form. Previous studies have demonstrated that PBO has its characteristic so that managerial polices for the organizations should be specifically reinvestigated. One of the management challenges comes from the nature of short- term project businesses that doesn't encourage long-term and

organizational quality culture developments. Compared with the conventional concept of top-down total quality management empowered by top manager's support and leadership, this paper introduces the bottom-up and self-motivated approach to improve organizational quality culture and performance. Systems thinking is employed in this paper to explore a total quality assurance system with value-driven reinforcing feedback systems and its real practices in Taiwan. Effectiveness of the proposed quality policy as well as the lessons learned from the case study are also discussed for supporting the development of total quality management philosophy in PBOs.

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Control Formulations for a Stock Management Problem with a Delay in Measuring and Reporting

Stock management task is a central issue in System Dynamics. The difficulty associated with managing the task is usually caused by the delays positioned at different places within the task. There are delays in measuring and reporting the current values of the stock, delays in making decisions, and delays between the control decisions and their results. Most studies focus on the delays placed between the control decisions and their results. However, only a very limited number of studies were carried out regarding the other positions of delay. The optimal ordering policy introduced by Bensoussan et al. (2006) and the measurement delay heuristic introduced by Yasarcan (2011) are suggested to be used in the presence of a delay caused by measurement and reporting. In this study, the performance of the measurement delay heuristic proposed by Yasarcan (2011) is compared to the benchmark performance obtained from the optimal ordering policy of Bensoussan et al. (2006). The measurement delay heuristic generates exactly the same dynamics as the optimal ordering policy in a stationary environment. Furthermore, the measurement delay heuristic is robust to the violations of the assumption that states that the loss from the stock has a stationary mean.

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Facilitating Diffusion of Innovations Through Niche Management Strategies

Niche-based policies (e.g. strategic niche management (SNM)) that advocate nurturing innovations in protected space (i.e. niches) are among novel policy approaches, which aim to facilitate the adoption of sustainability innovations. Despite being an intuitively appealing approach, there is a remarkable absence of specific guiding principles regarding the design of such policies. This absence is mainly due to the dynamic complexity of the innovation development and diffusion processes. This study aims to analyze niche management strategies, and the resulting diffusion dynamics with the help of an abstract simulation model. Using the model in a test ground for exploration, plausible diffusion cases are identified an analyzed. Furthermore, risky cases that result in "expensive failures" are also highlighted.

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Exploration of the Effects of Open Innovation Policies on National Innovation Systems through System Dynamics Simulation: Apply

Nowadays, the use of purposive inflows and outflows of knowledge to accelerate internal innovation and to expand the markets for external use of innovation has

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become essential in business strategies and national policies. In addition, the importance of knowledge and technology diffusion requires better understanding of knowledge networks and "national innovation systems". We want to answer this research question: What kinds of effect will occur in national innovation systems (NISs) if different levels of open innovation policies are introduced into the NISs? According to literature review, perfect open innovation policies should have three aspects altogether, such as knowledge and technology production, distribution, and consumption. We build up a causal loop diagram and a system dynamics model for simulating the effects of open innovation policies on the NISs and apply the results to Cambodia Case to build up a Cambodian Science and Technology Master Plan.

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Strategies for University Growth: A System Dynamics Analysis of Organizational Change

This paper reports on a study with a real-life client. In response to budgetary difficulties, administration at a tuition-dependent university pushed for growth in student enrollment. The expansion was resisted by the faculty who argued that the quality of education has declined. More students also impacted the use of university infrastructure. By actively engaging key stakeholders, a dynamic hypothesis was constructed and a small model was built that captured existing mental models. A working model was used to conduct experiments with the stakeholders. The experiments simulated key policy decisions to gain insights from the resulting behavior. University management is a topic that enjoys active debate and increased attention in the higher education policy and management literature. The current project could be expanded to include financials, graduate enrollment, and the pressure of academic research.

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Assessing the Liberalization of Biofuels

Global biofuel consumption has been growing in recent years as different countries worldwide have been exploring alternatives to gasoline and diesel fuel for transport. This is due to a hike in oil prices and their increasing volatility as well as both a high dependence of the transport sector on oil and also because, arguably, the supply chains of biofuels emit less CO2 than for fossil fuels. Biofuels have been available around the world for a while, with the aid of some government support. Biofuels are being widely considered as part of the solution to affordable fuels for transport. This research makes use of a system dynamics model to analyse the current leading policies aiming at increasing the penetration of biofuels. In this context, and given multiple uncertainties including technology evolution and fuel prices, scenario analysis has been considered for the examination of different, extreme, though plausible, futures. SD under extreme scenarios helped in assessing the possibility of removing incentives (that is, leaving decisions to an open market) and a partial reduction of subsidies. This paper concludes that for the case of Colombia, the potential of biofuels seems promising.

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A System Dynamics Model of the Greek Crisis: The Debt Trap and The Way Forward

This paper analyses the Greek debt trap under different assumptions. In doing such system dynamics has been integrated into existing economic models in order to test the forecasts of EU policy makers. The fact that forecasts of policy makers are not in line with actual economic conditions forces us to question the validity of present economic theories. The assumption of the EU policy makers is that the second bailout will be sufficient. We believe that this is not the case and that Greece will need a third bailout. We will illustrate this with a macroeconomic systemic model describing the current Greek debt trap and will draft an escape plan pertaining to such. The main benefit expected is the increased realism of the model itself and the discovering the causes of behavior that are observed in the real world.

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Determinants of Requirements Process Improvement Success

Improving the requirements process improvement (RPI) of software projects has become an important area of research and professional practice. This paper highlights the inefficiencies in the RPI that results in poor quality, and escalating cost or schedule. The efficiency with which the changing processes are managed determines how successful a project will be in terms of attaining a satisfactory balance between quality, cost and schedule of the delivered software systems. A number of software development companies suffer from ineffective RPI; therefore there is a need for understanding the underlying structure and explaining the determinants of the RPI success. This facilitates RPI stakeholders in taking informed decisions that would lead to more successful RPI due to improved understanding of the underlying structure and feedback that exists among the RPI success factors. This calls for continuous improvement of the requirements processes by analyzing the relationships and the dynamics that exist amongst the RPI factors for cost effective RPI decisions. The paper presents a system dynamics RPI model validated by practitioners and discusses the insights generated from the model. The authors suggest that the resulting model and the insights generated through sensitivity analysis tests constitute significant contributions towards understanding the factors that determine RPI success.

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Integrated Water Resources Management Incorporating Water Quality, Energy Consumption and Ecological Requirement

Water demand is increasing with the population growth and economic development, which result in the conflicts between different water users with limited water resources. This calls for an integrated water resources management, which considers water quantity and quality along with the socio-economic factors. This study developed a system dynamics model for water resources management in Hillsborough County. The model considers multiple water users including ecological system, different water supply options, water quality, and energy consumption associated with water supply. The result shows that current water

management mainly focuses on water quantity, especially for municipal water withdrawal. The incorporation of water quality and associated energy consumption in decision making will change the supply options. Surface water will be preferred for water supply and the simulated groundwater level will increase by 0.6-0.8% with minor decrease in the surface water level.

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Monetary Incentives as a Fix that Fails with Reciprocal Employees

Research has shown that the effect of monetary incentive systems on employee output is not straightforward. Based on literature on reciprocity and behavioral economics this paper distin-guishes the effects of incentives on opportunistic and reciprocal employees. It illustrates how the relationship between incentives and output can be presented by different balancing and reinforcing feedback loops for different groups of employees, representing a fixes that fail mechanism in the case of reciprocal employees. The behavioral analysis of the developed system dynamics model shows a counterintuitive effect of high monetary incentives, in particular when the workforce is reciprocal and does not desire monetary incentives. The analysis also reveals that employee behavior is not determined by their either reciprocal or opportunistic disposition, but that it evolves in relation to context.

Meetings, Special & Convened Sessions

Listed alphabetically by Session name

Jay W. Forrester
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A Fireside Chat with Jay Forrester

Industrial Dynamics, the seminal work in the field remains a truly great book to read even today. In that work Jay Forrester laid the foundations, and provided many of the tools, for understanding a broad array of social and economic systems. When Jay moved from businesses to cities, with the work of *Urban Dynamics*, he demonstrated the same unexpected outcomes from policies that created the problems they sought to solve. The next step, after businesses and cities, was *World Dynamics*, which showed the way in which fundamental elements of human endeavor come together to generate surprising, and not necessarily happy, outcomes. Beyond the coherence of relating structure to behavior, these books also have a common theme around the behavior of people looking for outcomes, whether selfishly or altruistically, and generating unexpected results. In the Fireside Chat, in a question and answer format, Jay will talk about these books, what they meant to him, and how he thinks they fit together in aiding our understanding of ourselves and the world we live in.

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American Experience's Earth Days

The System Dynamics Society has been granted permission for a one time screening of this film. Dennis Meadows and his work is highlighted in this film. Earth Days traces the origins of the modern environmental movement through the eyes of nine Americans who propelled the movement from its beginnings in the 1950s to its moment of triumph in 1970 with the original Earth Day and to its status as a major political force in America. Director Robert Stone ("Oswald's Ghost," "Guerrilla: The Taking of Patty Hearst") drawing heavily on eyewitness testimony and a wealth of never before seen archival footage, examines the reworkvolutionary achievements - and missed opportunities - of a decade of groundbreaking activism. The result is both a poetic meditation on man's complex relationship with nature and a probing analysis of past responses to environmental crisis. Includes interviews with former Secretary of Interior Stewart Udall; renewable energy pioneer Hunter Lovins; Biologist Paul Ehrlich; former congressman Pete McCloskey; Earth Day organizer Denis Hayes; forecaster Dennis Meadows, and Apollo Nine astronaut Rusty Schwecikart. Includes footage of all the presidents from JFK to George W. Bush discussing the environment.

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Assessing Systems Thinking Across Skill Levels

Within the System Dynamics community, there is agreement about the importance of systems thinking (ST), the role education plays in fostering it, and even how we should teach it. There is less clarity about what ST skill is in terms of specific capabilities (e.g., what one should be able to do at varying levels of proficiency in particular domains). We propose an interactive symposium to discuss how ST success would manifest across levels of skill, how to assess this, and how to use such assessments for educational change. We will invite those working on aspects of systems thinking and engage them in guided discussion on these topics. In the end we hope to have 1) more of a common basis of

understanding among those studying ST, 2) a clearer view of the points of disagreement about ST, and the research needed to resolve those points, and 3) a basis for the development of new assessment tools. Participants should also leave understanding how 4) assessment tools can be utilized to advance theory about what ST is, and 5) how the assessment tools can be used to mobilize those outside the SD community for educational policy changes.

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Barry Richmond Scholarship Award Announcement (External Award)

The Barry Richmond Scholarship Award was established in 2007 by isee systems to honor and continue the legacy of its founder, Barry Richmond. Barry was devoted to helping others become better Systems Citizens. It was his mission to make systems thinking and system dynamics accessible to people in all fields and professions. The award is presented annually to a deserving systems thinking/system dynamics practitioner whose work demonstrates a desire to expand the field or to apply it to current social issues. Applicants are considered based on quality of work as well as financial need. The recipient receives a $1,000 cash scholarship to help offset the cost of attending the annual System Dynamics Conference.

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Benelux Roundtable and Benelux Chapter Annual Meeting

The Benelux Chapter of the System Dynamics provides a platform for information exchange and cooperation for anyone interested in System Dynamics with a clear link to Belgium, the Netherlands, or Luxembourg. The annual chapter meetings organized in the Benelux allowed members to present finished work. This meeting at the annual System Dynamics conference in Cambridge is dedicated to information exchange between existing members (and new members) regarding (i) work in progress, new projects, and future funding opportunities, (ii) great ideas, excellent plans, exciting activities, and brilliant strategies for the chapter, (iii) recent and future developments and possible cooperation in our educational programs. It also offers new (current) members the opportunity to get to know current (new) members. Do not miss this opportunity to meet and greet your Benelux colleagues. For the Dutch: the coffee is for free!

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Applied System Dynamics

Biomedical Roundtable and Biomedical SIG Annual Meeting

The Biomedical SIG provides a platform for information exchange and cooperation for anyone interested in biomedical system dynamics. Practitioners interested in biomedical applications, with skill levels ranging from novice to master, are invited to attend and participate in this exciting, growing group. Our discussion will address strategies for the growth and development of this practice, along with selected examples of works in progress.

Brazil Chapter Annual Meeting

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WeSee - System Dynamics Vision

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The Annual Meeting of the Brazil Chapter will be divided into three parts of 20 minutes each: 1) personal introductions; 2) election of new member(s) to the Chapter Policy Council; and 3) discussion of plans for the near future (2013-2014). The official meeting (of one hour in duration) will be followed by a social gathering (over dinner at a local restaurant), where we will continue our conversations and networking.

Business SIG Annual Meeting

Frederick Kautz
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Berkeley Research Group

The purpose of the Business Special Interest Group (SIG) of the System Dynamics Society is to promote and support the wider adoption of System Dynamics methodology and best practices in businesses and provide communication channels for recognizing the achievements of System Dynamics practitioners across all business sectors. Among the specific goals of the SIG are (a) facilitating wider networking of System Dynamics practitioners in businesses, (b) raising awareness of System Dynamics, its methodology and achievements, and areas of application among prospective practitioners, business unit leaders, and senior executives, (c) supporting the expansion of the Case Repository and its accessibility through the Society web site, (d) increasing awareness of educational resources and short-term training opportunities for business practitioners, (e) facilitating improved awareness and access to System Dynamics modelling resources and best practices for a broader base of business practitioners, and (e) identifying candidates for awards such as the Application Award and promoting such awards to businesses. The roundtable of the Business SIG will focus on exchanging ideas related to the focus of the Business SIG and on announcements of SIG activities and plans. For additional information please contact Fred Kautz (fkautz@brg-expert.com), Kim Warren (kim@strategydynamics.com), or Bob Eberlein (bob@astuteSD.com).

Canada Chapter Roundtable and Annual Meeting

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The Canadian chapter of the System Dynamics Society provides an opportunity for information exchange and the promotion of system dynamics in Canada. Because of our wide geographical extent, our principal physical chapter meeting is at the System Dynamics conference, this year in Boston. This will be our first physical meeting since the formation of the chapter and the 2 hour time slot will be split roughly equally between a business/strategy meeting and sharing of system dynamics work. We hope you will be able to attend the meeting. If you will be in Boston, please contact us regarding presenting a brief description of your work and interests.

China Chapter Annual Meeting

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The first summer school program on system dynamics in China was offered by Shanghai Institute of Foreign Trade from August 21 to August 30, 2012. The summer school was tuition and accommodation free for postgraduate students. The program recruited 61 postgraduate students and young scholars from more than 25 universities and institutes in China. Six members of the China Chapter attended the 30th International Conference of the System Dynamics Society at St. Gallen in July, 2012. All of them gathered at the Chapter Poster session on July 23, 2012. On September 16, 2012, China Chapter of SD held a regular meeting which focused on summarizing the summer school of SD and planning for the activities in 2013. The modeling workshop on the application of SD in environment and sustainable development is going to be held on May 18, 2013 in Beijing with the purpose of exchanging ideas and sharing experience to upgrade the research ability on the related field. An academic forum is planed to be held on August, 2013 with the support of Systems Engineering Society of China and System Dynamics Professional Committee, which will further provide a more extensive and deeper probe into the academic and application of SD.

Conference Debriefing Meeting

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All are welcome to attend this meeting to talk about what worked and what needed improvement at the conference. Also, please remember to complete and return the conference survey. Post-conference you may complete our online survey at: http://fmru.qualtrics.com/SE/?SID=SV_5ngpHFKIU2878Z6.

Conflict, Defense, and Security SIG Roundtable and Annual Meeting

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The CDS/SIG focuses on modeling and simulation of social phenomena related to conflict and conflict resolution, defense, and security. Some application areas include: cyber security, information security, military applications, terrorism and counter-terrorism actions, and insurgency studies. The roundtable of the CDS/SIG will focus on exchanging ideas related to the focus of the Conflict, Defense, and Security SIG and on announcements of SIG activities and plans. For additional information please contact Edward G. Anderson (Edward.Anderson@mccombs.utexas.edu) or Ignacio J. Martinez-Moyano (imartinez@anl.gov or martinez-moyano@uchicago.edu).

Dana Meadows Award Announcement

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The Dana Meadows Award was established in 2001 to honor the late Dana Meadows and encourage the next generation of students in the field of system dynamics. The award is given annually for the best paper by a student presented at the annual System Dynamics Conference. Students can self-nominate any manuscript that they have submitted as sole author, or co-author, for inclusion in the conference. The winner receives a cash award, a conference registration and an allowance for travel expenses. Be sure to read the detailed expectations and conditions that Award-worthy papers must meet.

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Economics Chapter Annual Meeting

The Economics Chapter annual meetings are dedicated to welcoming new members, discussing the past year's events and the coming year's themes, and to appointing the members of the executive committee. At the St. Gallen conference, discussion centered on changes in the structure of the Chapter's executives, the role of System Dynamics in economics, and ways to reinforce this role. This year the proposed agenda covers: 1. Introduction of new members and catching up with current members. 2. Conduction of the AGM, reflection on the executive structure decided upon last year, appointments. 3. Report on and discussion of the two book projects initiated last year (reference book "Feedback economics" and economics textbook using SD). 4. Teaching issues related to economics and SD. 5. Frank Fisher Award. These are really important issues, and there is a lot to do. We look forward to seeing you all in Cambridge in July!

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Economics Chapter Roundtable

The Economics Roundtable will provide the opportunity to discuss the current macroeconomic events (aftermath of the financial crisis, debt crises). In addition, the Economic Roundtable will discuss tax related issues, which have been brought forward by the Frank Fisher Award.

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Education SIG Annual Meeting

The Education SIG continues to pursue its twin interests of publicising and enhancing both the contribution of System Dynamics (SD) to Education Management and the evolution of the contribution of SD to the curriculum – in both cases the interest spans the whole span of education from K-12 to Higher Education. Please come to the E-SIG session to tell us about your work and find out what others are doing. See you there!!! Michael Kennedy University of Bedfordshire Department of Accounting & Finance, School of Business Park Square, Luton, Bedfordshire LU1 3JU E-mail: Michael.Kennedy@beds.ac.uk Carol Frances Claremont Graduate University 165 E. Tenth St. Claremont, CA 91711 E-mail: carolfrances100@hotmail.com Key words: System Dynamics, Education Abstract The System Dynamics Society (SDS).

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Energy Roundtable and Energy SIG Annual Meeting

The Energy Special Interest Group (Energy SIG) brings together system dynamics practitioners within the energy field. In the last few years the number of people associated with the Energy SIG has grown substantially (over 200 members today), reflecting growing interest in this important field. Among other activities, the SIG has a large and active discussion forum going on Linkedin.com. In this year's SD international conference a large number of presentations on energy-related issues will take place, indicating the significant amount of research that is being conducted on this topic around the world. The proposed Energy SIG roundtable this year will be on the issue of assessing energy sustainability. We welcome everyone interested to join our annual meeting at this year's conference.

Asmeret Bier
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Environmental Roundtable and Environmental SIG Annual Meeting

The Environmental Special Interest Group welcomes everyone to join us for a discussion about modeling and analysis of environmental and natural resource systems. The Environmental SIG is interested in human activities in the natural environment, including sustainable development, ecology, climate change, energy transition, renewable resources management, water policy, food security, and many other topics. The methods used by the members include the system dynamics and other dynamic modeling approaches, simulation gaming, experimentation in decision analysis, and mediated, collaborative approaches to model building and analysis. This roundtable will be used to discuss SIG planning issues (representation, communication, etc.), research priorities, collaborations, and any other topics of interest to the group.

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Exploring Ideas for Broadening Access to System Dynamics Learning: MOOCs and more

The goal of this structured brainstorming session is to develop concrete objectives for promoting system dynamics learning outside of and complementary to formal academic training. Online technology provides opportunities for broadening access to SD learning. MOOCs (massive open online courses) are one approach for reaching a wide audience. Other ideas include a web clearinghouse for high-quality, modularized, resources that can stand alone, and could be assembled into short or long courses. These could be used by SD academics in traditional courses, as building blocks for a MOOC, by individuals who want to teach themselves, as part of short courses, as introductions or foundations for group modeling exercises, and so on. There are many questions that need to be answered about developing widely accessible, high quality system dynamics teaching materials, beginning with whether this should be a Society-wide or Society-sanctioned initiative, how we might secure grants or other funding to develop resources, how to ensure appropriate rigor and quality of "learning objects", and how to use the experience of others who have done similar things in other fields. Please join us for this Society-wide discussion.

Daniel J. W. Arthur
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Geoff Coyle: legacy and prospects for system dynamics - Video Presentation

The UK Chapter of the System Dynamics Society held this commemorative event on May 29, at the Royal School of Mines, Imperial College, London. The event was hosted by the Department of Earth Science and Engineering, Imperial College. Daniel Arthur gave the welcome address. Speakers and the titles of their talks included Eric Wolstenholme, "The Pioneering Work of the Bradford Group;" Jonathan Coyle, "The Diaspora of People Inspired by Geoff;" Bob Cavana, "The View from One of Geoff's Students;" and John Morecroft, "Encounters with Geoff and His Work: Samples from a Timeline." The event was recorded and portions will be screened during a lunchtime session at the conference.

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German Chapter Informal Gathering

The German Chapter advances networking and collaboration among System Dynamicists in Germany. By end of 2012 the German Chapter had 7 institutional members (also listed on our website) and 112 (personal) members and keeps more than 300 interested researchers, managers, and students updated through its e-mail newsletter. System Dynamics colloquia and roundtables are regularly organized in Frankfurt/Main. These events provide a basis for meeting fellow System Dynamicists and for discussing modeling projects. On June 13-14, 2013, the Chapter's 7th Annual Meeting is held in Würzburg. This event brings together modelers from the scientific and corporate world, and by combining talks, presentations, and modeling exercises, it offers a formidable and appreciated platform for establishing links within the community as well as for actively advancing SD skills. In addition, the Gert-von-Kortzfleisch-Prize for extraordinary work in SD conducted in Germany or in German will be awarded. More information on the activities of the German Chapter is available from our website at http://www.systemdynamics.de (in German).

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Getting to Know 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.

and

Hosting the International Conference of the System Dynamics Society

In 2017 the System Dynamics Society may once again hold its annual conference in a place selected from submissions by Society members. It is not too early to think about being a conference host and what that entails. This meeting will explain the process of submitting a conference hosting proposal, give prospective proposers a chance to talk to previous conference chairs and co-chairs, learn about the available support from the Society Home Office, and look at the existing planning tools available. The Society Policy Council and the Society VP Meetings are ready to accept proposals now.

J. Bradley Morrison
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Brandeis International Business School

Health Care Adventures at the Center for Medical Simulation

Designed specifically for people with interest in system dynamics or simulation, this event will thrust you into the dynamic environment of healthcare on the front lines. Participants will step into the healthcare arena and take on challenges of patient care and crisis management with a simulated patient. The event will be held at the Center for Medical Simulation, a highly realistic clinical environment in which non-clinicians will actually get the chance to care for a patient and experience real-life issues first hand. It's sure to be an engaging experience. CMS faculty will work with the group before the simulations, discussing objectives and expectations, and again after the simulations, identifying important interactions, key learnings and suggestions for improvement at individual, group, and system

levels. As one of the first medical simulation centers in the world, CMS has more than 25 years of experience creating and staging medical simulations. Using our experiences in the day and drawing on the decades of experience at CMS, we will explore how to use simulation to create effective learning experiences for practitioners concerned about improving performance in real-world settings. No clinical experience or training is required. Clinicians are welcome.

Wayne Wakeland
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Portland State University

Health Policy Special Interest Group Business Meeting for Exploring Collaborations

The Health Policy Special Interest Group formed more than ten years ago and has grown to over 300 members, about half of whom are SD Society members. We are a worldwide SIG with active collaborations employing system dynamic analyses to advance major health policy initiatives. Regardless of whether you are new to the field, a policy analyst, or a veteran SD modeler, we welcome your participation in exchanging ideas about how SD can better engage and support health policy leaders around the world. HPSIG will participate with an e-poster, hold a session on Sunday, and will sponsor a special lunchtime session on Wednesday on "Using the ReThink Health Model of Local Health System Reform." The Annual Meeting will be devoted to exchanging information regarding recent and current Health Policy work and activities, explore possible collaborations, and elect officers of the SIG.

Andrew P. Jones
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Climate Interactive

Interactive Experimentation with a Policy-Maker-Oriented Global Energy and Climate Simulator

Society's energy infrastructure and the Earth's climate are each complex dynamical systems driven by multiple feedback processes, accumulations, time delays and nonlinearities, but research shows poor understanding of these processes is widespread, even among highly educated people with strong technical backgrounds. Existing energy and climate models are opaque to policymakers and too slow to be effective either in the fast-paced context of policymaking or as learning environments to help improve people's understanding of climate dynamics. Here we present a transparent, intuitive policy simulation model that provides policymakers, negotiators, educators, businesses, the media, and the public with the ability to explore, for themselves, the likely consequences of energy, GDP, land use, and GHG emissions policies. The model runs on an ordinary laptop in a fraction of a second, offers an intuitive interface and has been carefully grounded in the best available science. We describe the need for such tools, the structure of the model, and calibration to climate data, energy data, and state of the art general circulation and energy models. This simulation is an extension of a climate simulator that is being used by officials and policymakers in key UNFCCC parties, including the United States, China and the United Nations.

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Senshu University School of Commerce

Japan Chapter Annual Meeting

We are pleased to inform you that Japan Chapter Meeting will be held in Cambridge, Massachusetts. Join all the attendants who are interested in Japan and Japan Chapter. Japan Chapter was founded in 1990. In 1995, Japan Chapter held The International System Dynamics Conference hosted by Gakushuin University in Tokyo. As Research activities, Japan Chapter publishes an annual journal and holds regular research meetings and annual symposiums. We always welcome

System Dynamics members or users who visit Japan. Several System Dynamics researchers have already had meetings hosted by Japan Chapter. Contact us without hesitation. -Akira Uchino, the head of Japan Chapter.

Peter M. Milling
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Mannheim University

Last Call Documentary Screening

Italian filmmaker Enrico Cerasuolo and his team have produced "Last Call," a documentary about the story of "The Limits to Growth." The film presents rare historical footage and extensive new interviews with all the principals to portray the Club of Rome project from its birth at MIT until its profound relevance today. This will be the US premiere. An informal discussion lead by Peter Milling, Dennis Meadows and Erich Zahn will follow. More information about the film is available at (www.lastcallthefilm.org).

Gloria Pérez Salazar
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Tecnológico de Monterrey

Latin America Chapter Annual Meeting

The Latin-American Chapter meeting that will place at the 31th International Conference in Cambridge, Massachusetts, will bring us the opportunity of interacting and being an actively involved with different colleagues from the Society. We will talk about our next annual meeting, the 11th. Latin-American System Dynamics Conference which will take place in México, D.F, November 6 through 9, 2013. This is a very special conference because we are celebrating 10 years of friendship gatherings around System Dynamics. For further information please contact Gloria Pérez Salazar, gloria.perez@itesm.mx or visit our Chapter webpage: http://dinamica-sistemas.mty.itesm.mx.

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Lifetime Achievement Award Announcement and Introduction of Winner

The System Dynamics Society occasionally recognizes people for making a significant contribution to the field over an extended period of time by giving them the Lifetime Achievement Award. This is the only award of the Society that is based on a body of work done over a lifetime and not on a single publication. No nominations are solicited for the award, and the Forrester Award Committee selects the winner. The award carries a plaque recognizing the recipient's achievement. The award has been given only twice in the past: in 1999 to R. Geoffrey Coyle and in 2011 to Diana Fisher. The third Lifetime Achievement Award in our history will be presented at the 2013 conference.

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Model Analysis Roundtable and SIG-MA Annual Meeting

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. The activities of SIG-MA also includes the further development of tools for

model analysis and clear communication of their use (and benefits) in applications. The SIG-MA is open to all system dynamicists interested in formal analysis.

Model Expo

Share your model? Definitely! This year there is a new way to do this at the Conference. Over lunch* on Monday there will be a Model Expo in the Charles View Ballroom, on the top floor of the Hyatt Regency Cambridge. Authors who are presenting model-based work will have the opportunity to show their model to others and let them interact with it. The presentation will be on a notebook, tablet, or phone with the model loaded, or cellular connectivity (sorry no wireless available). In addition to encouraging all authors to upload copies of models and additional supporting material so that others may study them and reproduce results, the Model Expo is a chance to talk to people about how the models work, get important comments, and just show off. *Lunch is not included.

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Homer Consulting

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Initiative for SD in the Public Sector

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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Özge Karanfil Yigit
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Newcomer Orientation

This is a special event for newcomers (first-time conference attendees) is scheduled on Sunday afternoon. Newcomers and veteran attendees (guides) will be brought together based on their topics of interest. The guides will answer questions and provide information to help the newcomers get the most out of the conference. The orientation session will "self-organize" into groups to cover general topics. Newcomers will also be advised of the Society Chapter meetings and the Special Interest Group (SIG) meetings that might match their interests. To participate in this program, check the box on the registration form for first-time participant, or just come to the meeting!

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Washington State University

Outstanding Service Award Announcement

The System Dynamics Society Outstanding Service Award recognizes individuals that have, on a volunteer basis, made exceptional contributions to the Society over an extended period of time. The Society has a long and proud tradition of volunteer service and Julie Pugh, who volunteered as the first Executive Director,

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has inspired this award. Even after establishing a central office with a paid professional staff in 1996, the growth and development of the Society has been heavily dependent on the work of volunteers. To acknowledge this work, emphasize its importance in achieving Society goals, and highlight efforts that can inspire others, this service award was established in 2009. It is awarded as often as once per year during the annual conference.

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PhD Colloquium

The PhD Colloquium is a whole day event for 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. Plenary presentations by students at the colloquium will identify common problems encountered by student researchers in their theses. Presentations are followed by a discussion session, providing a unique opportunity for learning among all attendants, and particularly for young researchers. Combined with a workshop and poster session, we expect the all-day colloquium to be an exciting and insightful event. Everyone is more than welcome to join the PhD Colloquium. It is a great opportunity to meet students from around the world and exchange ideas. More information is available at www.systemdynamics.org/chapters/student. Any questions about participating in the colloquium can be directed to phdcolloquium@systemdynamics.org.

Edward G. Anderson
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University of Texas

Practitioners' Roundtable

A large, important, and vital group in the System Dynamics Society is its practitioners. As a Society, we seek to actively support the practitioner community by developing a sense of community among those involved in or have an interest in applying the system dynamics methodology in practice as opposed to academia or education. The goals and issues that this roundtable seeks to address are: (1) What efforts can the Society undertake to serve practitioners that have heretofore neglected? (2) How to we make system dynamics practitioners aware of each other and their work? (3) How do we publicize the great work that is done by SD practitioners? (4) Discuss ideas on how to create a repository of outstanding practitioner work.

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Albert Einstein College of Medicine

Ralph L. Levine
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Michigan State University

Psychology Roundtable and Psychology SIG Annual Meeting

Our roundtable will focus on epistemological issues of including psychological constructs in formulation, simulating, and validating system dynamics (SD) models. We will discuss the epistemological basis of SD models in general, with emphasis on social and psychological variables. Psychological variables and social processes can (1) be used in dynamic models to lead to better understanding of the causes of the problem and (2) can enhance the field of psychology by developing dynamic models of social processes, per se. A variety

of strategies for integrating psychological and other information variables will be presented, with general discussion about the utility of iterative deliberation via group model building and other qualitative research techniques.

Red Ribbon Event and SD Career Link Bulletin Board

The goal of the Red Ribbon Event is to allow job-seekers as well as attendees with job-finding resources or job opportunities to easily connect and network. Anyone who would like to be identified as having job-finding resources or job opportunities will be wearing a red ribbon on their name badge. Although not everyone wearing a ribbon will have a job opening, ribbon-wearers are willing and prepared to spend some time helping out job-seekers. This event is NOT a Job Fair with scheduled interviews between members of a search committee and job-seekers. The meaning of the ribbons will be announced throughout the conference to encourage job-seekers to approach ribbon-wearers. This event will provide an opportunity to exchange contact details, to arrange another time during the conference for a cup of coffee or other meeting, or to interact directly at a later coffee break. This event is about networking and providing guidance and support to job-seekers. In conjunction with the Red Ribbon Event the SD Career Link Bulletin Board will also be available. We hope to see you there!

Jeff W. Trailer
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California State University Chico

Simulating your strategic architecture: Home Depot 1992-2012

This model is used in a strategic management class to illustrate growth dynamics. Home Depot is used as an example of a company that used external financing to grow the business at a rate exceeding its internally generated cash rate. Data was obtained from 10-k annual reports to shareholders, and includes not only standard reporting of earnings and expenses, but also new stores opened each year, and sales per store decomposable into sales per associate per store and sales per associate. The latter sheds interesting light on the pattern of performance over the last 20 years. The major feedback effect is the positive loop involving generating investing cash flow which is used to open new stores, which generate more cash. This example shows how Home Depot pushed the positive loop forward, in the 1990's, via external financing policy.

Linda Morecroft
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Spouses' Lounge

Building on the success of last year, the Spouses' Lounge will be open again. The Spouses' Lounge offers a place for spouses, significant others, travel companions, and family members to meet, gather and make plans to do fun things in the Cambridge/Boston area. It is a great opportunity to make new friends and renew acquaintances. The Spouses' Lounge will be located in The Crow's Nest, a comfortable area overlooking the main lobby of the Hyatt Regency hotel. Please join us for the morning kickoff meeting on Monday 22 July (approximate time 9:30 am). Light refreshments will be provided by Worcester Polytechnic Institute (WPI). More information will be available on the conference website: http://conference.systemdynamics.org/venue/social-program/.

Student Chapter Annual Meeting

Chris Browne
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Australian National University

The Student Chapter will elect its 2013/2014 leadership at its Annual General Meeting. The Student Chapter brings together all students who are involved in System Dynamics research and give them the opportunity to raise key questions and/or concerns related to their research and discuss these in depth in a constructive and enjoyable atmosphere.

Student Chapter/PhD Colloquium Fundraiser

Jill A. Kuhlberg
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Washington University in St Louis

This year the Student Chapter will offer coffee and tea mugs and to-go cups emblazoned with the System Dynamics Society logo. Additionally, the students will offer a number of raffle items including an SDS membership, SDS conference registration, Beer Game, and Fireside Chat DVD!

Swiss Chapter Annual Meeting and Roundtable

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Univ of Applied Science St Gallen

Lukas Schmid
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Get together of the members of the Swiss chapter of the System Dynamics Society. Aside from the regular three meetings during the year this meeting is another opportunity for exchange. The Swiss Chapter activities include regular meetings which combine exchange, discussion and presentations of ongoing or completed System Dynamics studies. The participants of these meetings include members of academia as well as from practice. The PhD colloquium, however, which was for a number of years an important activity of the chapter, is no longer taking place. This colloquium offered a unique opportunity for exchange and getting feedback for PhD students from different universities in Switzerland. The chapter is currently thinking about opportunities to increase the benefit from being a member of the chapter in order to increase the number of members and to encourage participation in the meetings. Justus Gallati, Lukas Schmid Co-presidents of the Swiss Chapter.

System Dynamics Applications Award Announcement and Introduction of Winner

J. Bradley Morrison
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Brandeis International Business School

The System Dynamics Applications Award is presented by the Society as often as once every two years for the best "real world" application of system dynamics conducted within 10 years of the submission deadline. The award will be presented once again in 2013. The best application is based primarily on demonstrated measurable benefit to an organization through the use of system dynamics, and secondarily for new ideas that improve the art of applying system dynamics, or for relating work to existing system dynamics literature and/or other disciplines.

SYstem Dynamics Italian Chapter (SYDIC) Annual Meeting

Stefano Armenia
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Engineering Ingegneria Informatica SpA

SYDIC started a new path since the Nijmegen ISDC, also thanks to innovative tools now available to members. A new website, newsletter, forum, all have contributed to spread knowledge over the net about SD, achieving the goal of raising new members. Practitioners, professionals and academics can now find a

way to discuss about common interests and research. The Chapter activities during the year will be discussed and future steps to manage the chapter will be planned. For the period July 2012 - June 2013 the SYDIC (SYstem Dynamics Italian Chapter) Policy Council will present the main activities of SYDIC members both in the Academic (Universities & Reseach centers) and in the Consulting (Private & Public Administration) areas as well as will help planning next year events/workshops and in general Chapter activities. The annual report of the Chapter members is presented by a e-poster which will point out, through a visual geographic distribution on the Italian territory, the main activities of the operative members both in the academic area and in the professional sector.

Kim D. Warren
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System Dynamics Society Business

All members and interested parties are invited to attend the annual System Dynamics Society Business Meeting. Rogelio Oliva, Executive Editor will talk about the state of the "System Dynamics Review."

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The Persistence of Pests and Other Undesirable Populations

Undesirable populations offer considerable resistance to policies designed to eradicate them: - Stray dogs roam the streets of many cities in spite of efforts to euthanize or castrate them. - Street gangs continue in many cities in spite of considerable effort on the part of law and order institutions to contain them. - Terrorist attacks continue in spite of concerted military offensives to eradicate their perpetrators. We will demonstrate three simple models that represent these populations and the policies designed to control them. The models will be presented in a format the audience can experiment with. The presentation will be adapted from "Stray dogs, street gangs and terrorists: manifestations of a latent capacity support system," April 13, 2009, Khalid Saeed, Worcester Polytechnic Institute, which was earlier presented as a paper poster at the SD conference in Albuquerque.

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Creator of Learning Environments

Bobby Milstein
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Fannie E Rippel Foundation

Jack B. Homer
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Using the ReThink Health Model of Local Health System Reform (hosted by the Health Policy SIG)

In the U.S., we often think of health system reform as being something that happens at the national level, but much, indeed perhaps more, must also be done locally, at the level of a city, county, or region. A system dynamics model of local health system reform was developed as part of the ReThink Health initiative of the Fannie E. Rippel Foundation. This model was presented in a plenary session at ISDC 2012 in Switzerland, and has now been developed further, and calibrated to represent various real locations, as well as a microcosm of the U.S. overall we call "Anytown USA", depicting realistic changes from 2000 to 2040. This two-hour session (held during the Wednesday lunch break) will give participants, organized as small teams, the opportunity to experiment with the online version of the model. This experience will be followed by a broad discussion on health system reform and possible further uses and extensions of the model. Participants should bring their own lunch and a laptop with wi-fi capability. This special session is hosted by the Health Policy SIG, but all are invited.

Steffen Bayer
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Imperial College London

Daniel J. W. Arthur
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UK Chapter Roundtable and Annual Meeting

Current UK Chapter activities will be discussed. These include the UK Chapter Strategy Exercise, a review of the Geoff Coyle event, discussions with World Resources Institute (Washington DC) and Jorgen Randers about climate change and his recent book "2052 - A global forecast for the next forty years", as well as upcoming future prospects for applied system dynamics work in the UK, which include: commodity price dynamics and Corporate Social Responsibility modelling in the mining industry, rebalancing supply chains in the food and drink retailing sectors, systemic issues in international trade, modelling UK industrial policy, system dynamics modelling of the social evil of human trafficking, integrating dynamic and detailed complexity in corporate enterprise forecasting.

Workshops

Listed alphabetically by Workshop name

Chris Browne
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Barry Newell
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Australian National University

Paul Compston
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The Australian National University

Building Better Mental Models of the Impact of Anthropogenic GHG Emissions - a Hands-On Activity

The problem of anthropogenic GHG emissions has been of serious concern for decades, yet little action on the issue has been achieved over this period. Public awareness of the problem is high, but the lack of action suggests that the shared public understanding of the problem is low, encouraging a 'wait-and-see' approach. We propose that public understanding could be improved by participation in an activity that uses a simple physical analogue as the basis for a better metaphorical understanding of anthropogenic perturbations of the natural carbon cycle. The physical analogue is a manipulable stock-and-flow model, involving water, pumps, and containers. Participants take on the role of emission and absorption processes within the carbon cycle and work together in an effort to stabilise the atmospheric carbon level. The analogue is an interactive and visible introduction to stocks-and-flows, and exposes participants to SD concepts like feedback, delays and dynamic behaviour of systems.

Requirements: Participants should bring: N/A. Advanced Reading: There are no preparation activities required. We will show a short video to (attempt to) build a shared understanding of the problem space at the beginning of the workshop. Level: Everyone.

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William Schoenberg
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Karim J. Chichakly
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Creating Simulations for the Web with STELLA and iThink

This workshop is intended for new or current STELLA and iThink users who want to share models online. Using STELLA or iThink, participants will create a web interface to a model and publish it online with the isee NetSim wizard - no HTML programming required! The session will be conducted as a hands-on workshop and will include guided instruction for creating an interface to a model, publishing models online with isee NetSim, and editing models that have already been published. Please bring a computer with STELLA or iThink Version 10 and isee NetSim installed or arrive 15 minutes early to install the software.

Requirements: Participants should bring: Laptop computer with STELLA or iThink Version 10 and isee NetSim installed or arrive 15 minutes early to install the software. Advanced Reading: N/A. Level: Everyone.

Dennis Meadows
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Laboratory for Interactive Learning

FishBanks in Teaching

FishBanks is a computer-assisted, operational game, based on a system-dynamcis model that conveys insights about sustainable use of renewable resources, systems behavior, team work, and decision making under uncertainty. The game has been translated into 15 languages and is used by hundreds of teachers around the world. It was the first game to be certified as an effective teaching tool by the

US Department of Education. Dennis Meadows, developer of the game, will conduct a workshop to introduce the simulation and discuss its use in teaching. The session will include participation in an actual game session. This session will be useful for those who regularly use the game in their teaching as well as for those who are seeing it for the first time. Because the game is based on a system dynamics model of resource harvesting and regeneration, it is widely used to introduce the field of SD to new students. Every participant will receive a free set of the materials that they require to conduct game sessions back in their home institutions. Those who already use the game in their teaching will be invited during the workshop to comment on their own experiences with it.

Requirements: Participants should bring: N/A. Advanced Reading: Every participant will receive a free set of the materials that they require to conduct game sessions back in their home institutions. Level: Everyone.

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Games for a New Climate: Leveraging Immersive, Situated Learning Experiences for Climate Change Education and Decision Support

As the challenges brought by climate change grow, so too does the need for tools that enable citizens and decision-makers to understand, respond to, and innovate in the climate and energy space. It is now clear that simply delivering information about climate change science does not create an informed public or effective policies to address its causes or effects. We argue that new tools are needed to foster the construction of robust mental models of climate change and the human systems that interact with it. In this workshop, we introduce a set games and interactive demonstrations that aim to meet this goal. These interactive tools range from a complex role-playing game to simple interactive demonstrations of stocks, flows, feedbacks, and delays involved in climate and human systems. Workshop participants will be given access to all materials used, as well as training on facilitating and de-briefing games. These tools can be brought to settings that range from middle school classrooms to advanced graduate degree programs, community meetings or events, high-level policy exercises, or municipal or corporate decision-making.

Requirements: Participants should bring: Something to take notes with (pen and paper are fine). Advanced Reading: N/A. Level: Everyone.

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Forio Online Simulations

Getting Started with Forio: Turn Your Model into a Web Simulation

Bring your own Vensim, AnyLogic, iThink or Forio model along with your laptop and by the end of our workshop you'll have your simulation running on the web in a free Forio Simulate account. If you don't have a model or a laptop you can pair up with someone during the workshop and collaborate to produce a web simulation. The session will start with a ten minute introduction to Forio Simulate. After the introduction, we'll divide the workshop into two phases. In the first phase we will help you get your model running on Forio Simulate. We'll walk through the process of importing your model as a group and then give you time to get your own model running on the platform. In the second phase we'll focus on creating a user interface for your model. We'll start phase two with a class introduction on how to use Simulate's drag- and-drop interface designer. After the introduction, you will be able to work on your own simulation with help

from Forio. Any volunteers can present their simulations to the class. Forio will provide a debrief on the web simulations presented and suggest possible next steps for enhancing those sims.

Requirements: Participants should bring: Laptop and a small to medium sized sample model. Advanced Reading: N/A. Level: Everyone.

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Getting Started with pmBLOX

This workshop will provide instruction on how to use pmBLOX, the only commercially available project planning tool that uses SD as its foundation. The workshop is intended for SD practitioners (at any level) that are involved in project management or scheduling for their organizations. The session will be conducted as a hands-on workshop and will provide software that participants can use at their own organizations. Participants will learn how to navigate pmBLOX, how to build project plans within pmBLOX and run simulations, how to import plans from Microsoft Project format, and how to conduct advanced analyses that are not available in planning tools today. Participants should bring their own computers. Prior to the session, participants can download the required pmBLOX software application at www.pmblox.com. CD's will also be provided at the workshop. People without computers are welcome to watch or team up with some else that brought a computer.

Requirements: Participants should bring: Laptop is preferred, but not required. Advanced Reading: Participants can download software at www.pmblox.com. Level: Everyone.

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Getting Started with Powersim Studio

This workshop will be an introduction to building system dynamics models using Powersim Studio. The workshop is intended for people who are relatively new to the field or do not have experience using Studio. The session will be conducted as a hands-on workshop and will demonstrate basic techniques for building and analyzing causal loop diagrams, stock and flow diagrams and simple simulation models. It will also point out some of the advanced Studio features such as arrays, user interface tools, VB scripting, and the powerful Studio interactive development environment (IDE). Sample models will be available.

Requirements: Participants should bring: A laptop and download Studio Express from the link site. Advanced Reading: None. Level: Everyone.

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Getting Started with scmBLOX

This workshop will provide instruction on how to use scmBLOX, the only commercially available supply chain management tool that uses SD as its foundation. The workshop is intended for SD practitioners (at any level) that are involved in supply chain planning or management for their organizations. The session will be conducted as a hands-on workshop and will provide software that participants can use at their own organizations. Participants will learn how to navigate scmBLOX, how to build complex supply chains within scmBLOX and run simulations, and how to conduct advanced analyses and plot results. Participants should bring their own computers. CD's will be provided at the

workshop with necessary software. People without computers are welcome to watch or team up with some else that brought a computer.|

Requirements: Participants should bring: Laptop is preferred, but not required. Advanced Reading: None. Level: Everyone.

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Getting Started with STELLA and iThink

This workshop will be an introduction to building and communicating system dynamics models using STELLA or iThink software. The workshop is intended for people who are relatively new to the field or do not have experience using STELLA or iThink Version 10. The session will be conducted as a hands-on workshop and will demonstrate how to build hierarchical models using modules. Participants will also learn basic techniques for analyzing and communicating simple simulation models. Please bring a computer with STELLA or iThink Version 10 installed or arrive 15 minutes early to install the software.

Requirements: Participants should bring: Laptop computer with STELLA or iThink Version 10 installed or arrive 15 minutes early to install the software. Advanced Reading: None. Level: Everyone.

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Getting Started with Sysdea Online Modeling Software

This workshop will explain the main features of Sysdea and their benefits for both teaching and for real-time modelling of projects with teams. The workshop is intended for people relatively new to the field or wanting to compare Sysdea with alternative software products. It will be a hands-on workshop, demonstrating basic techniques for building simple simulation models, and will also cover model sharing and collaboration - especially useful in teaching environments. Participants should bring their own laptops with WiFi access. People without laptops are welcome to work together with those who do.

Requirements: Participants should bring: A laptop (PC or Mac) with current browser: Chrome, Firefox, Safari, Internet Explorer 9+. Internet Connection. People without laptops will be invited to work with others in groups. Advanced Reading: None. Level: Everyone.

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Getting Started with the Beer Game on Steroids (BGOS)

This workshop is intended for SD practitioners looking to apply the concepts of the Beer Game to real-world supply chains. The session will be conducted as a hands-on workshop and will provide free software that participants can use at their own organizations. Instruction will be provided for how to navigate the BGOS application, how to set up simulations in the BGOS, how to plot results, and how to make model changes. Participants should bring their own computers. Prior to the session, participants can download the required BGOS software application at www.beergameonsteroids.com. CD's will also be provided at the workshop. People without computers are welcome to watch or team up with some else who brought a computer.

Requirements: Participants should bring: Laptop preferred, but not required. Advanced Reading: Participants can download and install BGOS prior to the workshop: www.beergameonsteroids.com. Level: Everyone.

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Getting Started with Vensim

This hands-on workshop will provide a quick introduction to modeling with Vensim. The primary purpose is to obtain technical proficiency with the software - building diagrams, writing and checking equations, running models and displaying output. However, in the process, we will work with interesting, classic models that demonstrate growth and decay, nonlinearity and shifting loop dominance and other interesting phenomena. As time permits and governed by the interest of participants, we will also cover modeling discrete events, stochastic behavior, tipping points and/or crafting good behavioral decision rules.

Requirements: Participants should bring: A laptop, or a friend with a laptop to share. If possible, install a copy of Vensim on your computer in advance, or arrive a few minutes early to prepare. You can use Vensim PLE from the download page at Vensim.com. Limited-time evaluation copies of Vensim DSS, along with course materials, will be distributed on USB flash drives. Advanced Reading: N/A. Level: Beginner.

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Model Analysis with Vensim and Classic Global Models

In this hands-on workshop, we will explore ways of testing models and the conclusions that flow from them, using Vensim. This process is crucial to the development of understanding and avoidance of errors. Topics covered will include dimensional consistency and conservation laws, feedback elimination, extreme conditions tests, parameter sensitivity, and other formal and informal methods for getting the most out of a model. We will perform these experiments on one or a few classic models like World3 and World Dynamics. These are interesting testbeds because they are dynamically complex and, while they have flaws, they have also provided enduring insights.

Requirements: Participants should bring: A laptop, or a friend with a laptop to share. If possible, install a copy of Vensim on your computer in advance, or arrive a few minutes early to prepare. You can use Vensim PLE from the download page at Vensim.com. Limited-time evaluation copies of Vensim DSS, along with course materials, will be distributed on USB flash drives. Advanced Reading: Optional: read any or all of the classics of global modeling: - World Dynamics (Forrester) - Limits to Growth, Beyond the Limits, Limits to Growth - the 30 Year Update (Meadows et al.) - Models of Doom (Jahoda, Pavitt, Cole & Christopher Freeman) - 2052: A Global Forecast For the Next 40 Years (Jorgen Randers) - Measurement Without Data & Lethal Model (Nordhaus) Level: Everyone.

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Optimization with Vensim

In this hands-on workshop we will explore optimization in Vensim, for model calibration, testing and development of effective policies. We will use a single boom-and-bust market model as the backdrop for our calibration and policy experiments. While the primary focus is on the mechanics of optimization, we will also discuss the philosophy, mathematics, and limitations of the methods.

Requirements: Participants should bring: A laptop, or a friend with a laptop to share. If possible, install a copy of Vensim on your computer in advance, or arrive

a few minutes early to prepare. You will need Vensim Pro or DSS. Limited- time evaluation copies of Vensim DSS, along with course materials, will be distributed on USB flash drives. Advanced Reading: Participants should have a working familiarity with building and running models in Vensim. Level: Advanced.

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Powersim Studio User Group and Advanced Techniques with Powersim Studio

A meeting of members (current and prospective) of the Yahoo Tech Group powersimtools. A look at some of the advanced features of Powersim Studio (e.g. IDE, ranges, risk analysis, optimization, interface techniques, model quality, etc.).

Requirements: Participants should bring: N/A. Advanced Reading: None. Level: Everyone.

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Rapid Modeling and Teaching with Sysdea Online System Dynamics Software

Modern modeling software packages have made system dynamics understandable to many people, but two challenges remain. First, how to make the actual building of models accessible to new-comers? Secondly, how to build robust models fast enough with teams to solve their challenges in real-time? Sysdea deals with both of these challenges by adopting a few basic principles. Every object in the model displays its behaviour over time. That behaviour is displayed immediately, with every model change, with no need to 'Run' the model. Every item carries both "simulated" and "entered" values to compare modeled performance with actual or forecast results. This workshop will use a hands-on demonstration to show how these principles make it possible to build robust models in a fraction of the time needed to do the same in other packages. This speed is enhanced by the intuitive modeling and command methods, and the sharing of online models.

Requirements: Participants should bring: A laptop (PC or Mac) with current browser: Chrome,Firefox, Safari, Internet Explorer 9+. Internet Connection. People without laptops will be invited to work with others in groups. Advanced Reading: None. Level: Everyone.

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Schneider Trucking Game: A Multiplayer Simulation on the iPad

Over 10 simulated days players purchase tractors and trailers, accept loads for which they earn revenue, and move trucks from dispatch centers in different cities. Players must work together in teams to create the most profitable trucking company! Bring your iPad to participate in this workshop. Participants will play the role of a dispatch operator at Schneider Trucking in this interactive multiplayer game to manage a fleet of trucks and fulfill orders within the shipping network. This workshop is an educational and entertaining exercise for anyone interested in logistics and operations management, and how system dynamics can be used to model transportation networks. The game is for people in the transportation industry, but should still be accessible to anyone. The Trucking

Game has been developed in conjunction with Schneider Trucking, a leader in logistics and transportation services and Forio Simulations.

Requirements: Participants should bring: An iPad. A limited number of loaner iPads will be available. Advanced Reading: N/A. Level: Everyone.

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Scriptapedia 4.0: A Tool for Designing "Scripted" Group Model Building Workshops

This workshop introduces participants to Scriptapedia 4.0, a database application for designing scripted GMB workshops. Scriptapedia 4.0 is a free Filemaker Pro based tool that runs on both Mac OS X and Windows platforms containing over 40 documented scripts and sample agendas for GMB sessions. Scriptapedia allows users to design single and multiple session GMB workshops; develop detailed agendas with workshop timings; produce facilitation manuals for GMB teams; adapt and tailor agendas and scripts; generate workshop evaluation instruments; and, export GMB workshops and scripts to Word documents for more customized formatting. Participants will also get an introduction to the design philosophy underlying scripted GMB workshops and how to use Scriptapedia to design GMB workshops. Participants will be given a copy of Scriptapedia 4.0 and given a "hands on" opportunity to walk through the design of a GMB workshop illustrating some of its key features, including the creation and submission of new scripts.

Requirements: Participants should bring: Laptop. Advanced Reading: N/A. Level: Everyone.

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System Dynamics Model Documentation and Assessment Tool (SDM-Doc)

To help modelers increase the transparency of their models through enhanced documentation, scientists at Argonne National Laboratory (ANL), building on model documentation work by Oliva (2001), developed the System Dynamics Model Documentation and Assessment Tool (SDM-Doc) that enables modelers to create practical, efficient, HTML-based model documentation and provide customizable model assessments. The model documentation created by the SDM-Doc tool allows modelers to navigate through model equations and model views in an efficient and practical way creating documentation of the model sorted by variable name, type of variable, group, view, module, module/group/name, and variable of interest. Additionally, model tests are performed allowing modelers and reviewers of models to gain confidence in fundamental characteristics of model structure. The tool, its use, and the different model assessments included in it will be presented and explained. Participants are encouraged to bring their laptops to be able to use the tool during the workshop. A copy of the software will be distributed to participants at the workshop (the tool is accessible at http://tools.systemdynamics.org/sdm-doc/).

Requirements: Participants should bring: Laptop is desired. Advanced Reading: Recommended: Martinez-Moyano, I. J. (2012), Documentation for model transparency. System Dynamics Review, 28: 199–208. Level: Everyone.

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World Dynamics Revisited

Imagine an industrial society, in a vast yet finite world, with static population, accumulating capital in the search for prosperity. Starting with this 'scenario thought-experiment' the workshop leads participants through the structure, simulations and selected formulations of Jay Forrester's original World Dynamics model. There is a facilitated discussion of the full World Dynamics 'framework', including a hands-on mapping exercise for participants. These preparations set the stage for simulation experiments with the full World Dynamics model and the challenge of coordinating global industrial growth.

Requirements: Participants should bring: Laptop, pencil, paper and eraser. Advanced Reading: This workshop builds on a workshop I ran in St Gallen entitled 'Metaphorical Models for Managing the Transition from Growth to Sustainability' As preparation, participants should review the materials and sims from St Gallen. They are on the 2012 Conference website. In addition participants can read the following published journal article as background: Morecroft JDW 2012. Metaphorical Models for Limits to Growth and Industrialization, Systems Research and Behavioral Science, 29 (6), 645-666. Level: Everyone.

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