Proceedings of the 32nd International Conference

July 20-24, 2014
Delft, Netherlands

Partners:
Greenwood Strategic Advisors AG and Ventana Systems
Faculty of Technology, Policy and Management
at Delft Universty
TU Delft Aula Congress Centre

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Rochel Rubin, and Joan M. Yanni

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32nd International Conference
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System Dynamics Society

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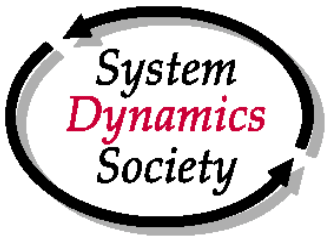

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Welcome

Welcome to the 32nd International Conference of the System Dynamics Society. This year, the conference takes place in the wonderful city of Delft, The Netherlands. Delft University of Technology is the conference host.

This year's program shows that the field of System Dynamics continues to thrive. Conference participants come from over 50 countries from all around the world. Starting with the PhD Colloquium on Sunday, followed by 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, **Good Governance in a Complex World,** highlights the role that model based analyses may play in understanding and effectively governing complex systems. The program consists 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 providing an interactive hands-on experience with models presented at the conference. The program schedule also includes exhibits, model assistance workshops, panel discussions, special sessions, a student colloquium, and Society business meetings. Wednesday will serve as a Business Day where we expect local corporate representatives to join us and to bring along their clients for the day.

During the conference there will also be time for social and professional interactions—the Welcome Reception at the Faculty of Technology, Policy and Management on Sunday, the Poster Symposium and Buffet at the Aula Congrescentrum on Monday, the Conference Banquet aboard the largest paddle steamer of Europe in Rotterdam on Tuesday, and the lunch buffets and coffee breaks at the Aula Congrescentrum will provide such opportunities. Additionally, the Faculty bar will be open each day for informal gathering after the last conference or workshop session. Also, the Spouses' Lounge, inside the university library, offers a place for spouses, significant others, travel companions, and family members to meet, gather, and make plans to do wonderful things in Delft, Amsterdam, and The Hague.

This year, 30 Thread Chairs, supported by several hundred volunteer reviewers, screened and commented on around 360 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 three conference partners: Greenwood Strategic Advisors AG and Ventana Systems; Faculty of Technology, Policy and Management at Delft University; and TU Delft Aula Congress Centre. We sincerely appreciate the enthusiasm and support of all our sponsors.

We have confidence that 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!

Best wishes from the Conference Organizers,

Pål Davidsen, Etiënne A. J. A. Rouwette, Erik Pruyt, Wil A.H. Thissen, C. Els van Daalen, Jack B. Homer, Hazhir Rahmandad, and Roberta Spencer

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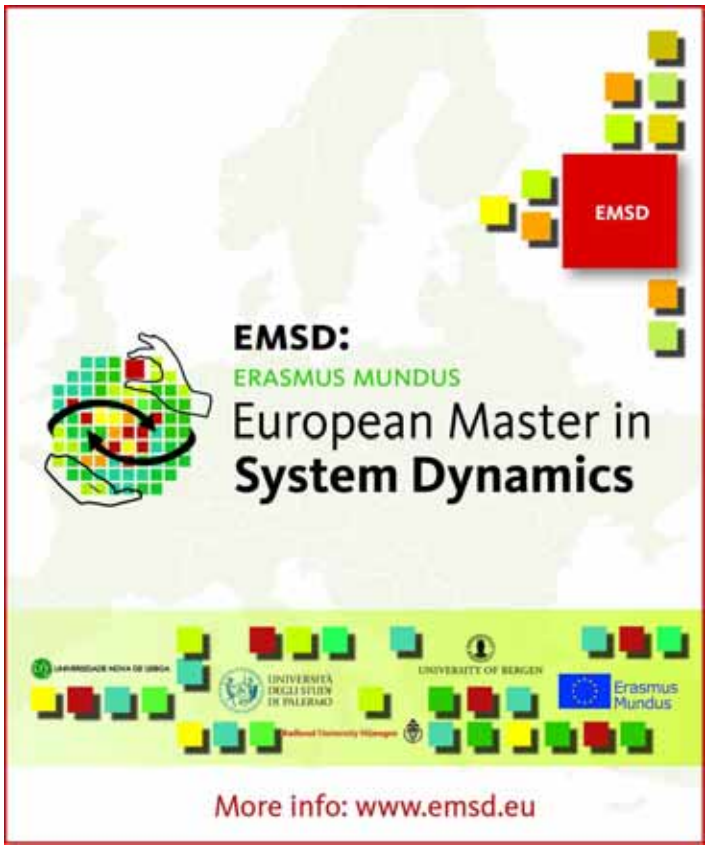
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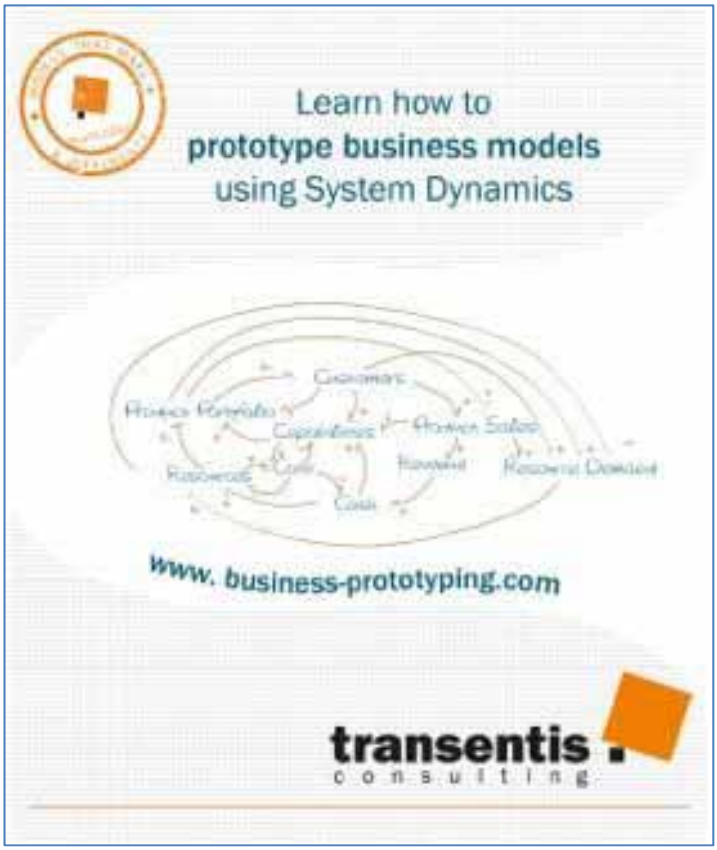
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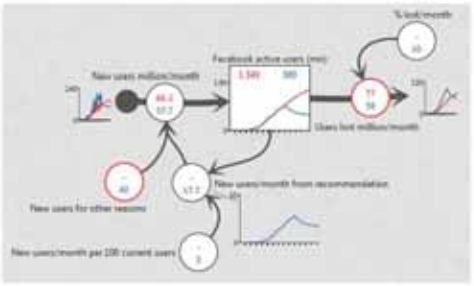

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Supporting materials will contain either a single file, or .zip/.rar or other archive which can be opened with a number of utilities or directly on some operating systems. Supporting materials may include plain text files or other commonly used file 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 no-cost readers or run-time versions of 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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Dirk Inghels
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Influence of composition, mass and number of passenger cars on end-of-life vehicles waste in Belgium: a System Dynamics approach

Sue Elizabeth McAvoy
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The impact of Australia's carbon tax on a non-qualifying "emissions intensive trade exposed" manufacturing industry

PARALLEL PRESENTATIONS

Jonathan Gomez
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Car Technology Scenarios using System Dynamics: Exploring Market Penetration and Energy Consumption in China, Germany and US

Deborah L. Jarvie
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Using System Dynamics to Explore the Use of Tax Incentives for Aquifer Protection during Unconventional Natural Gas Extraction

Jesse Joonas Juhani Lastunen
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Macroeconomic Dynamics of Greece in the Midst of the Eurozone Crisis – Application of SD Modeling and Insights for Policy

Mary Jo Stahlschmidt
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Inside the Arizona Child Protective Services Crisis: Using System Dynamics to Understand Caseworker Turnover

POSTER PRESENTATIONS

Yvonne Beck
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What can a rural village achieve? - A System Dynamics study on self-sufficient energy supply

Romana Berariu
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Flooding events and their cascading effects – analyzing the impact on disaster relief with System Dynamics

Matthew Hoyle Bigman
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Using System Dynamics to Assess the Growth of a Field through a Student-Practitioner Perspective

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Etiënne A. J. A. Rouwette
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Risk Management in Banking and the Promise of Dynamic Adaptive Policy-making Supported by System Dynamics and Group Model Build

Sarah Megan Boyar
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Thoughts on Philosophically Defending Use of SD Beyond Method in PhD Dissertations

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Application of System Dynamics in the Assessment of Uncertainties and their Effects on the Development of Tar sands in Nigeria

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System analysis of factors impacting the success of renewable energy projects in developing nations

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Understanding the Dynamics of Innovation

Emma Sarah Hanley
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Stage 1-System Dynamic Comparison of Decentralised Wind Energy Storage; Compressed Hydrogen vs Vanadium Redox Flow Batteries

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Issues in Parameter Calibration of a Dynamical Cobb-Douglas Production Function

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What worked and why? Using SD to understand mechanisms of change in a lifestyle behaviour intervention

Tomas Hubik
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Importance of the Human Resources Management in a Professional Service Firm

Lucie Jelínková
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Modern approaches for evaluating the company competitiveness and their implementation in the Czech business environment

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Using System Dynamics in the risk analysis process to overcome methodical weaknesses of statistic approaches

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The Impacts of Governmental Policies on the Investment Decision for Renewable Energies in the Swiss Electricity Market

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Integrated Project Delivery: A Normative Model for Added Value Creation in Complex Building Projects Using System Dynamics

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Maqasid Shariah as a Complementary Framework to Human Development Index (HDI): A System Thinking Approach

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Conflicts between stakeholders and unsustainable industries: participatory modeling approach in cases of Brazil and Guatemala

Variation in a Medical Home: Clusters of Practice, Disparate Outcomes and Dynamic Tensions

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Presentation Abstracts

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Applying Existing System Dynamics Business Formulations to Model Terror Organizations

A growing body of literature has shown that terror groups in particular have similarities to organizations whose operation are recognizable to the author and the readers – the firm. If terror groups and businesses are similar it would have significant implications to counter-terrorism community. It would enable the application of a broad set of existing theory (regarding the firm) to inform counter-terror policy, and possibly elucidate structures previously hidden to the decision-making communities. This paper highlights and references the public policy literature to build a case for describing terror organizations as businesses. System dynamics and system thinking models of terror and insurgency organizations are reviewed. The author develops a Vensim model using well-known system dynamics business formulations. The author then simulates the model to demonstrate logical flow and test policy. Finally, this paper outlines further development goals and a long-term research agenda for further development of the developed model.

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Energy transitions in Built Environment of Netherlands: A System Dynamics approach to diffusion of Solar boilers and Insulation

In context of rising demand for energy amidst limited resources, energy efficiency and sustainability are one of the major concerns of a modernized world. Gas consumption in the built environment constitutes for more than 30% of the overall energy consumption in the world. Hence, energy transitions and their preferences in the built environment demand urgent attention by policy makers in order to implement cost-effective and long-term sustainable policies. But, the highly dynamic nature of decision making adopted by households involves complex interaction between various factors. Therefore, in this study, a modified Bass diffusion structure was used in a System Dynamics model to examine energy transitions and subsequent reductions in overall gas consumption in the built environment of Netherlands. Specifically, the gas consumption by different types of owner-occupied houses having different attributes was studied by considering the probability of adoption of solar boilers and/or insulation by these households. Also, the effect of different policy measures such as subsidies, demolition, innovation driving, and increased advertisement/awareness, under different scenarios, was evaluated. These experiments confirmed that there is great potential for energy saving in the building sector. Moreover, policies that focus on changing people's behavior were found to be more effective in the energy transitions process.

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A System Dynamics Model for the Investigation of Additional Source of Raw Water from Effluent Water from a Constructed Wetland

There exist a gap in the demand and supply of water supply to the University of Lagos, Nigeria (Unilag). The University mainly depends on internal boreholes and municipal supply (the Lagos State Water cooperation) as sources of water supply to the University. While a number of boreholes serve as the source of raw water to the University's water treatment plants, the municipal water is pumped directly for distribution. In addition to water shortages that do arise occasionally from these sources, the combined quantities of the internal and municipal water supply are far below the current water demand of the University. It has been established, from another study, that the quality of water from the University's constructed wetland based domestic sewage treatment plant (CWDSTP) is acceptable as source of raw water for further treatment. In this study, a System Dynamic Model is developed to examine the quantity and impact of the water reclaimed from the CWDSTP in reducing water stress in the Unilag by closing the existing gap between water demand and supply. The results obtained from the study shows that 76.2% of the University's water demand can be met as against the current 42.6% supply level. An additional 3,141m3 of raw water can be added to the available raw water sources.

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The Clinical Risk Management in a Hospital Ward: a Case-Study adopting System Dynamics Approach

During the last two decades, the issue of clinical risk management CRM became one of the key topics in the Health care sector due to the increasing attention to the patient safety and the increase in monetary and non monetary costs. This paper explore the role of hospital's patient safety culture in the generation of medical adverse event by using system dynamics methodology. The hypothesis is that a safety culture assessment represents a tool for improving patient safety. We use system dynamics to explore the multidimensional facets of hospital's complex structure. By using a simulation model we want to test the role that the patient safety culture has in the generation of adverse events, in order to identify the best policies able to achieve the hospital target about patients' safety. The research was carried out in a public hospital placed in Sicily (Italy), in particular it was decided to concentrate the research in a specific operational unit: the ward of obstetrics and gynecology. We provide a summary of our findings and their empirical and theoretical implications and contributions. Suggestions about the power of system dynamics simulation model in capturing organizational behaviors are provided.

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Using system dynamics principles for conceptual modelling to resolve causes of rework in construction projects

Rework in construction projects has brought in two major challenges: cost overruns and delay. In this regards a study was conducted by considering various construction projects in the South West part of Nigeria to understand the causes of rework and interventions to mitigate it. Survey research

methodologies followed by the conceptual system dynamics (SD) modelling were used in the analysis. This study identified the sources of rework in construction projects from the design related, the client related and the contractor related issues and attempted to derive policy/strategic interventions to limit or eliminate rework on construction projects and its delivery by using conceptual SD models based on the influence of the variables on rework. The findings include that inappropriate scheduling for time pressure or delay at the planning stage, lack of adherence to the specifications, and non-availability of skilled human resource are the major causes of rework. However, rework in construction projects would be reduced or eliminated through policy interventions, such as, achieving client satisfaction with scheduling for time pressure or delay at the planning stage, adherence to specifications ensuring quality of work resulting in client satisfaction, and the availability of skilled manpower ensuring quality management.

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System Dynamics Methods on a Shoe-String

Addressing wicked problems is often delegated to communities and non-profits operating on shoe-string budgets, often relying heavily on volunteers. Because of this distribution of resources, the set of theoretical, financial and technical resources available to front-line workers in developing solutions is persistently insufficient and contributes to problem complexity. This paper presents work applying basic system dynamics methods in just such resource-constrained problem-solving settings. Each project is a stand-alone analysis, addressing a mission-sensitive problem where decision-makers faced high uncertainties and resource constraints. The approaches employed vary based on need and available resources. More constrained resources indicated more simplified variants from standard approaches. These variants were based on group model building, simulation modeling and purposive text analysis. Findings indicate that high-leverage actions for addressing problems were identified across all settings. Policy outcomes observed to date indicate that models achieved a high level of fidelity to problems. Even very basic methods identified useful insights. These projects serve to demonstrate that system dynamics methodology can be adapted to environments where analysis is necessarily constrained by scarce resources.

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Sahel Learning Lab

In this occasion we'll examine a fragil and desert ecosystem called the SAHEL at the North of Africa, under Sahara's desert. Where in the recent 50 years an unusual drought has caused famine, poverty and death in the population. Even though there have been well-intentioned efforts from global organizations as the UN, to support, with strategies for change, the improvement of the quality and life expectancy for people, very little has been achieved and the results have collapsed in a few years. Any change in any part of the system, wether applied to pumping waters from wells, health campaigns for population, the genetic improvement of animals to increase the food production, or to improve the field productivity, almost immediately affects on another part of the system and the cause-effect cycles of negative balance settle the system, where is very complex to overcome the constrains imposed by the environment. In this activity, the

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student will learn to model complex ecosystems, where any improvement strategy to implement in one of its parts, affects all simultaneously. As their main goal, they'll look for achieving a long-term sustainability in the ecosystem, where the economic, social and ecological goes together.

Urban Dynamics Learning Lab

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The growth or decline of cities is a very current issue in which we can help our authorities taking better decisions in urban policies. It involves complex and non linear interconnections that should be studied by methods that iluminate the feedback cycles that underline the urban dynamics and cause decisions be counterintuitive. In this activity, the students will discover the cause-effect cycles that link the use of the soil with the building construction for bussiness, houses for people, and at the same time, with the dynamic wroght of population in the Phase I. And after that, to connect with water, food cultivation, pasture for animals, the animals and their milky products, as well as their meat and articles for the human consumption; the income production and its relation with predators and hunters in Phase II. All together to develop better policy decisions for a sustainable long-term educational proyect.

Chinese Dynasties Learning Lab II

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This paper models an economy of farmers, bandits and soldiers. In addition to the economic factors affecting the economy studied by Saeed and Pavlov (2008), and the effects of two psychological factors broadly categorized as exposure to violence and group identity studied by (Saeed, Pavlov, Skorinko, Smith†), we have added to the model, the ability to review the impact of the phenomenon of collusion between soldiers and bandits, and the effects in the policies of population dynamics and policies related to changing the parameters representing the productivities and behavioral scaling factors in the economy, which has often been observed both in history and in some developing countries, and we have adding control checks for limiting collusion. We have also developed a storytelling to explain step by step, how the model was created and enriched, also we have developed an interactive presentation of the history, in iBook format for iPad and Mac, and we have created Chinese Dynasties learning lab II, that can be accessed from the web, allowing users to run the simulation easily, especially to review the impact of their decisions and to avoid as far as possible, the unintended consequences of any change, before they can be implemented in real level.

Alcohol Learning Lab

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During this activity, the students will develop a model that helps them to understand the speed at which rises or lowers the alochol level in the blood of a person, the time that it takes to recover for driving a car, the way the weight affects during it lasts, the different impact in the gender (male or female), the type of drink, the tolerance level, and the paticipation in consecutive sprees a person could have. The students will also understand what happens with the absorption of the alcohol in the stomach and thru there to the rest of the body through the bloodstream before being eliminated for the liver and the kidneys.

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They'll discover the cause-effect cycles that underlay the problem and, how they become a part of the solution.

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Exploratory Model of Conservation Agriculture Adoption and Diffusion in Zambia: a Dynamic Perspective

Population growth and constant arable land in Zambia constantly decrease the soil availability for agricultural purposes. At the same time, they increase the risk of food insecurity. The importance of soil as a vital resource in the agricultural production system increases in the course of projected negative impacts of climate change. Conservation agriculture has been highly promoted in Zambia as a sustainable agricultural practice. Conservation agriculture protects the sustainability of minerals in the soil which leads to higher and more stable yields. However, conservation agriculture in Zambia is only conducted as part of farmers' farming practice, which means farmers still use other practices or mix some practices from conservation agriculture with conventional agriculture practices. Previous studies have identified important determinants of conservation agriculture adoption as an innovation in farming practice in sub-Saharan Africa. However, none of those studies capture the dynamics of adoption and diffusion process. This study aims to explain observed adoption and diffusion patterns of conservation agriculture using a system dynamics model. The model structure is based on economic and social determinants identified in previous adoption studies and reports and calibrated using a combination of quantitative and qualitative data collection methods. Policy analyses identify coherent policy options to increase the implementation of conservation agriculture.

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A Dynamic Model of Centralized vs. Decentralized Process Improvement

Vigorous debate exists in process improvement circles between the proponents of "lean" and other methods in which line workers lead process improvement efforts and advocates for more centralized approaches (such as six sigma) in which improvement is lead by experts. We build a model that simulates two kinds of process issues: those that are system-wide and those that are localized. We also simulate centralized and decentralized process improvement efforts to manage each of these two types of process issues. This allows us to explain a number of interesting phenomena found in the literature. In particular, we have captured the benefit—seen in e.g. Toyota—of beginning with a centralized period of process improvement attacking systemic problems followed, when those returns begin to diminish, by a period of decentralized process improvement that attacks local problems. Our simulations have also supported the possibility that high levels of technology change may cause a firm to prefer to remain forever in the centralized mode of process improvement. Finally, our

simulations have also shown that, in environments with many local issues like healthcare, a concentration on decentralized process improvement may make more sense, even if the workers doing the process improvement are not highly trained.

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Educational attainment and incidence-based projection of functional disability among older Singaporeans

This study projects the number of elderly Singaporeans with functional disability , comparing projection based on incidence estimates not accounting for educational attainment, with incidence estimate taking into consideration educational attainment. The incidence of disability was estimated from the Social Isolation, Health and Lifestyle Survey (SIHLS), a nationally representative survey of community-dwelling Singaporeans aged years (N=5,000). Transition and mortality rates by age, gender, and educational attainment (distinguished by low: primary school or less and high: secondary school or more) were estimated using data from the SIHLS and its follow-up study (Panel on Health and Aging of Singaporean Elderly). A multi-state model was parameterized by linking with the population model. Due to population aging, the elderly population in Singapore is projected to more than double from now to 2040; of these, those with high education will increase from 40 percent now to 90 percent in 2040. Consequently, between now and 2040, the number of individuals aged 60 years or more with ADL and IADL limitations is projected to more than double; but if educational attainment does make a difference in disability transition and mortality, not accounting for the cohort effect of education is likely to overestimate the number of elderly with functional disability.

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Projecting the effects of long-term care policy on the labor market participation of informal caregivers: Simulation Insights

Objectives: Population aging is increasing demands for care from informal family caregivers of older adults. Using Singapore as a case study, this paper aims to provide a better understanding of the effects of the current long-term care (LTC) policy and various alternative policy options on the labor market participation of primary informal family caregivers of older adults. Methods: A model of the LTC system in Singapore was developed using a System Dynamics methodology. The model features several interacting elements that describe essential interdependence and information feedbacks among disabled elderly individuals, primary informal family caregivers, LTC services and policies. Results: Under the current LTC policy, by 2030, 3.6 percent of primary informal family caregivers (0.38 percent of the domestic labor supply) are expected to withdraw from the labor market. Alternative policy options would reduce primary informal family caregiver labor market withdrawal; however, the number of workers required to scale up LTC services is greater than the number of caregivers who can be expected to return to the labor market.

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Economic Evaluation of Obesity Prevention and Treatment Strategies via System Dynamics Modeling

Obesogenic social environments have contributed to the growth of childhood obesity. A variety of interventions have been shown to effectively reduce BMI, but information regarding cost-effectiveness is limited. Linear methods to estimate cost-effectiveness may not fully account for the complexity of peer and adult social influences over time. The objectives of our study were to: (1) assess the health impact and total implementation cost of specific research-tested prevention and treatment interventions at child and adult levels on child overweight and obesity prevalence, (2) present a broader public health decision making perspective for obesity interventions via system dynamics model that takes into account the social influences. We adapted the system dynamics model from our previous work to model the social transmission of overweight and obesity among adults and children, and tested specific interventions using evidence from the literature. A population-based approach to restrict food advertising toward children was the most effective and cost the least to society. Worksite wellness achieved the greatest indirect impact on child obesity compared to other adult targeted interventions, and was similar in cost-effectiveness to school-based interventions. Evaluation of public health interventions should take into account these influences for better effectiveness and cost effectiveness assessments.

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A System Dynamics approach to Critical Infrastructures Interdependency Analysis: the experience of the CRISADMIN Project

Critical Infrastructures are widely perceived as the backbone of today's society and awareness about their security needs is constantly growing. Due to the fact that infrastructures are no longer a public-authority monopoly, investments in security and resilience need to be proven effective and cost-efficient vis-à-vis with the emerging challenges and the issues at stake. Decision makers need to assess their investments alternatives by means of scenario modelling tools, such as the CRISADMIN Decision Support System. The CRISADMIN project aims at realizing a DSS based on a system dynamics model of critical infrastructures' interdependencies, thus attempting to provide information on the impact of critical events on the very same infrastructures. This paper describes the CRISADMIN methodological framework applied to modeling Critical Infrastructures interdependencies, focusing specifically on the energy supply, the telecommunication and the transport networks.

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Analyzing counter-terrorism and asymmetric conflict policies by means of a system dynamics approach

The aim of our research is to analyze the development of some Islamic terror groups, by means of System Dynamics (SD). SD is a qualitative and quantitative methodology that helps analyzing complex systems, characterized by feedback mechanisms between actions taken by a decision maker and the

reactions that the system manifests over time. After building a possible model accounting for the development dynamics common to some Islamic groups of terror, we will first analyze traditional counter-terrorism actions and their effectiveness in terms of resolution of threat (we will refer to these traditional counter-terrorism measures like “tactics”). Subsequently, our analysis will focus on a proposal for "strategic" counter-terrorism actions, in order to show the differences between tactical and strategic actions in terms of resolution of threat. We will also show how strategic measures, through the exchange of data and information between countries, will help in containing and isolating different groups, rather than contrasting them in their direct illegal activities.

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Understanding Security Policies in the Cyber Warfare Domain through System Dynamics

In this paper we will delve with the analysis of the Italian Presidential Decree on Cyber Security, dated January 2013. By reading such Act, we got the impression that, again, policy makers lack both systemic skills and nonetheless the ability to evaluate the impacts of their choices and assumptions before implementing their decisions. The Italian Cyber Security Act (DL.2013) basically establishes, in case of national security put under threat by a cyber menace, to recur to an inter-ministerial working group (Inter-Ministerial Committee for the Security of the Republic - CISR) which, in case of deep crises, should be able to take decisions in a timely and effective manner. In this paper, we won’t argue about the effectiveness of such Board, which would have to be discussed by analyzing on one hand the specific competences (if any) brought to the Board by the various official stakeholders and, on the other, by the processes put in place in order to favour the work to be carried out by such Board; rather we will argue about the inherent delays in the system ultimately even made worse by the need to activate such Board for certain critical decisions.

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Julius Caesar's System Understanding of the Gallic Crisis: a peek into the mind of a History Maker

When studying history, it is usually through the accounts of the achievements of some outstanding leaders, who were capable of grasping the defining elements of the complexity of situations they faced, like Julius Caesar, whose political career was a collection of successes that were the result of his deep understanding of the Roman society and of his sensitivity in appreciating the complex situations in the lands under his control. In this work we will focus on the early stages of Caesar’s campaign in the Gallic war. By a Systems Thinking approach, we will retrace Caesar’s thought process, thus showing that what Caesar faced in those years is not different from many situations that today’s policy makers are required to manage. It is striking to see how many similarities there are between then and now, and how many lessons could be learned (re-learned?) and applied by our policy makers. Caesar’s decisions and following actions were, in fact, the consequence of his deep and thorough understanding of the environment, and because of such systemic comprehension, he could achieve Rome’s desired end-state: securing the northwestern borders. Rarely, modern day interventions, despite military victories, are able to generate the same kind of long lasting solutions.

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Inclusive growth and sustainable finance in connected national economies

We discuss the impact of economic connectedness upon the policies of sustainable finance in a two-country model which is based on a previous paper, where we analyzed the relationship between economic growth and consumer debt from a financial and distribution-political perspective. According to our previous single-country model we found that a rebalancing policy through achieving more income equality would be a good choice. Our latest simulations, however, show that this strategy may be undermined by free international trade. The higher the degree of free movement of goods, the more likely the two countries will, as in a Prisoners' Dilemma, choose the policy of austerity – the worse option.

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Estimating the Dynamics of Individual Opinions in Online Communities

How do opinions change as a result of public interactions and exchange of ideas? How does the proliferation of online media influence these dynamics? While theoretical research provides several hypotheses, empirical analysis of opinion dynamics in online communities is lagging. We develop a unique method for quantifying users' opinions in a social news website and estimate the decision rules that regulate website visit, story posting, voting, and opinion change. We find evidence for significant and nonlinear opinion change as a result of exposure to near-opinions. We also find evidence of learning as people adjust their activity based on the feedback they receive online and strategic reciprocal voting. Incorporating these decision rules in a simulation model we show the propensity of this online community to converge to the majority opinion, and discuss the underlying mechanisms and implications.

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Modelling the Skinner Thesis: Consequences of a Lognormal or a Bimodal Resource Base Distribution

The copper case is often used as an example in resource depletion studies. Despite these studies, several profound uncertainties remain in the system. One of these uncertainties is the distribution of copper grades in the lithosphere. The Skinner thesis promotes the idea that copper grades may be distributed with a bimodal distribution instead of a lognormal distribution. This paper presents a System Dynamics implementation of both the lognormal and the bimodal distributions. By simulating this model for different demand scenarios, it was demonstrated that in case of a bimodal distribution, a slower degradation of copper grades is to be expected. This is in contrast with the common believe that the bimodal distribution, and the 'mineralogical barrier' between the two modes, limit the availability of affordable copper.

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The Geopolitical Impact of Shale Gas: The Modelling Approach

The US' shale gas revolution, a spectacular increase in natural gas extraction from previously unconventional sources, has led to considerable lower gas prices in North America. This study focusses on consequences of the shale gas revolution on state stability of traditional oil and gas exporting countries in the vicinity of the EU. For this purpose, we developed two separate SD models. The first model was used for assessing the impact of shale gas and energy decoupling on oil and gas price developments. We selected some of these price developments as input scenarios for a second SD model. This SD model was used for assessing the impact of energy price scenarios on countries' economic development, and via the development of unemployment and purchasing power, on state stability. The conclusion of this study was that while shale gas developments may be seen as a part of the standard energy hog-cycle, this may lead to pressure on oil prices, which may cause instability in traditional oil and gas producing countries in the neighbourhood of the EU. Further, the effects of energy decoupling may have an even larger effect on putting energy prices under pressure, thus leading to social unrest.

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Food Insecurity in Ethiopia: Population, Food Production and Market

This study investigates the underlying problems causing food insecurity in Ethiopia and tests policy options that could alleviate the problem in the future. For this purpose, we designed, calibrated and tested a system dynamics model that integrates population, food production and market dynamics. Model analyses showed that both availability of and access to food constrained the actual food consumption of the population, that is, both food supplies and purchasing power were insufficient for ensuring the required daily calorie intake of the population. Moreover, degraded land contributed considerably to the poor average productivity of the agricultural land. We have examined effects of future policy options such as land rehabilitation and capacity building on agricultural imputes supplies.

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Peak Waste: a dynamical analysis of global waste trend production

The modern industrial cycle is mainly based on non-renewable mineral resources extracted from the Earth's crust. After being processed and transformed into commodities, the products of mining become are then discarded in the form of gaseous, liquid, or solid waste. A large number of model studies have been performed on the first phase of the cycle, the production of mineral commodities, with a special interest in fossil fuels, with the objective of determining the future perspectives of extraction. However, very few model studies of this kind have been performed for waste and little is known about what the future trends of waste production could be. In this paper,

we examine models of the industrial cycle compared to historical trends in solid waste production in some regions of the world. We show that waste production in developed countries goes in parallel with the trends of industrial production and that several region are showing a declining trend. Therefore, the "waste problem" may not be so bad as it is commonly perceived.

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Matching Integrated Reporting with System Dynamics for Integrated Thinking: Focus on the Airline Sector

The principles and values according to which modern organisations manage their operational processes and report performance are under scrutiny. New reporting guidelines were subsequently developed over the last years, usually providing multidimensional frameworks for accounting reporting and strategic management. In detail, this work focuses on "Integrated Reporting" (IR) (developed by the International Integrated Reporting Council) which is one of the latest novelties in corporate reporting and is aimed to provide a comprehensive communication of an organisation's results through an annual "integrated report". However, if on one hand IR can assist decision-makers to better manage their organisation's value creation and communication processes, on the other hand IR still lacks specific tools and principles in order to clearly represent the business domain under investigation and support policy analysis and strategy formulation in that context. To this aim, this work explores the potentialities of System Dynamics (SD) in combination with IR for a coherent and comprehensive integrated thinking approach to management and decision-making. In detail, focusing on the airline industry and the Low Cost Carriers business model, this work aims to discuss how to develop an IR-based SD model and an IR-based SD Interactive Learning Environment to support decision-making and strategy formulation.

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System Dynamics Model of an Assembly System in Ramp-Up – Focusing Inspections

This paper presents a System Dynamics (SD) model of an assembly system in ramp-up with special focus on inspections. The time in-between product development and stable series production is characterized by dynamically changing conditions referring to the product, processes and the assembly system's organization. Thus, SD serves as an excellent method to model the system's behavior within the ramp-up period. Based on a qualitative derivation of the system variables an explanation of their interconnection is conducted in order to be able to model the system quantitatively and thereafter to simulate effects which parametrical variations have on the superior ramp-up target time to volume. A special focus is set on the role of inspections as they verify the product quality which is a precondition for achieving an as short as possible time to volume. So far the analysis of inspections has not been in the focus of the existing research on ramp-up.

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Unintended Consequences of the North Dakota Oil Boom: Stress on the Local Counties

After the discovery of the Parshall Oil Field in 2006, the current North Dakota oil boom started to unfold. The fast growing oil and gas industries have created thousands of new jobs and a billion dollar budget surplus for the state

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government. Meanwhile, the boom challenges the oil producing counties that are struggling to maintain high quality social services to a rapidly increasing population. Our paper describes the main aspects of the interactions between oil sector employment, secondary employment, domestic immigration, and the fiscal policies of Dunn County and the State government. We use the increased mileage of high impact roads in the County of Dunn as an example of pressures on the provision of infrastructure and it also serves as a proxy for the provision of social services in general. We stress the importance of thoughtful fiscal policy to mitigate the impact of the oil boom. Also, we stress the need for system dynamics work in the region. System dynamics can be used as a tool in planning and evaluating policies for the oil producing counties and we believe that the North Dakota oil boom model can serve as a starting point for further research on the topic.

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A General Theory of Societal Governance and Power Dynamics of Extremist Groups

How do extremist groups gain power within communities that aren't ideologically inclined to support those groups? This paper describes a dynamic theory of the general phenomena that give rise to active support for extremist groups. We focus on extremist groups seeking to garner support from the local community by providing services and dispensing their brand of justice and law. We describe the theory based on a nonspecific extremist-group model. We are currently working on transferring this general theory to a computational system dynamics model that can be used as a base for simulating a variety of scenarios and extremist groups.

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Strategic Resources and Reestablishing Presence in the German Olive Oil Markets: A DPM Case Study

For Small-Medium Enterprises (SMEs), a companies' continuing presence in a key market can be the difference between success and failure. This case study looks at how Dynamic Performance Management (DPM) , a combination of traditional Performance Management (PM) frameworks and System Dynamics Modeling (SD) can be used to optimize a companies handling of strategic resources, and performance drivers to recapture lost market share. The paper shows the initial model design and testing for a small Italian SME focused on olive oil manufacturing, then subsequent policy design based on conclusions drawn from the modeling process and DPM efforts.

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The Mystery of Job Performance: A System Dynamics Model of Human Behavior

In the knowledge age, human resources decide about success or failure of an organization. How can management cause employees to act in a way that organizational goals are achieved, i.e. to perform? Using system dynamics we model job relevant mental processes and behavior of an employee. Our system dynamics model builds on in behavioral science well established ability, motivation, and opportunity theory. The effects of different human resource management policies and practices on job performance of an employee can be simulated. This helps management practitioners to identify sustainable human

resource management policies and practices. Furthermore, our research contributes to closing an existing research gap. The link from human resource management policies and practices to performance is still not fully understood. The causal loop diagram of our model facilitates the critical discussion between scholars from different fields of research about relevant elements and interdependencies of this link. As a result, our model will shed some light on the 'black box' of human resource management.

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The distribution of project performance: initial investigations of its nature and what we can learn from it

All too often projects perform very differently to how they are expected to, and indeed, how organisations would wish them to. There have been many attempts to further our understanding of the reasons for this behaviour by looking at the dynamics that exist within a single project environment. This paper looks to investigate the nature of the distribution of the performance of a number of projects, across a portfolio, and poses the question of whether unexpected project performance should in fact be expected. The aim of this work is to provide an initial framework to explore this question by investigating the distribution of simulated results from a System Dynamics project model based on the rework loop. Furthermore this research gives an opportunity to further investigate the hypothesis that this distribution may follow a power law, as has been discussed in literature and also within our own research team.

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Hybrid model for analysis of the oil pipeline transportation system in Colombia

The dynamics of crude oil transportation by pipeline in Colombia is subject to special conditions where technical capacity is impacted by variables lost, such as terrorist attacks, continuous oil theft and stakeholders' protests. The selection of loss mitigation strategies and their impact on the dynamics of the transport system has not been sufficiently dealt with until now. Therefore, this article discusses the search for optimal combination of technologies based on sensitivity analysis developed in a linear programming model which was applied to the dynamic relationship of oil reserves, the capacity of transport by pipeline, production rate and costs associated with these subsystems. The dynamic model describes the behavior of the system until 2020 and allows decision making on policy within the company according to its focus, whether the priority is utility or service delivery and environmental commitment.

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The Study of Relationship Between Population Dynamics and Climate Change in China - an Ongoing Research Project

Adaptation and mitigation of climate change is receiving immense global attention. For China, the population's dynamics is both the factor and the impact receiver of the climate change. Based on the literature survey of previous studies on the global and China climate change, few effort and attention has been paid on the relationship between population dynamics and climate change. Some previous studies included the population factor, but with very primitive models only considering the total volume change of population, while overlooking the diversity within the population, e.g., quality, structure

and dynamics, impact on carbon emission and climate change, and multiple effects of climate change on the population dynamic behaviors, such as how the haze could affect the birth, decease and migration of population. This study, utilizing the system dynamics, considers the climate change, population dynamics, regional sustainable development, carbon emission, capture and pricing mechanism in an integrated model, and analyzes how the climate change interact with the population volume, structure and quality. This research project is jointly funded by the P07 program of United Nations Population Fund and China's National Development and Reform Commission. This paper presents an overview of the research approach of this on-going project.

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Interactive Dynamic Modeling for the Passenger Flow Bottleneck and Security Checkpoint Management at an Airport

In this paper, the current structure of the passenger flows in Atatürk Airport is examined, aiming an improvement in the management of passenger flows. It is observed that security checkpoints are the main causes of the bottlenecks in the passenger flows. In this regard, passenger flows and their relations with security checkpoints/personnel are modeled dynamically. The model is set up based on two main flows through the domestic and the international terminals. After analyzing real hourly flow data of both international and domestic terminals and estimating their statistical properties, results are used in the model as input data. Validity of the model is tested under various extreme conditions, against real data and under different scenarios. In initial simulations, number of active x-rays devices and personnel needed are formulated as dynamic inputs. After obtaining these initial simulation results, an algorithm is developed to distribute necessary number of active x-rays/personnel to each security checkpoint. Finally, for the airport managers to test their own strategies, a game version of the model is built. It is expected that by using the model and the simulation game, decision-making structure of security personnel allocation at the airport will be improved.

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Modelling a Startup Energy Service Company (ESCO) Using System Dynamics

This paper describes the development of a system dynamics model for exploring and learning about the dynamics of a startup energy service company (ESCO) which business is based on energy performance contracting (EPC). The simulation of that model provides a helpful basis for analysing and explaining the development of key variables, and for accelerating learning on the managerial processes that are critical for the success of the venture. The simulation of the modelled firm produces an overall negative market value added mainly due to long sales cycles, indicating a low probability of success. The model is sensitive to changes in the word-of-mouth contact rate parameter which suggests that effective management or policy interventions should consider initiatives that accelerate word-of-mouth among EPC adopters and prospects. Also, the model simulations point out that a policy to subsidize the interest rate on debt would provide an effective support to this business venture.

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Effect of the emissions-mitigation policy on the electricity sector

The effects of greenhouse gases on climate variation set policy challenges for the energy industry – the largest greenhouse gas contributor worldwide. In this context, major markets are conducting reforms with a focus on the environment, internalizing emission costs and promoting cleaner technologies. To overcome the challenges posed by the emission of greenhouse gases (GHGs), governments have implemented mitigation policies in the power supply industries. One of the most commonly used forms of policy is the economic and financial incentive; however such incentives generate impacts on electricity prices and consumer behaviour. Most recent research on these issues has focused on the supply side, while there has been little highlighting the demand side and very little research integrating both. This paper studies the effects that these policies generate for prices and demand, through an integrated demand and supply analysis. Results indicate that an emission reduction policy, from an integrated supply and demand perspective, has a significant effect on electricity prices and, consequently, on demand. The internalization of emission costs generates increases in electricity prices and more efficient consumption, which is perceived by the decline of electricity demand in the long run. Furthermore, this structured modelling of policy helps to explain how the ultimate intended goal might be achieved: sustainable emissions reduction.

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Simulating Pelletization Strategies to Reduce the Biomass Supply Risk at America's Biorefineries

Demand for cellulosic ethanol and other advanced biofuels has been on the rise, due in part to federal targets enacted in 2005 and extended in 2007. The industry faces major challenges in meeting these worthwhile and ambitious targets. The challenges are especially severe in the logistics of timely feedstock delivery to biorefineries. Logistical difficulties arise from seasonal production that forces the biomass to be stored in uncontrolled field-side environments. In this storage format physical difficulties arise; transportation is hindered by the low bulk density of baled biomass and the unprotected material can decay leading to unpredictable losses. Additionally, uncertain yields and contractual difficulties can exacerbate these challenges making biorefineries a high-risk venture. Investors' risk could limit business entry and prevent America from reaching the targets. This paper explores pelletizer strategies to convert the lignocellulosic biomass into a denser form more suitable for storage. The densification of biomass could reduce supply risks, and the new system would outperform conventional biorefinery supply systems. Pelletizer strategies exhibit somewhat higher costs, but the reduction in risk is well worth the extra cost if America is to grow the biofuels industry in a sustainable manner.

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Causal Mapping of the New Zealand Natural Resources Sector System: Group model building approach

In September 2013, the seven agencies that comprise the New Zealand Natural Resources Sector agreed a process to analyse and develop strategic advice from a sector, rather than agency, perspective. A group model building workshop (using qualitative system dynamics) was held in November 2013, with the following aim: Map the wider environmental system that the natural resources sector operates within and better understand the linkages between land, water and marine systems. To achieve the proposed aim, the workshop was split into three groups that each looked at each sub-system (land, freshwater and marine) to make the approach achievable in a day. The groups met subsequently to refine their work. The systems maps that emerged from this process, together with a climate system map, were subsequently combined to form an integrated systems map covering the wider environmental system in New Zealand. This map was subsequently analysed for feedback connections and leverage points within the system. This paper discusses the methodology, the group model building scripts used, the process on the day, subsequent meetings and analysis, systems maps produced and offers some reflections on the process.

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Applying Systems Thinking to Design a Criminal Policy

This paper illustrates the design of a holistic criminal policy through various methodological tools, based on objective and rational parameters. The main purpose of this particular design of criminal policy is to provide the justice prosecutors with valuable elements in order to make crime investigation more efficient, and also, to be used as a complement for the correct use of the capacities that the new accusatory system assigns. The relevance of this study resides on the systemic structuring of the crime incidence and other analysis criteria, it also provides elements for the decision-making process of the authority, crime investigation, use of alternative solutions and coordination activities with more instances involved in crime prevention and prosecution; which will derive in human and material resources optimization.

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The use of system dynamics in a strategic review of the English dental workforce

This paper describes how system dynamics (SD) was used in 2013 on a strategic review of the English dental workforce. The project was commissioned by Health Education England (HEE) through the Department of Health (DH) with the purpose of projecting and analysing the future supply of, and demand for, the English dental workforce through to 2040. The project was driven by the need to provide sustainable, high quality dental services in a complex and evolving environment given recent fluctuations in dental student

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numbers. The system dynamics approach meant that robust, evidence-based supply and demand models could be created to test potential policies and their impact. Significant policy decisions were made as a result of this work.

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Assessing Sustainable Development of Isolated Communities: The Role of Electricity Supply

The term "rural development" refers to initiatives undertaken aiming to improve the quality of life of non-urban communities. Sustainable development (SD) of rural communities is directly linked to the communities' skills for adapting themselves to changing conditions in constructive ways. Different studies have shown that one important factor contributing to the development and growth of rural communities is power supply (Berglund & Soderholm, 2006; B. Borroto, Borroto, & Vázquez, 1998; DFID, 1997). However, assessments on the influence of power supply over rural development have fallen short of expectation as they have been too technical, mainly using econometric approaches or coefficients based on misery line. This paper seeks to contribute from a holistic approach to identify economic and social development in which energy is a crucial factor that contributes to human, social, and economic development, all supported on information technologies and mechanization processes, thus enabling sustainable development.

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Access to Healthy Food Innovations and Initiatives across Socio-economic Classes

We analyze the problem of and solutions for the inequality of access to nutritional innovation and policies. Recent evidence shows healthy-eating-related efforts geared towards reducing obesity are not reaching the most vulnerable and highest benefiting populations. We analyze this problem using a system-dynamics-based nutritional food market transformation model that captures interactions between food supply, consumer demand, consumer health and government policies with a focus on differences between socio-economic classes. Grounded in data from the Canadian context, our preliminary results show a nutritional inequality, with ingredient-driven innovations (healthier food products currently marketed by many firms) leading to disproportionally low BMI improvements for the poorer population segment. We explore mechanisms underlying the differential impact by examining various industry- and government-driven actions currently used and designed to improve nutrition in the population, namely (a) investments into improving nutritional quality of food and its taste, (b) policies to lower the cost of this food for lower-income consumers, and (c) policies to subsidize the cost of research and development. We identify success factors that may help healthy food innovations overcome the inclusiveness gap. We consider community-based innovations and directives directly targeted to lower-wealth. We discuss their implementation in the model as well as next steps.

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A Spatial-Dynamic Approach for the Integrated Management of Coastal Ecosystems

Coral reef is a key coastal resource to indicate the integrity and soundness of the marine environment. Inappropriate coastal management practices are likely

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to weaken coral reef ability to cope with disturbances and may therefore lead to undesirable phase shifts in ecosystem composition. Ecosystem-Based Management (EBM) is now recognized as being the most appropriate tool for the sustainable use of coastal resources. To incorporate EBM in coastal management for resource conservation, interdisciplinary modelling approaches are needed. This study develops a spatiotemporal modelling framework based on the Ecopath with Ecosim (EwE) software for sustainable coral reef management in Nanwan bay, Kenting, Taiwan. The System Dynamics (SD) approach is used to integrate socioeconomic and ecological systems and perform scenarios analysis. Preliminary results suggests that an integrated Marine Protected Area (MPA) (no take + no waste water discharge) might have more beneficial effects on both the ecosystem and the fishery sector than a simple no-take MPA.

Locked in a capability trap? The case of the composites industry

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How can a new material technology create growth? Is having a better material a guarantee for industrial success? This work suggests that technological growth requires a different level of analysis to enable a holistic understanding of issues around the production capability for a new material technology. In this paper issues around the development of the composite material industry are explored. The main tenet behind this work is that the composite industry is locked in a capability trap; the paradox of fixating on seemingly profitable short-term results, while losing focus on the strategic vision. A qualitative study and interviews with experts in composites provide the basic evidence to initiate the discussion around this phenomenon.

A Developmental Framework for Assessing Application of Systems Thinking and Systems Dynamics in Teams and Organizations

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There is growing awareness of the potential benefits of systems thinking as a way to approach complex and dynamic problems in organizations and, more broadly, society. Systems thinking and the more rigorous methodology of system dynamics is increasingly included in curricula from primary and secondary education to undergraduate and graduate programs in business, engineering, public health, and social work. Yet, organizations seeking to apply systems thinking and moreover system dynamics as an innovation and practice, routinely encounter a number of challenges. These challenges stem from the diversity of definitions, approaches, communicating, and building support for systems thinking in the organization. Ultimately, developing professional competence and confidence in applying systems thinking using system dynamics also hinders its application in a team or organization. On top of these challenges, there are relatively few frameworks available for organizations to assess their understanding and application of systems dynamics. This poster addresses the gap by proposing a developmental framework for individuals, teams, and organizations to evaluate their application of systems dynamics.

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Using System Dynamics to Explore the Water Supply and Demand Dilemmas of a Small South African Municipality

This paper explores the challenges faced by small municipalities in providing water services in a developing-world context of increasing urban demand. The paper uses a case study of the Sundays River Valley Municipality (SRVM) in South Africa. The municipality faces multiple dilemmas in reconciling its available water supply with growing demand for potable water in the primary urban settlement in the area, in a struggle that is typical of the broad category of South African municipalities to which the SRVM belongs. These dilemmas are explored using a system dynamics model, referred to as the 'Kirkwood water demand system dynamics model' (K-DEM). This paper specifically introduces the K-DEM structure, which is aimed at investigating the impacts of households progressively receiving full water and sanitation services; the use of rainwater harvesting as an alternative form of water supply; and the possible effect of a household-level water conservation / water demand management programme. Baseline results are discussed, and areas for future research identified.

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Mathematical modeling and computational semiotics: methodological approach to formalization of semiotic concepts

This paper aims to conduct a research on the state of the art of artificial intelligence techniques to investigate the relationships between cognitive actions addressed in steps of mathematical modeling and computational semiotics activities. It also briefly reviews the main techniques of artificial intelligence, with particular emphasis on intelligent systems techniques. Such analysis use semiotic concepts in order to identify the use of new techniques for modeling intelligent systems through the integrated use of mathematical and computational tools. At last, once understood that semiotics can bring contributions to the study of intelligent systems, a methodology for modeling computational semiotics based on the semiotic concepts formalization extracted from the semiotic theory of Charles Sanders Peirce is proposed.

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Using inclusive wealth for dynamic analyses of sustainable development: Theory, reflection and application

The concept of inclusive wealth as an indicator of sustainable development has garnered increasing attention in academic and policy circles. Inclusive wealth is defined as the value-sum of a country's capital asset stocks, and the associated economic theory states that development is sustainable if this value-sum does not decline through time. This framework for conceptualizing sustainable development should have immediate appeal to the system dynamics community given the centrality of capital stocks, and it represents potential for reaching common ground with the economics community. This paper describes the

inclusive wealth framework, highlights gaps in the current literature, as well as areas rife for future system dynamics research. To illustrate how one might apply the framework in a system dynamics case study, it uses water and energy infrastructure policy in the Kingdom of Saudi Arabia (KSA) as an example. Some preliminary results from the case study are presented and analyzed in the context of sustainable development. The paper concludes by discussing how the system dynamics community can embrace the theoretical advances of the inclusive wealth framework in their applied work on sustainable development.

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A Research Framework To Design Sustainable Patients' Mobility Policies In Sicily

The movements of patients seeking public healthcare treatments out of their territorial jurisdiction is currently a policy makers' concern, both at international and national level, due to the socio-economic implications of this phenomenon. This paper presents the research framework of a project being carried out on the patients' mobility flows from Sicily towards other Italian regions. Such study, undertaken with the collaboration of the Sicilian Regional Healthcare Department, aims to build a System Dynamics model to support the design and implementation of sustainable patients' mobility-related policies. Main features of the research are presented and discussed, together with the first outcomes of the preliminary cause-and-effect model.

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Sanitation technology options in informal settlement: a system dynamics approach

Provision of sanitation services to urban informal settlement is one of the challenges that the urban planners and decision makers are face with in the current era. High population growth and lack of legal status in informal settlements makes it challenging to improve the level of sanitation. The question then is whether there are possible technology options that can be utilized to achieve sanitation crisis in informal settlements. This paper thus delves into the dark and complex world of the sanitation crisis in informal settlements. Using system dynamics approach, it describes the key elements in the sanitation provision in informal settlements, and specifically, in the context of Enkanini, an illegal informal settlement in Stellenbosch. The system dynamics model demonstrates differences between four sanitation technologies, namely: pour flush; ventilated improved pit latrine; compost toilet; and regular toilet. The results show that there is a long-term benefit from waterborne sanitation, as well as rapid improvement in sanitation from cheaper options of a compost toilet and ventilated improved pit latrine. The pour flush toilet and ventilated improved pit latrine occupied the beneficial middle ground of minimal investment for decent output in sanitation improvement as well as improvement of the sanitation experience.

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A systems approach to understanding the effect of Facebook use on the quality of interpersonal communication

Social networking platforms such as Facebook have become integrated into the milieu of modern-day social interactions. Facebook, one of the most prominent social networking platforms globally, is widely used as a primary medium for communicating and networking for personal, professional and recreational purposes. This paper attempts to grapple with an identified problem in the tension between the use of Facebook and the quality of interpersonal communication. Using qualitative systems dynamics modelling, the paper explores the effects of Facebook on the quality of interpersonal communication from the perspective of a potential Facebook user. Given that one of the co-authors is an active Facebook user, the paper employs this case study area with the purpose of understanding and illustrating it, primarily, from a subjective, individual point of view. In this way, a personal experience of Facebook and its impact on the nature of interpersonal communication provides the intuitive starting point for the inquiry.

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Energy Transition Dynamics; Understanding Policy Resistance in the Dutch Energy System

Various countries seek to establish an energy transition, a structural change towards a more sustainable energy system. Countries implement a combination of energy policies aimed at establishing an energy transition, but these policies frequently result in unintended negative consequences. This study provides an attempt to unravel the complexity of the Dutch energy transition. We present a model of the Dutch energy transition, showing its various components and their interrelations. The model is based on eight group model building workshops in which a total of 96 stakeholders in the Dutch energy transition participated. In each workshop, a variety of stakeholders engaged in the collaborative construction of a model that explains the current progress of the energy transition. In this paper, we aggregate these eight models into one overarching model, which we lay out step by step. The model shows how technological, ecological, social, economic, and political aspects of the energy transition influence each other either directly or indirectly. We discuss several policy implications, with a focus on reducing unintended negative consequences.

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Integrating Disaster Risk Reduction and Climate Change Adaptation into National Development Planning

Small islands developing States (SIDS) are recognized as a special case in the United Nations system as a special case because of their inherent vulnerabilities, including, among others, external shocks. These shocks can take different forms such as volatility in energy prices, global financial and economic crisis, natural disasters, and climate change. It is also recognized today that while SIDS are vulnerable because of their inherent characteristics, policies can be tailored to enhance their resilience in the face of these shocks. These policies should also have sustainable development dividends or social,

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environmental and economic co-benefits. In this paper, we deal primarily with the integration of disaster risk reduction (DRR), climate change adaptation (CCA), and 'loss and damage' into national development planning. A framework for carrying out this integration is proposed. Using the island of Mauritius as a case study, system dynamics modelling is applied to operationalize the framework. The impacts and policy responses corresponding to the reduction in precipitation from climate change, and extreme precipitation events arising from climate variability are simulated for the agriculture sector. By adopting a more conceptual approach, the cross-sectoral impacts of cyclones are simulated stochastically. All simulations have been carried out over the 2050 time horizon.

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Towards a shared understanding of nutrient pollution in Cape Cod's coastal waters

Increasing population and economic development around coastal areas have left many embayments throughout the world severely impaired. Excessive nutrient enrichment in water bodies, also known as nutrient pollution, is one of the leading impairments in coastal waters. Algal blooms, dead zones, and fish kills are spreading because of the nutrient pollution. This paper presents a systems analysis of the nutrient pollution problem in Cape Cod, Massachusetts, where the continuous degradation in coastal waters is considered as one of the greatest threats to the region's environmental and economic future. A system dynamics model was created with a diverse stakeholder team to uncover the underlying system structure that has created the degradation in Cape Cod's coastal waters since 1960s. An important goal of this work was to support the development of a regional water quality management plan by creating a shared understanding of the nutrient pollution problem across a wide range of stakeholders including residents, local municipalities, regional authorities, the state government, and the U.S EPA. The proposed model and simulation experiments reveal several critical insights, including nonlinearity of the system behavior, delay in the system's response to interventions, and the importance of timely actions.

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A knowledge intervention to explore stakeholders' understanding of a dynamic coastal nature reserve

As quantitative modelling can be used to build stakeholder understanding for management decisions, and can help build consensus (Stave, 2003), a system dynamics modelling study of the abiotic dynamics of an archetypical small estuary, the Slufter in the Netherlands is formulated. The model is used in combination with an analysis of stakeholders' values, their perceptions and the multi-functional utility of the Slufter in the design and application of a participatory approach aimed at enhancing the (collaborative) long-term decision-making on the inherently dynamic, coastal nature reserve. In particular, the utility of the information derived both from the model and the interviews with stakeholders for enhancing the system understanding amongst stakeholders indicates that a shared understanding of the social-ecological functioning of the Slufter estuary can be enhanced by integrating a stakeholder-based approach with problem modelling. Although stakeholders' opinions changed less than expected, we believe that such an integrated approach can contribute to increased effectiveness of problem modelling in multi-actor systems.

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Strategic Resources Investment Planning for Growth and Development: An executive training model

This paper proposes a simulation model designed for executive skills building in strategic resource investment allocation, seeking a best organization growth and development strategy. Investment strategy amount, capacity versus productivity trade-off, two different types of productivity resources, earnings, debt implications and delay impacts are considered in the model. An Interactive Learning Environment (ILE) based on an underlying growth model is proposed and tested. The model is based on the System Dynamics methodology. Laboratory experiments were conducted with graduate and undergraduate students. The experiments show differences in student investment stategy profiles and final results. The simulation model structure is inspired on the Barney and Pedercini (2003), Pedercini, et al., (2007) and Kopainsky, et al. (2009) development planning models.

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A data-driven and tool supported CLD creation approach

The creation of Causal Loop Diagrams (CLDs) is a major phase in the System Dynamics (SD) life-cycle, since the created CLDs express dependencies and feedback in the system under study, as well as, guide modellers in building meaningful simulation models. The creation of CLDs is still subject to the modeller's domain expertise (mental model) and her ability to abstract the system, because of the strong dependency on semantic knowledge. Since the beginning of SD, available system data sources (written and numerical models) have always been sparsely available, very limited and imperfect and thus of little benefit to the whole modelling process. However, in recent years, we have seen an explosion in generated data, especially in all business related domains that are analysed via Business Dynamics (BD). In this paper, we introduce a systematic tool supported CLD creation approach, which analyses and utilises available disparate data sources within the business domain. We demonstrate the application of our methodology on a given business use-case and evaluate the resulting CLD. Finally, we propose directions for future research to further push the automation in the CLD creation and increase confidence in the generated CLDs.

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A Method for Modelling and Calibrating Disaggregated Diffusion Models

Complex dynamic problems, such as infectious disease spread, have at their core diffusion processes that are driven by reinforcing feedback loops. System dynamics approaches tend to view such diffusion problems at an aggregate level, based on the assumption of random mixing within the population. However, in the public health area, assortative (within-type) mixing is a recognised empirical phenomenon, and therefore simulation models must disaggregate across key cohorts in order to maximize engagement with policy makers, and provide more robust and accurate models of disease spread. This paper integrates key ideas from modern infectious disease modeling approaches into a system dynamics context, and presents key formulations to allow for the disaggregation of SD diffusion models. It also shows how case data can be aligned with structural SD models, thereby allowing the model to be calibrated and fit to historical data. The approach is validated using an SEIR model, and based on a case study of the 1957 flu outbreak in the United Kingdom.

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Facilitating Bottom-Up Knowledge to Support Decision-Making in Long-term Healthcare Providers

Service output in healthcare organisations and especially in long-term care depends on collaborative efforts of frontline workers, management and the customers. However, the top-down style of management in traditional service organisations discourages participation of employees, customers and other stakeholders in decision making. Senior management of healthcare service organisations and policy makers need tools that will facilitate the collaborative input and will help them produce long-term policies shaped by evidence in order to tackle the causes of the problems and not the symptoms. The case study, set in a healthcare service provider in the Netherlands, illustrates that cognitive mapping and qualitative system dynamics techniques can be meaningfully combined to promote stakeholders representation in managerial decision making. Service experiences in long-term care are often intangible as they are the outcomes of interactions between organisations, the employees and the customers. They depend on soft factors like staff motivational levels, abilities and traits, role perceptions and management support. The study demonstrated that long-term healthcare service providers can improve their efficiency if they improve collaboration with the frontline workers and the customers with the help of the methodology, which allows generating structured presentation of mental models of the key stakeholders appropriate for managerial decision making.

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The Effect of Semi-Rational Supply Chain Members on the Decision Parameters Used in Managing the Stock of an Echelon

A supply-chain is a series of connected stock management structures. Therefore, the structure of a supply-chain consists of many cascading inventory management problems. It is shown that the optimal inventory control parameter values suggested by the literature are also valid for a supply-chain. The motivation for this study is to investigate the optimality of the literature suggested optimal values of the decision parameters in the presence of semi-rationally managed supply-chain echelons. We use a soft coded version of The Beer Game as an experimental platform to carry out the study. According to the results of the simulation experiments, it is not rational to continue to use the optimal parameters when other echelons' inventories are managed sub-optimally.

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Analyzing the Dynamics of the Bio-methane Production Chain and the Effectiveness of Subsidization Schemes under Uncertainty

Bio-methane is a renewable gas option that can be injected to the natural gas grids to increase the sustainability of the energy system and to deal with natural gas supply problems. However, being based on several factors such as resource availability, competition between bio-methane and electricity sectors for biogas and biomass supply, demand, capacity installation and profitability, the future dynamics of bio-methane production is uncertain. In this study, we investigated the dynamics of bio-methane production in the Netherlands by constructing a system dynamics model and using this model for exploration of future scenarios and policy testing purposes. The results showed that the subsidization is crucial for the development of bio-methane in the early years, but increasing supply and reduced prices can cause a loss of competitiveness against the electricity sector, which can result in inadequate biomass supply for bio-methane. Future research can focus on testing more policies, enhancing the robustness of the subsidization policy and investigating the relation of bio-methane to the natural gas sector.

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Modeling the Dynamics of Canine Rabies and Policy Analysis under Uncertainty

Rabies is a viral fatal disease transmitted to humans mainly from dogs. Human deaths due to rabies have been increasing in recent years, especially in Africa and Asia where socioeconomic factors play an important role in the revival of the epidemic. In the current situation, it is unknown how the epidemic will evolve and which policies can prevent undesired futures. Therefore, the dynamics of rabies are investigated with a system dynamics model and several policy options are tested in this study. An exploratory approach is adopted to deal with uncertainties associated with model formulation, lack of data and the epidemic characteristics. The results showed a wide variety of future dynamics for possible human deaths, and following dog culling, human vaccination resulted to be the best policy to decrease the maximum possible number of casualties. However, when the cost effectiveness is taken into account, high

rates of dog vaccination and high levels of human hospitalization upon exposure to a dog were found as the policy that maximizes the number of future favorable cases in terms of human casualties and costs. Future research can include extending the model with underlying socioeconomic factors and multiple species.

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Exploring Airports' Landside Congestion Impacts on the dynamic of Passengers Satisfaction

International airports may suffer landside congestion when air traffic grows. This is likely to generate an impact on the service quality provided to passengers. Due to the high complexity of the airport system and very often the lack of data available, few studies adopt a systemic perspective in investigating the dynamic of passengers' satisfaction. The airport service quality management literature identify six main critical areas on which airport managers should focus on. In this preliminary research, a System Dynamics model was built to support airport managers to outline alternative policies to improve passengers' satisfaction. The analysis was carried out in an Italian international airport. It focused, in particular, on how security controls waiting time and airport terminal cleanliness impact on passengers' satisfaction. Although only two critical areas were investigated in this preliminary stage, simulation results portrayed counterintuitive behaviours. After a literature review on airport service quality management, main drawbacks are highlighted and the contribution of the System Dynamics methodology is made explicit. In the second part of the paper, a brief introduction of the investigated international Italian airport is provided. Then the System Dynamics model built is presented and validated simulation results with airport managers are shown. Finally, main contributions of this preliminary study and further research are also discussed.

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Modeling Obesity Trends among U.S. Children: A System Dynamics Model for Estimating the Energy Imbalance Gap

This paper presents a population-level system dynamics model that quantifies the energy imbalance gap responsible for the obesity epidemic among U.S. children during the past four decades. Our system dynamics model divides the U.S. child population into subpopulations by gender and ethnicity. Each subpopulation is then further divided into four age groups and each age group into 14 body mass index (BMI) classes. Transition rates between these BMI classes are defined as a function of pediatric metabolic dynamics within each class according to existing validated models. The energy intake in each BMI class at any point in time within the last decades is estimated as a multiplication of the reference energy intake (the energy needed for normal growth) for children in that class by an energy gap multiplier. Through calibration, the energy gap multiplier for each gender-ethnicity-age-BMI subgroup is estimated by matching simulated BMI distributions for each subpopulation against data from NHANES using maximum likelihood estimation. Our results shed light on differential energy imbalance gaps across different subpopulations over time. The system dynamics approach creates a modeling platform to better understand intervention targets in different segments of children and upon which intervention strategies can be modeled and tested.

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Macroeconomic view of sustainability of dry forest in Androy region. A system dynamics approach

The Tandroy communities do not cease to practice slash and burn agriculture to satisfy their subsistence needs. To get rid of the spines, before feeding their zebu, peasants burn the cactus cladodes (omputia) and the mozotse (euphorbia stenoclada) vegetation. Despite these techniques, the performance of the agriculture and the breeding of zebu are successful only for a brief period. Nevertheless, in long term, these practices are unsustainable vis-à-vis the ecological pressure on the neighboring dry forest. These activities may lead to greater risk of socioeconomic disasters on both local and global scales in the near future. In this paper, we report the concept of a methodological framework for integrating the subjects of system of thinking and system dynamics and confront it with the Tandroy macroeconomic view, accordingly. Thus, we analyze the effect of both interlinks and causal relations between socioeconomic and environmental variables in Androy.

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Dynamics of Solid Fuel Rocket Engines: Exploring Physics and Feedback

Increased interest in science, technology, engineering, and math (STEM) curriculum opens the door to many non-linear and dynamically complex systems for study. Gaining a basic understanding of dynamic complexity can get lost in the detail complexity of the subject. This paper uses the dynamics of a solid fuel rocket engine to describe a modeling structure that allows three layers of exploration. The first exploration layer provides an interface for gaining an intuitive feel for the system through interactive experimentation. The second exploration layer provides an overview of the feedback structure of the major components of the system. Finally, the third exploration layer provides the mathematical and scientific details one component at a time for users who desire a more detailed understanding of rocket engine dynamics. It is proposed that the presented model structure could be used as a blue-print for describing other dynamically complex processes within a successful STEM curriculum.

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Implications of MBA Durability for Providers of Masters in Business Administration Degrees

The Masters in Business Administration degree is a popular graduate degree offering the promise of employment at high income levels. MBA enrollment rates have generally increased since the degree was first established at the end of the 20th century. Once granted, an MBA degree remains with its recipient for the remainder of their lifetime. Considering the MBA degree as a durable good, a dynamic diffusion model is used to explore the eventual saturation of MBA enrollments in the US. Reference data is used to ground the model results and to generate possible future enrollment rate scenarios. Sensitivity analysis is performed on model parameters to explore policy decisions for the benefit of MBA degree granting institutions.

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A System Dynamics Model of Ukraine's Monetary Sector

This paper presents a system dynamics model of the monetary sector of the Ukrainian economy. It is one of the products of a project for developing system dynamics modeling capacity among economists at the National University of Kiev-Mohyla Academy, organized by the University of Bergen and funded by the Norwegian Center for International Cooperation in Education. Prepared by a PhD student from Kiev, the monetary sector is a sub-model of a comprehensive macroeconomic model being developed by a team of Ukrainian students taking a special topics course in macroeconomic dynamics in Bergen.

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Building Systems Thinking Capacity: An essential skill set for policymakers

Policymakers, worldwide, must tackle some of the most challenging and complex issues, yet their political environments make solving these issues nearly impossible. Political environments that are polarized, partisan, and divisive are ineffective and do not permit policymakers to be effective. System dynamics-based thinking skills are an essential skill set for policymakers facing adaptive challenges. The Georgia Health Policy Center created an innovative educational initiative that applies system thinking skills to health policymaking. This approach to legislative education can begin to change the way legislators frame issues, ask questions, build understanding and develop solutions to complex health care issues. In this paper, we describe the adaptive challenges faced by policymakers and how the traditional approach to legislative education – providing more and better information -- is necessary but insufficient for creating high leverage policies. We describe how the Legislative Health Policy Certificate Program, an intensive training for policymakers in Georgia (USA), integrated health policy content with conversational systems thinking skills, stock and flow maps, and simple and complex models to move policymakers into evidence-based, more collaborative decision-making. We provide examples of how we used each approach and suggest lessons learned that can be applied to anyone interested in fundamentally shifting political discourse.

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Bees population decline as a threat to crops production

A model has been built by the authors to explore the effect of population dynamics of bee colonies on food production. The objective is to facilitate the creation of scenarios for decision making regarding usage of pesticides in crop fields. The model includes the effect of food availability, the seasonal effects as well as the exposure to pesticides on population dynamics, to ultimately determine the impact on food production. The results presented are based on different scenarios and become a clear example of the potential comparative/exploratory analysis that it can be used for. An important relationship between temperature and the colonies resilience towards the exposure of foraging bees to pesticides has been found comparing the mentioned scenarios. The model has been made with the potential to expand to a macro scale one by having multiple instances of the created micro scale model dynamics; thus helping to gain insight in the regional opportunities for policy regulation regarding the usage of pesticides. Future development on this model

may include variables such as UMTS, varroa mite and honey harvesting. Since bees are one of the main pollinators worldwide and play such crucial role in the production of food globally, urgent measures are needed regarding the policy approach on bee colonies in crops production.

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Seeking Implementation in Group Model Building Interventions

The key question addressed in this study relates to the role of group model building (GMB) in the implementation of the policies derived from a system dynamics model. After conducting literature analysis from publications in change and project management, it is concluded that even though group model building (GMB) is crucial in ensuring stakeholders' readiness and commitment to implementation, thus satisfying the needs for the establishment of change antecedents, the technique by itself does not ensure recommended changes are actually incorporated into the organization. A new paradigm of system dynamics interventions needs to arise such that organizational theories or knowledge from other sciences are integrated into practitioners' consultancy practices to transfer policy formulation to a more operational phase. Approaches in current change management literature along with a brand-new problem-based business model for system dynamic projects are also suggested as means of turning intention (commitment) into behavior (implementation) within organizations. The paper deals with the proposed research question as follows: the first section introduces the relationship between system dynamics, specifically of group model building (GMB), with the concept of implementation, whereas the second part is devoted to introducing change management concepts to broaden current practitioners' perspective of change initiatives.

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Linking Brand Equity and Customer Equity: A System Dynamics Perspective

Customer equity and brand equity are two important concepts in the current debate among marketing researchers and practitioners. This research attempts to conceptualize the linkage between brand equity and customer equity from a system dynamics perspective. While isolated models for both concepts exist, they are usually highly abstract and hard to operationalize in day to day marketing management. Conceptualizing the linkage between brand equity and customer equity explicitly in a system dynamics model provides insights on how these two concepts interact with each other and, thus, improves the marketing management decision-making process. This research engages well-known hierarchy of effect models (AIDA and ATR) to investigate the customer development chain related to brand equity and customer equity. The resulting system dynamics model is tested with a variety of initial settings and policy options.

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Food Security as an Outcome of Food Systems: A Feedback Perspective

Hunger is an important topic still today: one out of eight people worldwide lives food insecure even after having received attention through the United Nation's Millennium Development Goals. This article looks at national food security as

the outcome of food systems and tries to capture some of the system's complexity using a feedback perspective. Following a generic socio-ecological system approach a general food system framework on country level has been developed in form of a causal loop diagram. Based on the framework three exemplary cases of general food security oriented and sustainability enhancement strategies are discussed. These cases illustrate that there are trade-offs between different goals such as food security and sustainability or between different stakeholders. The cases illustrate further that the impact of policies depends on the country's specific context, the interlinkages within and related to the food system and the timing of implementation. This implies that there is no generally valid single solution and that a context specific understanding of the complexity of the system is needed for policy evaluation and formulation.

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Hiring College Graduates to Flip Hamburgers: An Endogenous Theory of Professionalization

In this paper, we offer an endogenous theory of professionalization and ever-higher degree attainment. We theorize that higher education is a self-driving growth engine. We introduce two endogenous mechanisms that act on the education enterprise, causing the number of educated people to increase dramatically with relatively short-term changes in the job market. Using an illustrative dynamic model based on simple rules of degree attainment and job selection, we argue that these self-driving growth engines are adequate to over-incentivize degree attainment, and can affect the match between supply and demand for college-educated labor. We also show that the mechanisms magnify effects of short-term recessions or technological changes, and create long-term waves of mismatch between workforce and jobs. The implication of the theory is degree inflation, magnified pressures on those with lower degrees, underemployment, and job market mismatch and inefficiency.

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Dynamics of Fisheries

In this paper, using a system dynamics approach, we develop a model to investigate the effect of industrial fishing on the average body size of targeted fish populations. Our model demonstrates that in the absence of fishing, larger fish would dominate the fish population as suggested in the biology literature. However, in presence of heavy fishing activity, population of larger fish collapses. We model the adaptive behavior of fishermen in choosing smaller gear sizes as fish become smaller over time. We observe that a side effect of this adaptive behavior is an increase in the ratio of catch of untargeted fish species to targeted one. This issue is called bycatch and is disliked both by environmentalist and fishermen.

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A Model For Eliminating Veteran Homelessness in the USA

Today, military veterans are disproportionally represented in the homeless population of the United States. In an effort to combat this alarming trend, President Obama's administration has established a goal to eliminate homelessness among veterans. The Department of Veterans Affairs has

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embarked on an ambitious strategy to meet this objective using a portfolio of housing, prevention, treatment, and employment programs. A system dynamics model was built to help program leaders better understand, manage, and communicate the dynamic complexities of eliminating homelessness. This model, based upon carefully collected historical homeless population and program performance data, captures the flow of veterans from discharge from active duty through various stages of homelessness, into and out of multiple treatment programs, and ultimately into permanent housing. The capacity and performance of programs in the model are tied to funding levels, allowing program leadership to gain insight into the system-wide impact of different funding scenarios on the homeless veteran population over time. A Monte Carlo approach was used to provide bounded estimates of homelessness among veterans in future years. The model has been successfully used as additional justification for requested funding and management decisions, and continues to be refined as new data become available.

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Modeling the Feedback of Battery Raw Material Shortages on the Diffusion of Alternative Automotive Drives

Increasing energy prices due to limited availability of fossil fuels in combination with ambitious reduction targets of combustion gas emissions, particularly in urban areas, will force the diffusion of alternative drives such as hybrid and battery electric vehicles in the automotive market in near and midterm future. However, the increasing need of rechargeable batteries with high energy densities strongly affects the demand for specific battery raw materials like lithium and cobalt. In this paper, we present a system dynamics approach which combines a fleet model of the global automotive market with a material flow model of cobalt as a key battery raw material. This combined model enables the simulation of effects of increased battery demand on the cobalt market and the potential feedback of raw material shortages on the development of battery technology and the diffusion of alternative drives which once again affects the demand for cobalt. This modeling approach may serve as a tool for getting a better understanding of future raw material markets influenced by emerging technologies and the feedback of raw material availability on the technological development.

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Dynamic Modeling of Peritoneal Dialysis and Its Implementation in Children with Chronic Kidney Failure

This study has been conducted to shed light on the dynamic interactions between the peritoneal dialysis (PD) treatment and the nutritional intake decisions, with respect to the physical development of children with chronic kidney failure. The interrelationships between the substances such as protein, albumin, calcium, phosphate, sodium and potassium -the major developmental and vital indicators of the child-patients - along with their relationships with the PD treatment have been analysed with the help of System Dynamics

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methodology. To analyse the dynamics of PD treatment, the time unit of the model has been chosen as a day and the time horizon has been chosen as three years in order to better observe the differences in the growth and development of child-patients. Simulation experiments are carried out to search for effective combinations of PD and nutritional recipes for child-patients. Finally, an interactive simulation game version of the model, which represents the relationship between the diet and the ratios of accumulated toxic or beneficial materials in the body, has been designed. Such simulation game can be used to help doctors, patients and patients' families in seeking diet and treatment recipes suitable to patients' monthly needs for a better growth and physical development.

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Defense Capability Engineering: Design of a Conceptual Model

The Ministry of National Defense (MoD) and the Armed Forces of Colombia have undergone a transformation in the way planning is carried out from resource-based planning to capability-based planning; this transformation has been led by the Capability Projection Directorate at the MoD. To date, the Armed Forces have developed joint and coordinated plans in terms of capabilities and are being coordinated with budget and acquisition plans. The Capability-Based Planning approach offers several advantages for strategic planning, including a systemic view and a coordination among resources and the operational context. Part of the purpose of such approach is to aid decision makers in connecting budgetary decisions with the accomplishment of strategic objectives; however, addressing the complexity of the Defense System itself is a difficult and can become an overwhelming task. This is the reason the Chief of the Capability Projection Directorate has underlined the need for complementary tools that reduce complexity and contribute to the formulation of strategic plans. In this paper the design of a System Dynamics model that serves as a platform for decision making and strategic planning is presented and discussed. The model is expected to simulate the evolution of capabilities and their behavior under different plausible scenarios.

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Opportunity to improve: the first large scale empirical analysis about the replicability of system dynamics studies

Organizational and management sciences have continuously fail to replicate existing studies. Moreover, replication – the hallmark of scientific inquiry – is not investigated adequately. The few existing studies examine pertinent questions about scientific integrity since errors in publications are more commonplace rather than single instances. Since computational simulation modeling is increasingly employed in studies in organizational and management sciences, we investigate the replicability of simulation studies, especially of the system dynamics type. Based on a sample of 105 studies in scholarly management and organizational journals we conclude that fundamental limitations exist in replicating existing models. Only in 20% of the cases, is an identical replication possible. Often the necessary details to replicate the

simulation are not available or the available details are incomplete. Most often, it seems, this incompleteness is a surprise to the original authors as well. We provide suggestions to improve the degree of replicability to ensure full replicability is a standard for system dynamics simulations models in organizational and management sciences.

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System Dynamics and GMB in Practice – the Case of Heavy Cannabis in The Netherlands

At the Ministry of Security and Justice in The Netherlands, System Dynamics and group model building are used to estimate possible effects of new policy measures (ex-ante impact analysis). One example is a measure (not yet confirmed by the Dutch parliament) to make a distinction in criminal law between 'soft' and 'heavy' cannabis, depending on the concentration of its active ingredient THC. When the law becomes operative, higher sanctions will be imposed on the production, trade and possession of 'heavy' cannabis. SD and GMB were used to gain insight in the effects of this measure on the behaviour of users, coffee shops and illegal markets, and on the extra workload for actors in the criminal justice chain.

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Natural capital in climate-economic models

Several influential climate-economic models represent increased global warming as the only significant environmental cost of economic growth. This makes assumptions about exogenous productivity growth rates decisive for the climate policy recommendations of the models. However, economic growth may carry multiple environmental and resource-related costs, which may interact with future climate effects. To analyze this possibility the DICE-2007 model by Nordhaus (2008) is expanded with a component that explicitly represents natural capital. In the expanded model, natural capital is influenced by climate change and economic activity and incurs costs to the economy when depleted to lower levels. Including the natural capital component implies more and earlier abatement of CO2 emissions than what is recommended by DICE-2007. The results also show that low-growth scenarios caused by natural capital loss can have opposite policy implications from low-growth scenarios generated by lower factor productivity growth rates. This illustrates the importance of model structure. Non-optimal policies are also analyzed by simulation, which suggests that the costs of choosing the wrong policy are higher in the expanded model.

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Robust optimization for policy design in system dynamics models

Designing policies in complex systems requires innovative methods/techniques for dealing with nonlinearity and deep uncertainty. Adaptive policymaking is a new approach that aims to design robust adaptive policies that can be revised over time. It is crucial to monitor the system and specify under what condition to take necessary actions. In adaptive policymaking, triggers are used as policy parameters. The policy performance significantly depends on the appropriate

parameterization of trigger values. Under uncertainty, robust optimization is a promising approach that helps design policy parameters properly. In this study, we propose to use robust optimization for policy design in system dynamics models. Robust optimization is used for determining the appropriate values for the policy parameters, i.e. triggers. Not only uncertainty but also the multiplicity of conflicting objectives is an important issue to be addressed for complex systems. Thus, we use multi-objective robust optimization that results in multiple policy alternatives which creates room for a better guided policy discussion on trade-offs. We illustrate the proposed approach through a case a system dynamics model about the transition of energy systems in the European Union toward renewables. It is shown that multi-objective robust optimization helps better determine the policy parameters in system dynamics models.

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Demand Endogenization of Intermediate Products in Supply Chains through a System-Dynamics-based Modularization Concept

A huge variety of System Dynamics models have been developed to endogenize short-term demand variations in supply chains. The Beer Game, used as a standard System Dynamics introduction in management courses, is co-responsible for having made these models wide-spread and of high-quality. Surprisingly, models that deal with long-term demand development aren't seen that often. Even in the Special Issue on Supply Chain Management (SCM) in the System Dynamics Review 2005, the editorially responsible team of authors summarizes that this issue plagues firms in innovation driven industries and is often ignored in conventional SCM research. In this paper a suggestion of a long-term demand endogenizing framework is provided, helping to close this gap in recent research. The framework is designed to deal with the diffusion processes of innovative intermediate products. Although most product transactions are intermediate product transactions, many diffusion models are apparently designed to deal with the diffusion processes of end products and not with intermediates as evidenced by the structural causality of these models. With this focus on intermediate products also new ground is claimed. Additionally, generic reusable models and guidelines how to apply the concept to a case under study, makes the aim of the paper, helping to optimize production capacity and inventory planning, practically implementable.

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Modeling the inner-European trade volumes of natural gas

The paper presents a subscripted model of the European gas market that aims on replicating inner-European gas flows. The model is tested and found consequential. The model is then used to analyze three scenarios: 1. The omission of long term contracts (LTC) 2. The increase of liquefied natural gas (LNG) capacities 3. The implementation of bi-directional pipeline flows The model is used to show the possible trends in the given scenarios. It was found that the omission of long term contracts lead to a need of more gas. Increased LNG capacities lead to more competition and the implementation of bi-directional flows increases the system's flexibility.

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Understanding the policy implementation deficit of the Swedish Environmental Quality Objectives system

The Swedish Environmental Quality Objectives (EQO) are sixteen in total and describe the desired state of the environment within one generation in each of the areas the EQO addresses. In the brief history of the EQO, there has been need of understanding what and how to measure success towards fulfilling the EQO. There is a need to create a better transparency between the implementation of policy to carrying out measures to, observing changes in the status of the environment into the desired direction. In this regards, identifying and understanding feedback loops and key driving forces that render implementation of environmental measures non-successful. This study analyses in what way environmental policy implementation can be better connected to success indicators and observation of changes in environmental state over time. And gives a proposal for a new gap-analysis process that is coupled with simple system dynamic modelling. The result of the case study show that the implementation of environmental policy has to be put into the context of understanding different time delays of the different factors within the system, i.e. time until environmental state has reach its target value. The study is ongoing and shows how novel qualitative analysis can be used to compare different types of policy option that address different types of strategies within the EQO.

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Impacts of Climate Mitigation Policies on Sectoral Distribution Effects and overall Economic Growth in Germany

This paper describes the macroeconomic impacts of impulses from technological sectoral models for climate protection policies. The analysis was done with ASTRA-D, a System Dynamics model of the German economy, and the time horizon is 2050. We present here the results of this integrated assessment regarding consumption, investments and employment. Included in the assessment are second round effects and effects of energy expenditure changes on intermediate deliveries and price changes of goods and services. The results indicate an acceleration of economic growth; however, shifts in sectoral demand lead to mixed results in employment. We also discuss the financing of additional climate protection investments and their implementation in ASTRA-D and some of the related problems with that. Finally we review the results in the light of some sensitivity tests.

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Resilience in Civil Conflict and Implications for Intervention Policies: An integrative systems approach to policy design

The USG and others in the international community have adopted resiliency frameworks for designing and evaluating conflict intervention policies in both the security and development/aid sectors. These frameworks acknowledge the need for multi-level systems analysis that bridge security and development/aid domains. In practice, however, they tend to focus on either individual agent

agency or system structure within single domains, and lack understanding of integrative causal mechanisms and dynamic feedback processes. In this paper, I demonstrate a theoretically grounded approach for combining individual agency and system-level dynamics at the nexus of security-development policy domains for evaluating impact of interventions on resiliency of various actors in instances of recurring armed civil conflict. Building on the work of (Choucri et al., 2007) to model state stability, I show how integrating individual agency with system dynamics can operationalize the USG resiliency framework for policy analysis of third party interventions through security and aid vectors. In so doing, sensitivity of combatant as well as societal resiliency to different vectors for implementing intervention strategies can be examined. The modeling framework is demonstrated for case studies of recurring conflicts.

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Model Building with Soft Variables: A Case Study on Riots

A methodology for incorporating soft variables into system dynamics models is proposed. Building on previous research, the methodology uses a systematic assessment to identify soft variables, and concepts from software engineering to implement them. Data hiding is used to separate the units and scale of a soft variable from its effect on other model elements. By encapsulating the soft variable in a module with well defined inputs and outputs, it can be used from knowledge of its parameters alone, and not its internal construction, that is it is referentially transparent. The methodology is applied to an existing population model on riot growth, extending it to include soft variables whose scales are limited. The effects of the different soft variables on the populations are combined together using cognitive algebra. The extended model is compared to historical data and found to give a richer explanation of the riot dynamics than the original model. The paper is exploratory and intended to inspire further research.

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Operationalizing Systems Thinking and System Dynamics Principles, Methods, and Tools in Government Policy and Management

This paper addresses the 32nd International Conference of the System Dynamics Society theme of Good Governance in a Complex World—from global to village levels—with examples and lessons learned through the author's application of systems thinking and system dynamics principles, methods, and tools in various settings. Four 'vignettes' are presented: (1) Strategic Planning in Honduras; (2) Sustainability Planning in Hawaii, (3) Development Project Evaluating in Guatemala, and (4) Rio+20: Global Sustainability Lessons Not Learned. The paper includes basic causal loop diagrams and stock and flow maps. … A premise of this paper is that both in spite of—and because of—the many relative advances in knowledge, communications, technology, and so on, during especially the past several hundred years, globally we are increasingly in a Titanic-after-it-has-struck-the-

iceberg situation. It is argued that even when system dynamics has been successfully employed to help explain complex sustainability issues, such as limits to growth and causes and effects (causes) of climate change, and as an aid in identifying potential solution leverage points—the net result has generally been too little, too late relative to the increasing global unsustainability trends. Why? The paper's conclusions and recommendations focus on this question.

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Integrating System Dynamics with traditional management tools: a case study in the Apparel Industry

This case presents an exploratory example of how System Dynamics can be combined with other management tools and mode methodologies in order to produce an effective and agile strategic analysis process. Since its inception (Forrester, 1961), System Dynamics has been successfully used to tackle support the strategic process and to give managers value insights to solve complex problems (e.g. Rich et al., 1995; Vennix, 1995 or Warren, 2005). However, System Dynamics effectiveness is some times constrained by: the short time available, high uncertainty and problems to integrate it with the current databases. This paper analyzes a System Dynamics based intervention conducted in the Apparel industry in Latin America. In this case, System Dynamics was combined with other management tools to support an agile (six weeks) process of rethink the company's strategy. The paper presents the approach used to build the System Dynamics model and combine it with the company's Balance score card, Discrete operation models and Montecarlo simulations. Finally the results and client evaluation of the intervention cases are provided.

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Combining group decision support systems and system dynamics to create strategic statements

The present research evaluate a Multi-method approach combining GDSS and System Dynamics as tool to support the effective the strategic planning process in the formulation of strategic statements. It is agree that organizations need clear and effective strategies to compete in a dynamic world. These strategies are summarized in strategic statements that include not only the organizations' goals but also the means they find relevant to achieve those goals. Unfortunately, many organizations present discrepancy between their strategic statements and they daily decisions. Because, the strategic analysis is often focus on issues (goals, problems, opportunities and threats) set up by the C.E.O or the planning department, top management teams (TMT) often perceive the strategic statements are disconnected of the real issues of the organization. In consequence, most of organizations' strategic statements do not represent what organization actually does. This paper evaluates a study case using a modification of the scripts of Ackerman et.al.(2010) to combine GDSS and System Dynamics in the process of formulate strategic statements . The results show the combination of SODA and System Dynamics contributes to create consensus about the strategic goals and give the top management team value insights bout the dynamic of the organization.

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Using System Dynamics and Fuzzy Logic to Assess the Implementation RFID Technology

The Technological growth has led to the acquisition and implementation of technologies to improve the performance of organizations that make up the supply chain. The paper presents a RFID Technology Implementation Model on picking operation under the approach system dynamics and fuzzy logic, to analyze behavior over time and information and material flow in the fruit supply chain assessed by means of technology change policies. The results show that the model has a better performance by integrating fuzzy inference system and system dynamics simulation, allowing make decisions through policy implementation traceability technology in fruit supply chain on the lead-time picking operations. Whereas, an innovation approach that combines elements complexityuncertainty, causality-experience, behavior-knowledge through of loop causal, dynamics simulation model and fuzzy inference system.

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Using Difference Equation to Model Discrete-time Behavior in System Dynamics Modeling

In system dynamics modeling, differential equations have been used as the basic mathematical operator. Using difference equation to build system dynamics models instead of differential equation can be insightful for studying small organizations or systems with micro behavior. In this paper we explain how we can use difference equations to build system dynamics models. We illustrate the use of this method through its application to a case study in supply chain management.

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A Model-Based Governance and Planning System for HIV-AIDS Services in Vietnam

Planning services for HIV-AIDS is complicated by the nature of the disease and the manner in which it spreads. Reducing the HIV-AIDS burden in a country requires sophisticated tools and agreement among stakeholders about effective strategies. This paper describes a tool for governance and planning of HIV-AIDS services for use at the provincial level in Vietnam. The tool includes an SD model and an interface that enables its use by planners and multiple stakeholders. Hands on use of the model has been shown to engage stakeholders and promote conversations necessary to developing strategies that meet their multiple needs. The tool can be used to allocate constrained budgets more effectively or to develop more idealized solutions and calculate their cost. As such, it can meet the needs of countries like Vietnam that are moving toward middle income status and must the transition toward greater responsibility for funding, management, and governance of HIV-AIDS services.

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Dwarf Shrubs Alichur: GIS-SD Hybrid Model

This paper introduces the model "Dwarf shrubs Alichur", a hybrid model combining System Dynamics (SD) and geoinformationsystem (GIS). The model is employed to outline how spatial resolution may enhance visual presentation of SD modeling results and to yield insights into the system described. It uses GIS to preprocess space related data for spatially dynamic simulation. The model focusses on the spatial and temporal availability and utilization of biomass around the case study village of Alichur. The area under investigation is tessellated using a hexagon grid. The likelihood of a grid cell to be harvested is determined by its accessibility from the village of Alichur. Local growth of biomass is determined by the present amount of biomass at the given location and is at optimum for shrub stands having a density of 0.5. Biomasses at different locations and simulation times are exported into GIS and visualized in a vivid manner. Two scenarios are compared, harvest at growth optimum and harvest far from growth optimum. The model yields space demand to satisfy the village's biomass needs for both scenarios. By means of presenting simulation results in GIS, scenario results are improved in terms of usability and communicability as in comparison to classical SD presentation techniques.

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Modeling the hypothalamus-pituitary-adrenal axis: A review and extension

Multiple models of the hypothalamus-pituitary-adrenal (HPA) axis have been developed to endogenously capture the oscillations seen in the cortisol concentration and to examine HPA axis dysfunction. We reviewed the existing models, replicated, and compared them by finding their correspondence to a dataset consisting of ACTH and cortisol concentrations of 18 individuals. We found that existing models use different feedback mechanisms, vary in the level of details and complexities, and often offer contradictory conclusions, while none provides a great fit. We therefore re-calibrated the best performing model using partial calibration and individual fixed effects. Our estimated parameters reduced the mean absolute percent error by around 50% and offered the best fit among existing models of HPA axis dynamics. Our analysis also suggests that circadian and ultradian cycles are not created endogenously by the HPA axis feedbacks.

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A Survey of Methods for Data Inclusion in System Dynamics Models: Methods, Tools and Applications

Numerical data is experiencing a renaissance because 1) traditional data such as census and economic surveys are more readily accessible 2) new sensors are measuring things that have never been measured before, and 3) previously 'unstructured' data - such as raw text, audio, images, and videos - is becoming more amenable to quantification. Because of this explosion and the popular buzz surrounding 'Big Data', clients expect to see strong incorporation of data methods into dynamic models, and it is imperative that System Dynamics Modelers are fully versed in the techniques for doing so. The SD literature contains surveys that explain methods for including data in system dynamics

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modeling, but techniques have continued to develop. This paper attempts to bring these surveys up to date, and serve as a menu of modern techniques.

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Extending Group Model Building to Agent Based Modeling: A Case Study on Understanding the Paradox of Primary Care

Group model building (GMB) has historically been applied using system dynamics. However, the growing interest in GMB and systems science methods including system dynamics and agent based modeling has led to increased curiosity about the feasibility of extending GMB to agent based modeling (ABM). This paper reports on a study seeking determine to the degree to which GMB can be extended to ABM. The study involved eight time-separated 2.5-hour structured sessions with 15 community participants over a period of nine months, focusing on understanding a paradox in primary care. An ABM was successfully developed through multiple iterations. At the end of the project, participants demonstrated ownership in the model and commitment to the outcomes. Many aspects of GMB could readily be extended to ABM with similar types of outcomes raising the possibility of using GMB as a gen.

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Global and Regional Health Partnerships: Improving the Linkages Between Global and Domestic Primary Health Care Policy Agendas

Governance issues are a major challenge to developing effective global health partnerships (GHPs) critical to advancing the Millennium Development Goals (MDGs). While there are numerous applications of system dynamics (SD) to policy analysis, development, and health policy, there are relatively few examples of using SD to directly engage stakeholders to address these issues. This paper presents a case study of applying SD using group model building (GMB) to design a plan for a countrywide initiative to improve population health for the poorest 20% within a large multinational initiative. The paper describes the work in different phases starting with initial engagement and how

the use of SD/GMB led to important shifts in mental models and changes in the planned investments to include neonatal mortality. Implications for GHPs and system dynamics practice are discussed.

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Using System Dynamics to Analyze Social and Economic Challenges for Myanmar

Three years ago Myanmar, also known as Burma, experienced a historical transition from a dictatorial military-led government to a civilian one. The newly established government has repeatedly expressed its intentions of opening up to the world after decades of seclusion resulting from long-term economic sanctions imposed mostly by western countries. Within this context, this study describes the results of a system dynamics model commissioned for democracy leader Aung San Suu Kyi by the CEO of one of Myanmar's biggest importers of heavy machinery to investigate the implications of an agricultural vs. an industrialized economic model. Overall, model results suggest (1) demographic dividends from the working-age population segment should be sized immediately before this segment gets old, (2) even aggressive investments in education will not be enough to build the large stock of high-skilled labor the country demands, (3) investments favoring big mechanized farms will result in low wages both in the agricultural and industrial sector, and (4) investment in manufacturing does not by default connect to high wages as expected. Although this study was conducted throughout a 2-week period, it produced insights that raise questions about the way Myanmar is laying out its new economic model for the future.

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Exploring a New Mechanism Increasing Emergency Department Visits

Per capita visits to the emergency department have increase dramatically over the past two decades. This model examines this change from an endogenous viewpoint, as a result of competing interests among different actors within the broader healthcare system interacting with patients. A new mechanism is proposed in which general practitioners have redirected patients to the emergency room instead of directly admitting them to the hospital as a result of third party payers attempting to control rising healthcare costs by reducing hospital admissions. The resulting model shows this mechanism could account for a significant portion of the increase in emergency department use.

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Adaptive sampling to explore the behavioral spectrum of system dynamics models: The case of mineral/metal scarcity

This paper describes a method for searching for undiscovered behaviors dynamically complex models could generate. Random sampling methods are sometimes used for determining the breadth of behaviors a system dynamics model could generate. However, as illustrated in this paper, an adaptive sampling strategy allows for the enumeration of a greater number of behaviors compared to preexisting methods. The method is used to analyze a previously

studied scarcity model and to identify new behaviors not exhibited by random sampling. Furthermore, the application of the adaptive sampling method allows for a set of new visualization techniques, which allow to capture the large-scale behavioral patterns of the model.

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Analysis of project management processes at a Dutch public infrastructure agency using group model-building

System dynamics has been widely used for solving complex problem. The combination of system dynamics modeling process incorporates implementation or use of the model as the final process of system dynamic modeling yet implementation is always the most difficult part in any organizational changes. Implementation often becomes its own issue, client may not understand how the policy will work to solve the problem or the other possible case is consultant may not understand the underlying problem. The messy problem condition occurs in Rijkswaterstaat (RWS), one of the directorates from Ministry of Infrastructure. RWS' duties are to develop, maintain, and operate traffic infrastructure throughout Netherland. Financial sector of organization is seen as a more obvious problem than communication problem which finally makes the organization is aware of the implicit problem. Based on the issue explained by stakeholders, GMB is seen as a suitable method to capture the problem. The primary goal is not to build the model of the system, but rather to get a group engaged in building a system dynamics model of a problem in order to see to what extent this process might be helpful to increase problem understanding and to devise courses of action to which team members will feel committed.

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Business Strategy Deltares' Delft3D

A research institute in the field of coastal life and infrastructure has changed its strategy from licensing to the open-source code for the Delft3D modelling software – the company decided to use "dare to share" concept. In order to increase the number of users of the product, the company was looking for a methodology that could help to understand how to do that well. System Dynamics had been chosen as a tool, which is helpful to analyze the current strategy (to see how the system is working now) and create the policy in order to reach the goal and adjust the strategy. In order to do that, we will research the effectiveness of previous marketing efforts and test them in the model.

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Sandbox SD Models: Catalyzing the Widespread Understanding of Dynamics

If the dynamically complex systems we live in today are to be managed successfully, widespread understanding of their dynamics seems essential. In this paper, we deduce a framework of desired characteristics for any medium targeting the creation of such understanding. Existing media are reviewed through the lens of this framework with a specific focus on system dynamics (SD) microworlds. We then use this framework to design the concept of "Sandbox SD Models" as a medium for catalyzing the creation of widespread understanding of dynamics. Sandbox SD models are stand-alone system dynamics models wrapped in intuitive interfaces without compromising on the critical elements of SD (such as, model endogeneity, stock and flow

representations and the indication of causal linkages). They are designed with the aim of reducing the effort required to understand system dynamics and increasing the intuitive interest of users towards doing so. Sandbox Models are positioned as a stepping stone towards the more extensive use of conventional stock and flow models. In this paper we describe a prototype sandbox based on the Urban Dynamics model along with plans for its evaluation through pilot usability testing.

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Dynamics of Obesity Interventions inside Organizations

In the US, obesity has been recognized as a major public health challenge for over two decades. A large number of obesity interventions, from upstream (policy) to downstream (individual level), have been put forward to curb the obesity trend; however, not all those interventions have been successful. Overall effectiveness of obesity interventions relies not only on the average efficacy of a generic intervention, but also on the successful Adoption, Implementation, and Maintenance (AIM) of that intervention. In this study, we aim to understand how effectiveness of organizational level obesity interventions depends on dynamics of AIM. We focus on an obesity intervention, implemented in food carry-outs in low-income urban areas of Baltimore city, which aims to improve dietary behavior for adults through better food access and point of purchase prompts. Building on data from interviews and literature, we first develop a contextualized map of causal relationships integral to dynamics of AIM, and then quantify those mechanisms using a system dynamics simulation model. The objective is to enhance our understanding of organizational dynamics that impact the effectiveness of chronic disease preventive interventions. We show how as a result of several reinforcing loops that span stakeholder motivation, communications, and implementation quality and costs, little changes in the process of AIM can make the difference between success and failure. [Word count: 4,610].

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A study on the dynamics of government investment in graduate education capacity and employment in Iran

In this paper, the effect of governmental investment in graduate education on job market steady development and GDP growth is studied. In recent decades Iranian government invested heavily in graduated education. Iran government benefited from this policy by which delayed graduation period of university student that leads to lightened unemployment problem. The model defining Iran current situation and it studied the result of investment in graduate education capacity heavily which reduced job market development investment of government in this period. The proposed model suggest that the government could invest more in employment for short period of time in order to improve GDP and as a result, empower private sector to invest in their necessary graduate education fields.

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A Model of Population Movement, Disease Epidemic, and Communication for Health Security Investment

This paper outlines the formulation of a system dynamics model designed to compare investment alternatives intended to limit the onset and spread of

human or animal disease. The model has been created to support the investment planning process for public health organizations worldwide, but also has relevance for public health systems research in general. It has been compiled from a sample of available generalized information as well as discussions with public health professionals. A scenario representing a common animal disease in a hypothetical developing country is used to demonstrate how the model can provide insight into investment impact. The details of the model structure are also discussed, which directly couples two well-known system dynamics constructs – the SEIR model and the population dynamics model – while adding a model of biosurveillance processes.

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Bathtub Dynamics Revisited: Does Educational Background Matter?

Prior studies ascribed people's poor performance in dealing with basic systems concepts to different causes. While results indicate that, among other things, domain specific experience and familiarity with the problem context play a role in this stock-flow-(SF-)performance, this has not yet been fully clarified. In this article, we present an experiment that examines the role of educational background in SF-performance. We hypothesize that SF-performance increases when the problem context is embedded in the problem solver's knowledge domain, indicated by educational background. Using the square wave pattern and the sawtooth pattern tasks from the initial study by Booth Sweeney and Sterman (2000), we design two additional cover stories for the former, the Vehicle story from the engineering domain and the Application story from the business domain, next to the original Bathtub story. We then test the three sets of questions on business students. Results mainly support our hypothesis. Interestingly, participants even do better on a more complex behavioral pattern from their knowledge domain than on a simpler pattern from more distant domains. Although these findings have to be confirmed by further studies, they contribute both to the methodology of future surveys and the context familiarity discussion.

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A Dynamic Model for Breast Cancer Screening: Misperceptions and Feedback in Screening Mammography Debate

In this study we develop a feedback rich theory to explain the dynamic nature of the screening problem within the US context. Our model is tightly grounded in evidence base, parameterized for the US data and replicates the basic dynamics concerning breast cancer, including the diffusion dynamics for mammogram screening and the noncompliance with recommendations against screening. We demonstrate how a medical decision making-process is distorted by misperception of risks, over-awareness, and by other special features which further distort the quality of the discussion, like single-issue advocacy groups and gender politics. The entire system is shown to dynamically interact with available facts to cause a self-reinforcing over-awareness and over-screening trend for breast cancer in the US, which leads to over-diagnosis and over-treatment, i.e. the over-use of health services. The dominant feedbacks are shown to drive the system towards a balance that is not consistent with the optima.

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Our Walk to the "End of Cancer": Understanding the Trade-Offs and Feedback in Mammography Screening Decision

Implications of widespread mammography screening remain controversial, and major health organizations in the US adopt different guidelines reflecting significant variations in actual practice. Literature suggests that implementation of routine screening over the past 30 years has incurred less benefit and more harms than is formerly believed. The classical approach to setting guidelines is based on the statistical paradigm of TypeI and TypeII errors, seeking to find an evidence-based balance between sensitivity and specificity, given the costs and benefits of different outcomes. However, a wide range of considerations play important roles in determining both the formal guidelines and how these are interpreted and acted upon by providers, payers, and advocacy groups. Science and evidence, including the processes that generate evidence, are embedded in a sociopolitical system. In this study we develop the first explicit feedback theory around the dynamics of health screening. The theory we develop includes core issues around costs and benefits of screening including the fundamental tradeoff between sensitivity and specificity. However it also includes some of the sociopolitical feedbacks that condition formal guidelines and the actual practice. We use the mammography case as the motivating example, but our model is generic enough to be applicable to other contexts.

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A structure-based System Dynamics Approach for Assessing Engineering Design Processes

The dynamic behavior of engineering design processes is a well-known challenge within engineering. Assessing different possible process sequences for their behavior remains a major challenge within engineering design research. This paper proposes a structure-based System Dynamics approach for assessing engineering design processes for their dynamic behavior. A composition panel within the SD model is introduced to enable an eased modelling and assessment of different process sequence variants. The suggested composition panel incorporates the idea of structural methods such as Design Structure Matrix (DSM) and Multiple-Domain Matrix (MDM) into System Dynamics. By applying the DSM and MDM methods, the SD models for the different sequences become more clearly arranged and more easily to handle. Each process step within the approach is represented by the same composite concept of a rework cycle which enables the addition or deletion of process steps. This allows for a quick modeling of various variants of the engineering design process. Assessing different scenarios of engineering design process sequences by simulation offers the possibility to further improve the planning and management of engineering design processes by providing an approach to assess their dynamic system behavior.

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Phosphate Scarcity? A model-based analysis of the global phosphate market and the potential of phosphate recycling

Phosphorus is an essential, critical and scarce element. It is needed for the growth of plant cells and human bones. The primary source of phosphorus is

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phosphate rock, which is mined to produce fertilizers. Two-thirds of global phosphate rock mining occurs in China, the US and Morocco. Global dependence on these countries is big, especially with peak phosphorus expected to happen soon. Some countries have started a phosphate recycling programme. Research has shown that phosphate can be recycled from sewage sludge and manure. If recycling is successful, the question arises whether phosphate will still be scarce. This question is addressed using a global System Dynamics model with a time horizon until 2050. The simulations show that a global recycling market will develop, without any intervention, around 2025. Phosphate mining will probably keep increasing despite increasing amounts of recycled phosphate, due to the increasing phosphate demand. If the recycling market develops as in the model, quantitative phosphate scarcity will not be significant. And If the demand per person is decreased with 5% by 2050, the economic scarcity will not be significant either. For better use of the model research should be done into the costs of recycling and mining, as these values are crucial, but unknown.

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Estimating the Effect of Climate Change on the Hydrology of the Nile River in the 21st Century

The purpose of this study is to employ estimates of precipitation and temperature changes from a large number of General Circulation Models (GCMs) in order to estimate the potential effect of climate change on the carrying capacity (volume) of the Nile River throughout the 21st Century. We employ estimates from 33 General Circulation Models (GCM), inclusive of Representative Concentration Pathways (RCP) 4.5 and 8.5, within a Vensim model in order to model the dynamic interplay between climate change and river hydrology. We subdivided the time periods into 30-year intervals for 2010-2039 (early century), 2040-2069 (mid century), and 2070-2099 (late century). Our analysis offers several key findings. First, precipitation is likely to increase throughout the Nile River Basin with the possible exception of Egypt. Second, temperature is likely to increase throughout the Nile River Basin with the most pronounced increases in Sudan. Third, the effect of climate change on the Nile River is likely to result in a net decrease throughout the basin with the possible exception of the Blue Nile. The value of these findings is then discussed within a broader agenda.

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Natural Gas Pathways and Alternative-Fuel Vehicle Diffusion in the US Automotive Fleet

The recent abundance of low-cost domestic natural gas in the United States is an opportunity for many energy-intensive industries. While several conversion pathways exist to fuel automobiles using natural gas, the automotive pathways that should be pursued given fuel costs, environmental impacts and the diffusion of alternative-fuel vehicle technologies remains an open question. Here I develop an empirically grounded dynamic model of alternative-fuel vehicle diffusion, parameterized for a range of competing vehicle platforms and conventional and natural gas fuel pathways. Using comparative analysis of technology and policy scenarios, I find that promotion of compressed natural

gas (CNG) vehicles has the potential to stifle diffusion of more-efficient hybrid and electric vehicle platforms, leading to an increase in greenhouse gas emissions. The most promising opportunities lie with plug-in electric vehicles and hydrogen fuel cell vehicles, where natural gas can be used as a transitional fuel until renewable electricity is introduced.

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Study on the Impact of CO2 Emission Depending on Change of the Urban Structure: Case Study of Khon Kaen, Thailand

In terms of measures against global warming, huge amount of CO2 emission reduction from urban transportation has been absolutely imperative because automobile usage is expected to grow in many developing nations. To realize such huge reduction, many studies proposed comprehensive countermeasures including introduction of urban rail or guide way system, introduction of renewable energy, usage of eco-friendly vehicle and introduction of taxation and economical restriction such as road pricing and estimated CO2 emission reduction by implementing such countermeasures through change of travel behavior of households and enterprises and also change of automobile usage. However, change of urban structure such as Transit Oriented Development (TOD) has not be regarded on those estimation which might bring huge reduction of CO2 emission. Also, most of studies estimated CO2 emission reduction in certain targeted year only. Thus dynamical impacts of countermeasures on CO2 emission is not clarified. Therefore, in this study, relationship between urban area and Vehicle Kilometer Traveled (VKT) was analyzed based on former study in Khon Kaen, Thailand first. Then, a system dynamics model was developed to estimate CO2 emission based on relationship between urban structure and VKT. Finally, impacts of proposed measures were analyzed.

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Misconceptions of the Dynamic Nature of Building Energy Retrofitting Rates in Germany

A large proportion of the fossil energy consumption and CO2-emissions in Germany is due to heating of buildings. Building energy retrofits have been proposed as one of the most cost-effective and high-leverage ways to reduce fossil energy consumption and CO2-emissions in Germany. Accordingly, the federal German government declared increasing the building energy retrofitting rates as being a key priority in their long-term Energy Concept. A close look at governmental targets as well as some of the research on building energy retrofits reveals a misconception on the dynamic nature of retrofitting rates: they are assumed to constant instead of exponentially decreasing. This is a result from these rates being commonly defined relative to the whole stock of buildings instead of the stock of buildings in need of retrofit. The overestimation of future retrofitting rates that results from this misconception casts serious doubt on a suggested keystone of the German Energy Transition.

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Dynamics of Basketball Player Performance Evolution: A System Dynamics Approach

The skills and physical characteristics of a basketball player play a role throughout his early development and later carrier. Basketball coaches rely primarily on empirical observations and past experience for assessing a player's ultimate performance potential and guiding his training accordingly in order to realise it. They are inherently faced with two challenges: (i) the interactions of player characteristics and their influence on performance are complex and (ii) most teams have no standard data framework for recording this. The present paper has two goals: (i) to propose a data framework for player characteristics and (ii) to develop a system dynamics model that provides a basis for exploring their interactions, their effect on player performance.

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National Governance

National governance refers to how public institutions conduct public affairs and manage public resources. It also describes the process by which decisions are made and implemented or fail to be implemented. This session explores the contribution of system dynamics modeling to these issues. It reports on applications of modeling projects for national-level planning purposes supporting transformation processes towards sustainable development. The presentations in this session illustrate the importance of a proper representation of dynamic complexity, that is, of feedback loops, accumulations and nonlinearities for effective management of public resources. They illustrate how stakeholder involvement across policy sectors and institutional levels enables identifying dynamic complexity and formulating effective policies. This has important consequences for the likelihood of adoption and diffusion of policies by decision makers across policy sectors and institutional levels. Finally, the presentations reflect on the importance of institutionalizing simulation models in ongoing planning processes and the challenges of doing so.

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A Different Outlook On Stock-Flow Tasks: Using Eye Tracking Methodology To Explore Eye Movements Of Problem Solvers

Is it justified to state that the eyes are the mirror of our mind when performing stock-flow tasks? We are tempted to answer this affirmatively. This paper reports ongoing research on the use of eye tracking in the field of stock-flow tasks. Our aim is to shed more light on the relation between viewing and answering behavior when solving the Department Store task. The findings indicate that answers to the questions three and four of the Department Store Task were preluded by distinct viewing patterns. On average participants use two viewing cycles, sequences of looking at areas of interest in the graph. The participants with correct answers or answers according to the correlation heuristic look more frequently to the corresponding, typical parts of the graph. Participants answering 'cannot be determined' lack such a focus in the second cycle.

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A Stock and Flow Based Framework for Indicator Identification for Evaluation of Crop Production System

Crop production and crop yield has been the sole focus of most of the existing agricultural policies and interventions, which has resulted in several undesirable outcomes over a long term. To evaluate any production system holistically, it is necessary to identify a set of indicators accounting for economic, social and environmental dimensions. While the existing indicator selection frameworks help in identification of indicators, they lack a logically structured and transparent process. In this work, we develop a stock and flow based framework for a systematic selection of indicators for evaluating crop production systems. Stock and flow diagrams are used for conceptualization of the system and are sorted with respect to material, energy, and financial flows associated with the system. Various causal flows and their linkages are traced for each of the input-output component, and one representative indicator is selected for each causal flow. The indicators associated with desirable outcomes are taken in terms of input-output efficiency while undesirable outcomes are considered in terms of their absolute values. Using this process, a set of thirteen indicators have been identified for assessing the viability of agricultural practices with respect to socio-economic and ecological sustainability.

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The Impacts of Governmental Policies on the Investment Decision for Renewable Energies in the Swiss Electricity Market

Switzerland faces the challenge to shut down the existing nuclear power plants and mutually stimulate a shift to renewable electricity sources, while ensuring a secure electricity provision. The investment decision for the specific technologies is a central leverage point in the system. The currently applied feed-in remuneration tariff policy to alter the profitability of renewable energies is very cost-intensive and does not bring the desired results. A System Dynamics simulation model was built to better understand the interplay of the different electricity technologies and test alternative policies to raise the competitiveness of renewable energies. Results are gained on long-term developments of the installed capacity of the different technologies depending on varying costs trends and public policies. This paper makes a practical contribution to the management of the energy transition by evaluating different policy options to steer the electricity provision system towards a more sustainable direction.

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Using system dynamics to improve integrated Life Cycle Cost of Physical Assets

Owners of physical industrial assets often make ineffective Asset Management decisions which may lead to lower returns on investments. This presentation takes a business oriented approach and looks at a practical case in which improvements can be made by using System Dynamics to assess the dynamic behavior of the physical asset and the interactions with the environment. We discuss the case of a large investment company which has experiences in the

capital-intensive industry. We observe that facilitating group model sessions and workshops focused on experiencing behavior contributes to collaborative behavior between different organizational disciplines and stakeholders. System dynamics proofs to be a useful tool to create shared vision and understanding of the integrated business processes that ultimately leads to higher returns on investments and a better control on risks.

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Formal Behaviour Classification under Uncertainty: Applying Formal Analysis to System Dynamics

A study was performed by the author on formal analysis of deeply uncertain non-linear systems in the context of System Dynamics (SD). The objective of this study was to develop a more insightful method to classify model behaviour for exploratory modelling. The long term vision of this study is an exploration method that results in more transparent behaviour clusters with more insightful influence of uncertainties than the current sampling and clustering approaches. To achieve this, a simple predator-prey model from literature was analysed. Uncertainties were specified on the parameters and the resulting behaviour was represented in phase portraits. Through further analysis of local, linearised behaviour around equilibrium points, classes of behaviour were defined on mathematical properties of the system instead of properties of the output. No model runs are required for this classification, which makes the method computationally attractive. For the predator-prey model, these behaviour classes resulted in well-defined analytic boundaries in the uncertainty space. The major finding of the study is that formal analysis can divide the uncertainty space into regions that result in different behaviour.

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Sustainable Diffusion of Improved Cookstoves in Rural India: Exploring Key Determinants through System Dynamics Modeling

Around 3 billion people still cook and heat their homes using solid fuels (biomass: wood, leaves, etc. or fossils: coal) in the traditional stoves which are the most significant contributors of indoor air pollution. In the case of India, the traditional cookstoves contribute to an estimated 570,000 annual premature deaths from biomass smoke exposure. The National Program on Improved Cookstoves launched in India to diffuse the improved energy efficient cookstoves is emblematic of the kind of government led stove interventions that can go wrong with specific strictures on misunderstanding the community needs and poor distribution networks although having robust funds at disposal. Though the improved cookstoves meet with early adoption, there has not been a sustained usage of these improved energy efficient cookstoves. The system dynamics model described here highlights that in addition to the exogenous thrust of pumping the improved cookstoves into the communities, it is critically important to garner and emphasize on the supporting structures such as local expertise, influence of community leaders, and overall attractiveness of the improved cookstoves. These support systems are significant in creating a successful dissemination strategy of the improved cookstoves in the rural Indian communities.

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Visualising Strategies: The impact of user interpretation of a strategic decision support system

On the one hand, simulation models have been employed to support managers to understand the complexity in their businesses. On the other hand, there are different simulation models and different user interfaces to support managers' decision making processes. The use of simulation models will have different impact on managerial effectiveness to understand the information provided by the performance measurement system and manage their businesses. In this paper, we explore the interpretation of users of a strategic decision support system based on the concepts of dynamic resource-based view/strategy maps and its impact on the strategic decision making process. Our aim is to identify what is the impact of the interpretation assigned to the decision support system on the decisions made. The research has been conducted with 30 product managers from the pharmaceutical industry exploring similar decision support system. The results indicate that sense making is a key factor affecting the usefulness of decision support systems and impacting the decision making process.

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Adoption of Qualitative System Dynamics in Primary and Secondary Education in the German-speaking Part of Switzerland

In this study, we analyze the supporting and limiting factors for implementing qualitative system dynamics as an innovative, cross-curricular qualification in the classroom of K-9 schools in Switzerland. Teachers who participated in a standardized one-day training in systems thinking are the main focus of our design-based research using mixed methods. The results confirmed the importance of available time, supporting material, as well as, systems thinking specific self-efficacy as supporting factors. Although previous knowledge of systems and of systems thinking was limited in all of our groups of teachers, it was not necessarily a barrier when adopting systems thinking into the classroom. Our study revealed that the experience of autonomy and competence and, above all, the attribution of significance to systems thinking are key elements to foster systems thinking in schools despite the initial low level of competences.

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Comparing Behavioral Dynamics Across Models: the Case of Copper

In many public policy issues diverging understandings of the system can be encountered. These diverging understandings can reside in the mental models of the different actors involved, or even be codified into structurally different models of the system. For an analyst it can be of great use to get insight into how and under what conditions the behavior of the models is different. In this paper, we address this problem. We present a general approach for comparing two or more structurally different models in the presence of additional uncertainties. This approach can be used to get insight into how different the results of two or more models are, and the conditions under which the models produce different results. The approach uses Exploratory System Dynamics

Modeling in combination with the dynamic pattern feature metric. We demonstrate the approach using a case study. This case study focuses on the future dynamics of the copper system. Here, there are experts favoring a top down way of modeling the system and there are experts favoring a bottom up way of modeling the system. We use both and find that for some outcomes of interest adopting either perspective makes no difference, while for other outcomes of interest only under specific additional assumptions about other uncertainties there is a difference in behavior.

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Collaboration in model use

Whilst there is a considerable body of literature on collaborative or group model building there is less in the field of collaboration post-model building. The advent of an enhanced ability to host models on the web contributes to the sharing of models, but true collaboration using system dynamics modelling in a web based environment is relatively rare. This paper sets out an innovative approach to both the technological advances necessary to achieve this and embeds it in a real world collaborative modelling environment, namely that of medical workforce planning in England.

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Equality?

This paper describes a theoretical application of systems thinking and the use of a simple system dynamics model to throw light on a question of political philosophy – when it comes to equality, what is it that we are trying to measure? The context of the original work was an exploration of inequalities in health. The purpose of this paper is to further explore the contribution that a system dynamics approach can make to this conundrum. In it I briefly comment on why equality and inequality are important concepts in political philosophy, what the competing claims are in considering what it is we are trying to equalise, and I then introduce a simple system dynamics conceptualisation and model from which insights arise. This paper is an extract from, and development of, an MA dissertation in Applied Professional Ethics from the University of Leeds in which one marker suggested that "the best parts of the dissertation seemed to be those in which a system-modelling approach was taken to the evaluation of Rawls' theory of justice, including comparing it with other theories……. It would have been good to see this material given more than the fairly short section it received." This paper takes a small step in fulfilling the markers wishes!

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Decision Heuristics and Human Performance in a Policy Management Simulation

Psychometric research has delivered reliable means for assessing various forms of intelligence, yet there has been relatively little success in predicting the human ability to solve complex problems in dynamic environments. The present work aims to profile dynamic decision making strategies using dynamic simulations in order to predict individual complex problem solving performance. We report an experiment assessing decision heuristics with the

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goal to predict complex problem solving ability. We used the COmplex DEcision Making (CODEM) system dynamics testbed to assess information seeking behaviors and the similarity of decision patterns to different types of heuristics. The Democracy 2 serious game is then used as an objective measure of complex problem solving ability. Democracy 2 is a realistic government management simulation requiring strong planning and systems thinking skills. A set of three new metrics is proposed to quantify similarity to different heuristics. Three models are compared on the basis of their predictive accuracy: a linear regression model, an artificial neural network and a support vector machine. Results show that the support vector machine has the most potential due to its superior results in a cross-validation test. We conclude with a discussion on future model extensions and generalization tests.

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Reviewing Child Protection in England

This paper gives an account of how causal loop diagramming was used in 'the Munro Review', a high-profile examination of child protection activities in England, conducted for the Department for Education. The activities constituting 'child protection' and the circumstances that led to the Munro Review are outlined. Two examples of the use of CLDs are then considered: the visualisation of how a 'compliance culture' had grown up and, via group model building, the creation of a large, complex CLD of current operations. The paper continues by describing how this work was then used to give structure to the range of issues the Review had to address, and used as an organising framework for the final recommendations. The paper closes with an account of some significant steps that have been taken so far to create a child protection system with the critically reflective properties of a learning organisation, and a reflection on how the use of systems ideas helped bring this about.

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Macroeconomic Dynamics of Greece in the Midst of the Eurozone Crisis – Application of SD Modeling and Insights for Policy

This paper examines the effectiveness of and alternatives for the economic policy measures taken after 2008 to tackle the debt crisis in Greece. It also investigates the general value in using system dynamics modeling in policymaking to better understand macroeconomic dynamics. The analysis is based on constructing a system dynamics model of the Greek economy, simulating the model under different scenarios and testing its robustness. The paper concludes that the austerity measures implemented in Greece should have been cancelled or postponed to effectively ease unemployment, facilitate economic growth and cut budget deficits within 5–7 years from the beginning of the crisis. Moreover, the analysis discovers that aggressive debt write-offs have a significant role in alleviating the Greek debt load. In the actual case of excessive political barriers to revoking public spending cuts, a prominent alternative solution would have been to accompany the mandatory cuts with a tap program in which Greek government bond yields are fixed to a specific, sufficiently low level by the European Central Bank. An efficient long-term solution, drawn from the insights of the paper, would be likely to require large-scale institutional reforms in the eurozone.

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Using system dynamics to inform future pharmacist student intake in England until 2040

This paper describes the use of system dynamics in a major piece of work supporting the Department of Health, Health Education England and wider Government policy. The Centre for Workforce Intelligence (CfWI) carried out an in-depth review of the pharmacist workforce in England, projecting and analysing the future supply of and demand for pharmacists between 2012 and 2040. The purpose of the review was to inform future pharmacist student intake at university level and was driven by the need to provide sustainable, high-quality pharmacy services in a complex and evolving environment. The work was set in the context of recent increases in the number of students studying pharmacy at university and proposes for training reform. System dynamics modelling was extensively used to produce a range of supply and demand projections across challenging and uncertain scenarios. This enabled potential policy interventions to be tested for robustness, with uncertainties and sensitivities fully recognised. The methodology and framework used allowed the CfWI to work transparently with pharmacy system professionals and stakeholders, eliciting knowledge of those closest to the system. The review, its findings and suggestions are currently being used to support major discussions regarding the future pharmacist workforce and training environment in England.

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Why Do Cattle Prices Fluctuate?: Structural Characteristics and Simulation Works

Simulation works of market fluctuations have revealed that fluctuations occurred due to an imbalance between Korean cattle population and its appropriate level, and an imbalance between cattle prices, beef consumption amount, and number of cattle slaughtered. The simulation results presented that only the basic policy model would show a strong fluctuation in the price of cattle until 2018 due to such a feedback structure, and thereafter a somewhat weak fluctuation pattern until 2025. In addition, the findings of this study have revealed that if cattle population exceeded the appropriate level, the method of simultaneously reducing the population of all types of cattle in all stages of breeding would prove to be more desirable than the method of purely reducing the number of large fertile cows. Lastly, the findings have exposed the following point: there exists a very inelastic relationship between production-site cattle prices, cattle slaughter amount, and amount of beef consumption. To ameliorate these problems, the government's efforts should focus on improving the beef distribution structure to flexibly connect the cattle supply and price, and beef consumption, rather than pursuing a strategy with the focus on supply aspects such as reduction of the cattle population and encouragement of calf-breeding.

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Do Indemnities Make Pollution Victims Happier?:A System Dynamics Perspective

This study examined the reasons for the declining economic quality of life of pollution victims residing in the most severely dioxin-polluted site in Southern Taiwan. At this site, the government has spent enormous amounts of money to

compensate victims for their losses and alleviate their anger, and to alleviate the local poverty problem. We constructed a problem-oriented system dynamics model, and identified the reinforcing feedback mechanism in the system that renders the government's expenditures ineffective based on the simulation results. Because the cash compensation program activates a reinforcing feedback mechanism, worsening the economic quality of life among victims, we suggest that both the government and pollution victims be prudent in primarily employing cash compensation programs to solve problems caused by pollution.

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The Mednyi Mystery: An Hypothesis for the Collapse of an Arctic Fox Population Due to Removal of Human Predation

Over the decade of the 1970s, following the end of the presence of human fur trappers on Mednyi Island, a small Russian island off the coast of the Kamchatka Peninsula, the indigenous population of arctic fox (vulpes lagopus) declined precipitously. This collapse is typically attributed to an outbreak of mange in juvenile foxes, though the cause of the outbreak and influence of factors like levels of mercury pollution in the environment are not well understood. However, recent surveys of the fox population have found no evidence of residual mange pathogens in the current population, and mercury levels in modern juvenile foxes is believed to be lower than the levels found in museum specimens of juvenile furs that were harvested prior to the population collapse. This paper offers a mathematical model expressed in the System Dynamics language hypothesizing a causal connection between the departure of humans and the subsequent collapse of the fox population. This model also demonstrates why it might be that no mange pathogens are present in the current population and how levels of mercury pollution in juveniles may have declined as the population collapsed.

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Increasing Resilience of Supply Networks to Climate Change Induced Disruptions

A model is constructed to investigate the response of a supply network to disruptions due to extreme weather events, such as the 2011 flooding in Thailand that affected hard disk drive production. The supply network simplifies the complex networks seen in the real world to consist of just three business categories: manufacturers, suppliers that provide a key component to the manufacturers and retailers who sell the finished product. The suppliers, manufacturers and retailers collectively employ the same two-part mathematical rule, based on their own current inventory's level and on the recent rate of shipping to the next business category downstream, to determine how much of the good in their own inventory to manufacture/procure. Though the model is simple, some of the behaviour is non-intuitive, including non-monotonic recovery from a severe disruption and a case seen where the time to recovery (TTR) of the manufacturer's inventory is faster when all of its production capacity is destroyed than when a portion of the production capacity is retained. We believe this model is generic enough to serve as a basis for testing the effect of climate change scenarios on measures that can improve the resilience of supply networks.

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Machine Strategy Evaluation Using System Dynamics Group Model Building

Modelling projects, in order to build richer understanding of the dynamics of real-world phenomena in manufacturing systems, benefit from utilizing System dynamics group model building. This paper describes such project utilizing such method in order to identify the interrelated dynamics of aging machinery equipment, competence development, and level of automation for accurate manufacturing systems development. These central aspects were identified by the project group during modelling and were considered vital in order to approach the proper Machine Strategy for the system of interest. Aspects of attention in the study also considered participants' learning of the system of interest, participants' perception upon model results, and the comparison between utilizing group model building and the traditional modeller-client approach. It is shown that System dynamics group model building has potential use in manufacturing, and indeed that more efforts are needed for successful use in projects. For that reason the need of a framework for supporting system dynamics projects in manufacturing is identified. Keywords: system dynamics, group model building, manufacturing system.

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Diabetes in The Netherlands: Exploratory Modelling and Analysis of a Macro Diabetes System Dynamics Model

Type II Diabetes Mellitus is one of the fastest growing chronic diseases in the western world. This exploratory research provides an insight into the causes for the diabetes prevalence in The Netherlands by performing an Exploratory Modelling and Analysis (EMA) study on an adaptation of an existing macro-level diabetes System Dynamics model. The model used is adapted from the diabetes model by Jones et al. (2006) and a number of policies that are currently considered to be implemented are tested. The analysis shows that high numbers of diabetes patients are caused by high levels of risk of (pre)diabetes for certain groups and diabetes and prediabetes onset. Recommended is more research into narrowing the uncertainty bandwidth of these parameters or to monitor these parameters in Dutch society. The policies as currently proposed, where high risk groups for having prediabetes are determined via a questionnaire and prediabetes patients are offered lifestyle interventions do not have considerable effect. By making these interventions less non-committed, effects of the policy increases considerably in terms of number of diabetes patients and costs, but it requires testing a much larger part of the risk group. Researching whether these high attendances of risk groups should be further researched.

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The seen and unseen: Emergent control and project progress in IS integration efforts

This simulation study proposes a theory of emergent control of collaborative group process that relies on feedback loops containing both tangible accumulations of work-in-process and intangible accumulations of individual and group understanding and engagement. The theory was constructed through a series of group model building sessions among action researchers who had worked as participant-observers in National Science Foundation-sponsored initiatives to integrate information systems of New York's criminal justice

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agencies and offices. The paper's contributions are 1) articulating a "control theory" appropriate for emergent, collaborative processes that must rely on reinforcing feedbacks, as well as negative feedback loops; 2) proposing a coherent explanation with which scholars and practitioners can understand and manage the interplay of tangible and intangible accumulations generated by purposive group activities; 3) demonstrating an innovative approach to theory construction through the group model building process.

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Simulation of the pension system process development

The article proposes a comprehensive economic-mathematical tools for study and implementation of government programs to develop and reform the pension system of the Russian Federation. These tools allow developing the consolidated scenario oriented on constant growth of pensions in conditions of unfavorable demographic trends, the deficit of the pension fund, the introduction of new institutional forms under transitional economic processes. Dynamic models and possible scenarios are formed by experts using ontologies for conceptualization of simulation models and introducing the models of the balancing interests of different groups. Developed model complex of pension system includes a number of subsystems, such as population, insurers, pension funds, pension legislation, financial market and management companies, which reflect the underlying socio-economic processes. The study considers such aspects of social behavior of insured persons as formation of the individual trajectory of pension insurance, including choosing of management company and retirement age. The model complex is implemented on the basis of a combination of system dynamic and agent-based models, parameterized using regression analysis and the results of expert assessments.

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The missing seventh stage: model construction

The system dynamics methodology life cycle has benefited from a substantial amount of work in model formulation, group collaboration, and model testing. There seems to be a missing link, the link that corresponds to model construction. The hypothesis is that system dynamics modelers report on models they have built. Modelers do not report on the model construction process. This may be due to limited space and time for presentation, especially at conferences. A measure, or measures, of the quality of the model construction process is appropriate to judge the quality and usefulness of those models. This paper examines models submitted to the International Conference of the System Dynamics Society from 2009 to 2013 via the 'Supporting' link on the conference proceedings web page. Presented are the results of applying objective and subjective criteria to model construction.

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Managing Complexity and Uncertainty in Offshore Outsourced New Product Development 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 each approach is more effective at handling different types of tasks, given the characteristics of its respective team structure and capability composition. The results bear implications for traditional notions of firm boundaries and organizational forms.

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Policy Making for a Mixed Strategy Game between Taxpayers and Tax Authorities

Game theory can model rational decision making, hence it has been used for policy making. However, these recommendations can sometimes be counterintuitive, such as George Tsebelis' (1989) argument that the rate of penalty does not affect criminal behaviour, but instead it changes the behaviour of law enforcement. Kim and Kim (1997) modelled this game and found that due to oscillations in the system Tsebelis' policy recommendation is not necessarily useful for policy makers: the equilibrium level may only have little or insignificant on behaviour. We will revisit this issue by replicating Kim and Kim's model and putting into a different context: tax evasion. Our model will look at how setting the right policies, such as introduction a tax inspection rate goal or changing the behaviour of the tax authorities, can affect oscillations. Our model shows that the oscillations can be reduced by changing the rules according to which tax authorities react to tax evasion, and also eliminated by setting a goal to tax inspection rate.

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Adversarial Dynamics: Coupled Reversals in Asynchronous Conflicts

Adversarial dynamics form the core of a wide range of social conflicts, but these dynaHohbergmics are deeply contextual and, accordingly, a challenge to model. The present study seeks to provide type-theoretical definitions for adversarial dynamics that can provide a link from the broadest concepts to the most detailed tactics. We illustrate this strategy by addressing the area of transportation security in extensive depth, including the way in which it is shaped by strategies of contention.

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Projecting long-term water demand for the City of Bulawayo

Water supply reliability for urban centres is in jeopardy of climate change, population growth, urbanisation and changes in life styles. To ascertain reliability of water supply, either water supply-side and water demand-side management strategies are often implemented, which however, are dependent

on forecasted demand for their appropriate enforcement. The water demand for Bulawayo, the second largest city of Zimbabwe, is thus forecasted using systems dynamics; a simulation model which appropriately analyses complex systems whilst tracking socioeconomic changes. It is projected that unmanaged demand is likely to surpass current supply by 2015 which implies that Bulawayo should have developed a new resource by then. This would be unrealistic in view of the uncertainty in the current economic status. However, managed demand by using various demand management measures will enhance supplies till 2032. This delay will aid in proper planning for new water resources or other alternative sources of water supply.

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Combining the Strengths of System Dynamics and the Multi-Level Perspective to Explore Policies for Sustainable Transitions

This paper outlines a system dynamics driven approach that can be used to assess policy making with regard to future sustainability transitions. Insights from transition literature and the multilevel perspective are used to translate policy targets into transition scenarios that are then explored with the help of system dynamics. While past approaches involved the translation of whole socio-technical systems into complex system dynamics models, this approach compares the transition goals of policy makers with stereotypic transition pathways in order to constrain the boundaries of the transition problem. This leads to simple and problem-oriented models that allow a better understanding of the dynamics of the socio-technical systems and therefore a more efficient application of system dynamics. The application of the approach is illustrated with the help of the case study of a transition towards the electrification of private transport vehicles.

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SOA Governance Dynamics in a multiparadigm approach

SOA refers to the coordination of people, processes and technologies within an organization that has the aim of achieving certain strategic benefits, both by increasing the return on investment (ROI) and organizational agility and by reducing the information technology governance (IT) burden. The ability of SOA to interoperate many different information systems, including legacy systems, helps to accelerate the integration of core systems. From a combination of established methods that include system thinking, Godet's strategic prospective, discrete event simulation, agent based modeling and System Dynamics comes an adaptation of Forrester's Market Growth model to formulate a decision-making governance flight simulation model to represent the interactions of intended rational policies in the study of dynamics that can arise from the complex combinations of SOA Governance factors, principles, and structures.

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Governance, Big Data and Flow: A Current Example – Modelling Risk Stratification in Health and Social Care

The conference theme is Good Governance in a Complex World, to address the role of models in governance. This recent example of a model explores the relationship between Big Data and System Dynamics, showing how the

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necessity of understanding flow is constrained by governance considerations in predictable (individuals' rights to confidentiality) and unexpected ways, when the restructuring of the health service produced changes in authority to use data rendering the data analysis required by the model potentially unrepeatable. The paper also proposes some generic approaches to modelling the impact of health interventions, and a concept model illustrates why understanding flow matters.

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Modeling the Influence of Job Stress on Musculoskeletal Disorders in Process Industries in India

The aim of this paper is to model for the influence of job stress on work related musculoskeletal disorders in chemical process industries in India. The job stress in organisations is considered an issue that needs to be addressed. The job stress is in turn a vector in inducing the musculoskeletal disorders in the work place. Based on system dynamics methodology, initially a causal loop model was developed which was finally transformed to a dynamic simulation model that captures the job stress influence on work related musculoskeletal disorders in chemical process industries in India. The data was collected using a closed ended questionnaire in chemical process industries in the country. The base run results show the adverse effect of job stress on musculoskeletal disorders. The policies of improving the physical work factors, improving of the work environment and a combined policy of these two policies were experimented. The policies were found to alleviate the musculoskeletal disorders due to job stress with the combined policy outperforming the other individual policies for the chemical process industries in the country.

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Making the Most of Simulation Modeling in Community Settings: A Conceptual Framework with Practical Value

The ReThink Health Dynamics model is a realistic, but simplified, portrait of a local health system. It was designed to support innovators leading collective efforts to improve health system performance over time. Here we present findings from a rapid, formative evaluation in five sites where the ReThink Health (RTH) model was piloted. We address several practical questions that are broadly relevant to those who use simulation modeling in diverse community settings: How does simulation modeling enhance collective efforts to transform local systems? In what ways? Using what methods? Under what conditions? An initial program theory was explicated using a table of domains, each grounded in the literatures on health system transformation and system dynamics modeling, then supplemented with insights from veteran practitioners. Preliminary hypotheses were tested and revised based on cross-case analyses, resulting in a robust framework that encompasses three major areas of interest in any modeling project: Contexts (i.e., settings and participant characteristics); Engagements (i.e., interactive experiences); and Effects (i.e., insights and consequences among individuals, groups, organizations/systems; and methodologies). Cross-site observations indicate that sites with certain pre-existing collaborative characteristics and leadership capacities as well as internal motivation for the project were better able to use the model and harness its potential to catalyze change among individuals, groups, organizations, and methods.

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Impact Analysis of Various Scenarios Implementation of Jakarta Coastal Defense Strategy Policy Toward Jakarta's Sustainability

The Jakarta economic growth provides significant opportunities for sustainable urban development. On the other hand, such growth also triggers higher population growth in Jakarta which create other problems, such as tidal flood, clean water scarcity , limited land for business development , residential and Green Space. In the face of these problems, the Government issued Jakarta Coastal Defense Strategy (JCDS) policy as a solution to these problems. This study objective is to analyze the impact of various scenarios of JCDS policy against Jakarta sustainability aspects in the future. The research developed four policy scenarios of JCDS policy; namely Jakarta Under Water, Jakarta Goes Green, Jakarta Goes Green Without Reclamation, and Jakarta Waterfront City by using scenario planning method. The model was developed by integrating JCDS model with T21 Jakarta sustainability model based on system dynamic modeling approach to analyze scenarios of JCDS policy. The results of this study show that the Jakarta Waterfront City scenario provides the best results on the economic aspects and social aspects. Jakarta Goes Green Without Reclamation scenario gives the best results on the environmental aspects. Meanwhile, Jakarta Goes Green scenario shows an increase in the quality of the environmental aspects and economic growth.

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A System Dynamics Model for Analyzing the International Diffusion of Emerging Climate Change Mitigation Technologies

Developing countries are rapidly increasing their emissions of greenhouse gases, which can have serious adverse effects on climate change mitigation efforts. The international diffusion of Climate Change Mitigation Technologies (CCMTs) can help changing this trend. However, the international diffusion of CCMTs poses difficult coordination challenges for developed and developing nations as this confronts them with hard to solve economic and environmental dilemmas. Therefore it has become essential to understand under which circumstances CCMTs can be adopted by both developed and developing countries. This paper describes a system dynamics model that takes into consideration several technological and macroeconomic processes for modeling the international diffusion of CCMTs. The behavioral analysis of this model provides insights on the importance of considering the technological potential of CCMTs and the economic differences among developed and developing countries in assessing the likelihood of stabilizing international CO2 emissions at safe environmental levels. Keywords: climate change mitigation technologies, developing countries, international climate technology policies, technological uncertainties.

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Sustainability of Colombian Livestock Systems: the Stocking Rate Submodel

This study is included in a broader PhD project of the National University of Colombia on socio-economic sustainability of rural areas in Colombia. The area of study included the Departmento of the Valle del Cauca - Colombia. The project aim to focus cattle farms and land use, their relationships with rural development (socio-economic aspects) and with environmental impacts (effects on water and ecological footprint). In this paper the casual loop diagram of the general project was shown and presented. In addition the stoking rate submodel was described as developed stock and flow diagram of animal categories and biomas availability from land. The developed submodel model was able to describe the equilibrium of the herd consistency when costant precpitations lead to constant biomass production from the owned land. When drop in rainfall were simulated on a given farm, the management strategy implemented in the model acts on animal selling in order to adjust the stocking rate of the farm to the stocking rate capacity of the land. A strong structure of balancing loops regulated herd dynamic explaining the maintenance of stocking rate equlibrium in the modeled farm depending on pasture biomass availability.

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A simulation model for corporate sustainability performances. Motivated search, survival ability and learning feedback

Relying on computer simulation and a contingency approach, we analyze the conditions leading firms to implement robust sustainability programs that would ultimately benefit society. We ask two questions: Under what conditions would a firm implement sustainability programs? What would explain difference in sustainability performances in a population of firms? To answer these questions, we develop a formal model that captures differences in firms' sustainability orientation (economic, legitimacy seeking and ethical orientations), organizational inertia and capabilities. We differentiate sustainability initiatives on three performance dimensions (economic return, legitimacy, and social and environmental value creation) and on their complexity. We found that under standard macroeconomic conditions firms employing simultaneously economic and ethical criteria, not these drivers in isolation, tend to achieve stronger sustainability performances. We also found the relationship between sustainability orientation and sustainability performances to be mediated by 1) the extent to which markets reward firms for social and environmental value creation 2) the extent to which companies are able to turn their intentionality into actions. Three mechanisms explain the results: (i) motivated search, that is the motives that influence individual firms in selecting initiatives; (ii) survival ability of firms in competitive environments;(iii) feedback among initiative implementation, competence building and motivated search.

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An hybrid System Dynamics – Agent Based model to simulate Complex Adaptive Systems: a new model for sustainability analysis

Sustainability analysis represents a form of Complex Adaptive Systems (CAS) because it involves multiple sectors and agents displaying non-linear and non-rational interacting behaviours characterized by feedbacks and time lags. Thus, it cannot be properly addressed with classical econometric models such as General Equilibrium Models (GEM), nor with traditional simulation models alone including System Dynamics (SD), Dynamic Systems (DS), Discrete Event Simulation (DES), Agent Based Models (ABM). We present a hybrid SD-ABM approach and argue that this may potentially better address such issues in a more informative and effective way because they exploit the strengths of both of these forms of models. In particular, we describe how this modelling framework can contribute to understanding complex systems, increasing modelling accuracy and computational efficiency. Then, we highlight the methodological challenges of SD-ABM integration. Among the relevant applications, this approach would aid the understanding of the characteristics and evolution of the resources-economic growth-population nexus. The model we introduce aims at contributing to the wider development and refinement of hybrid models for sustainability analysis which will provide policy makers with meaningful and timely results on alternative policy scenarios to allow them to introduce more targeted low carbon, resource resilient environmental sustainability policies.

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Exploring the Effects of Shale Gas Development on Natural Gas Markets: a Multi-method Approach

Now that conventional gas resources are rapidly declining in many industrialised regions, national governments are considering the exploration and production of unconventional resources, with shale gas in particular. Large-scale development of these resources could significantly lower the import dependency of the gas supply of many countries. The complexity of gas markets and the uncertainties affecting it make that simulation modelling is required to assess these economic implications of global shale gas development. In this study, System Dynamics and Agent-based Modelling are deployed in parallel to discover scenarios for the effects of shale gas development on regional gas markets, while accounting for method uncertainty. It is shown that the gas market is mainly demand-driven, hence forecasts for economic growth are likely to have a larger impact on gas import dependency than the actual size of shale gas resources. The use of a multi-method approach provided additional insights in the behaviour of gas markets. Future work should focus on the inclusion of additional structural uncertainties in order to obtain a more complete view on plausible economic implications of global shale gas development.

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A System Dynamics Investigation of Employment and Production in the Fars Province Agricultural Sector

This research analyzes agricultural employment and production in Fars Province while rural areas are taken into consideration. The researcher will face with some employment problems in rural areas as a separate problem from static viewpoint. On one hand, employment in rural areas may relate to labour supply and demand and on the other hand to the social challenges such as population growth rate and emigration in a systematic model. This study aims at considering the most measurable issues related to the agricultural employment and production along with econometrics estimations in the form of a formulated System Dynamics (SD) model. The overall results indicates that the unemployment problems rooted in rural areas will be aroused in the urban areas in near future and agricultural production, per capita income, labour demand and finally employment can be affected by increasing investment in the agricultural sector. Also, the effective policy in increasing employment is cultivated lands which are increased by development modern irrigation systems and improvement in agricultural production technology.

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Resilience in the Emergency Department: An Endogenous, Dynamic Phenomenon

Emergency Departments (EDs) offer an ideal laboratory to study how individuals cope with the challenges of their working environments. ED work takes place largely under conditions of time and resource constraints, physical stress, uncertainty, and ill-defined and shifting goals, so it is somewhat striking that the mounting stress from overcrowding has not resulted in more instances of failure or catastrophe. This paper looks at how the ED system has been coping with the chronic conditions of overload to achieve resilience. Motivated by ethnographic observation of the day-to-day operating practices in the emergency department, including a level 1 trauma center, of a large, inner-city teaching hospital the paper develops a system dynamics model and analysis with a particular focus on how the people and systems on the front lines adapt and adjust to cope with the challenges of excess demand. The result is a model of resilience as an endogenous, dynamic phenomenon. Simulation analyses generate important insights for theorizing about resilience.

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Socio Economic Effects of Food Insecurity in Kenya and Possible Reduction of Undernourishment through a Different Crop Mix

Many studies have revealed that crop production in Kenya needs to increase at higher rate than the yield trends in order to meet the projected food demand from a rising population. Because national production, especially maize, is not keeping pace with the growth in national demand, imports and changes in crop diversification are trying to fill the food needs gap. The outcome of this paper is to provide a general perspective of the crop mix in Kenya and its influence on the different aspects of Food Security as well as on the economy and society. To do so, the analysis has been performed using a System Dynamics model that includes the most basic sectors involved in Food Security in Kenya. The resulting model can simulate and evaluate different decisions under different

scenarios. Such scenarios can help to identify adequate interventions to maximize reduction in food insecurity and undernourishment while observing the repercussions in economic production, education and health.

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Testing training programs to limit binge drinking

Background: Juveniles becoming overly intoxicated by drinking alcohol is a widespread problem with consequences ranging from hangovers to death. Previous research has shown that high school students do not know that the slow diffusion of alcohol from the stomach to the body can cause them to continue becoming more intoxicated even after they stop drinking. A natural next step is to explore training programs designed so juveniles will learn to avoid becoming drunker than intended. Will better understanding lead to immediate changes in drinking patterns? Or, will changes show up later as deeper understanding enables better interpretation of one's bad experiences? Method: Two training programs, a training simulator and printed information, are tested on two groups of high school students and contrasted to a control group receiving neither treatment. Students were asked to report drinking experiences before, one month after, and two months after the training. Results: [Data will be collected until early May]. Focus will be on effects of training programs over time, and on the importance of background variables for drinking and learning. Conclusion: Main results, implications, generalizations, and further research.

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Learning From Erroneous Models Using SCYDynamics

Dynamic phenomena are common in science education. Students can learn about such system dynamic processes through model based learning activities. This paper describes a study on the effects of a learning from erroneous models approach using the learning environment SCYDynamics. The study compared three conditions. Two experimental conditions where students had to correct errors in a model were contrasted to working with a correct model. The experimental conditions differed on whether or not the students had to detect the errors before correcting them. Results indicate that this approach enhanced students' model testing and revising activities. Furthermore this approach was found to have a beneficial effect on learning common errors. Contrary to expectations this approach showed no learning effect on domain knowledge acquisition. The discussion further elaborates on improvements that might enhance this learning from erroneous model approach.

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Effect of Lead Time on Anchor-and-Adjust Ordering Policy in Continuous Time Stock Control Systems

Anchor-and-adjust is an ordering policy often used in stock control systems. Weight of Supply Line, the relative importance given to the supply line compared to the importance given to the stock, and Stock Adjustment Time, the intended time to close the discrepancy between the desired and current levels of the stock, are the two critical decision parameters of the anchor-and-adjust ordering policy. In this study, we conduct an extensive simulation study using a generic stock management structure and offer suggestions for the selection of these two decision parameters. The decision parameter values are significantly affected from the order and duration of the lead time.

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Desired Supply Line Value Calculation for Multi-Supplier Systems

Desired Supply Line is the product of expected acquisition lag and desired acquisition rate. This calculation ensures that supply line would produce the desired acquisition rate given that it is at this desired level. A wrongly calculated Desired Supply Line value leads to a steady-state error preventing stock approach its goal. Therefore, correct calculation of Desired Supply Line values is crucial. Desired acquisition rate is equal to the expected loss flow in a single-supplier system. However, it is not easy to decide on the desired acquisition rates for a multi-supplier system. We give a general formula for the calculation of Desired Supply Line values based on the supplier utilization priorities and supplier production/shipment capacities.

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Modelling the trio infection of HIV, Malaria and TB: A System dynamics approach

Chronic illnesses to which HIV/AIDS, Malaria and TB is part, have had long term direct impact on the population, social economic status as well as health in general. This paper explores factors that influence the progression of HIV into AIDS with particular emphasis on opportunistic infections particularly malaria and TB. Although there has been tools and techniques geared towards study of these diseases many of them have been lacking systemic approach or fail to communicate to healthcare providers therefore rendering their efforts ineffective. The authors argue that the range of infectiousness in the population specifically HIV/AIDS, incidence of new cases and its progression including interventions ideally reduce mortality rate leaving more people living with the disease and requiring more care in the course of the disease. Living with the disease while still on medication awakens latent infections which go on unnoticed but the patient continues with the medication allowing these new infection to gain undue advantage of the immune system. With models to leverage realistic predictions and awareness, simultaneously allowing care delivery can unveil hidden trends in the disease under consideration. The descriptive model allows systematic inquiry that yields explanations and provides healthcare providers with common decision making platform. The authors further suggest triumvirate model of HIV, malaria and TB that utilizes system dynamics in a resource limited setting.

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Foresight and System Dynamics for modelling the dynamics of Organizational Knowledge

The loss of organizational knowledge due to the departure of skilled staff generates negative impacts on both an organization's productivity and its functional capacity to understand the key strategies and actions necessary to achieve stated goals. In order to identify, understand and model the factors likely to be involved in the causes and impacts of the loss of organizational knowledge, this article examines the dynamics of knowledge processes in a Project Management Office of the Brazilian Aeronautical Command, which is responsible for the implementation of complex aeronautical projects in Brazil. Presented here is a dynamic model based on concepts from Nonaka and Takeuchi's "Theory of Organizational Knowledge Creation", and on Michel

Godet´s methodology for identifying key variables within Strategic Foresight Studies. The model enables the simulation of diverse scenarios in which are represented the consequences of changes in key variables of influence. The work concludes with a discussion of concerns and opinions that could facilitate the formulation of policy and active intervention aimed at minimizing the unwanted impacts that result from the loss of an abstract entity known as organizational knowledge.

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Modeling Government Intervention in Agricultural Commodity Markets: U.S. Dairy Policy Under the Agricultural Act of 2014

The U.S. Agricultural Act of 2014 creates a new "margin insurance" program under which dairy farmers can receive indemnity payments from the U.S. government if a margin (defined as the difference between milk prices paid to farmers and an index of feed costs) falls below the insured level. The design of the program suggests that it has the potential to substantially weaken feedback processes that would adjust milk production, prices and margins if margins fall below program threshold levels, especially if the proportion of milk covered by insurance is large. This paper discusses motivations for the implementation of a dairy margin insurance program, then describes an empirical SD commodity model for the U.S. dairy industry based on the commodity model described in Sterman (2000). We use the model to compare the results of a baseline scenario representing status quo dairy policies to outcomes under implementation of the new margin insurance program. Our analysis indicates that if margins fall to levels that activate indemnity payments, weakened feedback processes are likely to result in persistent low prices, low margins and large government expenditures. However, U.S. and international dairy product consumers would benefit from substantially lower dairy product prices under the program.

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Feedback Mechanisms in the Financial System: A Modern View

There is significant empirical evidence of dynamic feedback effects in financial crises. Evidence shows that financial system has a number of elements with procyclical response to various shocks. Under shocks, these elements can initiate a dynamic sequence from being shock absorbers into shock amplifiers. The purpose of this study is to conduct an integrative review of the feedback mechanisms that have been developed to theoretically explain financial system dynamics. Ability to understand various theoretical feedbacks consistently and comprehensively facilitates policy actions to prevent undesirable amplifications. Accordingly, this paper systematically reviews precedent concepts of amplifications and feedbacks. This study proceeds from definitions, then explains the view of positive and negative feedbacks in the financial system, and proposes a typology for organization of systemic feedbacks identified in theoretical literature. The proposed typology incorporates key aspects of a modern financial system and key intermediary functions of financial institutions: transformation of assets and liabilities, credit, and liquidity. In addition to the traditional delegated monitoring intermediary functions, the feedbacks also include key features of modern financial intermediaries: loan sales and off-balance sheet activities, including commitments, securitizations, and derivatives.

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The value of Stakeholder Group Model-Building when facing a System Dynamic problem

Group Model-Building (GMB), is often used as approach to form a model in system dynamics (SD). The purpose of this article is to explore how participants in GMB experience the process and analyze the value of it. The paper presents a qualitative research based on the grounded theory, carried out with interviews with SD specialists and participants in GMB. Results are presented in this paper among the authors speculations based on the experience of stakeholder GMB workshops. Results indicated that the value from the stakeholder point of view lies foremost in the networking aspect of GMB and in the platform to communicate their ideas and learning. From the GMB managers point of view the results are in line with the textbooks and indicate that the value lies first and foremost in trust towards the resulting model from those who have the power to use them but number of other aspects come to consideration and are presented in a value framework and in the form of a theory.

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The War on Drugs: A Failure in (Operational) Thinking

We suggest that the currently recognized failure of the so called “war on drugs” is an opportunity to explore how academics and policy-makers fail in operational thinking, that is, they fail in thinking in terms of “how things really work”. We illustrate this failure with certain modes of reasoning that seem to underpin the way in which the war on drugs has been debated in Colombia. We selected various studies and policies that show a way of thinking that favors a type of knowledge anchored on a cause-and-effect rationality that leaves out the very actions that produce and explain the performance of the social system that those studies and policies deal with. Systems adapt, systems respond to our actions. Policies that exclude such decisional nature of a social system are doomed to fail. Operational thinking means, among other things, to recognize, first, that a social system is a system driven by actors, that is, decision makers whose sequences of actions and decisions from intricate and complex networks of accumulations and feedback structures that can better be understood with the help of computer simulation.

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The Scientist Personality of System Dynamics

The System Dynamics (SD) community frequently seems to defend and to protect its “scientific” status by recurring to scientific principles. In fact, the philosophy of science has been the place to identify the philosophical standing of System Dynamics. However, SD typically aims at designing artifacts of different types, e.g. models, policies, plans, organizational schemes, etc. that address a specific situation that is wanted to be improved. Such an attitude is the trademark of engineering, a stance that is easy to see in the underpinnings of the field that Jay Forrester shaped. This paper shows why the epistemological stance of SD finds its natural ground in the philosophy of engineering. Moreover, the best defense of SD against its critics is to hoist its engineering flag, once this is done, the questions of the “scientific status” of SD, with all the

demands that come from such a concern, e.g. validation, confirmation of knowledge, truth of statements, scientific method, predictability, generalizability, replicability, empirical basis, etc. become truly irrelevant.

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Structural dominance in large and stochastic models

The last decade and a half has seen a significant effort to develop and automate methods for identifying structural dominance in system dynamics models. To date, however, the interpretation and testing of these methods has been with small (less than 5 stocks), deterministic models that show smooth behavioral transitions. While the analysis of simple and stable models is an obvious first step to provide proof of concept, the methods have become stable enough to be tested in a wider range of models. In this paper we report the findings from expanding the domain of application these methods in two significant dimensions: increasing model size and incorporating stochastic variance in some of the model variables. Exploring the effectiveness of these methods in these two dimensions will increase their applicability into more realistic model analysis situations.While we only show results of the analysis of one large and stochastic model, the results are promising. We find that the methods work as predicted with large stochastic models, that they generate insights that are consistent with the existing explanations for the behavior of the tested model, and that they do so in a very efficient way.

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From Singlehood to Marriage

Marriage is a key factor in Singapore's fertility crisis: increasing marriage rates and lowering the median age at first marriage have a direct bearing on the birth rate. However, the trend of Singaporeans not marrying or marrying later has persisted for several years. The two reasons most frequently cited for not marrying are: not having met a suitable partner, and choosing to concentrate on studies or career. To explore the dynamics of available singles in search of a life partner, System Dynamics modeling is used to find the answers to the following questions: What goes on in the search for someone eligible? What factors influence the success of such a search? What are the variables affecting decisions to get married or wait for a better match? What is the relative importance of different sets of variables in influencing such decisions? Some of the findings are that ample supply and consumption of match-making services is counter-productive; and that engaging the help of external parties such as employers, community and religious bodies, educational institutions, professional associations and others to create group participation opportunities for singles can do much more for the marriage rate than relying predominantly on private dating agencies.

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Security of Supply in the Swiss Electricity Market: A System Dynamics Approach

Guaranteeing the security of supply (SoS) has become more complex since liberalization of electricity markets started. Liberalization and the larger share of intermittent sources (photovoltaic [PV] and wind energy), combined with increasingly interconnected markets, have a direct impact on SoS. Given the large number of elements and stakeholders involved, actions to enhance security may conflict with economic efficiency and/or environmental protection, thus increasing problem complexity. We develop a SD model that

allows us to analyse the investment decision process and, understand, how the presence of PV and wind energy affects the reliability of the system. We focus on the Swiss electricity market, which is currently undergoing a liberalization process, and has simultaneously decided to encourage the implementation of renewable energies and to phase out nuclear energy. Results of the simulation show that nuclear production is replaced mainly by PV, CCGT and imports, which impacts the SoS negatively. Although installed capacity increases, the decreasing de-rated margin indicates a drop of the system's reliability. This reveals a problem of capacity adequacy that is partially "solved" by increasing imports. Regardless of the increasing share of inexpensive sources, this large dependency drives prices up, especially in winter, and to a lower extend in autumn.

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Future reductions of residential electricity consumption in the Netherlands? A model-based policy analysis

Electric appliances are an indispensable part of a household and through their sheer number contribute substantially to its electricity consumption. This paper explores residential electricity consumption from electric appliances in the Netherlands using a bottom up engineering approach. Policy scenarios are explored regarding efficiency, smart meter and standby killer devices diffusion. Results indicate that electricity consumption can be reduced but it will be hard to reach the levels suggested by European directives.

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Technology diffusion: How long does it take?

This model aims to explore how and if the number of competing technologies affects the time it takes for a market to undergo a transition. It is based on Loch and Huberman (1999). The basic question is centered on the notion that maintaining a diverse portfolio of energy sources and technologies until the market chooses one is preferable to choosing "champion" technologies. However, it remains to be seen how long does it take for this diverse portfolio to bear fruits, how long it needs to be maintained and whether it delays or accelerates the transition?

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Technology, performance and team adaptation to regulation in Formula 1

This paper looks at how competition, regulation and technology coevolve in Formula 1 and how teams adapt. It does so at two levels: (i) the system level viewing Formula 1 competition as a whole and (ii) the organizational level, viewing team adaptation and car development level. The path this coevolutionary trajectory competition has taken in modern Formula 1 (1970 – 2013), is examined by looking at season results and regulation changes that punctuate its path. The understanding developed through this are summarised in a causal loop diagram and some implications are worked out for the forthcoming 2014 season.

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A model of evolutionary theory development

Research is challenging irrespective of the number of research methods that are used. This paper develops a model of the research process and explores the simultaneous use of two methods. The motivation for this lies on the effect of human cognition limitations, when trying to understand the evolution of complex, non linear systems and processes in time, and arrive at their causal mechanisms. Considerable time may be required when a single method is used. Viewing research as an evolutionary process where better explanations are continuously sought, generated, selected and retained, the model is used to support the notion that a satisfactory level of system understanding can be attained in less time by using two methods.

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Factors for winning Format Battles: a modelling approach

There is considerable literature on format competition with several review articles establishing lists of factors that are thought to apply broadly in such contexts. However, the literature is not unequivocal regarding some factors that apparently can have a reinforcing or balancing effect on format adoption and dominance. This paper attempts to transfer a recent theoretical framework proposed in the literature to a system dynamics generic model. It is intended to validate the hypothesis that the factors listed in the literature actually result in format dominance. Furthermore, it will allow an exploration into whether there are other intermediary factors underlying those listed as important, and look at what the ambiguity of some of them implies for the dynamics of format competition.

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Dynamics of Smart Grid Technology Acceptance

Consumer acceptance is a main factor of the expansive deployment of smart grid technologies. Accordingly, many studies have emphasized to ensure consumer acceptance to promote the implementation of smart grids, and scientific researches investigating the acceptance factors have been actively conducted in recent times. However, there are few studies examining the process of smart grid acceptance from a dynamic perspective. This study attempts to describe dynamics of smart grid acceptance providing the causal map and suggests important further tasks for ensuring smart grid acceptance.

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The Design of Educational Programs in System Dynamics at WPI

Educational programs leading to degrees in system dynamics are rare and thus of critical importance to the future of the field of system dynamics. However, to a large extent such programs have not yet been made transparent to the system dynamics community as a whole. The present article describes the design and

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rationale for undergraduate and graduate programs at WPI. The goal of the article is to invite feedback from the system dynamics community about our specific programs as well as to facilitate wider discussion about the appropriate content, design, and pedagogy of degree programs and courses in system dynamics.

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Addicted to Fertilizers - How soil mismanagement makes our food systems increasingly vulnerable

A System Dynamics model of the bio-physical dynamics involving soil organic matter and mineral nitrogen is used to analyse the implications of different farming practices, in particular in terms of mineral fertilizer use, on the sustainability of the farming system and land fertility. The analysis reveals how industrial agriculture practices in search of higher yield can backfire as the soil becomes 'addicted' to fertilizer, soil organic matter is degraded, and natural soil fertility is undermined. Our results indicate that an agricultural system that is highly dependent on synthetic fertilization, is not only unsustainable, but also vulnerable to the risk of a likely future scarcity in external inputs (e.g. as a result of rising energy prices). In the event of such fertilizer scarcity shock, a consequent transition from industrial to sustainable agriculture practices is going to be a lengthy and expensive process. Our analysis indicates that the sooner the transition happens, the quicker and the less costly it is going to be.

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Understanding the Low Proportion of Women in Employment in Indonesia: A System Dynamics Approach

Despite considerable economic growth and the introduction of gender equality legislation, the labour market participation of women in Indonesia has been stagnating at a level of 37 percent from the total employment (MMTRI, 2013). As a result, Indonesia's performance on the Gender Inequality Index (GII) is lower than its neighboring countries in the ASEAN region. Therefore, in order to identify policy scenario's that may contribute to alleviating the unequal proportion of women and men in the Indonesian labour market, we develop and test a formal system dynamics model that explains the dynamic behavior of women's employment in the Indonesian labour market.

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Dynamics of EHR Implementations

In this paper we develop a theory to explain the dynamics of an Electronic Health Record (EHR) implementation. We base our theory on a well-established system dynamics model of improvement evolution—the model by Repenning and Sterman (RS)—with modifications that incorporate aspects of the more detailed Affordance Actualization (AA) theory. To do so we develop two simulation models: an abstract generic model for conceptualization and a more detailed operational model for policy design purposes. The conceptual

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model can explain general EHR implementation dynamics producing success or failure in healthcare (HC) settings. However, it is not sufficient for comprehensive policy design and analysis. The detailed operational model, on the other hand, is flexible enough to allow users to design and test their own policies. Experimentation with the operational model revealed that initial characteristics of the system are crucial to determine success or failure of an EHR implementation. We show that in the case of a failed implementation a strong connection between organizational benefits and individual benefits can make the implementation a success. Specifically, it is important to consider the reward scheme for physicians to make the implementation successful.

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The Dynamics of Public Trust in a Business Organisation: Perspective from a Focus Group of Business Consultants

Whilst trust is an increasingly popular subject amongst management scholars, very few scholars have attempted to address the public-business trust relationship. However, it is the loss of public trust in business (and the need to restore it) which appears to be of the most concern in practice. This paper discusses the perspective of a group of experienced business consultants on factors that drive public trust in a business organisation and examines the causal structure of these drivers in order to determine public trust. The focus group design was influenced by group model building practices. The key insights include how they perceive the importance of competence over characters, how they identify trust drivers, and how they perceive the interplays between trust drivers, trustworthiness dimensions and the moderating factors. A causal loop diagram is used to map the key insights into a conceptual model.

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From data-poor to data-rich: System Dynamics in the era of Big Data

Although SD modeling is often called data-poor modeling, it does not mean it should always be data-poor. SD software packages allow one to get data from, and write simulation runs to, data bases. Moreover, data is also used in SD to calibrate parameters or bootstrap parameter ranges. But more could and should be done, especially in the coming era of `Big Data'. `Big' data simply refers here to more data than was until recently manageable. Big data requires data science

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techniques to make it manageable and useful. There are at least three ways in which big data science may play an important role in future SD: (1) to obtain useful inputs from data, (2) to infer plausible model structures from data, and (3) to analyse and interpret model-generated ``brute force data''. Interestingly, data science techniques that are useful for (1) may also be made useful for (3) and vice versa. Real cases from diverse application domains will be used to illustrate these possibilities. In fact, there are many application domains in which the combination of SD and Big data science would be beneficial. Examples, some of which are elaborated here, include policy making with regard to crime fighting, infectious diseases, cyber security, national safety and security, financial stress testing, housing market management, marketing, etc.

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Uncertainty and System Dynamics

System Dynamics is often used for dealing with dynamically complex issues that are also uncertain. This paper reviews how uncertainty is dealt with in System Dynamics modeling, where uncertainties are located in models, which types of uncertainties are dealt with, and which levels of uncertainty could be handled. Shortcomings of System Dynamics and its practice in dealing with uncertainty are distilled from this review and reframed as opportunities. Potential opportunities for dealing with uncertainty in System Dynamics that are discussed here include (i) dealing explicitly with di cult sorts of uncertainties, (ii) using multi-model approaches for dealing with alternative assumptions and multiple perspectives, (iii) clearly distinguishing sensitivity analysis from uncertainty analysis and using them for di erent purposes, (iv) moving beyond invariant model boundaries, (v) using multi-method approaches, advanced techniques and new tools, and (vi) further developing and using System Dynamics strands for dealing with deep uncertainty.

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The Future of Modeling and Simulation: Beyond Dynamic Complexity and the Current State of Science

After a brief introduction to the state of the art of SD modeling, we discuss recent and foreseeable innovations, and sketch a picture of what the future field of (SD) modeling and simulation could, according to us, look like. The pictures of the current state of the art, of the current state of science, and of the foreseeable state of science, and three illustrations, help us to sketch a functional road map from the current state towards that future. Implementing this road map will require the field to voluntarily reinvent itself. Since we do not know beforehand which new methods, techniques and tools will be most useful, it is clear that the innovators will have to experiment in a methodological sense. Without experimentation and innovation, we could either stay on the aimless plateau or retreat into a safe village. With experimentation and innovation, we may discover several routes into the mountains, enjoy spectacular views, and reach many high peaks.

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Calibrating System Dynamics Models of Technology Diffusion with Structural Breaks: The case of Android Handsets

Among the different application domains for system dynamics (SD) models,

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diffusion of new technologies has been a major category. A common assumption when calibrating such SD models is that the key parameters driving diffusion, such as contagion strength, are constant over the duration of analysis. For a variety of reasons, particularly in the context of new technologies, these parameters may change over time, sometimes dramatically. This can result in so-called called structural breaks in the diffusion pattern. Calibrating SD models in the presence of structural breaks presents some challenges. One has to first identify if such breaks are present and their temporal location. Once break points are identified, the calibration can proceed in different ways, each with its advantages and disadvantages. We discuss these issues in the context of Android handsets, using quarterly sales data for the period 2009-2012, and referring to specific events in its evolution.

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Modeling the 2005 Hatlestad Slide

It has long been recognized that the management of emergencies requires that response organizations act flexibly, becoming an "emergent organization" to better manage the fact that disasters do not follow scripts. Nevertheless, recent research shows that crisis response organizations prefer to follow patterns adequate for normal situations. Arguably, the resistance to become an emergent organization could be related to poor understanding of how to move from disorganization to self-organization. We present a system dynamics model describing the transition from disorganization to self-organization in the management of the fatal Hatlestad landslide in Norway. We suggest that the causal structure of the system dynamics model describing the Hatlestad case should be considered a candidate for an emergent "middle-range theory" describing the management of disorganization in emergencies. We propose specific data collection to test the candidate theory.

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Coilia Ectenes: Crisis and Solution

The paper makes an analysis on the crisis that the Chinese Coilia ectenes is currently facing from the point of system dynamics and proposes a relatively feasible solution for it. The paper explains the crisis of Coilia ectenes at present and in the future through analyzing the impact of human activities and national policies on species population quatity of Coilia ectenes, and analyzes whether the crisis can be relieved or solved by state control policy.

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Embedding Learning Aids in System Archetypes

This paper revisits the systems archetypes proposed in The Fifth Discipline. Authors believe there exists a framework, which explains how these archetypes arise. Besides, the framework helps integrate the archetypes and infer principles of organizational learning. It takes the system archetypes as problem archetypes and endeavors to suggest solution by embedding simple learning aids in the archetypes. Authors believe problem in the systems do not arise due to the failure of a single paramount decision-maker. More often than not the problems are manifestations of cumulative and compound failures of all players in the system. Since system dynamics does not account for the behavior of individual

actors in the system and it accounts for the individual behavior only by aggregation the only way it can hope to improve the behavior of individual actors is by taking system thinking to their doorsteps.

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The Effects of Energy Consumption on Environmental pollutants and Social Costs in Iran Using System Dynamics Approach

Energy consumption has constantly been increasing during these years. Excessive energy consumption causes reduction in energy sources as well as making environmental pollutants which demands high social costs in the society. Due to the inappropriate methods employed in most studies on energy consumption, all-inclusive effects of excessive energy consumption has not been dealt with. System Dynamics, on account of its comprehensibility, can be an effective method to detect and investigate energy consumption effects. So, in this study, System Dynamics approach was used to analyze effects of energy consumption on the environmental pollutants and social costs in the planning horizon of 2024 in Iran. Simulation results indicated that energy consumption in 2024 would reach to 2150 million barrels of oil. On this basis, environmental pollutants would reach from 283 million tons in 1999 to 1185 million tons in 2024 horizon. The rate of social costs would be equal to 28875 million dollars. This cost is equal to 27% of GDP. The findings suggest that energy consumption in the future creates several problems in providing energy sources as well as social costing and health. A lot of problems would be created in the environment and healthcare of the society in case of not planning for the excessive energy consumption.

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Exploring the Role of Entrepreneurship and Business Models in Technology Diffusion

Entrepreneurial activities and business models describe ways to start and maintain a business. Empirical data show that they play an important role in bringing technology-based products or services to market. However, the role of entrepreneurial activities and business models in the diffusion process has not been systematically explored and discussed in the adoption and diffusion literature, and there is a scarcity of simulation models that have examined technology adoption and diffusion phenomena from an entrepreneurship and business-model perspective. The purpose of our study is to contribute to this area by exploring the role of entrepreneurship and business models in the diffusion process through a System Dynamics modeling and simulation approach. We built a simulation model based on technology-diffusion-related literature and empirical data collected through the process of implementing a sustainable consumption and production initiative called I-Choose over three years. Our simulation experiment results show that different entrepreneurial activities and business models lead to different diffusion paths and associated market behaviors.

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The Diffusion of Constellations of Small SAR Satellites: A Complex System Approach

Marine oil spills may cause major environmental damage. SAR (Synthetic Aperture Radar) sensors seem to be one of the most effective instruments for oil spills monitoring. SAR imagery, provided by large satellites carrying SAR instruments, has been successfully employed in this task. But the fabrication and deployment issues associated with placing a large SAR satellite into orbit are not compatible with the growing demand for spaceborne SAR imagery. Any failures in these satellites can cause irreparable damage to the user community, because its replacement into orbit is expensive and time consuming. These constraints might open a "market window" for a new technology which has recently been developed: the constellations of small SAR satellites. The present paper proposes an analytical tool for exploring the diffusion of this innovation in the global market of marine oil spills SAR monitoring: a hybrid model based on Bass Model and Social Network Analysis (SNA).

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Drawing Insights from a Small Model of the Growth of a Management Science Field

A formal model of the dynamics of growth, stagnation, or decline of an emerging field is presented, followed by eleven scenarios and strategies that might affect those dynamics. The purpose of the model is to stimulate thought and conversation within the field of system dynamics about the growth of the field and to provide a bit of simulation-based grounding for those conversations.

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Budgeting games as unintended consequences of budgeting-based management control

The use of budgeting for management control is widely - and since decades - discussed and criticized. Especially budgeting games are seen as problematic. Budgeting games describe managerial behavior to secure higher budgets than necessary (slack) or spend budgets for reasons incompatible with overall firm targets. Typically, gaming behavior is seen as a result of leadership style or stemming from individual traits of certain managers. In this paper we present a system dynamics model that explains budgeting games through feedback processes, i.e. caused by using budgets themselves as management control instrument not by some exogenous factors like leadership styles. The model helps understanding the effectiveness of certain remedies and conditions to reduce gaming behavior.

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System Dynamics, Optimal Control and Analytic Hierarchy Process applied to the Chemotherapy of Leukemia

The Myelogenous Leukemia (ML) is a neoplastic disease involving hematopoietic cells. A natural way to model its dynamics is by means of

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capturing cell cycle kinetics. In this work we develop a formal mathematical model where variables capture quantities involved in the cell cycle phases. It is in some of these phases that medications such as killing agents and recruitment agents can intervene to combat the neoplasic cells. Our work combines system dynamics, optimal control theory and Analytic Hierarchy Process to yield a chemotherapy optimized treatment protocol for instances of ML, tackling in a systematic way the subjectivity involved in the choice of the cost function coefficients.

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Utilization of Knowledge in Construction Projects

This study explores problem of utilizing knowledge in construction projects. Based on experiences and theoretical analysis, knowledge has not been fully utilized in general and project management environments. This gap in appropriate utilization of knowledge influences construction works too. The study aims to develop System Dynamics model to examine why gap in knowledge utilization is occurring and how it is influencing project performance. Empirical data has been gathered from three construction project cases that were implemented in Kosovo. At this stage of the study, only basic qualitative model has been developed. Study indicates that knowledge utilization systems in construction projects should be developed as explicit systems of rules and processes. Sole behavior of such systems is not possible without: continuous initiatives, leadership and mentoring capacity. Finally, embedding of ethical values in the overall project culture is another prerequisite for the successful utilization of knowledge in construction projects. The outcomes of this study are aiming to indicate to project managers, importance of managing projects by having in mind knowledge utilization as dynamic structured activity.

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Closing the Loop of Supply Chains

This paper discusses possible applications of SD on closed-loop supply chains, which are supply chains where, in addition to the typical “forward” flow of materials from suppliers all the way to end customers, there are flows of products back. In order to present those applications, the paper addresses SD and its suitability to model such operations from a theoretical point of view and later develops and explains an example, by using a simple manufacturing supply chain classical model and including the reverse operations in stock and flow language. The results evidence that SD is very capable of modeling reverse logistics structures and to offer valuable insights to supply chain managers.

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Building Shared Vision As a Project Management Strategy: Quantitative model for a Qualitative Problem Context

The paper presents a group-model building design (GMB) for discussing and attempting to solve a persistent “messy” problem within a student-led NGO in the Russian Far East, Vladivostok. Even though the projects conducted by the NGO had reached their targets, there was always an implicit concern over the way those projects were conducted. Throughout a one-day GMB session the

management team elaborated a causal loop diagram (CLD) titled "Dissatisfaction with successful projects". The CLD made explicit an important mental model within the NGO: the projects were considered to be truly successful only if they served as learning opportunities for project team members. As the coordinators lacked the capacity to develop shared vision among team members with diverse perspectives, that important mission of the projects was not fulfilled. The case was presented in a poster format at the 30th International Conference of the System Dynamics Society in St. Gallen. While building on the data from that case, the current paper gives the new perspectives of the conflict and power difference issue amplifying the “messy” problem and how the specifics of the implemented GMB design managed or mismanaged the conflict. As a further step of implementation, the quantitative system dynamics model has been developed and presented.

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An Exploration of the SD field: a Model-Based Policy Analysis Perspective

Abstract The objective of this study is to use a model-based policy analysis perspective in order to investigate the future of the SD field. To reach the objective a network and actor analysis was conducted to explore part of the SD field. Further exploration was made by conducting over forty interviews with actors in the field. These interviews were then analyzed; the perspectives of the interviewees were captured using basic models for visualization. Five main perspectives were identified and are called collaboration, oversimplification, broad SD and domain support, academic growth engine and no problem. The first three of these perspectives were further specified into SD models and used for policy testing. The major finding of this report is that the differences in these perspectives show a complex problem that warrants action which considers multiple perspectives.

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Using Case Survey Methodology to Extract Variables and Causal Links: An Example from Studying Business Process Change

Business process change (BPC) projects are complex initiatives with many interrelated factors that still cause unforeseen delays and even cancellations. While research on BPC provides useful insights into successes and failures of BPC projects, we argue that these insights remain rather fragmented. We present a multi-method approach to create a coherent picture by extracting variables and causal links within BPC projects. We do so by adopting case survey methodology and causal loop diagrams. We show the usefulness of this approach by analyzing and consolidating insights of 129 BPC case studies. We make two main contributions: (1) we show the potential of system dynamics in BPC research by integrating the fragmented research on BPC to achieve more coherent picture, and (2) we contribute to the literature on qualitative methods used in system dynamics, as we propose to use case survey methodology for developing causal loop diagrams.

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Adoption Dynamics of Chronic Care Model

Health care renewals that aim for integrated care programs based on the chronic care model have a systemic focus: they aim at simultaneously developing

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organizations, technologies, services, and partner relationships. Empowerment of citizens and multidisciplinary collaboration among professionals play central roles in them. This article examines the challenge of combining the system view with the multiple operational improvements that are needed at the practical level when the chronic care model is implemented. We identify key factors that need to be taken into account as well as feedback mechanisms that can easily operate as vicious circles but that can be leveraged in order to gain momentum for the renewal process.

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Win-lose, Lose-lose and Win-win Stabilization Policies for a Growth Cycle

This paper considers the Fanti and Manfredi Goodwinian two-dimensional model that stabilizes growth cycle by profit-sharing, although a long term employment rate declines, whereas the stationary relative wage is not affected. For checking robustness of profit-sharing, flexible capacity utilization is included. The Phillips-Wolfstetter-Flaschel 'capricious' investment function destroys stability of a non-trivial stationary state. Adding 'neo-classically' balanced government taxes and expenditures results in attaining stable stationary state again in a three-dimensional model. Yet labour share (even gross) and employment ratio become lower in the long run than in the initial model. This paper revises the preceding equations. The first non-linear three-dimensional model implements proportional and derivative control over growth rate of profit. This rate depends on a gap between the indicated and current employment ratios and on growth rate of this ratio. The second four-dimensional model redefines this combined control applying excess income levy that equals subsidy. The previous models enable extreme condition tests for these non-Goodwinian models. Parametric policy optimization supported by Vensim shortens a transient to a deliberately high target employment ratio without lowering stationary relative wage against the Goodwinian models. The proposed policies enhance stability and efficiency of capital accumulation; they also provide stronger gains for workers' well-being.

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Analysing Delays and Disruptions in Aircraft Heavy Maintenance

It is challenging to plan and manage heavy maintenance services in the aviation industry due to large amounts of resources involved and complex interactions between them. Furthermore, during the aircraft heavy maintenance process, unexpected damages and discrepancies may arise that must be solved by programming unscheduled tasks. The dynamism of the process and the uncertainty caused by unscheduled tasks require the adjustment of a maintenance service plan constantly, which might impact on delivery times, process costs and even the quality of the maintenance service. To address this problem, it is proposed to use System Dynamics as a tool to understand and analyse complex and dynamic systems. In this paper the interrelationship of scheduled and unscheduled tasks and its impact on delays and disruptions during aircraft heavy maintenance are explained and analysed designing a causal loop diagram. Additionally, the effect of occurrence and discovery of discrepancies and damages on unscheduled tasks is presented using a system dynamics model, which also highlights the relevance of workforce allocation for the project performance.

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Dynamic decision making in coupled social-ecological systems

Climate change will lead to significant yield reductions in maize dominated farming systems in sub Saharan Africa. Combined with a growing and more demanding population, food systems in this region thus face the challenge of undergoing a considerable transformation in order to meet the challenges of achieving food security and adapting to climate change. Increasing food security and adapting to climate change is a dynamic decision making task that involves a wide range of stakeholders such as farmers, the private sector, consumers, civil society, and policy-makers. In this paper, we focus on the particular stakeholder group of small-scale farmers in Zambia and collect interview data on the multiple decisions they make in the course of a year. Our data provides a rich description of farmers' dynamic decision making and their adaptive capacity to deal with existing and future challenges related to food security. As people also need an enabling institutional and policy environment to successfully adapt in the longer term and diversify livelihoods for positive wealth accumulation, we reflect on the use of a multi-method approach that combines our qualitative interviews with quantitative system dynamics modeling.

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The Dynamics of Violent Crimes in New York City: A 50-Year Perspective

The present study shows both a causal loop diagram and a stock and flow diagram of a system dynamics model that seeks to explain the trend change in violent crimes in New York City over a period of 50 years. It combines four important factors that have been used to explain the big increase and subsequent fall in these kind of crimes: demographics, differential association theory, law enforcement, and drugs. It also tests and evaluates a policy to decrease further the number of violent crimes. Limitations of the model are also discussed. Word count: 4860.

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Analyzing Soil Nitrogen Management with Dynamic Simulation Experiments

Nitrogen cycle is among the geo-bio-chemical processes which are disrupted by anthropogenic influence on global ecosystems. Modern agriculture heavily depends on nitrogen fixed from the atmosphere and applied on farmlands. The result is an eventual loss of nitrate in soil solution, creating pollution and eutrophication of fresh water systems. There is worldwide evidence indicating that nitrogen fertilizers are overused and nitrogen use efficiencies are dramatically low. Most of the studies addressing the overuse problem either assess the socio-economic factors, or environmental and technological determinants that influence farmers' fertilizer application rates. In this study, we assess the problem of residual nitrogen accumulation on N applied farmlands and its perceptions by simulation modeling and decision experimentation. Although the residual nitrogen problem is very well known by

agronomists, it is hardly considered in studies aiming at educating farmers' fertilizer consumption behaviors. We argue that, our analysis is also interesting for the field of system dynamics because it presents a new case for misperceptions of basic dynamics that lead to overexploitation or over-pollution of environmental resources.

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Towards a System Dynamics Competence Framework

The system dynamics field requires a definition what a modeller needs to know and to be capable of doing to become a system dynamicist. This paper builds on previous work in the field to elaborate which knowledge is to be expected at successive stages of learning system dynamics modelling. It adopts the Dreyfus & Dreyfus model of stage-wise competency development from beginner to competent. It also uses Bloom's taxonomy – a widely accepted educational framework – to articulate an organized set of learning objectives. A Delphi process with reknowned system dynamics experts enabled us to develop a system dynamics competence framework with clear statements about the learning objectives for beginners, advanced beginners, competent, proficient/practitioner, and expert. 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 our result, standard learning activities and materials as well as certification devices can be designed and developed.

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Can System Dynamics learn from Social Network Analysis?

This article deals with the analysis of large or complex system dynamics (SD) models, exploring the benefits of a multimethodological approach towards model analysis. To this end, we compare model analysis results achieved by SD and social network analysis (SNA) by deploying SNA techniques on a pertinent example from the SD literature—the world dynamics model. Although SNA is a clearly distinct method from SD—focusing on social actors and their interrelationships—we are going to advocate that SD can indeed learn from SNA, particularly in terms of model structure analysis. Our argumentation follows renowned system dynamicists who acknowledge the potential of SD to synthesize and advance theories in social science both at the conceptual and technical level.

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Group model building – do clients value reported outcomes?

Several recent papers have added to the evidence supporting group model building – in addition to supporting existing claims, this literature augments the number of outcomes associated with the application of system dynamics tools to participatory processes. It is not clear which of these outcomes are important to clients. Interviews were conducted with public servants who commission and conduct participatory processes, to help understand what outcomes are valuable to potential clients in the public sector.

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Check-Sim: Cultural Heritage Check-up Simulation model

In Italy there are almost 20,000 cultural towns, 40,000 castles and gardens, 3,000 museums, 10,000 churches, 200 archaeological sites.These cultural resources represent an essential factor for the Italian tourism industry and in general for the national economic system. Italy needs to distribute over the year its tourist offer. Except for the art cities like Rome, Florence or Venice, the Italian tourism today is mainly concentrated on the so called "beach tourism". Therefore it is more and more necessary to promote cultural heritage as an essential source to attract tourists throughout the whole year rather than to focus only for the seaside beauty. The paper aims to describe a research work, in progress, where the objective is to study the risk analysis and the decay process of the "movable" (transportable) artwork due to different reasons: aging & preservation location; natural & criminal events; inappropriate restoration and finally transportation & exhibition time. The presence of many endogenous and exogenous variables which interact each other through different feedback loops creates non-linearity. Different risk elements (pollution, vandalism, natural events, …) are taken into account and a cost-benefit analysis is also elaborated. A first version of a microworld System Dynamics simulation model has been developed.

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Market Penetration of Alternative Powertrain Concepts in Heavy Commercial Vehicles: A System Dynamics Approach

Diffusion of alternative powertrain concepts in heavy commercial vehicles will start in the upcoming years after electrification and natural gas engines have already been introduced for passenger cars. Numerous quantitative forecasting and technology diffusion models exist for passenger cars but cannot be transferred unchanged to heavy commercial vehicles. A system dynamics model for the diffusion of alternative powertrain concepts in heavy commercial vehicles is developed by adaptation of existing simulation models for passenger cars. The structural validity is assured by changing the structure and parameterization based on stakeholder interviews, secondary studies, and theoretical foundations. The results reveal the significance of a satisfying refueling infrastructure for alternative fuel trucks and the transitional market potential of hybrid electric trucks. The discussion of the system dynamics model emphasizes the analysis of customer demand as an essential field for future research of alternative powertrain diffusion in heavy commercial vehicles.

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A dynamic analysis on the child labour population in Iran

This work is a start phase for developing an integrated system for protection and mitigation of Iranian child Labourers. The paper explains an aggregated system dynamics model for better understanding of the problem, relation and role of different socioeconomic sectors as determents of this phenomenon. The efforts were implied for achieving an endogenous model that explains causes and effects of child labour. Substantial advantage of this study is its focus to feedback loops that in past works was ignored or not emphasis as much as their

significant role. As a result, a useful tool for better communication by national policy makers and better understanding of the role and importance of different social mechanism are eventuated.

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Long Term Policy Analysis of Malaysia's Renewable Energy Fund Budget: A System Dynamics Approach

Malaysia has abundant potentials of renewable energy resources in bio-power, solar PV systems and small-scale hydropower. Feed in Tariff mechanism has been applied since 2011 in Malaysia to expand utilization of renewable energy for electricity generation. In this study a comprehensive system dynamics model is developed to simulate the impacts of assigning different Feed in Tariff rates for different potential renewable resources on the generation mix of Malaysia between 2011 and 2030. Results demonstrate that although the policy may lead to a satisfactory level of target achievement but the government may face an increasing shortage in its RE fund budget starting around 2019 unless it increases its income sources by rising the surcharges on electricity bills or decreases its expenditures by optimizing the amount of FiT payments in different periods. Sensitivity analysis illustrates that the more funding will not lead to a more sustainable generation mix unless it is paid in the right time and in the right direction. Using this model, policymakers can carry out analysis to determine the amount of money that must be collected from the electricity consumers as well as the amount of feed in tariff to be paid for different renewable resources in different periods.

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An Adaptive Statistical Data Processing Algorithm Applied to SD Modeling of Iran's Demographic Transition

There are different official estimations about current and future growth rate of Iran's population. Inadequacy and unreliability of data in addition to usage of unsuitable forecasting methods are the main reasons for existence of this variety. To have accurate estimates for year on year growth rate, in this research, a population system dynamics model is implemented. To run the model, total fertility rate and other needful fertility parameters are calculated by processing raw data. In the next step and to resolve the statistical inconsistencies in census data which have been revealed by calculation of survival fractions and death rates, an appropriate adaptive process is proposed and applied to modify the parameters. The result of applying model shows that the next ten-year average growth rate will be about 1.9. Finally, simulation results of three possible scenarios on the fertility factor are obtained that warns on exceeding of population over 100m by 2020.

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A system dynamics approach to examine the method of resolving traffic congestion in Tehran

In this paper, a system dynamics approach is applied to study the consequences of highway construction projects and their method of funding in Tehran on traffic congestion. In recent 40 years, Tehran municipality has built new roads in Tehran but the traffic problem has not been resolved. Besides, in recent years the municipality has used an unsustainable method for revenue earning, which is selling excess building permits. This method has aggravating effect on traffic

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congestion. The proposed model simulates the traffic system behavior considering road construction and method of funding the road construction projects. The results indicate that continuing to selling excess building permits and construction of new roads will not result in desirable outcomes. Thus it is suggested that Tehran municipality raises the price of building permits and enforces the law on the maximum number of building permits which are sold each year according to the capacity of each area.

Regulation or information: Can we influence city competition?

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In this paper we model the impacts of competition between two cities when considering demand management strategies on both the optimal tolls and residential location choices. An isolated city is studied first and a simplified welfare function is used to determine the optimal toll around the central area. A twin city is then added. Traffic from the neighbouring city may be charged and the revenue retained - a form of tax exporting behaviour which should increase the welfare of the city. We show that there exists only one non-co-operative solution which forms a Nash trap with higher tolls than under the regulated case. We then set up a game in the form of a flight simulator and report on results of the game played by pairs of students who are asked to act as local authority decision-makers. The aim is to test (a) whether the strategies adopted are as theory predicts and (b) whether the players recognise the benefits of lower tolls when given information about the regulated solution and collaborate or continue to play to win. The results show that players respond to the information and maintain a collaborative solution which may have significant implications for regulation and the development of cities within regional partnerships.

Modeling Spin-off Creation in University Technology Transfer with System Dynamics

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University spin-offs become more and more preferred in recent years as an option to transfer university technology to the market due to its social economic advantage. As a result of Japanese government policy in 2001, number of university spin-offs increased at the beginning yet declined after five years. By focusing on university level, this paper explores activity of technology transfer from research project as initial step of technology transfer to university spin-off as one of technology transfer channel. System dynamics is used to model the system. The proposed model allows intervention to the activity in form of initial capital and support on business model and practice to increase number of new university spin-off. Simulation results show that both factors positively correlates with number of new university spin-off. In addition, support on business model and practice is found to have higher influence than initial capital.

Toll Road Infrastructure Development in Indonesia: A System Dynamics Perspective

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The development of infrastructure especially toll road in Indonesia is critical, because if compared with other countries like China or Malaysia toll road, Indonesia toll road growth move slower than them. This paper will examine the

development of toll road infrastructure in Indonesia from 1995 to 2012, and then analyzedwith System Dynamics methodology. At conceptualization stage of SD methodology, there is a significant gap between forecast based on current situation and forecast based on econometric data panel method. The result of this paper, based on current investment process from Government of Indonesia,is the whole of toll road construction, based on Government plan 2213 km, will be finished in 2080. It means that construction of toll road in Indonesia is very challenge. This paper recommands that to accelerate construction toll road in Indoesia should be leveraged with something innovated.

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Occupational Labour Demand Sub-model of Latvian Labour Market Forecasting and Policy Analysis System Dynamics Model

This paper shows occupational labour demand sub-model of the Latvian labour market forecasting and policy analysis system dynamics model. Labour market planning is topical in any country. The novelty element of the paper relates with the practical application of the system dynamics method for the state needs in Latvia for labour market forecasting as well as with development of a one of the most powerful models of labour market forecasting in the World. In the paper structure of the model, occupational labour demand sub-model position in labour demand module of the model, as well as components of occupational labour demand sub-model and the possibilities of the model and the forecast of the most important parameters of labour market in Latvia are shown.

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The Effect of Utility Cost Reduction

Hungarian households spend a significant part, 20% of their income to energy. One of the most important energy services is heating because of the cold winters. The efficiency of primary energy use for heating purposes is very low, 80% of the primary energy could have been spared with proper retrofit. The penetration of natural gas in the residential heating is approximately 60%. 80% of the natural gas will be imported from Russia. The Hungarian government started a utility bill decrease process, cutting the energy bills by 20% in 2013. This provides a unique research option to examine the impact of energy-price decrease on the heating behaviour of households and on the natural gas demand. The system dynamic model simulates the natural-gas demand of households in dependence of the external temperature, the energy efficiency features of the buildings, the income of the household and the subjective expectations of the inhabitants regarding the room-temperature. The model provides a framework for testing energy tariff systems, price incentives and energy efficiency measures.

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A system dynamics approach to exploring the relationship between income distribution and residential electricity consumption

The economic health and development of modern economies are dependent on reliable electricity supply, which in turn is enabled by adequate energy planning and infrastructure investment. Adequate electricity planning can only be

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achieved through consideration of electricity demand drivers. Residential electricity demand, coupled to household income, is a significant contributor to electricity demand. This work reports on a system dynamics study of household income dynamics, including causality with respect to residential electricity demand. Household income dynamics is of particular relevance and importance to South Africa because of the country's relatively high Gini coefficient and progressive redistributive policy measures. The flexibility and feedback dynamics offered by system dynamics provides an insightful alternative to conventional statistical-empirical approaches for exploring such relationships. The system dynamics model proves a strong correlation between income distribution and residential electricity consumption. Based on a GDP growth rate of 2% per annum, simulation results show that a transition in income distribution or Gini coefficient from 0.67 in year 2012 to 0.5 and 0.4 by year 2035 would result in additional increases in residential electricity demand of 3.1% and 4.7% respectively above the baseline demand growth caused by GDP growth. This dynamic is an important consideration for energy planners.

Dynamic Analysis of Trust and Commitment Building

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The aim of this paper is to create a deeper understanding of how small and medium-sized enterprises (SMEs) build relationships and commitment with partners that are distant locationally and culturally. We elicit challenges in building global logistics value networks by examining Finnish SMEs entering and operating in emerging markets, special focus is given to Finnish SMEs operating in China. Using a conducted survey as a starting point, we introduce prevalent difficulties that Finnish SMEs are experiencing in overseas operations. Furthermore, building on top of the prevalent problems a system dynamics model describing the dynamic nature of the identified factors is presented. The model tries to capture the problems simultaneously from the SME's as well as from the partner's point of views. Both parties interpretation of the actions of the other are biased, which is a significant factor in diminishing trust between them. Trust and its cultural divergences are an important part of creating and maintaining commitment.

The Impact of State's Legal and Organizational Framework on Social Capital Development

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The scientific community unanimously recognizes the critical effect of social capital on economic development. In fact, social capital benefits society as a whole in terms of lower transaction costs, fewer opportunistic behavior and speed of information among institutions, thus representing a key factor of the global competitiveness of a Country. At a macro level of analysis social capital arises by most formalized institutional relationships, structures and public policies constituting the State organizational and legal framework. In fact, good public management, services and transparency foster in individuals their social commitment, honesty, and a solid trust towards public institutions, all proxies of social capital. Oppositely, a bad public administration depletes social capital. So far the literature has been more successful at documenting the beneficial impact of social capital than at deriving policy prescriptions and providing guidelines about how to invest in it. The present research, tailored on the Italian State, represents a first attempt to evaluate ex ante public policies in terms of social capital development. System dynamics models, allowing to include such information in policy design, may effectively lead policy makers to select policy alternatives producing the best result in terms of social capital growth.

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Through the Red Queen effect

One of the important issues in the field of strategic management is to know the factors that explain why companies operating within the same sector have different performances. The evolutionary theory affirms that innovation could justify why certain firms remain in a prominent position in the market ensuring high yields. A scenario that explains the evolution of innovation among rivals is known as the Red Queen effect. In this scenario, an action carried out by a firm influences its performance and promote innovation among rival firms, affecting negatively the performance of the first. This paper is aimed to construct a system dynamic model capable of explaining the survival of two firms affected by the effect. To contrast the hypothesis on which the model is constructed, the innovation paths of two rival firms in a specific industry are examined. A simulation exercise tests the capacity of the model to replicate the creation of new products.

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Models focused on policies: the search for feedback

A solution to a problem can become the seed of a causal structure by means of which the impact of the solution on the problem can be studied. These structures might have certain advantages with regard to traditional one. In particular, they might be easily constructed as they are target to interconnect problem and solution. This aspect is especially important in a socio-economic context characterized by high complexity. Considering a government deficit problem, this paper constructs causal structures promoted for three policies, tax raise, infrastructure investment reduction and subsidies elimination. After documenting the structures, a meta-structure is formed by combining the structures associated to each policy. The new structure always describes the problem and allows us to examine the impact of all policies on it.

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Towards a Sustainable Social Service Delivery System Through Public-Private Partnership: A Conceptual System Dynamics Approach

This paper presents an assessment of the dynamics of a Public-Private Partnership(PPP) in delivering social services and it aims at improving such partnership. Despite the significance of social welfare services this topic has received limited attention in literature. Therefore, we intend to bridge this gap by focusing on a case study of food donation service in Lecce, Italy. System Dynamics, proven methodology for analyzing complex social systems, has been employed to qualitatively analyze the service delivery system. This qualitative analysis has helped us first, to conceptualize the current system into several dynamic sub-systems, second, to investigate the social capital exchanging process and identify the system problems and finally, to design a new subsystem to be implemented in order to overcome the dynamic challenges. Establishing an IT platform is proposed as the operational requirement to foster effective communication among the actors to facilitate information sharing and also to ensure the positive synergy in the delivery of food to citizens in need. We discuss how working together in such environment enables actors to bring on board efficiency and local innovation to achieve commonly identified objectives such as maximizing the supply of the system as well as the number of supported needy citizens.

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Renting versus Buying: System Dynamics Approach to Housing

This paper studies a widespread and important life dilemma of renting and buying a home. We adopt a system dynamics approach to housing research and clarify the benefits of system dynamics and double-entry bookkeeping in modeling the determinants of buying and renting a home decision. We included all important inflows and outflows of money and accumulation dynamics of assets, liabilities and equity for both dilemma choices. The model is general in the sense that one can use data from any market, but in this paper the parameters are estimated using Croatian historical data. We consider two policy scenarios; one in which there are tax deductions on interest payments, and the other without the tax policy measure. Our results suggest that the renting scenario is optimal in comparison to the buying scenario when there are no tax deductions on interest payments. This suggests that tax deductions should be introduced in case the government wants to stimulate the real estate market and the construction sector, or abandoned if the government perceives a housing bubble is being supported by a certain tax policy.

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Using Microfinance for Flood Mitigation and Climate Adaptation in Bangladesh

This draft paper describes the preliminary outcomes of a model-based investigation of long-term strategies to reduce the impacts of coastal flooding in Bangladesh. Specifically, a system dynamics model was constructed to simulate the effect of flood mitigation methods on the population, rural economy, housing and welfare of Bangladeshis in the coastal district of Cox's Bazar, if they were to be implemented. The model shows how microfinance-based investments could endogenously contribute to such infrastructures, in the context of policies for climate adaptation and rural development. Additional policy insights were observed by analyzing overall system behavior using techniques for Exploratory System Dynamics Modelling and Analysis (ESDMA).

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Too good to be true? Exploring the dynamics of a radical shift to a universal pension system in Greece

The mainstream policy debate on the issue of pensions is focused on the dipole between “privatization” according to the capitalization system and “trilateral funding”, where the reasoning of restitution and of capitalization often co-exist. Both perspectives, however, are quite sort-sighted: the pension system is perceived as a closed system, without major interactions with the economy. Mainstream accounts are also subjugated by the anxiety over the impact of demographic dynamics (also perceived as a closed system) and “fund viability”, as well as by a certain value set with the following key elements: link of the right to pension with past paid employment, unidirectional character of inter-generational solidarity, treatment of contributions as part of labor compensations (and hence part of the wage cost) and not as tax on paid employment (labor). A radically different approach is proposed here. Pension is

not treated as a result of savings, but as a right to decent active retirement and part of a guaranteed income system. Contributions are regarded as taxation on labor. The impact of the transition to a universal pension system (possibly income-tested) is examined under a broader set of socio-economic performance, such as fiscal burden and employment. It is shown that the transition to the new system would be quite beneficial in terms of fiscal burden as well as employment.

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Dynamic thinking about food system vulnerabilities in highly developed countries: Issues and initial analytic structure

This paper presents the first step in applying a system dynamics analysis to the question of food system vulnerability and resilience in developed countries. Existing literature and models about food security largely focus either on effects of climate change on agriculture at a global scale or on specific issues on a regional scale, most often in food insecure countries. While there has been considerable attention in highly developed countries to specific issues such as organic food, agri-business, effects of pesticide and fertilizer runoff, or introduction of genetically modified organisms, it is hard to get a clear picture of the ways in which the food system as a whole is vulnerable and resilient at the national level. Here we syn-thesize literature about food systems and discuss differences in food systems between less developed and highly developed countries. Based on the literature review, we develop a conceptual model. We describe next steps for developing an operational model for raising awareness of vulnerability and re-silience in developed country food systems.

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"I'm not hoarding, I'm just stocking up before the hoarders get here." Behavioral causes of phantom ordering in supply chains

Individuals often respond to product shortages by building safety stocks (hoarding) or ordering more than needed to meet demand (phantom ordering). Such actions create positive feedbacks that intensify scarcity. Hoarding and phantom ordering can be rational when customers compete with others for limited supplies. But they may also be behavioral and emotional responses to scarcity. To address this question we extend Croson et al.'s (2013) Beer Distribution Game experiment. There, hoarding and phantom ordering are never rational because there is no horizontal competition, randomness, or capacity constraint; further, customer demand is constant and known to all. Nevertheless 22% order more than 25 times the constant demand. We generalize the ordering heuristic tested in prior research to include the possibility of endogenous hoarding and phantom ordering. Estimation results strongly support the behavioral hypothesis, with hoarding and phantom ordering particularly strong for the outliers who placed large orders. We discuss psychiatric and neuroanatomical evidence showing that environmental stressors can trigger the impulse to hoard. We speculate that stressors such as large orders or late deliveries trigger hoarding and phantom ordering for some participants even though these behaviors are irrational. We discuss implications for supply chain design and behavioral operations research.

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Task complexity in individual stock control tasks for laboratory experiments on human understanding of dynamic systems

Dynamic stock control tasks have been frequently used in laboratory experiments in behavioral research to illustrate poor human understanding of dynamic systems. System dynamics modeling has regularly been used as a method to design simulation based stock control tasks. Studies applying these simulations are almost exclusive focused on how the structure of a system (represented in the form of the simulation model) affects human's inference of system behavior. In doing so, these studies hardly ever take into account that dynamic stock control tasks are more complex than 'just' the complexity of the underlying system structures. The concept of 'task complexity' is nothing new, but its application to research on human understanding of dynamic systems using stock control tasks applying system dynamics modeling remains virtually absent. Hence, the objective of this paper is to make a first attempt at carving out what task complexity entails when applied to dynamic stock control tasks in order to determine its usefulness for future research on human understanding of such tasks. In this paper, task complexity is conceptualized consisting of ten complexity dimensions: 1) size, 2) variety, 3) redundancy, 4) ambiguity, 5) variability, 6) unreliability, 7) novelty, 8) incongruity, 9) connectivity, and 10) temporal demand.

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Integrating Stock-and-Flow Structures in Decision-support Dashboards – A Catalyst to Improve Dynamic Decision Making

According to natural decision models, good decisions are mainly dependent on understanding the consequences of chosen options. Thus, receiving information on causal relations between options and results should be helpful. Using a capacity management simulator, we conducted laboratory experiments with two levels of complexity in which participants had to make decisions repeatedly. Results are that showing not only key performance indicators on the user interface but also visualizing causal relations between them leads to better decisions. The results are stronger in the more complex situation.

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Policy Insights from the Nutritional Food Market Transformation Model: The Case of Obesity Prevention

This paper presents a system dynamics policy model of nutritional food market transformation, tracing over-time interactions between the nutritional quality of supply, consumer food choice, population health, and governmental policy. Applied to the Canadian context and with body mass index as primary outcome, we examine policy portfolios for obesity prevention, including (1) industry self-regulation efforts, (2) health- and nutrition-sensitive governmental policy, and (3) efforts to foster health- and nutrition-sensitive innovation. This work provides novel theoretical and practical insights on drivers of nutritional market transformations, highlighting the importance of integrative policy portfolios to simultaneously shift food demand and supply for successful and self-sustaining nutrition and health sensitivity. We discuss model extensions for deeper and more comprehensive linkages of nutritional food market transformation with

supply, demand, and policy in agrifood and health/healthcare. These aim towards system design and policy that can proactively and with greater impact, scale, and resilience address single as well as double malnutrition in varying country settings.

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From Category Building to Industry Referent: Competition and Coevolution among Hybrid Electric Vehicles

This paper investigates the interplay between product differentiation and social exposure spillovers within an emerging product category. We explore a tradeoff involved in the timing of within-category differentiation: differentiation combines reduced competition with the other category members with reduced benefits from social exposure spillovers among alternatives. The latter also hurts legitimation of the category as a whole. This tradeoff suggests that new categories can follow different paths depending on the timing and degree of within-category differentiation. We examine these questions by: i) developing a conceptual model of category emergence; and, ii) empirically examining this in the context of hybrid electric vehicles (HEVs) in the United States between 2000 and 2010. In particular, we study interactions between the category's most successful product – the Toyota Prius – and other HEVs. We find that the interaction between the Prius and other non-Prius HEVs is characterized, initially, by low differentiation and strong familiarity-spillover. In later periods, however, we observe high differentiation and low familiarity spillover. Our findings suggest implications for policy and strategy decision makers seeking to shape the path of new market formation – issues of particular interest to addressing climate change. We discuss our next steps: a formal dynamic model of category emergence.

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Behavior Analysis and Testing Software (BATS)

Analysis of model behavior is mainly conducted in a pattern-based manner in system dynamics (SD) methodology. In pattern-based evaluation of model outputs, similarity of the overall behavior pattern (e.g. S-shaped-growth, oscillations) and of specific pattern characteristics (e.g. inflection points, periods, amplitudes) are more important than point-by-point similarity measures such as sum-of-squared errors. Although some output analysis tools/software that address this special pattern focus are available, they lack usability and are fragmented. In this study, new standalone analysis software, namely Behavior Analysis and Testing Software (BATS), is developed. It integrates a pattern classification algorithm and a set of statistical methods for analysis of steady-state behaviors. Apart from enabling comparison of behaviors with these algorithms/methods, BATS includes structured processes that enable user to conduct automated hypothesis testing, behavior space exploration, and sensitivity analysis. In its current state, BATS can seamlessly communicate with SD modeling software (Vensim) and other common data sources. This study provides illustrative examples of how BATS can assist the modeler and/or analyst in various phases of modeling; indirect structure testing, output evaluation, sensitivity analysis, policy analysis. Considering its pattern-orientation, user-friendly interface, and communication with modeling software BATS can be an important contribution to the analysis toolset of SD methodology.

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Forecasting Outcomes Achieved in Cultural and Creative Projects: System Dynamics Approach

The article provides project managers with a new approach to project planning with regard to monitoring the actual progress of the project implementation. The method introduced in the article is based on system dynamics modelling and project management principles outlined in the internationally recognised PRINCE2 methodology. It also makes use of the principle set in the EVM method, which is a part of the standard of the PMI. The System dynamics model of a plan and the real-life situation have the same structure but differ in the values of exogenous variables. The method enables better information for the project manager and their team on the expected project outcomes. The project model is divided into stages and the actual outcomes of the project are compared against the plan at the end of each stage, indicating the current trend for further development of the project. This approach provides the project manager with a strong argument for introducing timely managerial interventions in the project team. The method resembles checking the route by a traveller with the use of GPS navigation, which is why we named it GPS-PM. The method is used in real projects that are part of university courses in project management.

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To host a conference with short arrangement time

Recently, many countries and regions are trying to attract international conference. Conference participants are generally many. Big parties or other activities which cannot be offered to individual travellers can be held. In addition, conference participants can use money and experience real service and atmosphere directly. Good reputation of them can attract next prospective visitors. This kind of effects stimulates people to hold a conference even without sufficient resources. International conferences naturally require various resources. The most important and rigid resource is time. One of authors hosted an international conference in February 2014 with short arrangement time. Irrespective of arrangement duration, hosts must succeed in holding conference. This article shows the process from collecting papers to starting conference in a system dynamics model style. Each conference in future can be different in detailed condition; however, the model presented in this article can show points of which hosts should be aware. In particular, the meaning of time limit is shown by simulations. Conference hosts can be tempted to extend deadlines in order to gather more participants; however, it defeats its own purpose.

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Information Science in System Dynamics: A Review of the ISDC Bibliography

The Information Science and Information Special Interest Group (iSIG) wishes to understand its domain within the context of System Dynamics and how to advance its chosen field. To this end, the System Dynamics Society's (SDS) bibliographic database is examined for titles and keywords relating to information science within SD. The Web of Science, a popular online publication database is also examined for references to encourage future SD works. The majority of articles in the SDS database come from two sources: The System Dynamics Review and the ISDC conference programs. There is little overlap between the SDS database and the Web of Science, as the latter

does not generally index conference materials. This lack of overlap may limit the visibility of the Society's database to those individuals who already know of its existence rather than persons new to the field. There are also gaps within the Society's current database that limit its effectiveness when searching for items in the iSIG domain, as well as other areas of interest to the SD community. Changes to the submission system process are recommended to capture more meta-data and abstracts to increase the value of the database to the public.

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System Dynamics Model of Technology and Economic Growth: A Preliminary Study

The models of technological change and economic growth those have been developed so far do not provide satisfying directions for policy purposes. In this study, a simple system dynamics model based on an integration of micro- and macroeconomic theories is constructed to explore the process of technological change affecting the economic growth. It is hoped that by understanding the process, the developing country may have some directions more clearly how to design its technology policies. The capital-labor ratio change is used to represent the technology change and the mathematical equations of the model are derived from the underlying economic concepts. The main point of deriving the equations is that the production function has a capital intensity which is not constant. The study resulted in an important finding that the capital intensity is affected by the average life of capital in a negative direction. The study shows that the increase in capital intensity is an important source of the economic growth. This increase will strengthen the accelerator mechanism of the economy and creates larger multiplier effects. The increase in capital intensity can be obtained through managing innovation processes base on the development of education and the R&D capacity of the nation. Keywords: Capital-labor ratio, Capital intensity, Innovation, System dynamics.

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Evaluation of Lean Six Sigma Implementation Policies on Healthcare Services using System Dynamics Model

Lean production and Six Sigma quality management are famous improvement policies that been adopted in manufacturing industries for decades. Mostly, process performances and quality were improved when Lean or Six sigma were implemented on production processes. If we consider the method and results of Lean and Six Sigma approach on a production process, it could also implement on a service process. This paper aims to investigate behaviors of healthcare service processes of a hospital when the improvement policies were implemented. System dynamics was modeled as a methodology tool. The behaviors of the system studied were generated by four policies including current operation, Lean implementation, Six Sigma implementation and Lean Six Sigma implementation. Key performance indexes of Lean Six Sigma, process performances, quality of process and client responsiveness, were used to evaluate the policies. In conclusion, the simulation model gave Lean Six Sigma deployment was the best policy. If comparing between Lean and Six Sigma policy, in the short term, Lean could improve the process performances rapidly and gave better performances. However, Six Sigma was a better policy while quality of processes was more concerned. Six Sigma could make the process performances more stable. This led to gain client reputation in the long term.stable. This leads to gain client reputation in long term.

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Variation in a Medical Home: Clusters of Practice, Disparate Outcomes and Dynamic Tensions

Medical home evaluations often report modest and/or mixed results. We explore the variation in implementation, impact and understanding in a medical home. We also explore the use of analytical methods based in statistics that complement dynamic analysis. This project uses a mixed methods, multi-stage design to explore medical home variation. First, we explored implementation of the model, using semi-structured interviews, ANOVA and cluster analysis. Second, we explored the relationship between implementation and impact on patient outcomes using the New York Algorithm for Emergency Department (ED) use, propensity score matching and t-tests. Third, we explored employees' understanding of the model using causal loop diagrams (CLDs). Primary care providers practice differently across clinics and teams, and even across teams in the same clinic. This is shown to impact patient ED use, which varied significantly across clusters (at alpha = 0.05). CLDs point to key structural mechanisms -- understanding them and patience are required to overcome short term balancing loops. Dynamic tensions were found to produce variation in medical home implementation and resulting variation in outcomes. Causal Loop Diagrams identified causal pathways behind the tensions felt and outcomes observed. We are now developing the SD quantitative model.

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Grain Processing Strategic Growth Model & Tool for the Board of Directors

This project grew from the need of the board of directors to better provide oversight on strategic operations, with a specific desire to obtain a deeper understanding of the problem of company growth. Strategically, one chronic limit to growth for a sustainability-oriented, organic producer, is the supply of raw material. That is, the total number of acres for organic rice is limited and is not expected to expand as quickly as the demand for organic rice products. This paper provides an overview of our investigation of the causes of limits to growth in the supply of organic rice, and how the limit in supply in turn dynamically affects planning for the internal process of the company as it attempts to balance processing rates to meet the marketing & sales plan for the various product lines with a raw material supply system that replenishes only annually (at harvest). From this investigation, a dynamic model was developed for use by the board to better understand and respond to these strategic issues of growth.

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A Simple Sustainability Model: Simulating growth with just joules of energy and bits of data

The paper intends to help entangle the narrative about sustainability and growth. It seeks to describe the evolution of growth with the most minimalistic model possible. To this end, successive energy diagrams are made of the earth's most basic stocks & flows of energy, including the stock of greenhouse energy. A simulation model is then presented in which the energy dynamics are governed by the creation, storage and destruction of data in the DNA of living organisms, and by the ever increasing 'bits of data' created by humans. An example is given where the iPad based model can enable ad-hoc, one-on-one discussions about assumed trends and scenarios.

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Boundary Concepts in System Dynamics

This paper explores the use of boundary concepts in the system dynamics modeling process. It draws on the author's experience in teaching system dynamics as well as recent work on boundary objects in system dynamics and studies of best practices in SD modeling. The paper examines the iterative process of model development through the lens of boundary development. Boundaries regarding time, stocks, rates and other variables are considered. Boundary concepts are organized into a taxonomy with types and subtypes. The implications associated with each subtype are specified. An approach to boundary concept utilization, in the iterative model development process, is recommended. Recommendations for extending these efforts are an essential component of this paper.

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Analyzing Electric Vehicle Diffusion Scenarios for Istanbul

In this study, a dynamic simulation model for electric vehicle (EV) diffusion is constructed. The objective of this work is to investigate the question; what are the plausible diffusion patterns of electric vehicles for Istanbul under different scenarios developed considering both local and global socio-economic, governmental, technological factors and their interaction with each other? The results show that diffusion of battery electric vehicle (BEV) and hybrid electric vehicle (HEV) would likely reach around 19.76% and 20.77% respectively by 2042 in Istanbul. In addition, CO2 reduction in the transportation sector would only reach around 17.32% in 2042. Moreover, both gasoline and electricity cost influence EV diffusion. However, their impact on EV diffusion is mainly related with a mobility cost gap between gasoline and electricity. Furthermore, technological improvement would lead BEV sales to increase. Contrary to expectations, even if no technological improvements were progressed, BEVs would still likely succeed to penetrate around 10% of the market with its current technology within the 30 years. Both marketing activities and word of mouth have a remarkable impact on rapid EV diffusion. Subsidies would have a small impact on EV sales. Finally, BEV and HEV may inhibit sales of each other.

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Understanding & Modelling Corruption: Exploiting System Dynamics

It has been observed that developing countries normally have more corruption than developed countries, because the governments typically occupy a strategic position in processes of early capitalism. While this is true for most of the developing countries, the incidence of corruption and its effects are different because state capacities, policies and social and political contexts vary widely. Our research aims to arrive at a more nuanced understanding of corruption through critical observation of the everyday experiences of corruption. The corruption index is positioned in the center of the model, an increase in corruption increases the complexity of the feedback structure of the economic system since they add new causal relationships connected to those affected by unequal distribution of resources and going into poverty trap. Our key contribution is the rich insights about issues of values, social aspects, inflation government size and political norms when considering perceptions of corruption in Pakistan.

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Innovation Dynamics in High Tech Sectors

Firms innovate through complex and dynamic interactions with other knowledge agents forming an Innovation System. There is extant literature on the linkages between such agents however most previous studies have not taken into account its dynamic properties. This work aims to improve the understanding of the dynamic behavior of a sector as a result of innovative activities by designing a system dynamics model. A new framework, which includes the essential components and linkages of an innovation system is used and instantiated for the case of the Software Sector in Brazil and formalized through the use of a system dynamics model, using data from the Brazilian Innovation Survey (PINTEC) and previous literature. This research provides explanations of how internal components of a sectoral innovation system interact and, through the model, demonstrates the dynamics of the system by performing punctual experiments.

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Old Wine in a New Bottle: Towards a Common Language for Post-Keynesian Macroeconomics Model

Stock Flow Consistent methodology provide a common ground for the Post Keynesian Economics. System dynamics became a natural tool for solving simultaneous differential or difference equations or structural equations model. This paper aims for pedagogical and didactic approach by showing how to refactor a simplified a stock flow consistent model into a component based system dynamics model. By using hierarchical component based modeling approach, the model result would be easy to understand and to communicate.

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System Dynamics and Serious Games

This paper deals with the relationship between serious games and system dynamics. Games have been used in SD since the beginning. However, the field of serious gaming also has its own development. The purpose of this contribution is to provide a broad overview of the combination of serious gaming and SD and discuss the state of the art and promise. We first define serious game, simulation and case study and then point out how SD overlaps with them. Then we move on to define the basic components of a game and continue with an outline of important decisions and challenges of game design. After reviewing different possible purposes of SD-based simulation games, we discuss various approaches to game design with specific attention paid to learning effects. We also review the evolution of the interest for serious gaming in SD over the past 40 years. Our conclusion is that interest has oscillated between rising and declining, but that serious gaming is being recognized as an important component not only in educational settings, but also in policy design. We finish by offering important research questions for the future.

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Mautam famines in Mizoram: An exploratory system dynamics approach

Mizoram, a state in the Northeast of India, is affected every half-century by cycles of crop damages and famines. These events - locally known as Mautam - have been hypothesized to follow the periodic flowering of bamboo forests and subsequent rodent outbreaks. As such, the 1958-1960 Mautam resulted in a significant loss of lives; more recently, a 2007-2008 outbreak caused heavy damages to crops. However, the dynamics of the bamboo and rodent ecosystems remain poorly understood, as are their interrelationships with Mizoram's agriculture. This draft paper therefore presents an exploratory System Dynamics model of Mizoram's Mautam phenomenon, focusing on the application of a systematic framework for uncertainty analysis. Furthermore, a representative set of policies was tested under deep uncertainty to evaluate possible outcomes. Preliminary results indicate that although the model is highly sensitive to the properties of the human and rodent population subsystems, emphasizing market connectivity to facilitate food imports may be a promising and robust policy.

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Development of a generic Smart City model using MARVEL

The concept of the 'Smart City' is seen as double edged sword that should alleviate societal and environmental problems as well as fuel economic growth. Literature has identified many important characteristics of Smart Cities but has not yet provided a systemic approach that describes the interdependencies between these characteristics. The current study was conducted in support of an integrated approach for developing Smart City initiatives. We used group model building and interviews together with the MARVEL method to describe the interrelations between People, Environment, Living condition, Governance, Economy and Mobility. MARVEL is a method and a tool for developing CLD-

like causal models. The model forms the basis for a systemic framework to supports diverse sets of stakeholders in the development and analysis of future smart city initiatives. We demonstrate how various functions of MARVEL can be used to perform qualitative analysis to this end.

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Modern Nonlinear Optimization Techniques for an Optimal Control of System Dynamics Models

We study System Dynamics models with several free parameters that can be altered by the user. We assume that the user's goal is to achieve a certain dynamic behavior of the model by varying these parameters. In order to find best possible combination of parameter settings, several automatic parameter tuning methods are described in the literature and readily available within existing System Dynamic software packages. We give a survey on the available techniques in the market and describe their theoretical background. Some of these methods are already six decades old, and meanwhile newer and more powerful optimization methods have emerged in the mathematical literature. One major obstacle for their direct use are tabled data in System Dynamics models, which are usually interpreted as piecewise linear functions. However, modern optimization methods usually require smooth functions which are twice continuously differentiable. We overcome this problem by a smooth spline interpolation of the tabled data. We use a test set of three complex System Dynamic models from the literature, describe their individual transition into optimization problems, and demonstrate the applicability of modern optimization algorithms to these System Dynamics Optimization problems.

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Exploring Duplicate Orders in a Single-Manufacturer Multi-Distributor Supply Chains

This paper seeks to better understand how duplicate orders may dynamically influence the general performance in a single-manufacturer multi-distributor supply chain. We analyze a system where manufacturer sells her products through two distributors and the distributors sell the products to final customers. If a distributor is not able to satisfy his final customer demand, the unsatisfied demand will be backlogged and the customer will also place the order to the other distributor with certain probability. When the customer demand is satisfied by any of the distributors, the customer will cancel the duplicated order to the other distributor. Finally, when final customer demand exceeds available distributors supply, distributors often hedge against shortages by inflating orders to the manufacturers. Our results allow us to characterize the supply chain performance according to different probabilities to duplicate orders, different times to build manufacturer's capacity and the well-known anchoring and adjustment heuristic to model distributor orders and manufacturer capacity investment.

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A System Dynamics Model to Analyze the Role of Smart Grid Pricing Policies in Governing Electricity Consumption in Urban Areas

In this paper the role of Smart Grids pricing policies in governing the dynamics of electricity usage in urban areas is analyzed. A conceptual system dynamic

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model is formed to explain how the pricing policies can affect the electricity usage. The "Smart Grid" is offering a promising way to meet emission targets in an urban area. Carbon production is dependent on the amount of electricity consumption; therefore by effectively managing electricity consumption, emissions can be reduced. Since cities and urban areas are the centers of electricity consumption, Smart Grid has the best potential to be implemented in those areas and special attention must be paid to urban policies. Policy making can drive the growth of Smart Grid implementation and dynamic pricing is an important policy in this respect since it motivates consumers to reduce their electricity use. Based on the conceptual model, various types of dynamic pricing policies are analyzed and the main advantages and disadvantages for policy makers and the good governance of electricity consumption in urban areas are discussed.

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Application of System Dynamics to assess competitive rivalry in the airline industry - A Case Study

The present study applied system dynamics modelling to assess the competitiveness between airlines from Germany to Asia. Legacy airlines like Lufthansa, Singapore Airlines or Cathay Pacific who traditionally served a majority of travellers between Europe and Asia have come under pressure through airlines from the Gulf region, but also other European airlines, like Turkish Airlines or Finnair who position themselves as gateway. Some of these airlines offer lower airfare than their competitors, but a similar or even better product and according to their financial statements are in a sound condition. Therefore tools and processes were necessary to assess the internal resources of the airlines in scope - Emirates and Lufthansa - and to model the competition. Consequently, an exploratory-descriptive case study approach was chosen to set the scene and take this data into the system dynamics modelling. Due to the identification of key resources, changes to them were modelled to evaluate the dynamics of the system. It was found that system dynamics guides the researcher through the different tasks and forces to rethink and reapply certain steps to get to the notion, which resources contribute to the success of the airline.

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Hospital Evacuation During Disasters: A System Dynamics Approach

This paper explores and tries to understand hospital evacuation in the event of a natural disaster that prompts patient evacuation, aiming to uncover principles that apply to hospital evacuation and patient relocation. We use system dynamics to simulate hospital evacuation in the event of a disaster that prompts patient transfer. Our simulations found that the key to managing hospital evacuation efficiently lies less in the resources related to patient transportation, i.e., ambulances and evacuation routes, and more in the ability of the receiving hospital to manage the influx of patients. The decision maker at the hospital receiving patients holds the most leverage in determining the rate and amount of the evacuation. Based on simulation results, we uncovered principles that apply to hospital evacuation and patient relocation. Planners and policy makers can use the recommendations to facilitate efficient hospital evacuations.

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Increasing Accessibility of Participatory System Dynamics Modeling Methods: Proposal for a New Rapid Protocol

It could be argued that the time and resource costs involved in employing participatory system dynamics modeling (PSDM) methods deny their access to the young researchers facing constraints on human resources, funding opportunities, client acceptance, expertise, and experience. Similarly, many communities facing socio-ecological problems also cannot make use of PSDM methods for lack of adequate financial and human resources. The paper presents a review of various types of PSDM methods such as Group Model Building, Mediated Modeling, and Community Driven System Dynamics. Drawing from the analysis of PSDM projects based on these methods, this paper proposes a 'Rapid Participatory System Dynamics Modeling' (RPSDM) Method, which can be implemented even with limited time, resources, and expertise. The method involves three rounds, namely, Individual, Intermediate, and Plenary. The paper presents the details of these rounds, in terms of their goals, objectives, preparation, procedure, and importance. The method proposed was implemented to develop a system dynamics model of the socio-ecological system in the Lake Balaton Watershed region in Hungary. The paper presents the observations, changes in the protocol, lessons learnt and some examples of model versions.

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The Shale Gas Phenomenon: Utilizing the Power of System Dynamics to Quantify Uncertainty

Abundance of shale gas and cheap extraction techniques led to a boom of natural gas (NG) supply in U.S. with a corresponding drop in prices. This investigation captures the multitude of economic, technological, geoscience factors that impact production. A few of the key findings include the ability to more accurately model the shale gas behavior on top of the conventional and coalbed methane-based systems within the system dynamics environment. This is especially noteworthy given the recent rapid increase in production within the U.S.

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Counteracting the success trap in publicly owned corporations

Top management teams frequently overemphasize efforts to exploit the current product portfolio, even in the face of the strong need to step up exploration activities. This mismanagement of the balance between explorative R&D activities and exploitation of the current product portfolio can result in the so-called 'success trap', the situation where explorative activities are fully suppressed. The success trap constitutes a serious threat to the long-term viability of a firm. Recent studies of publicly owned corporations suggest the suppression of exploration arises from the interplay between the executive team's myopic forces, the board of directors as gatekeeper of the capital market, and the exploitation-exploration investments and their outcomes. In this paper,

system dynamics modeling serves to identify and test ways in which top management teams can counteract this suppression process. For instance, we find that when the executive board is getting stuck in the success trap, the board of directors can intervene by constraining exploration (in case of a rather stable environment) or by encouraging exploration (in case of a turbulent environment).

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Agile SD: Fast, Effective, Reliable

Recent concern about the progress and impact of system dynamics calls into question the means by which the method is deployed. Books, courses and published cases suggest we start by defining how the issue of concern is changing over time, then build qualitative causal-loop diagrams with stakeholders. The resulting shared mental model is taken to encompass the scope of the issue and represent the causal mechanisms involved. Stock-and-flow structures are then added and data sought with which to populate and formulate those structures, to create a working mathematical model. The process is difficult, time-consuming and unreliable. An alternative process moves directly from the performance behavior to a quantified mapping of stocks and flows. From there, interdependencies are traced and significant feedback mechanisms identified. Models are easier and faster to build, and incorporate quality from the start. They also deliver insights throughout the process – reminiscent of the “agile” approach in software development. The approach is also consistent with a complementary approach, common among leading practitioners, of leveraging proven structures repeatedly across similar cases.

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Standard Cases: Standard Structures: Standard Models

Increasing concern has been expressed about the quality of work done in system dynamics, and the thin stream of high-quality publications. However, since there is no incentive for leading practitioners to present or publish their professional work through those channels, it is entirely possible that a substantial volume of high-quality work is, in fact, being done, but remains unseen. Those practitioners, along with leading academics in the field, tend to focus their effort on specific application domains – natural resources, health-care, business and so on – and scrutiny of the limited published work in those domains suggest that valuable and reliable work is indeed being carried out on a significant scale. Those streams of work feature models with relatively standard structures that are replicated – with appropriate adjustments – from case to case. Consideration of the fundamental principles of the field suggests that there is considerable further scope for developing and codifying more such standard structures. This would both provide a platform for a greater volume of high-quality work for an increasing number of user organisations, and also offer an accessible and reliable source of guidance for young professionals trying to develop their system dynamics skills.

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From Debt Money to Public Money System -- Modeling A Transition Process Simplified

In the book ``Money and Macroeconomic Dynamics'' by this author, our current economic system, being dubbed as debt money system, is shown to be currently facing systemic failures of financial and debt crises, and, as its alternative

system, a public money system is proposed. Yet, a transition process from the debt money system to the public money system has been left unanalyzed, though vehemently called for by those who wish to implement the alternative economic system. Under the situation, this paper discusses its transition process by constructing a simple macroeconomic model based on the accounting system dynamics. It turns out that this model can briefly handle main features of debt money system, in 8 steps, that cause ``booms and depressions", debt accumulation and failures of recent quantitative easing finalcial policy. It then offers a transition path to the public money system in 6 steps. These analyses are carried out by focusing on the behaviors of monetary base and money supply as these rationales are laid out in the above book.

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Negative Deindustrialization: Japanese Experiences

The strongest yen's appreciation in 2011 made many Japanese companies choose overseas 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, there are several evidences to prove that current Japanese deindustrialization is a negative one. Why does Japanese economy fail to realize positive deindustrialization along the lines of the USA, Netherlands, or Norway? This paper develops a system dynamics model and examines important features of negative deindustrialization. Foreign direct investment largely affects manufacturing employment and productivity in the non-industrial sector.

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System Dynamics Project: The case of Electricity in Shanghai

The increasing energy demand in China due to urbanization has made study of different energy policies in big cities a crucial topic of discussion. Since the electricity market is a multi-actor system where various actors may have a great influence on the main issue we are focusing on, it is a very complex problem to solve. In order to solve the energy shortage and CO2 emissions problems existed in electricity market, a Shanghai case study was conducted. The model built in this paper was used to forecast the electricity demand and supply under different energy policy scenarios and also to analyze the associated reductions in emissions of CO2. Three different policy strategies were implemented in the model respectively, including: regulating the electricity price, changing the structure of primary energy consumption of the electricity generating system, building up an inter-regional integrated electricity market. The results show that the problems can be mitigated to some extent under these policies.

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A New Entity-Based System Dynamics Tool

Emerging needs for modeling large and complex systems require a new modeling language and platform that is based on system dynamics but that is designed from the ground up to support hierarchical and object oriented modeling. We describe a new platform for system dynamics modeling that supports detailed and object oriented modeling while preserving attractive features of existing tools, including a completely declarative language with a graphical representation. New concepts supporting this platform include collections of entities, attributes, relationships, aggregation and allocation

functions, and actions, which are presented with examples. A graphical language extends stock-flow diagrams to include the new concepts. The design facilitates modularity and collaboration, provides a more natural description of detail than arrays, and solves sparse matrix problems. It has application to both traditional system dynamics, with modular sectors, and to agent based modeling.

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Novel Sensitivity Analysis for Dynamic Models

This paper proposes a novel statistical sensitivity analysis for dynamic models, which is based on an enhanced maximal information coefficient (MIC) method. We enhanced the MIC method to handle multivariate sensitivity analysis; rather than just univariate analysis. The main motivation of this enhancement is overcoming the research gaps in the current state of the art of eigenvalue analysis. We postulate that this novel sensitivity analysis represents a solid foundation to study the multivariate complex nonlinear non-monotonic relationships between behavior modes – expressed by eigenvalues – and parameters, in the model. The experiments conducted corroborate our postulation.

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The Dynamic Relationships between Technology, Business Model and Market in Autonomous Car and Intelligent Robot Industries

This study develops a new dynamic innovation model based on three elements — Technology–Business Model(BM)–Market — for characterizing the knowledge-based economy and open innovation. It identifies the relationship dynamics between technology, business model, and market through analysis of in-depth interviews with Korean firms that belong to the autonomous car and intelligent robot industries, the analysis of technologies worldwide as well as business model patent applications of both industries, and the analysis of the reference and citation networks among these patents. It develops the Casual Loop Model and System Dynamics Model based on the dynamic relationships between Technology-BM-Market. In developing these models, the regulations, the standards, and the leading firm effects were considered. The Technology–BM–Market System Dynamics Model was validated through analysis of interviews with each firm, analysis of group meetings with experts from each industry, and analysis of technologies, and business model patent citations statistics and networks. It identifies the importance of the business model in addition to 3 conditions identified in this research, the leading effect, standardization, and regulation. The research suggests new market increase strategies and policies which are based on Technology-BM-Market model in technology intensive industries such as autonomous car and intelligent robot industries.

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Dynastic Cycle: A Resource Allocation Theme For Addressing Dissent In Universities

This paper utilizes the dynastic cycle framework proposed in (K. Saeed & Pavlov, 2008) to explain the role of dissent in universities. By combining the dissent expression framework (Kassing, 2011) and the dynastic cycle structure, we construct a generic model for dissent in organizations. The work is rooted in the literature of organizational communication, research and development, and higher education management. Using system dynamics methodology, we illustrate the dynamic interaction of composition, climate, and performance to simulate and explain how organizations evolve with regard to dissent. This model provides a platform for experimentation with different policy scenarios focusing on growth and productivity. The research suggests that as universities attempt to improve their performance through growth, despite initial short-term performance improvements, they are likely to devolve into low performance institutions with degraded management responsiveness and organizational productivity. Regardless of having high dissent tolerance, they could become dominated by high control and silence climates. When organizations invest in cultivating a dissent aware climate, and strive to improve their dissent processing capability, we suggest that the university and its members will be more productive and engaged.

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Exploration of the Growing Trend of Electric Vehicles in Beijing based on SD model

This research is conducted to explore the growing trend of private vehicles in Beijing in the coming 25 years based on the system dynamics (SD) method. First, the paper introduces the background about the private vehicles in Beijing and analyzes the traffic congestion and air pollution caused by them. Second, qualitative analysis is done to explore what possible policies the Beijing government can adopt to increase the percentage of EV and control the number of total private vehicles at the same time and a causal diagram is drawn to facilitate the way of thinking. Third, a quantitative SD model about the system is built based on the causal diagram and qualitative analysis. Finally, the SD model is used to explore the plausible future trend about private vehicles and study the implications of different policies.

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Dynamics of strategizing practices and framing processes in organizational identity transitions

Research has emphasized the importance of organizational identity for strategic moves. Using dynamic simulation, we therefore investigate mechanisms of strategizing practices in identity transitions. We identify dynamic processes of how strategic capabilities and organizational identity interact to affect strategic framing of organizational context. Results suggest that identity matures if organizations have available corresponding capabilities and that these capabilities accumulate based on organizational actions, experiments, or projections, i.e. based on actions as well as physical and mental experiments. We find that both identity shift and capability development, and the interaction between them, can constrain or provide opportunities for organizational change.

Meetings, Special & Convened Sessions

Listed alphabetically by Session name

Africa Regional Chapter Meeting

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The Society's Policy Council recently approved the formation of the System Dynamics Africa Chapter. This is an important step in creating awareness of SD and its applications in solving pressing societal challenges across Africa and its membership covers nearly 30 countries. The Africa Chapter meeting will provide an opportunity to develop contacts and exchange insights on potential research and scholarship collaboration. Join us at the Africa Chapter Meeting to learn about plans of the youngest Chapter and to contribute to our strategic direction in SD membership drive across Africa.

Asia-Pacific Chapters Meeting

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Meeting of the Asia-Pacific SD Chapters and SD Society members interested in the wider Asia-Pacific Region to discuss the recent Asia-Pacific SD Conference held in Tokyo in February 2014, the proposed next A-P Conference to be held in Singapore in 2016, the proposed formation of a new South East Asia Chapter, and any other items related to the wider Asia-pacific Region.

Australasia Chapter Annual Meeting

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The Australasian Chapter will have a meeting to discuss what's going on in the region, see how we can help foster the update of SD and welcome interested in joining our chapter. The ever-growing base of members of the Australasian Chapter has been pursuing our existing and new realms of research and activities in 2013-2014. These include our interests in our ecosystems and global environment, in terms of human interface and the various impacts of farming. Also in business and management, major advancements are seen in the integration of system dynamics with supply chain decision making, production planning, process design, and accounting. Towards the social and well-being aspect, system dynamic modeling of corruption was undertaken, along with other major projects on important social issues including occupational and traffic safety. On education, major universities and institutions in the region are continuously expanding the coverage of systems thinking and system dynamics, from the focus on postgraduate studies all the way towards undergraduate and high school levels, gaining momentum for the promotion of systems perspectives in education for all. We're looking forward to seeing you all at Delft.

Banquet and Transportation Details

Tuesday night of the Conference! We will be transported by buses to and from the Paddle Steamer. Details about transportation and the Paddle Steamer schedule will be available on site.

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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 Chapter Bonus Day

On Friday, the BeNeLux chapter of the System Dynamics society will organize a bonus day for its chapter members and other interested conference participants. Two types of presentations will be scheduled: graduation presentations and presentations by practitioners (no paper required).

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BeNeLux Chapter Meet and Greet

The Benelux Chapter of System Dynamics provides a platform to propagate further and encourage the advancement of System dynamics in the Netherlands, Belgium and Luxembourg. The Chapter promotes and facilitates the exchange of knowledge, ideas in the field of System Dynamics for practitioners, problem owners, scholars, researchers and students. This is achieved by organizing workshops and conferences every year. This year the Annual Chapter meeting was held on February 7 2014 in Nijmegen. This additional meeting at the annual International System Dynamics Conference in Delft is a meet and greet, as well as a means to exchange information among existing and new members.

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Brazil Chapter Annual Meeting

Abstract for: Brazil Chapter Annual Meeting 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 (2014-2015). 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.

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Business Day @ System Dynamics Conference (Wednesday)

Do you think system dynamics could be useful for your organization or would you like to brush up on your knowledge of system dynamics? Then the Business Day will be of interest to you. Business Day includes two introductory morning lectures, one on system dynamics in general and one on group model building. In the afternoon there will be three workshop sessions on different application

domains. The first workshop will be about strategy development in water and coastal management. The second workshop looks at the world of asset dynamics by linking life cycle management concepts to system dynamics. The final workshop considers changes in the Dutch mental health care sector in which instead of treating people who need care in institutions, new policy is to treat them in their own homes as much as possible (and feasible). Business Day special sessions are co-organized by Deltares, Copernicos Group, Significant, Delft University of Technology and Radboud University Nijmegen. Regular attendees to the System Dynamics Conference are welcome to join the Business Day sessions.

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Business SIG Annual Meeting

Since the inaugural meeting of Business SIG on July 24, 2013 during the 31st International System Dynamics Conference in Cambridge, MA, several initiatives have been proposed and pursued in collaboration with the Society, SIG members, and other organizations including iseeSystems and Leverage Networks. Currently active initiatives include (1) expansion of the Case Repository and improvements in its accessibility, (2) development and promotion of success stories in the application of System Dynamics to business problems, intended for audiences outside the System Dynamics community, (3) development of the System Dynamics Model/File Exchange (SDX), conceptually similar to the successful MATLAB File Exchange, to facilitate submission/exchange of models, modules, molecules, function libraries, and other modeling resources, (4) creation of a new membership category for corporates and organizations, which will be similar in outline to that adopted by a number of other professional societies, and (5) development and implementation of a "CRM"-like (Customer Relationship Management) platform to facilitate communication and collaborations across the SIGs, Chapters, Society leadership, and global membership of the Society. The latter initiative is being pursued as a collaboration between Leverage Networks, iseeSystems, and the Business SIG, which will serve as a pilot group for development and testing.

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Canada Chapter Annual Meeting

The Canada Chapter provides an opportunity for information exchange and the promotion of system dynamics in Canada. Please join conference attendees who are interested in Canada and the Canada Chapter at our meeting.

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China Chapter Annual Meeting

The first System Dynamics Academic Forum for Postgraduates was hosted by Shanghai University of International Business and Economics, Nov 1-2, 2013. About 80 postgraduate students and young scholars from more than 17 universities and institutes attended the forum. This forum brought the present members together with several keynote speeches and an academic salon. We believe that it has offered an extensive examination into the academics and application of SD. The second SD academic forum is offering on middle of November, 2014. Around 6 members of the China Chapter attended the 31st international conference of SDS where Qian Ying chaired the Chapter meeting. China Chapter held several regular meetings on May 11, 2013, Aug 31, 2013, and March 16, 2014 respectively which focused on the summarizing of the last year and planning for the forthcoming year. On December 30, 2013, a press

Conference of China's Industrial Park Sustainable Development Index was held at Tongji Development Research Institute. The SD modeling Training courses were set by Yitao Technologies regularly which involved more than a dozen attendances. Xu Bo and Yan Haiyan attended the First Asia-Pacific Regional Conference in Tokyo of the SDS held at Senshu University in Tokyo, Japan, February 22-24, 2014.

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Conference Debriefing Meeting

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, available on the conference website.

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Conflict, Defense, and Security SIG Annual Meeting

The CDS/SIG focuses on modeling and simulation of social phenomena related to conflict, defense, and security. Some application areas include: cyber security, information security, military applications, terrorism and counter-terrorism actions, conflict resolution, asymmetric warfare, and insurgency studies. The meeting 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).

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Dana Meadows Award Announcement

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.

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Economics Chapter Annual Meeting

Since its inception in 2003, the Economics Chapter has been promoting the use of system dynamics to study and improve economic systems. The chapter maintains a website and a mailing list. Members of the chapter have successfully organized system dynamics threads during economics conferences and coordinated the economics thread during annual meetings of the System Dynamics Society. We encourage anyone interested in Economics to stop by to learn about the activities of the chapter and its members. We also would like to hear about your interests and invite you to join the chapter.

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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 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 increased substantially, reflecting growing interest in this important issue. Among other activities, the SIG has a large and active discussion forum on Linkedin.com, and works to arrange webinars on specific topics. We welcome everyone interested to join our annual meeting at the Delft conference. Contact person: Isaac Dyner (Energy SIG chairman) at idyner@yahoo.com.

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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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German Chapter Informal Gathering

The German Chapter invites all interested parties to an informal gathering at the Delft International Conference. The chapter advances networking and collaboration among System Dynamicists in Germany. By end of 2013 the German Chapter had 10 institutional members (also listed on our website) and 117 (personal) members and keeps more than 300 interested researchers, managers, and students updated through its e-mail newsletter. Occasionally, System Dynamics colloquia and roundtables are organized in different places in

Germany. These events provide a basis for meeting fellow System Dynamicists and for discussing modeling projects. On May 22-23, 2014, the Chapter's 8th Annual Meeting is held in Karlsruhe. 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

This workshop explains the process of hosting the International Conference of the System Dynamics Society. If you or your organization would like to host, this is the workshop for you. Information on selecting sites, hotels, fund raising, etc. will be provided. You will be able to discuss the process with the System Dynamics Society's Executive Director and the VP Meetings among others.

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Health Policy Special Interest Group Business Meeting

The Health Policy Special Interest Group formed more than ten years ago and has grown to over 400 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! The 2014 Annual Meeting will: (1) facilitate the exchange of information regarding recent/current Health Policy work (1.1) Geography-based introductions -- mark on the map what countries you work in. Members will then introduce themselves country by country. (1.2) Mini-poster session -- bring Health Policy SD posters you presented at conferences throughout the year. Students please join in! (1.3) Presentation of Lupina Award and brief oral presentation by recipient (2) explore possible collaborations (2.1) Discuss grants of interests (2.2) Discuss current project needs -- student projects, research assistants, fellowships, consultancies (3) facilitate mentoring -- Mentor and mentee initial meeting. Sign up via the LinkedIn page! (4) review the previous year -- Discuss what worked, what can be improved, our priorities for the coming year and who can help! (5) elect officers of the SIG.

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iSIG Annual Meeting

As a domain, Information Systems and Information Science has been the subject of dozens of SD studies, including fundamental analysis of project dynamics, unforeseen outcomes, and the interaction of technology and organization. Also, the practice of simulation science is grounded in information technology. The iSIG can be a locus for discussions on the technologies used to support our work, such as model integration and data interchange standards (such as those under the emerging XMILE open standard), and other tools. We can also capture and disseminate best practices and guidelines for development of efficient and effective models. We look forward to meeting together at the conference, electing leadership, and gather ideas for activities for the coming year.

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Tecnológico de Monterrey

Latin America Chapter Annual Meeting

The Latin-American Chapter meeting that will place at the 32th International Conference Delf 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 12th. Latin-American System Dynamics Conference which will take place in San José, Costa Rica, December 2014. 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 three times in the past: in 1999 to R. Geoffrey Coyle, in 2011 to Diana Fisher and in 2013 to John Richardson. The fourth Lifetime Achievement Award in our history will be presented at the 2014 conference.

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Creator of Learning Environments

Lupina Young Researchers Award Announcement (External Award)

The Health Policy Special Interest Group (HPSIG) of the System Dynamics Society is proud to announce the Lupina Young Researchers Award for work in health system dynamics. The award is sponsored by the Lupina Foundation of Toronto, Canada, and will be accompanied by a check in the amount of CAN$5000. The award will be presented to the recipient (or recipients) during the HPSIG meeting on Sunday afternoon just preceding the conference. This award will be given to people at early stages of their careers to encourage them to do further work in health system dynamics.

Model Analysis SIG (SIG-MA) Annual Meeting

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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! The Model Expo will be scheduled at the conference during the lunch* break. 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 (wireless will be available). In addition to encouraging all authors to upload copies of their 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.

Modeling Assistance Workshop

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Initiative for SD in the Public Sector

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.

Newcomer Orientation

Leonard A. Malczynski
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Sandia National Laboratories

Özge Karanfil
karanfil@mit.edu
MIT

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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isee systems

Andrew Ford
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Peter M. Milling
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System Dynamics Society

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, 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 formally established in 2009. Winners for this award, as well as other recognition awards, are listed on the Society website.

Jill A. Kuhlberg
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Washington University in St Louis

Sibel Eker
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Delft University of Technology

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 keynote addresses, parallel and poster sessions, a social event and an annual group photograph, 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.

Pascal J. Gambardella
pascalgambardella@gmail.com

David W. Lounsbury
david.lounsbury@einstein.yu.edu
Albert Einstein College of Medicine

Psychology SIG Roundtable and Annual Meeting

Psychological variables and social processes within dynamic models can lead to better understanding of the causes of the problem and can enhance the field of psychology by developing dynamic models of social processes. The Psychology SIG studies ways for integrating psychological constructs into system dynamics models through use of system dynamics methodology to simulate psychological theories and the use of 'soft' variables in model formulation, simulation, and validation. To satisfy these activities the SIG supports networking, education, collaborative modeling projects, and manuscript/modeling consultation and review. The roundtable will consist of three segments: current progress, networking and collaboration, and future plans. During the first (and longest) segment we will discuss current progress, highlighting relevant conference presentations and inviting these presenters to discuss their work, including any lessons learned. During the next segment we will suggest new problems to explore and suggest areas where members can collaborate. We will conclude with a brief discussion of our plans to hold virtual presentations during the year.

Red Ribbon Event and SD Career Link Bulletin Board

The goal of the Red Ribbon Events, scheduled at the refreshment breaks, 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. The Red Ribbon 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 another time. This event is about networking and providing guidance and support to job-seekers. In conjunction with the Red Ribbon Events the SD Career Link Bulletin Board will also be available. We hope to see you there!

Natalia N. Lychkina
lychkina@guu.ru
State University of Management

Russian Chapter Roundtable and Annual Meeting

The Russian Chapter announces the Roundtable and Meeting at the Delft SD Conference. Everybody is welcome to meet with members of Russian academic, scientific, and business institutions, which use system dynamics. The meeting is intended as a forum for exchanging opinions and building partnership. The Russian Chapter of the SDS was formed in 2006 with participation of leading Russian universities. It participates in SDS Conferences since 2008. More information on the Russian Chapter can be found on www.sysdynamics.ru (in Russian). The attendees will share their experience on the most successful educational and research projects in system dynamics in the leading Russian universities in fields of management and economics, such as Lomonosov Moscow State University, State University of Management, and others. Topics will also include talks on consulting projects in corporate and government administration. Cooperation in the field of education and science, including creation of masters programs and research centers with international participation is important for the Russian SD community today. Most popular applications of simulation in Russia are industrial projects and policy research in economics and social care. All the interested parties are welcome to participate. For additional information, please contact Natalia Lychkina: lychkina@guu.ru.

Josephine Kaviti Musango
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Stellenbosch University

South Africa Chapter Annual Meeting and Roundtable

The South Africa System Dynamics Chapter is the first in sub-Saharan Africa, which was approved and recognised by the System Dynamics Society in February 2014. The goal of the Chapter is to promote the understanding and awareness of system dynamics as a problem-solving approach to many of the Africa-based problems. The participants of the roundtable will be Chapter members as well as any academics and practitioners interested in research on African issues and challenges. Being the first roundtable, the purpose will be to introduce the Chapter, discuss upcoming planned activities, exchange new ideas, and register individuals interested in joining the Chapter as Associate Members.

Linda Morecroft
lem@alum.mit.edu

Monique van der Toorn-Fennema
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Delft University of Technology

Spouses' Lounge

The Spouses' Lounge will be open during this year's conference in Delft. 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 Delft area. It provides an opportunity to make new friends and renew acquaintances. The Spouses' Lounge will be located in the Hive Room of Delft University Library (next door to the conference venue). Please join us for the morning kickoff meeting on Monday 21 July at 9am. Tea and coffee will be provided. More information on the Spouses' Lounge program is available on the conference website: http://conference.systemdynamics.org/venue/social-program/.

Vincent de Gooyert
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Radboud University Nijmegen

Student Chapter Annual Meeting

The Student Chapter will elect its 2014/2015 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.

Erik Pruyt
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Delft University of Technology

Summer School Wrap-Up

On Thursday, there will be a Summer School Wrap-Up Event. Agenda items of this wrap-up event include: (i) a retake exam, (ii) project presentations, (iii) a final Q&A session for summer school participants, (iv) final supervision meetings, (v) an opportunity to provide feedback to the organizers, and (vi) the organization of the next summer school.

Stefano Armenia
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Engineering Ingegneria Informatica SpA

SYstem Dynamics Italian Chapter (SYDIC) Annual Meeting

SYDIC (SYstem Dynamics Italian Chapter) 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 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 2013 - June 2014 the SYDIC Policy Council will present the main activities of SYDIC members both in the Academic (Universities & Research 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.

Edward G. Anderson
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University of Texas

System Dynamics Society Business Meeting

All members and interested parties are invited to attend the annual System Dynamics Society Business Meeting.

Douglas McKelvie
douglas.mckelvie@symmetricpartnership.co.uk
The Symmetric Partnership

UK Chapter Annual Meeting

Chapter Objectives in the United Kingdom are to: Identify, extend and unify knowledge contributing to the understanding of feedback systems; promote the development of the field of System Dynamics and the free interchange of learning and research in all related fields; encourage and develop educational programmes in the behaviour of systems. Each year the chapter organises the Annual Conference, a series of presentations from eminent practitioners and the opportunity to meet and discuss issues. At Delft, in addition to an informal gathering over drinks, this meeting will enable UK Chapter activities to be discussed, including the 2014 UK Chapter Conference and the format, timing and location of future conferences. Ideas for industry-specific topics for future UK events will be invited and discussed, plus the potential for UK practitioner collaboration on, for example, European Commission funded research as well as national and local government and private enterprise studies. Our website and twitter feed will keep you updated on this meeting as July 2014 approaches.

Robert L. Eberlein
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isee systems

XMILE Roundtable - Open Meeting

During last year's conference we announced the formation of the XMILE Technical Committee under the OASIS Open standards organization. Since then, we have created a draft specification that we are putting forward to the System Dynamics community prior to the OASIS review and approval process. The XMILE specification covers both the modeling language used to represent System Dynamics models and the layout of diagrams used to visualize and typically build such models. The language is based on the core precepts of System Dynamics, most notably stocks and flows, with extensions to capture most models in use today, and an extensibility that will support the rest. In addition to developing the spec, the committee has been very busy trying to promote awareness of both XMILE and System Dynamics. During the roundtable we will give an overview of what the specification looks like, what we have been doing to broaden reach, and, most importantly, invite discussion from participants.

Workshops

Listed alphabetically by Workshop name

Leonard A. Malczynski
lamalcz@sandia.gov
Sandia National Laboratories

Steinar Moen
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Powersim Software AS

Advanced Modeling with Powersim Studio

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: Laptop with Studio loaded or a commercial version of Studio. Go to www.powersim.com. Advanced Reading: Bring Studio models as appropriate.Level: Intermediate.

Kim D. Warren
kim@strategydynamics.com
Strategy Dynamics Ltd

Christopher Spencer
chris@sysdea.com
Strategy Dynamics Ltd

Agile SD: a fast, effective, reliable approach to model development

This workshop demonstrated the Agile SD process and gave participants experience of its use – both a facilitated white-board approach to capturing a quantified picture of an issue, and the same software model. The method specifies the time-path of the issue of concern. Performance aims (reducing crime rates, for example) are always traceable to stock-quantities (criminals) unless they are themselves stocks (number of criminals). The process therefore tracks the causes of the problem-issue until one or more stocks are reached, validating that causality with estimated time-charts for each item. The behaviour of the stocks is then explained by adding flow-rates (new people taking to crime, or giving up), again supported with time-values for each flow. Finally, the causes of each flow are traced back to three main root-causes – decisions by actors in the system (e.g. penalties for crime), external factors (e.g. unemployment) or existing stocks (e.g. police numbers). This step identifies interdependence and feedback among the stocks. The workshop both showed the approach in use for a real case and applied the process to an example from the workshop participants, to show how it can be done from a standing start, including live development of a working model**.**

Requirements: Participants should bring: Either a laptop or share of one - participants will work in groups of 2-3.Advanced Reading: Look out for the paper on "Agile SD" in the conference, if accepted.Level: Everyone.

Vladimir Koltchanov
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Anylogic Europe

AnyLogic 7 Multi-method simulation software

At this workshop we will introduce you to AnyLogic - the only simulation development environment that allows you to build not just System Dynamics models but also Multi-Agent and/or Discrete Event simulations. We'll show how to combine these approaches at the same level or hierarchically into Hybrid models. We'll demo the newest version AnyLogic 7 with enhanced support for multimethod modeling and easier creation of models using special wizards instead of writing java code. Other features to be demoed during the workshop; Using OptQuest optimizer; Saving and restoring the model state; Saving the experiment data; Exporting and using libraries; Exporting the model; Embedding

AnyLogic models into your software. Attendees will be given an AnyLogic brochure and a DVD with a trial version of AnyLogic 7 for Windows, Mac and Linux. You can bring your laptop and follow the presenter, or just watch.

Requirements: Participants should bring: You can bring your laptop and follow the presenter, or just watch. Advanced Reading: none. Level: Everyone.

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Robert L. Eberlein
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Building and Publishing Model Interfaces using Stella and iThink

This is a hands on workshop that will take participants through the process of creating an interface to their Stella or iThink models and potentially publishing that interface to the web. We will start with an existing model and work through the process of creating an elegant interface that allows users with no background training to have fun and gain insights working with a model. Using isee Netsim we will demonstrate how that interface can then be made available to anyone browsing the web. No special facility with Stella or iThink is required. Participants should bring a Windows or Macintosh computer and we will install the software for use during the workshop.

Requirements: Participants should bring: A Windows or Macintosh computer. Advanced Reading: None. Level: Everyone.

Rachel Ferencik
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Georgia Health Policy Center

Chris Soderquist
chris.soderquist@pontifexconsulting.com
Pontifex Consulting

Karen Minyard
kminyard@gsu.edu
Georgia Health Policy Center

Building Systems Thinking Skills for Policymakers: Using a range of systems thinking activities to deliver insight

Policymakers, worldwide, must tackle some of the most challenging and complex issues. Yet political environments that are polarized, partisan, and divisive are ineffective and do not permit policymakers to be effective. System dynamics-based thinking skills are an essential skill set for policymakers facing adaptive challenges. This workshop will provide hands-on techniques and strategies used in a university-based educational program for state policymakers that apply system thinking skills to health policymaking. This approach to legislative education can begin to change the way legislators frame issues, ask questions, build understanding and develop solutions to complex health care issues. In this workshop, participants will actively engage in hands-on examples and strategies to engage policymakers in public policy dialogue and decision-making that better prepares them to frame issues, ask questions and consider solutions to complex policy issues.

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

Thomas Fiddaman
tom@vensim.com
Ventana Systems

Calibration with Vensim

In this hands-on workshop we will explore model calibration in Vensim. To get some insight into the fundamentals of the process, we will begin with a discussion of likelihood and hand calibrate a model, using synthetic data. Then we will repeat the process, using the built-in functionality of Vensim. Finally, we will illustrate a variety of advanced techniques: Poisson and Bernoulli distributions that arise with individual or event data, state estimation with Kalman filtering, Markov Chain Monte Carlo and Bayesian estimation with priors**.**

See next page for Requirements.

Requirements: Participants should bring: Bring a laptop or share with a friend. We aspire to provide power, but a full battery is a good idea. Materials and a Vensim DSS trial copy will be distributed on USB key; arrive a little early to install software if you don't already have a copy of Vensim DSS or Pro (required for automated calibration). Advanced Reading: Familiarity with running models in Vensim and the most basic system dynamics concepts is assumed, but no other preparation is necessary. Level: Everyone.

David Keith
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MIT

Sergey Naumov
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MIT

John Sterman
jsterman@mit.edu
MIT

Driving The Future: A Management Flight Simulator of the Market for Alternative-Fuel Vehicles

The history of alternatives to gasoline-powered internal combustion vehicles is one of 'sizzle and fizzle' – an initial burst of enthusiasm and effort, followed by decline and failure as the entrant technology fails to gain a sustainable share of the market. Despite this, incumbent automakers and startups continue to pursue a range of alternative fuel vehicle (AFV) platforms to achieve energy and environmental goals, running on fuels including compressed natural gas, biofuels, electricity and hydrogen. In this interactive workshop, participants will experiment with 'Driving the Future', a management flight simulator of the US car market. Playing the role of 'car czar', you will make strategy and policy decisions as you seek to reduce oil dependence and greenhouse gas emissions from the US automobile fleet without breaking the bank. Bring your laptop computer to participate, or pair up with a friend in the workshop**.**

Requirements: Participants should bring: Laptop. Advanced Reading: None. Level: Everyone.

Erik Pruyt
e.pruyt@tudelft.nl
Delft University of Technology

Exploratory System Dynamics Modeling and Analysis

In this workshop, participants will become familiar with Exploratory System Dynamics Modeling and Analysis (ESDMA). In this hands-on workshop, participants will be guided through the different stages and will be introduced to several methods, techniques and tools used in ESDMA, such as adaptive sampling, time series clustering techniques, machine learning techniques to analyse models and their outcomes, and special visualization techniques. Note: this workshop is only for advanced modellers**.**

Requirements: Participants should bring: Preferably a laptop with Vensim DSS. Advanced Reading: Reading materials will be uploaded. Level: Advanced.

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Sandia National Laboratories

Steinar Moen
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Powersim Software AS

La Tonya N. Walker
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Sandia National Laboratories

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**.**

See next page for Requirements

Requirements: Participants should bring: Please get a free copy of Studio Express at www.powersim.com if you do not have a commercial license. Advanced Reading: Download Supporting documents.Level: Everyone.

Antti Villberg
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Semantum Oy

Getting Started With Simantics System Dynamics and Simupedia

Simantics System Dynamics is a new open source modelling tool developed in Finland by VTT Technical Research Centre of Finland and Semantum Ltd. The software is free and can be downloaded from www.simantics.org. Simantics System Dynamics provides basic modelling and simulation capabilities and adds useful features such as reusable model components and model-based game experiments. Users of Simantics System Dynamics can also create web user interfaces and publish them into a simulation cloud service called Simupedia. This workshop gives a first introduction into making models with Simantics System Dynamics**.**

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

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William Schoenberg
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Getting Started with Stella

Learn how to build, explore and communicate System dynamics models using Stella. This is an introductory workshop for people who are either new to the field or do not have recent experience using Stella. Participants will be taken through the mechanics of creating models using the basic stock and flow model building blocks. The process for simulating the model and analyzing results will also be worked through. An important takeaway from this workshop is the ability to articulate the manner in which structure determine behavior for simple systems. Please bring a Windows or Macintosh computer to allow installation of the software for use during the workshop. Stella Modeler for the iPad can also be used for this workshop, but will need to be installed in advance of the workshop**.**

Requirements: Participants should bring: A windows or Macintosh computer or an iPad with Stella Modeler installed. Advanced Reading: None. Level: Everyone.

Thomas Fiddaman
tom@vensim.com
Ventana Systems

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: Bring a laptop or share with a friend. We aspire to provide power, but a full battery is a good idea. Vensim PLE can be installed in advance from the web link provided. Materials and a Vensim DSS

trial copy will be distributed on USB key.Advanced Reading: Familiarity with the most basic system dynamics concepts is assumed, but no preparation is necessary. If you can't make it, there is a brief video tutorial at http://vensim.com/building-a-simple-vensim-model/ Level: Everyone.

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Ventana Systems

Larry Yeager
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Ventana Systems

David W. Peterson
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Ventana Systems

Hands-on Entity Based System Dynamics

This is a hands-on introduction to Ventana's new platform for system dynamics modeling that supports detailed and object oriented modeling while preserving attractive features of existing tools like Vensim, including a completely declarative language with a graphical representation. We will introduce the software and new concepts, including collections of entities, attributes, relationships, aggregation and allocation functions, and actions. Features facilitate modularity and collaboration, provide a more natural description of detail than arrays, and solve sparse matrix problems. It has application to both traditional system dynamics, with modular sectors, and to agent based modeling.

Requirements: Participants should bring: Bring a laptop or share with a friend. We aspire to provide power, but a full battery is a good idea. Materials and trial software will be distributed on USB key; arrive a little early to install software if possible.Advanced Reading: None. Level: Everyone.

Michael Bean
mbean@forio.com
Forio

High Performance Online Simulations with the Next-Generation Forio Simulation Platform

In spring 2014, Forio released its next-generation simulation platform. At this workshop, learn how to put interactive simulations in the hands of decision-makers with online simulations that let users change assumptions and instantly see results through their web browsers or mobile devices. With the Forio simulation platform, you can import models and enable users to share and compare scenarios online. The Forio platform combines sophisticated analysis, universal accessibility via online data visualizations, and centralized model with secure access**.**

Requirements: Participants should bring: Laptop. Advanced Reading: None. Level: Everyone.

Diana Fisher
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Portland State University

Introduction to System Dynamics Modeling for Math and Science Instruction: Online Professional Development Opportunity

If System Dynamics (SD) modeling is to be infused in precollege, community college, and early undergraduate mathematics and science classrooms, instructors need to have an opportunity to receive training that would give them instruction in some of the core SD constructs (stock/flow structures, feedback loop analysis, designing dimensionless multipliers, etc.), best model-building practices, curriculum (model-building lessons), experience building the lessons they could use with their students, and experience designing some of their own introductory SD modeling lessons. This online course will provide such experiences for the math or science instructor who is new to SD modeling but who wants to start having his/her students build small models as part of their course of study. Four

(quarter) credits from Portland State University will be available but not required. This workshop will present the structure of the online course and give participants an opportunity to build some small models. (Participants should bring laptops.) An online sequel course is being developed and will be available in a year. The sequel course will allow math and science instructors who want to expand their SD modeling capabilities to the next level, more independent model-building experiences, an opportunity to do so**.**

Requirements: Participants should bring: Bring a laptop. Advanced Reading: none. Level: Beginner.

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Copenhagen Business School

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Washington State University

Model Analysis Tools and Methods (in Computer Room B)

A large portion of the SD practitioners are unaware of the model analysis tools that had been developed in the field. Moreover, the ones who know some of the previously developed tools have limited information about how to access and use them. Naturally, this seems to hinder wider utilization and further development of these tools and methods. In that respect, this workshop aims to introduce a selection of model analysis methods and tools. In doing so, the aim is to 'demystify' these tools and methods. Therefore, it is aimed to go beyond simply lecturing the audience about these methods, and to help them actually practice with these methods on simple models during the workshop in a hands-on manner. The whole day workshop consists of four sessions that are devoted to pattern-based model testing, multivariate sensitivity analysis, statistical screening and loop eigenvalue elasticity analysis**.**

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

Diana Fisher
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Portland State University

Modeling Dynamic Systems: Lessons for a First Course

"Modeling Dynamics Systems: Lessons for a First Course" (third edition) provides a set of materials that enable educators at the secondary and college levels to teach a one-semester or one-year course in System Dynamics modeling. These lessons are also useful for trainers in a business environment. Developed for beginning modelers, the lessons contained in this book can be used for a core curriculum or for independent study. The lessons include some of the classic System Dynamics problems (population change, resource sustainability, drug pharmacokinetics, spread of an epidemic, urban growth, supply and demand, and more). Feedback analysis is integral to the lessons. Guidelines for an independent project and an outline for a technical paper explaining the creation process and structure of the final model, together with scoring guides for both the model and the paper, are included. Participants in the workshop will have a chance to build

some simple models (participants should bring laptops) and gain a sense of the progression leading to a more sophisticated model. Student work will be presented and can also be viewed at www.ccmodelingsystems.com**.**

Requirements: Participants should bring: Participants should bring a laptop.Advanced Reading: none. Level: Everyone

Kaoru Yamaguchi
muratopia@icloud.com
Japan Futures Research Center

Money and Macroeconomic Dynamics

Macroeconomics is one of the core subjects in social science, and macroeconomic behaviors such as the recent financial and debt crises are affecting all of us. The recent macroeconomic book by this instructor: Money and Macroeconomic Dynamics - Accounting System Dynamics Approach (2013) - can deal with these crises in an innovative way becasue it is based on the analytical method of system dynamics. This is the second workshop, being followed by the first one at the Asia-Pacific SD conf. in Tokyo, on Feb. 24, 2014. The workshop is organized for those who are considering the book as a textbook in the SD class and/or macroeconomic modeling classes at the undergraduate and graduate levels, as well as for those SD researchers and economists who are interested in expanding macroeconomic models for their researches and case studies of specific countries. All models are distributed in the workshop, and run on Vensim Model Reader, a free shareware for PC and Mac. Learning macroeconomics by running simulations turns out to be very effective, the instructor believes, not only for the beginners of macroeconomics as well as economic professionals, but also for the SD modelers in general**.**

Requirements: Participants should bring: Laptop. Advanced Reading: None. Level: Everyone

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Robert L. Eberlein
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isee systems

William Schoenberg
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isee systems

Organizing and Analyzing Models with Stella and iThink

This is a follow on workshop to Getting Started with Stella will teach participants how to organize models using modules and how to analyze them and test behavior under varying assumptions. We will combine practical, hands on, step-by-step instructions with discussion of the foundation for module based model construction and its role in large scale model development. We will also, time permitting, look at the connections between computation and presentation in order to provide a clear understanding of the relationship between tabular and graphical results. This workshop is intended for analytic and numerately inclined individuals with some experience with iThink or Stella including those who attended the getting started workshop. Please bring a Windows or Macintosh computer to allow installation of the software for use during the workshop**.**

Requirements: Participants should bring: Familiarity with Stella/iThihnk or attendance of the getting started workshop. A windows or Macintosh computer. Advanced Reading: None. Level: Intermediate.

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Washington University in St Louis

Etiënne A. J. A. Rouwette
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Radboud University Nijmegen

Scriptapedia 5.0: A Tool for Designing "Scripted" Group Model Building Workshops

This workshop introduces participants to Scriptapedia 5.0, a database application for designing scripted GMB workshops. Scriptapedia 5.0 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 5.0 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: No equipment required. Advanced Reading: None. 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 latest version of 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: Participants are encouraged to bring their laptops to be able to use the tool during the workshop. Advanced Reading: Martinez-Moyano, I. J. (2012), Documentation for model transparency. System Dynamics Review, 28: 199–208. Level: Everyone.

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System Dynamics with Repast Simphony

The current System Dynamics capabilities in Repast Simphony will be demonstrated. Repast Simphony is a free and open source cross-platform Java-based modeling system designed at Argonne National Laboratory. Repast Simphony supports the development of extremely flexible models for use on workstations and small computing clusters**.**

Requirements: Participants should bring: Participants are encouraged to bring their laptops to be able to follow along the development of an example at the workshop. Advanced Reading: None. Level: Everyone.

Business Day

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Introductory Lecture: System Dynamics

This lecture will introduce and explain the field of system dynamics. It is intended for people who are new to the field of system dynamics and would like to know what it entails and how system dynamics may be used for long term strategic issues. We will first discuss the background of system dynamics and introduce some important concepts, such as: stocks, flows, feedbacks, and delays. A system dynamics model is developed during a qualitative phase in which a causal diagram and/or stock-flow diagram is made, and a quantitative phase in which the model is quantitatively represented using specialized software. We will explain the modelling cycle, and discuss the steps that are taken in developing, testing and using a model. The wide variety of possible applications of system dynamics will be illustrated by showing different examples of applications, e.g. in health care, water management and energy.

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Introductory Lecture: Group Model Building

System dynamics modellers have been using facilitated approaches for several decades now. A generic term for approaches in which stakeholders are involved in the development of system dynamics models is group model building. Research on this approach has evolved in two directions. First, evaluation studies have consistently shown that group model building is able to create consensus and commitment among stakeholders. Second, although in use since the 1980s, the process of group model building remains opaque and has been called an art rather than a science. This has inspired the development of so-called scripts. Scripts are small parts of modelling process that have been tested in practice and serve as standard building blocks for projects. The lecture will address both the process as well as the impact of group model building.

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Workshop: Strategy Development in Water and Coastal Management; Can System Dynamics Modelling Contribute?

The focus of the workshop will be on exploring the potential of System Dynamics in bridging across existing hydro-morphological or hydrological modelling approaches, by qualitatively or quantitatively linking the existing models. This could imply the development of a policy-level quantitative system dynamics model, or it could imply undertaking causal diagramming or qualitative model development. But, who will build such models and how will they be built? For whom will they be developed? Will they be for policy makers or will they be for the advisors of policy makers? Will they be built with stakeholders, and will these stakeholders include people from affected communities? These are some of the

questions that will be discussed as we explore the role that system dynamics can play in strategy development in water and coastal management. The workshop aims to address this generic issue by a combination of presentations and active participation from workshop participants. Following one or more initial presentations that include examples of system dynamic models in water management, the participants will identify issues, potential benefits and barriers and will then work further on a specific case: the Scheldt Estuary.

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Workshop: Modelling Changes in Mental Health Care in The Netherlands

The Dutch mental health care system is in transition. Instead of treating people who need care in institutions, new policy is to treat them in their own homes as much as possible (and feasible). This will have benefits for their well-being, but it will also mean that the total costs of care will not rise as they have in the past. Lower costs are necessary as the total available budget will probably have to shrink in the coming years. The Dutch consultancy company Significant has developed a simulation model that shows what the (side-)effects of this transition can be. During the workshop, the changes in the health care system will first be introduced. Following this, systems thinking and modelling of mental health care in The Netherlands will be explained. The last part of the workshop will consist of a discussion session on other changes in the mental health care sector and how they can be modelled.

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Workshop Asset Dynamics: The added value of System Dynamics for Asset Management and Asset Life Cycle approach

The increasing complexity in today's technology results in tremendous challenges to successfully manage technical systems during their lifetime. In particular, the long-term safe and reliable functioning of technology in a dynamic environment creates a challenge for operators, maintenance engineers and maintenance managers to select the right interventions. In addition, the decision making process of technical assets often requires a multi-discipline and multi-stakeholder approach. For example, stakeholders may include investors, asset-owners, policymakers, and public actors. This workshop introduces participants to the world of Asset Dynamics by linking life cycle management concepts to system dynamics. Participants are challenged to engage in an Asset Management Game which captures the dynamics of typical decision-making processes in the field of maintenance issues and investments in new technology. The goal of this session is to exchange experiences between system dynamics professionals, asset owners, managers and maintenance professionals and together explore the role and potential of system dynamics in effective asset management approaches.

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