



Proceedings of the 30th International Conference

July 22-26, 2012
St. Gallen, Switzerland

Conference Host:
University of St. Gallen

Dynamic Partner:
Stiftung zur Förderung der Systemorientierten Managementlehre

Conference Partners:
Continental Tires

Greenwood Strategic Advisors AG and Ventana Systems
RoCC-Responsible Corporate Competitiveness Initiative
at the University of St. Gallen

System Dynamics Group, Institute of Management, University of St. Gallen

*Conference proceedings
sponsored by:*



**WILEY-
BLACKWELL**

Edited by:
Elke Husemann and David Lane

Production Team:
Robin S. Langer, LouAnne Lundgren,
Erin R. Sheehan and Joan M. Yanni

Proceedings
of the
30th International Conference
of the
System Dynamics Society

Proceedings
of the
30th International Conference
of the
System Dynamics Society

July 22-26, 2011
St. Gallen, Switzerland

Edited by:

Elke Husemann and David Lane

Production Team:

Robin S. Langer, LouAnne Lundgren,
Erin R. Sheehan and Joan M. Yanni



©2012, The System Dynamics Society

ISBN 978-1-935056-09-6

To obtain additional copies of these proceedings, or to learn more about the System Dynamics Society and the international research conferences, contact:

Roberta L. Spencer, Executive Director
System Dynamics Society
Milne 300 - Rockefeller College
University at Albany, State University of New York
135 Western Avenue
Albany, New York 12222, United States of America
Phone: + 1.518.442.3865
Fax: + 1.518.442.3398
Email: office@systemdynamics.org
Website: www.systemdynamics.org

Table of Contents

Welcome	1
Hosts, Partners and Conference Committees	3
Award Committees	4
Thread Chair and Submission Reviewer Volunteers.....	5
Acknowledgement of Sponsors.....	12
Sponsors, Exhibitors and Friends.....	14
2013 Boston, USA Conference Announcement.....	15
Reading Supporting Material.....	16
PhD Colloquium Presentations	17
Abstracts* <i>Listed alphabetically by first author within sections, unless noted otherwise.</i>	
Presentations	19
Meetings, Special and Convened Sessions	114
Chapter & Special Interest Group (SIG) Poster Presentations	124
Workshops	130
*Full works as provided are available on the Society website after the conference.	
Index of Authors, Presenters and Facilitators	135

Welcome

Dear Colleagues,

Guten Tag and *Grièzi*! Welcome to the 30th International Conference of the System Dynamics Society. This year, the conference is being held in St. Gallen, Switzerland, located in the heart of Europe, close to Lake Constance at the crossings of Germany, Austria, Switzerland, and the Principality of Liechtenstein. St. Gallen is the capital of Eastern Switzerland. It is a wonderful synthesis of a cultural center with 1400 years of monastic tradition, present in the historic Abbey District, which is World Cultural Heritage of UNESCO, and a powerful modern hub for economic activities, services, and education.

The program shows that the field of system dynamics is thriving. Conference participants come from 49 countries from all over the world. Including the PhD Colloquium, over the next five days, you will have a chance to present, listen to, and discuss system dynamics work of leading academics and practitioners.

The main theme is *Model-based Management*. This choice highlights the role that formal models can play in the effective management of dynamic systems and how skills in modeling and simulation can contribute to organizational design, organizational learning, and policy-making. The program will consist of invited and contributed sessions and workshops demonstrating the state of the art in the theory and application of system dynamics. The program schedule will also include exhibits, model assistance workshops, panel discussions, special sessions, a student colloquium, and Society business meetings.

To further increase your enjoyment of the conference, there will be time for social and professional interaction in a relaxed and fascinating setting, including a welcome reception with the Mayor of the city of St. Gallen on Sunday evening, an Informal Gathering on Sunday during and after registration, the Poster Symposium and Buffet on Monday, and the Conference Banquet on Tuesday, with a performance of traditional Swiss music. Visits of the Abbey Districts, and on an individual basis, excursions in the region, will also be offered.

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

In addition to our conference host, *the University of St. Gallen*, and all our other sponsors, we are very fortunate this year to have a number of conference partners, *Stiftung zur Förderung der Systemorientierten Managementlehre, Continental Tires, Greenwood Strategic Advisors AS and Ventana Systems, RoCC-Responsible Corporate Competitiveness Initiative at the University of St. Gallen, Helvetia Insurance and the System Dynamics Group, Institute of Management, University of St. Gallen.*

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

On behalf of the hosts and conference committees, best wishes from,

Markus Schwaninger, Elke Husemann, David Lane, Stefan Groesser, Jack Homer, and Roberta Spencer

Conference Hosts and Partners

Conference Host: **University of St. Gallen**

Dynamic Partner: **Stiftung zur Förderung der Systemorientierten Managementlehre**

Conference Partners: **Continental Tires**

Greenwood Strategic Advisors AG and Ventana Systems

**RoCC-Responsible Corporate Competitiveness Initiative at
the University of St. Gallen**

**System Dynamics Group, Institute of Management,
University of St. Gallen**

Conference Committees

Conference Chair: **Markus Schwaninger**
University of St. Gallen, Institute of Management

Program Chairs: **Elke Husemann**
David Lane
London School of Economics

Workshop Chair: **Jack B. Homer**
Homer Consulting

Organizing Chair: **Stefan Grösser**
University of St. Gallen, Institute of Management;
Bern University of Applied Science, Department of Economics

Conference Manager: **Roberta L. Spencer**
System Dynamics Society

Award Committees

Dana Meadows Award

R. Joel Rahn, Coordinator

Richard G. Dudley
Cornell University

Krystyna A. Stave
University of Nevada Las Vegas

Andrew Ford
Washington State University

John D. Sterman
System Dynamics Group
MIT Sloan School of
Management

John D. W. Morecroft
London Business School

Erich K. O. Zahn
Universität Stuttgart

Jay Wright Forrester Award

Jack Homer, Chair
Homer Consulting

Peter M. Milling
Mannheim University

Khalid Saeed
Worcester Polytechnic Institute

Erling Moxnes
University of Bergen

John D. Sterman
System Dynamics Group
MIT Sloan School of Management

System Dynamics Applications Award

Jack Homer
Homer Consulting

Kim D. Warren
London Business School

J. Bradley Morrison
Brandeis International Business
School

Eric F. Wolstenholme
Symmetric SD Limited

Mark Paich
Decisio Consulting Inc.

Erich K. O. Zahn
Universität Stuttgart

Community Service Award

David Lane, Chair
London School of Economics

Robert L. Eberlein

Andrew Ford
Washington State University

Roberta Spencer
System Dynamics Society

Thread Chairs

Edward G. Anderson
University of Texas

John A. Barton

Allyson Beall
Washington State University

Robert Y. Cavana
Victoria University of Wellington

Siôn Cave
QinetiQ Ltd

Brian C. Dangerfield
University of Salford

Vedat G. Diker
University of Maryland

Jim Duggan
National University of Ireland Galway

David R. Exelby
Decision Analysis Services Ltd

Thomas Fiddaman
Ventana Systems

Paulo Gonçalves
University of Lugano

Gary B. Hirsch
Creator of Learning Environments

Jack B. Homer
Homer Consulting

Peter S. Hovmand
Washington University in St Louis

Ignacio J. Martínez-Moyano
University of Chicago

John D. W. Morecroft
London Business School

J. Bradley Morrison
Brandeis International Business School

Erling Moxnes
University of Bergen

Paul C. Newton
The Boeing Company

Peter Otto
Union Graduate College

Özge Pala
Koç University

R. Joel Rahn

Scott F. Rockart
University of North Carolina

Etiënne A. J. A. Rouwette
Radboud University Nijmegen

Markus Salge
Greenwood Strategic Advisors AG

Krystyna A. Stave
University of Nevada Las Vegas

Jörn-Henrik Thun
Frankfurt Sch of Finance & Management

Jeff W. Trailer
California State University Chico

Silvia Astrid Ulli-Beer
Paul Scherrer Institute

Nuno Videira
New University of Lisbon

Submission Reviewers

Ahmed Abdeltawab Abdelgawad
University of Agder

Tarek K. Abdel-Hamid
Naval Postgraduate School

Emmanuel D. Adamides
University of Patras

Ashish Agarwal
Indira Gandhi National Open University

Salman Ahmad
Universiti Malaysia Pahang

Namsung Ahn
SolBridge Int'l School of Business

Bahadir K. Akcam
Western New England University

Fadhl Mohammed Al-Akwaa
University of Science & Technology

Mahmood Alborzi
Azad Islamic University

Stephen Alessi
University of Iowa

Ehsan Alikhani
Amirkabir University

Robert B. Allen
Victoria University of Wellington

Pedro Dagoberto Almaguer Prado
Beemprededor

Raed M. Al-Qireem
Al-Zaytoonah University of Jordan

Mónica A. Altamirano
Deltares

Richard Althouse
David Erway Group

Navid Amini Fard
Amirkabir University

Lianjun An
IBM TJ Watson Research Center

Lascelles Anderson
University of Illinois at Chicago

Santiago Arango
Universidad Nacional de Colombia

Seema Arif
University of Central Punjab

Stefano Armenia
CATTID Sapienza University of Rome

Holger Arndt
Universitat Erlangen Namberg

Steven P. Arquitt

Daniel J. W. Arthur

Mohamed Askar
Dominican University

Samuel Austin
US Geological Survey

Jorge Ayala-Cruz
University of Puerto Rico

Thread Chairs and Submission Reviewers

Ahmad Taher Azar
International Journal of SDA

George A. Backus
Sandia National Laboratories

Chris Baker

Bent Erik Bakken
Norwegian Defence University College

Yaman Barlas
Bogaziçi University

Adnan M. Barry
King Saud University

John A. Barton

Jan Bartoska
Czech University of Life Sciences

Pawel Bartoszczuk
Warsaw School of Economics

Daria Battini
University of Padova

Michele Battle-Fisher
Wright State University

Steffen Bayer
Imperial College London

Allyson Beall
Washington State University

Alemu Moges Belay
University of Vaasa

Todd BenDor
University of North Carolina

Asmeret Bier
Sandia National Laboratories

D. Bijulal
College of Engineering Trivandrum

Sumant Kumar Bishwas
DMS IIT Delhi

Enzo Bivona
University of Palermo

Laura J. Black
Montana State University

Peter K. Bradl
Univ of Applied Sciences Wuerzburg

Malcolm Brady
Dublin City University Business School

William Brown
US DOE/EIA

Fernando Buendia
Universidad Panamericana

Newton Paulo Bueno
Federal University of Vicosa

Kenneth H. Carpenter
Jewish Community Center of Schenectady

John Stephen Carroll
MIT

Steven A. Cavaleri
Central Connecticut State University

Bipin Chadha
Coensys Inc

Ricardo Matos Chaim
University of Brasilia

Jian Hung Chen
National Chi Nan University

Mario Gustavo Chong
Universidad de Lima

Anna Chroni

Jianxun Chu
Univ of Science & Technology of China

Martin Cloutier
University of Quebec at Montreal

Gianluca Colombo
University of Lugano

Dan S. Compton
The Boeing Company

Stephen H. Conrad
Sandia National Laboratories

Matthew A. Cronin
George Mason University

Scott Cunningham
Delft University of Technology

Orlando Roque Da Silva
United Metropolitan Colleges - FMU

Xin Dai
Sun Yat-sen University

Brian C. Dangerfield
University of Salford

Michael L. Deaton
James Madison University

Fabio Andreas Diaz Pabón
Universidad de los Andes

David Dickason
Bureau of Naval Personnel

Edgar Leonardo Duarte Forero
Escuela Colombiana de Carreras Industr

Richard G. Dudley
Cornell University

Jim Duggan
National University of Ireland Galway

Josko Dvornik
University of Split

Isaac Dyner
Universidad Nacional de Colombia

Robert L. Eberlein

Ezzat El Halabi
The Australian National University

Arun Abraham Elias
Victoria University of Wellington

Philip C. Emmi
University of Utah

Martijn Eskinasi
Netherlands Environmental Assessment

Gholamreza Eslamifar
Sharif University of Technology

Jan Faber
Utrecht University

Maurizio Faccio
University of Padua

Jeanne Fair
Los Alamos National Laboratory

Warren W. Farr
Refrigeration Sales Corporation

Larcio Ferracioli
Federal University of Espírito Santo

Lars Finskud
Vanguard Strategy

Diana Fisher
Portland State University

Michael Fletcher
Department of Defense

Fred Flett
JENTEC International

David N. Ford
Texas A&M University

Tom Lum Forest
Prometheal Systems

Jay Forrest
Forrest & Forrest

Scott Fortmann-Roe
University of California at Berkeley

Douglas Franco
West Center University

Meg Fryling
Siena College

Margaret Ann Fulenwider
Helmes & Co LLC

Tetsuma Furihata
Takachiho University

Valerie Gacogne
Complexio

Justus Gallati
Univ of Applied Science St Gallen

Luciano Gallón
Universidad Pontificia Bolivariana

Rafael M. García Rodríguez
Universidad de La Coruna

Nicholas C. Georgantzas
Fordham University Business Schools

Gus Geursen

Abhijeet Ghadge
Loughborough University

Navid Ghaffarzadegan
MIT

Nasim GhanbarTehrani
Tarbiat Modares University

Sameh Ibrahim Gharib
University of Bergen

David F. Gillespie
Washington University in St Louis

Diana P. Giraldo
Universidad Pontificia Bolivariana

Daniel Goldsmith
PA Consulting

Cleotilde Gonzalez
Carnegie Mellon University

Mark Gray
SigmaPM

Stefan Grösser
Bern University of Applied Sciences

Andreas Größler
Radboud University Nijmegen

Burak Güneralp
Texas A&M University

John W. Gunkler
Excelsior Group

Savas Hadjipavlou

Farshid Haghighi
USC University

Ali Haji Gholam Saryazdi
University of Science & Culture

Oliver Handel
Universidade Nova de Lisboa

Marzieh Taheri Hanjani
Research Center

Qingmin Hao
Tianjin University

Tim Haslett
Linchpin

Aime Heene
Ghent University

Magdy Helal
Higher Institute of Technology - Benha

Petri Helo
University of Vaasa

Gregory Hennessy
Furio Online Simulations

Gary B. Hirsch
Creator of Learning Environments

Siang Lee Hong
Indiana University

Peter S. Hovmand
Washington University in St Louis

Joe C. Hsueh
MIT

Bo Hu
Universität der Bundeswehr München

Lizhen Huang
Fuzhou University

Juan M. Huerta
Juan M Huerta Inc

Margarita Hurtado Hernández
Universidad Panamericana

Lihlian Hwang
Ming Chuan University

H. Kemal Ilter
Yildirim Beyazit University

C. Sherry Immediato
Heaven & Earth Incorporated

Jacob J. Jacobson
Idaho National Laboratory

Greg Jacobus

Sebastián Jaén
Universidad Nacional de Colombia

Justin Jagger
Department of Supply Chain Management

Harshvardhan Jaipurjar
Ashley Marketelligent Pvt Ltd

Mohammad S. Jalali
Virginia Tech

Balaji Janamanchi
Texas A&M International University

Arthur Janssen
Swissgrid

Robert Jeffers
Idaho National Laboratory

Jianguo Jia
Tongji University

Omer Jirdeh
Office of Mental Health

Klaus John
Chemnitz University of Technology

Paul E. Johnson
University of Minnesota

Scott T. Johnson
SysDynX LLC

Al Jones
NIST

Andrew P. Jones
Climate Interactive

Charles A. Jones
Harvard Kennedy School

Lee C. Jones
Ventana Systems

Phil Joyce
Swinburne University of Technology

Jasmin Kaiser
TU Darmstadt

Florian Kapmeier
Heilbronn University

Özge Karanfil
MIT

Evangelos Katsamakos
Fordham University

James Kehoe
Policy Impact Assessment

Thread Chairs and Submission Reviewers

Andjelka Kelic

Sandia National Laboratories

Andreas Kemper

European Business School

Karan Khosla

EarthSafe Products and Services

Dong-Hwan Kim

Chung Ang University

Hyunjung Kim

California State University Chico

Miroljub Kljajić

University of Maribor

Mirjana Kljajić Borstnar

University of Maribor

Deniz Koca

Lund University

Davorin Kofjac

University of Maribor

Hee-kyung Kong

ETRI

Ulli H. König

RWE Deutschland AG

Birgit Kopainsky

University of Bergen

Saroj Koul

Jindal Global Business School

Thomas Kuhn

armasuisse W+T

Veasna Kum

Zaman University

Ashwani Kumar

National University of Singapore

Martin H. Kunc

Warwick Business School

Jan H. Kwakkel

Delft University of Technology

Chester S. Labeledz

Central Connecticut State University

Peter Lacey

Whole Systems Partnership

Richard Langheim

Ramapo College of New Jersey

Sharon Lansing

New York State Div of Crim Justice

Ted J. Lawrence

New York State Energy Research and
Dev

Rene LeClaire

Los Alamos National Laboratory

Man-Hyung Lee

Chungbuk National University

Myoung Ho Lee

Han-Kuk University of Foreign Studies

Tsuey-Ping Lee

National Chung-Cheng University

Carlos A. Legna

La Laguna University

Rudi A. F. Lepomme

Gartner

Ilya Levin

Tel Aviv University

Anson Kin Tat Li

University of Auckland

Lan Hai Li

Xinjiang Inst of Ecology & Geography

Shyh-Jane Li

Commerce Development Research Inst

Chien-Liang Lin

National Kaohsiung First University

Keith Thomas Linard

John-Paul II Institute

Jing-jiang Liu

Zhejiang University

Manuel Liz

La Laguna University

Eduyn R. Lopez

Universidad Distrital Francisco

Luis López

INCAE Business School

David W. Lounsbury

Einstein College of Medicine Yeshiva

Mohamed Loutfi

University of Wales Institute Cardiff

Gregory A. Love

MITRE Corporation

Alexander Yury Lubyansky

University at Albany

Luis F. Luna-Reyes

Universidad de las Americas Puebla

Kathleen Lusk Brooke

Center for the Study of Success

John Lyneis

MIT

Kambiz E. Maani

University of Queensland

Roderick H. MacDonald

Initiative for SD in the Public Sector

Louis Macovsky

Dynamic BioSystems LLC

Mohammad Majdalawi

Arab Organization for Agricultural Dev

Leonard A. Malczynski

Sandia National Laboratories

Martin E. Maren

University of Bergen

Milica Marinkovic

University of Bergen

Jason Markham

Juan Martín García

Julia Martínez

Universidad de Murcia

Ignacio J. Martínez-Moyano

University of Chicago

Georgia Mavrommati

Michigan State University

Geoff McDonnell

UNSW

Marion McGregor

Canadian Memorial Chiropractic College

Stephen B. McIntosh

Cardiff University

Douglas McKelvie

The Symmetric Partnership

Alan Charles McLucas

Australian Defence Force
Academy/UNSW

Michael L. McManus

Children's Hospital

Arif Mehmood

Department of Transport

Carlos Manuel Méndez Acosta

Universidad de Belgrano

Luis Javier Miguel

University of Valladolid

Ihar A. Miklashevich

Belarusian National Technical Univ

Stanislava Mildeova

University of Economics in Prague

Peter M. Milling

Mannheim University

Nobuaki Minato
Keio University

Abdalla S. A. Mohamed
Cairo University

Jonathan D. Moizer
Plymouth University

Mohammad T. Mojtahedzadeh
The Boeing Company

Edoardo Mollona
Università degli Studi di Bologna

Mahri Monson
US Environmental Protection Agency

William M. Montante
Marsh USA Inc

Giovan Battista Montemaggiore
University of Palermo

Tae Hoon Moon
Chung Ang University

Andrew P. Moore
Carnegie Mellon University

M. Hashem Moosavi Haghghi
Ministry of Agriculture

Marciano Morozowski
WeSee

J. Bradley Morrison
Brandeis International Business School

Maximilian Mrotzek
University of Graz

Dong Mu
Beijing Jiaotong University

Matthias Otto Müller
University of Berne

Frank K. Murdock
Plymouth Tube Company

Josephine Kaviti Musango
Gauteng City Region Observatory

Landon S. Myers
The Boeing Company

Morteza Nazari
Sharif University of Technology

Adam Ng
National University of Singapore

Stephen Olu Ogunlana
Heriot-Watt University

Camilo Olaya
Universidad de los Andes

Rogelio Oliva
Texas A&M University

Gerard O'Reilly
LGS Innovations/Bell Labs

Nordin B. Othman
Zetta Consultants Sdn Bhd

Birnur Özbas
Rutgers University

Onur Özgün
Bogaziçi University

Ozgur Ozkan
Health Market Science

Gints Ozolins
Tele2

David W. Packer
Systems Thinking Collaborative

Özge Pala
Koç University

George Papachristos
University of Patras

Vassilis Papakonstantinou
Eugenides Foundation

Theresa Pardo
University at Albany

Randy E. Park
Decision Advancement

Sang Hyun Park
National Information Society Agency

Jorge Andrick Parra Valencia
UNAB

Jamshid Parvizian
Isfahan University of Technology

Kalyan S. Pasupathy
University of Missouri

Alberto Paucar-Caceres
Manchester Metropolitan University

Leonard Peacefull
University of Akron

Janecke Pemmer
PricewaterhouseCoopers

Gloria Pérez Salazar
Tecnológico de Monterrey

David G. Pfeiffer
University of Cincinnati

Kawika Pierson
Willamette University

Seçkin Polat
Istanbul Technical University

Roberto Poles
University of Melbourne

P. Jeffrey Potash
CIESD

Arash Pourhabib
Texas A&M University

Davide Provenzano
University of Bergen

Erik Pruyt
Delft University of Technology

Liang Qi
The Second Military Medical University

Ying Qian
Shanghai University

Rob Quaden
Carlisle Public Schools

Hassan Qudrat-Ullah
York University

Luis Rabelo
University of Central Florida

Jaziar Radianti
University of Agder

Martin Timothy Rafferty
SanMartin ltd

Hazhir Rahmandad
Virginia Tech

R. Joel Rahn

F. Vittorio Raimondi
Foresight Associates

K. Raman

Atefe Ramezankhani
Sharif University of Technology

Boris Ramos

Jørgen Randers
Norwegian School of Management

David Rees
Synergia Ltd

Juan C. Rego

André Reichel

Jose Luis Revah
SHL

Eliot Rich
University at Albany

Thread Chairs and Submission Reviewers

George P. Richardson
University at Albany

John M. Richardson
American University

Robert Rieg
Aalen University

James L. Ritchie-Dunham
Institute for Strategic Clarity

Donald Robadue
Coastal Resources Center

Lewlyn L. R. Rodrigues
Manipal University in Dubai

Jose Carlos Rodríguez
ININEE - UMSNH

Ricardo A. Rodríguez-Ulloa
Instituto Andino de Sistemas

David Rose
Fiserv

Jay K. Rosengard
Harvard University

Étienne A. J. A. Rouwette
Radboud University Nijmegen

Rahul K. Roy
Indian Institute of Management

Alexander V. Ryzhenkov
Institute of Economics SB RAS

Khalid Saeed
Worcester Polytechnic Institute

Abdolrahim Salavitar
Mahab Ghodss Consulting Engineers

Mohamed Mostafa Saleh
Cairo University

Hernando Alex Sanchez
Raytheon

Rui Ferreira Santos
New University of Lisbon

Jose Mari Sarriegi
Tecnum - University of Navarra

Ali Kerem Saysel
Bogaziçi University

Burkhard Schade
European Commission

Martin F. G. Schaffernicht
Universidad de Talca

Tim Scheffmann
Credit Suisse

William Schoenberg
Forio Online Simulations

Michael Schwandt

Markus Schwaninger
University of St Gallen

Markus Schwenke
University of St Gallen

Denisa Scott
KnowledgeBridge International Inc

Habib Sedehi
University of Rome

Man-Hua Sheng
Taiwan Textile Research Institute

Michelle Shields
AgResearch

Timothy J. Shimeall
Carnegie Mellon University

Vladimir I. Shiryaev
Uralsviazinform

William Siemer
Cornell University

Lukas B. Sihombing
University of Indonesia

Martin Simon
ipgroup

Andrej Skraba
University of Maribor

Valerijs Skribans
Riga Technical University

Jill H. Slinger
Delft University of Technology

Merica Sliškovic
University of Split

Vladimir Solodov
Moscow State University

Alireza Soloukdar
Islamic Azad University

Taiboo Song
The Boeing Company

M. Dolores Soto-Torres
Universidad de Valladolid

J. Michael Spector
University of North Texas

Thomas Stefan Spengler
Technical University of Braunschweig

Yeoryios A. Stamboulis
University of Thessaly

Peter Stasinopoulos
The Australian National University

Krystyna A. Stave
University of Nevada Las Vegas

William Steinhurst
Synapse Energy Economics Inc

Paul L. Stepanovich
Southern Connecticut State University

Hendrik Stouten
Ecological Economics Res New Zealand

Jürgen Strohhecker
Frankfurt School of Finance and Mgt

Jeroen Struben
McGill University

George F. Stuart
Future Impact Ltd

Lees N. Stuntz
Creative Learning Exchange

Toru Suetake
Japan Futures Research Center

Marek Susta
Proverbs Corporation

Aziiz Sutrisno
European Master Program in System Dyn

Harald Sverdrup
Lund University

Fabian Szulanski
ITBA

Mihaela Tabacaru
University of Bergen

Yutaka Takahashi
Senshu University School of Commerce

Muhammad Tasrif
Bandung Institute of Technology

Anas Tawileh

Ivan William Taylor
Policy Dynamics Inc

Timothy R. B. Taylor
University of Kentucky

Pard Teekasap
Rajamangala University of Technology

Daniel Thiel
University of Paris 13

Victor Thombs

Decision Dynamics

James P. Thompson

Duke NUS Graduate Medical School

Fang Tian

University of Southern California

Warren W. Tignor

SAIC

Jeff W. Trailer

California State University Chico

Denis Trček

University of Ljubljana

Kostas Triantis

Virginia Tech

Ya-tsai Tseng

Tunghai University

David Turbow

Trident University International

Ufuk Turen

Turkish Military Academy

Fusun Ülengin

Istanbul Technical University

Muhammad Aman Ullah

University of Auckland

Silvia Astrid Ulli-Beer

Paul Scherrer Institut

Imrana A. Umar

Powersim Solutions

Mauricio Uriona Maldonado

Federal University of Santa Catarina

Keyvan Vakili

Sharif University of Technology

Cornelia van Daalen

Delft University of Technology

Theo van Mullekom**Margarita Vázquez**

La Laguna University

Anders Vesterberg**Nuno Videira**

New University of Lisbon

Roberto E. Villasenor

ITESM Campus Toluca

Klaus Ole Vogstad

Agder Energi and NTNU

Viktor Vojtko

University of South Bohemia in Ceske B

John J. Voyer

University of Southern Maine

Khaled Wahba

Cairo University

Wayne Wakeland

Portland State University

Grit Walther

Bergische Universität Wuppertal

Cuixia Wang

Jiangxi University of Finance and Econ

Keming Wang

Counties Manukau District Health Board

Wei Yang Wang

National Kaohsiung Univ of Applied Sci

Lalit Narendra Wankhade

SGGS Institute of Engineering and Tech

Kim D. Warren

London Business School

Elise Weaver

Human Resources Research Organization

J. Chris White

ViaSim Solutions

Elin Whitney-Smith

Netalyst Inc

Sanith Wijesinghe

MITRE Corporation

Ines Winz

University of Auckland

Ellen Wolfe

Resero Consulting

Yangang Xing

Cardiff University

Li Xu

Fudan University

Kaoru Yamaguchi

Doshisha University

Min-Ren Yan

Chinese Culture University

Michael Yearworth

University of Bristol

Seung-Jun Yeon

Electronics and Telecom Research Inst

Joseph Yoon

Institute for International Commerce

Jiong You

Fudan University

Gönenç Yücel

Bogazici University

Dewi Yuliani

Mining and Energy Office of West Java

Erich K. O. Zahn

University of Stuttgart

Nicole Zimmermann

University of Siegen

Roy G. Zúñiga

INCAE Business Schoo

Many thanks to every volunteer for their time and energy. Our apologies if we inadvertently omitted anyone from any list.

Session Reporters will be listed and their reports will be published after the conference.

If you are interested in volunteering for future conferences, please contact the System Dynamics Society at office@systemdynamics.org; include your name, contact information and area of interest.

Acknowledgment of Sponsors

Host



University of St. Gallen

Dynamic Partner

Conference Banquet Sponsor

Stiftung zur Förderung der
Systemorientierten Managementlehre

Partners



Responsible Corporate Competitiveness



University of St. Gallen



and



Poster Symposium and Buffet Sponsors



System Dynamics Group

University of St. Gallen

Mid-Level Sponsors



Refreshment Breaks Co-sponsors

Mayor of St. Gallen
and
Kanton St. Gallen



Welcome Reception Sponsors



Refreshment Breaks Co-sponsors

Exhibitor Level Sponsors



Additional Sponsors and Friends



*Printed Conference Brochures
Part-sponsor*



Other Anonymous Sponsors



*Printed Abstract
Proceedings Sponsor*

Many organizations and individuals contributed to this conference. We wholeheartedly thank our sponsors and encourage you to thank their representatives during the conference. Please see contact information for conference sponsors and exhibitors on the following pages.

Our Sincere Thanks To All Our Sponsors

Sponsors, Exhibitors and Friends

Amber Blocks Ltd.

New York, New York, USA

AnyLogic Europe

Avon, France

www.anylogic.com

Continental Tires

Worldwide locations

<http://www.conti-online.com>

Dynaplan AS

Norway and Switzerland

dynaplan.com

Forio Online Simulations

San Francisco, California, USA

www.forio.com

Greenwood Strategic**Advisors AG and****Ventana Systems, Inc.**

Worldwide locations

greenwood-ag.com and

ventanasystems.com

Helvetia Insurance

St. Gallen, Switzerland

www.helvetia.ch

**HSG Alumni, University of
St. Gallen**

St. Gallen, Switzerland

www.alumni.unisg.ch

**International Society for the
Systems Sciences**

Pocklington, York, United

Kingdom

www.iss.org/world

isee systems

Lebanon, New Hampshire, USA

www.iseesystems.com

Jantz Morgan LLC

Boston, Massachusetts, USA

www.jantzmorgan.com

Lane Press of Albany

Albany, New York, USA

www.lanepressofalbany.com

The Manufacturing**Game®/Ledet Enterprises,
Inc.**

Houston, Texas, USA

www.manufacturinggame.com

Mayor of St. Gallen and**Canton of St. Gallen**

St. Gallen, Switzerland

www.sg.ch and www.stadt.sg.ch

MITRE Corporation

McLean, Virginia, USA

www.mitre.org

PA Consulting Group

Cambridge, Massachusetts, USA

and additional worldwide

locations

www.paconsulting.com

Paul Scherrer Institut

Villigen, Switzerland

www.psi.ch

**Pegasus Communications,
Inc.**

Waltham, Massachusetts, USA

www.pegasus.com

Powersim Software AS

Bergen, Norway

www.powersim.com

Powersim Solutions, Inc.

Herndon, Virginia, USA

www.powersimsolutions.com

PROGNOZ

Office locations worldwide

www.prognoz.com

RoCC-Responsible**Corporate Competitiveness
Initiative at the University****of St. Gallen**

St. Gallen, Switzerland

<http://www.rocc.unisg.ch>

Sandia National**Laboratories**

Albuquerque, New Mexico, USA

www.sandia.gov

SoL, The Society for**Organizational Learning**

Cambridge, Massachusetts

www.solonline.org

Stiftung zur Förderung der**Systemorientierten****Managementlehre****(Foundation for Systems-****Oriented Management****Education)**

St. Gallen, Switzerland

Strategy Dynamics Ltd

Princes Risborough,

Buckinghamshire, United

Kingdom

www.strategydynamics.com

System Dynamics Group,**Institute of Management,****University of St. Gallen**

St. Gallen, Switzerland

www.ifb.unisg.ch/en/sd

transentis management**consulting GmbH & Co.****KG**

Berlin, Germany

www.transentis.com

University of St. Gallen

St. Gallen, Switzerland

www.unisg.ch/en

Vanguard Strategy

London, United Kingdom

www.vanguardstrategy.com

Wiley-Blackwell

Chichester, United Kingdom

www.wiley.com

Worcester Polytechnic**Institute (WPI)**

Worcester, Massachusetts, USA

www.online.wpi.edu

Online Graduate Programs in System Dynamics

Master of Science

Graduate Certificate

Individual Courses



**WPI offers the only online
Master's in System Dynamics:**

online.wpi.edu/sysdyn.html

Do you want to advance your career by learning concepts that will help you think strategically?

The System Dynamics graduate program at Worcester Polytechnic Institute allows you to **earn a Master of Science or Graduate Certificate completely online**; you can also take individual courses based on your professional interests.

- Courses begin in September 2012 and January 2013
- Materials are accessible online at anytime
- Learn from distinguished faculty who implement system dynamics concepts into various fields

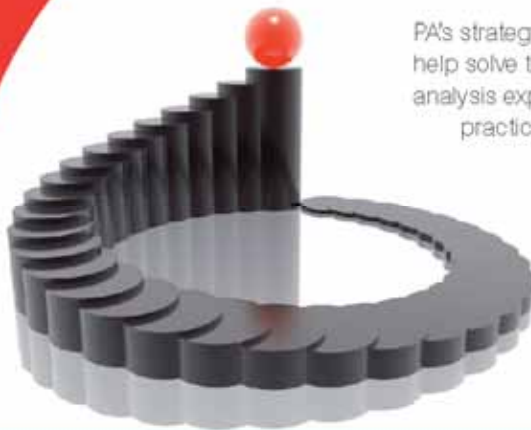


WPI

Worcester Polytechnic Institute
Online Learning

508.831.5517 | online@wpi.edu | online.wpi.edu
Worcester, MA 01609

PA Consulting
Group



PA's strategy and modeling experts work with major organizations to help solve their most important challenges. We combine world-class analysis expertise with in-depth industry knowledge to develop practical and enduring solutions, with a particular focus on government, energy, and healthcare problems.

- Corporate strategy and market analysis
- Government policy, planning and assessment
- Prioritizing major investments
- Strategic management and performance improvement on major projects
- Negotiation support and dispute resolution

www.paconsulting.com

System Dynamics Review

The official Journal of the System Dynamics Society

Publishing advances in systems thinking and system dynamics and their application to real-world challenges

Ranked in the ISI Management category and the Social Sciences, Mathematical Methods category

Get the latest *System Dynamics Review* table of contents delivered direct to your desktop and keep up-to-date with what's new in your research field. Simply visit www.wileyonlinelibrary.com/journal/sdr and click 'Get New Content Alerts'.

System Dynamics Society members can access full content of the *Review* online at:



www.wileyonlinelibrary.com/journal/sdr



Amber Blocks, Ltd.

535 Park Avenue, Suite 4A
New York, NY 10065
Tel (212) 593 3110

Allen L. and Jane K. Boorstein

IT HAS BEEN OUR PLEASURE to fund the Dana Meadows Student Paper Prize. Thanks to all who helped establish the fund to permanently endow this valuable award.

Best wishes to all the students, who are the future of system dynamics.



the world leader in Systems Thinking software™

STELLA *iThink*
for education & research *for business*

isee NETSIM™
web-based simulation sharing

www.iseesystems.com
support@iseesystems.com (603) 448-4990

Forio Simulate

Create, share, and publish your simulation online

- Make your own web simulation
- Learn how to write simulations
- Copy and Customize models developed by others for your own use
- Publish your simulation on your own website and blog



Try Forio Simulate at www.forio.com/simulate



The Manufacturing Game[®]

www.mfg-game.com (281)812-4148



The Manufacturing Game Workshop is an excellent example of how System Dynamics is used in the world of manufacturing, mining and refining every day.

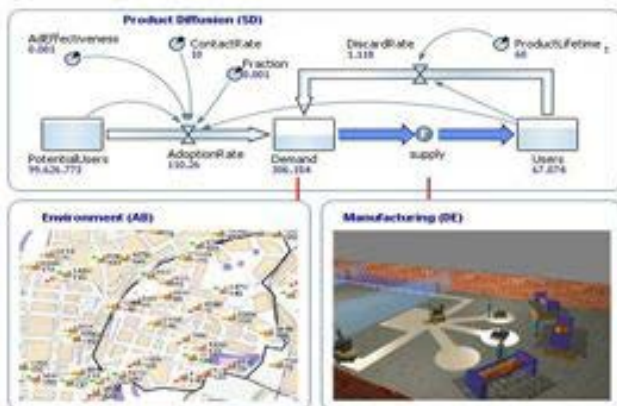
It is a **thought provoking simulation** that encourages all employees to get involved in the reliability of their facility as part of their normal routine.

The Manufacturing Game[®] facilitates organizational change through defect elimination and cross functional teams. It changes the way people think and how they work.

For more information on the Manufacturing Game Workshops and the development of other simulations contact us at info@mfg-game.com

AnyLogic[®] 6 www.AnyLogic.com www.RunTheModel.com

- Combine System Dynamics, Agent and Discrete event models
- Import VenSim models
- Share your models with RunTheModel.com



Powersim Studio 9

- New look - New features
- On high demands - Premium edition
- Free edition - Express
- Instructions through videos - Getting started

by
Powersim Software

WWW.POWERSIM.COM

POWERSIM solutions

a simulation-based strategic solutions company™



ExTrain™: Leadership & Management Training

ExPlan™: Planning & Performance Management

Studio™: Business Simulation Creation

- In-depth system dynamics modeling training workshops
- Powersim Studio™ modeling software
- Consulting: custom business simulation development

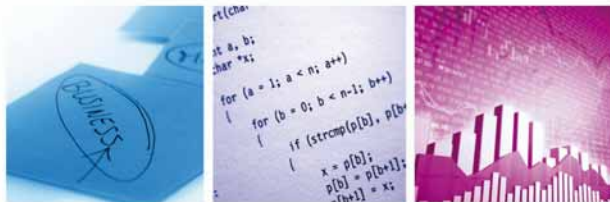
www.PowersimSolutions.com T +1 703-467-0910 • F +1 703-467-0912

VANGUARD STRATEGY

Vanguard Strategy is a London-based specialist consultancy providing dynamically-informed market and growth strategy to leading global brands. We assist our clients across a broad spectrum of industries to identify and capture growth opportunities, with a particular focus on optimising their ability to compete for consumer choice.

We integrate SD modelling with a variety of data analysis techniques, creating economically-correct market representations to identify and quantify leverage opportunities for our clients. The work and SD models provide our clients with a strategic edge and differentiated view of the market.

We are looking to expand our team with highly proficient quantitative Analysts and Consultants – ideally with some SD experience. If you are interested in progressing your career with a leading-edge strategy consultancy at the forefront of dynamic modelling, please contact our Recruitment Director Ruth Dines for further discussion: rdines@vanguardstrategy.com



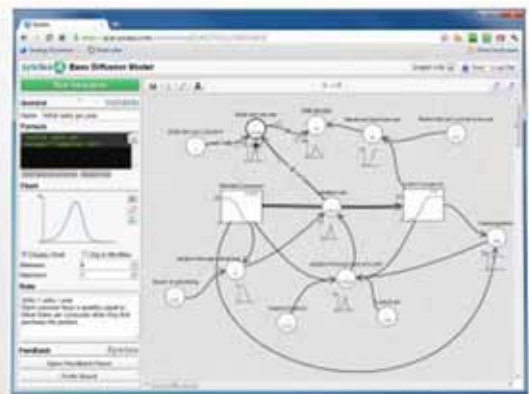
PROGNOZ

Business Intelligence....Made Simple

www.prognoz.com info@prognoz.com



Visit us in the exhibitors section to find out more about the new online modelling software from Strategy Dynamics and enter our competition to win a one year subscription. Workshop and Exhibitor demos also being held.



strategydynamics.com / sysdea.com



Responsible Quantitative Value Investing™

Using the power of **System Dynamics** to deliver exceptional investment portfolio performance since 2002.

Please contact us to learn more.



Jantz Morgan LLC, 470 Atlantic Ave, Fourth Floor, Boston, MA 02210
info@jantzmorgan.com 617.273.8018 www.jantzmorgan.com

TRANSFORMATION FOR SUCCESS

BUSINESS PROTOTYPING - THE TOOL OF OUR CHOICE

- OWNERSHIP** An approach and results that everybody can identify with.
- TRACEABILITY** Increased understanding of why changes are necessary and what they entail.
- WOW FACTOR** Clarity and new perspectives that motivate and inspire.
- PREDICTABILITY** Changes that are planned, simpler that is transparent.

WE GET YOU THERE.



WWW.TRANSENTIS.COM



Announcing the 31st International Conference of
the System Dynamics Society
Cambridge, Massachusetts, USA July 21 – 25, 2013
conference.systemdynamics.org



Creating the Future from Within

Contacts

Program Chairs:

Robert Eberlein
*Duke-NUS Graduate
Medical School*

Ignacio J. Martínez-Moyano
*Argonne National Laboratory
and
The University of Chicago*

Workshop Chairs:

Jack B. Homer
Homer Consulting, USA

Hazhir Rhamandad
Virginia Tech

Conference Manager:

Roberta L. Spencer
*Executive Director
System Dynamics Society*

Welcoming the full range of system dynamics applications and research, the 2013 program will emphasize the role of endogeneity in shaping past performance and creating successful interventions. Studies that communicate the relationship between structure and behavior in novel and broadly understandable ways are especially encouraged.

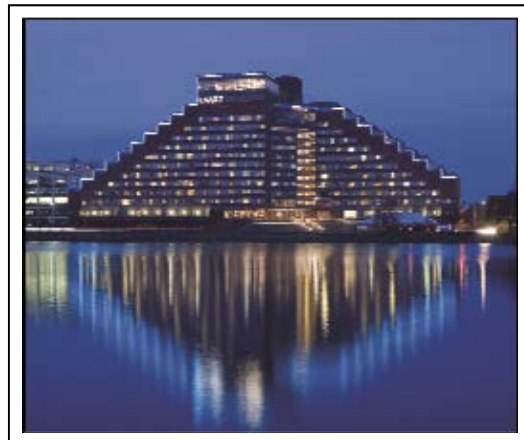
The conference program will consist of invited and contributed presentations, poster discussions and workshops demonstrating the state of the art in the theory and application of system dynamics. There will also be panel discussions, special interest group sessions, student colloquia, the modeling assistance workshop, cultural events, vendor displays, exhibits, demonstrations, Society business meetings and other related activities.

Leading academics, aspiring students, seasoned consultants, new practitioners, and representatives from education, industry and government will come together at the conference giving you the opportunity to meet the most active people in the field. The schedule will provide ample time for relaxed social and professional interaction.

We welcome all research and documented consulting activities in System Dynamics including applications of the methodology to solve real world problems, new

technical and software

developments and productive integration of complementary methodologies in order to create new solutions. The topics to be addressed include: agent-based modeling; business applications; complexity; conflict, defense and security; economic dynamics; education; environment and sustainability; health policy; information science; methodology; operations management; organizational dynamics; participatory modeling; public policy; social and psychological dynamics; supply chains; and strategy.



The 2013 conference will be held at the Hyatt Regency Cambridge hotel, conveniently situated along Boston's scenic Charles River and within walking distance of MIT.

Watch for further announcements and details. www.systemdynamics.org

Reading Supporting Material

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

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

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

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

File Name Extension:	.itm, .stm	.sip	.sim	.vmf, .vpa, .vpm, .mdl
Software Needed:	iThink, STELLA	Powersim Studio	Powersim	Vensim

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

This link will navigate you to the FREE isee Player. The isee Player lets you view, run, print and share both STELLA and iThink models. Available in both Windows and Macintosh versions, the isee Player allows exploration of all model layers - map, model, equation, and interface, and never “times out.”

POWERSIM SOLUTIONS offers Powersim Studio by Powersim Software:

<http://www.powersimsolutions.com/SystemDynamicConference.aspx>

New features of Studio 9: multi-core support, 64 & 32 bit versions, and presentation sidekick that can use HTML content. ***A new, FREE Studio 9 Express for STUDENTS, TEACHERS, & others to build and test small models, along with fully-functional 30-day trial version of Powersim Studio 9 Enterprise edition are available for download.

VENSIM by Ventana Systems:

The Vensim Model Reader can be used to open Vensim model files with extension .vpm or .vpa. This is free software which will allow you to view and simulate models, changing the parameters but not model structure. Many models (.vmf, .vpm, and .mdl) can also be opened using Vensim PLE which is free for educational use. Both PLE and the Reader are available from: <http://www.vensim.com/freedownload.html> and <http://www.vensim.com/reader.html>

PhD Colloquium Presentations

Plenary Presentations

Mario Bosslau

bosslau@lps.rub.de

Ruhr-University Bochum LPS

Dynamic Business Models for Industrial Product-Service Systems

Eva-Maria Cronrath

eva.cronrath@gmail.com

Mannheim University

Understanding the Airline Profit Cycle – Research Approach and First Results

Vincent de Gooyert

v.de.gooyert@fm.ru.nl

Radboud University Nijmegen

Group model building; From stakeholder theory to stakeholder practice

Neus Vila-Brunet

nevib5@gmail.com

Community Policy Analysis Center

How Can Mitigation and Adaptive Capacities to Climate Change Be Best Enhanced? A Human Values Evolutionary Approach

Parallel Presentations

Martin R. Dastig

martin.dastig@arcor.de

London Southbank University

Development Banking Model

Erin Hoffer

erinrae.hoffer@autodesk.com

Autodesk

The Response of Capital Investment Decision-Makers to Green Building Policy Change

Timothy S. Mbasuen

timothy.mbasuen@cantab.net

University of Oxford

Application of System Dynamics as a Policy Evaluation Tool: the Nigerian Perspective

Richard C. Darton

richard.darton@eng.ox.ac.uk

University of Oxford

Tiago Cravo Oliveira

tiago.oliveira@imperial.ac.uk
Imperial College London

Economic evaluation of teleconsultations using system dynamics

James Barlow

j.barlow@imperial.ac.uk
Imperial College London

Steffen Bayer

s.bayer@imperial.ac.uk
Imperial College London

Poster Presentations

Salman Ahmad

salman_psh@yahoo.com
Universiti Malaysia Pahang

Modeling sustainable electricity supply using System Dynamics simulation: A Malaysian case

Olasunkanmi Oriola Akinyemi

oladescendant@gmail.com
Olabisi Onabanjo University

The development of a predictive model for planning and managing runway safety

Jelena Arsenijevic

j.arsenijevic@maastrichtuniversity.nl
Maastricht University Medical Center

Modeling the poverty effects of out-of-pocket payments for health care: The case of Serbia

Milena Pavlova

m.pavlova@maastrichtuniversity.nl
Maastricht University

Wim Groot

w.groot@maastrichtuniversity.nl
Maastricht University Medical Center

Simon Gloeser

simon.gloeser@isi.fraunhofer.de
Fraunhofer ISI

Quantitative analysis of the criticality of mineral and metallic raw materials on the basis of a system dynamics approach

Anna Hulda Ólafsdóttir

anna.huldaolafsdottir@gmail.com
University of Iceland

Active use of quality management system (QMS) in the construction industry

Marta Ormazabal

mormazabal@tecnun.es
Tecnun - University of Navarra

An evolutionary model of environmental management

Eirini Grammatiki Pagoni

egpagoni@gmail.com

Aristotle University of Thessaloniki

**Risk Management in Public Private Partnerships; A
system dynamics approach**

Gloria Pérez Salazar

gloria.perez@itesm.mx

Tecnológico de Monterrey

**Toward a governance model: building long lasting
cooperation in a policy network trough Systems thinking
and System Dynamics**

Iilir Rodiqi

ilir_rodqi@yahoo.com

RO & ZE

**Systems for Knowledge Utilization in Construction
Projects (Cases from Kosovo Construction Sector)**

Lukas B. Sihombing

lukas_sihombing@yahoo.com

University of Indonesia

**Financial Innovation Risk-Based System Dynamics Model
to Improve the Investment Performance of Indonesia Toll
Road Development**

Markus Spiegel

markus.spiegel@uni.li

University of Liechtenstein

**Organizational Change and Transformation in
Technology-Oriented Firms A Complex Adaptive Systems
Perspective: Research Design**

Katharina Wachter

k.wachter@tu-bs.de

Technical University of Braunschweig

**Innovation diffusion under competition – simulative
strategy development for the introduction of alternatively
powered vehicles**

Thomas Stefan Spengler

t.spengler@tu-bs.de

Technical University of Braunschweig

Ranran Wang

ranran.wang@yale.edu

Yale University

**Applying System Dynamics to Water-Energy Nexus
Research**

Presentations

Listed alphabetically by first author

Munaf S. Aamir

msaamir@sandia.gov
Sandia National Laboratories

Vanessa Vargas

vnvarga@sandia.gov
Sandia National Laboratories

Model of Drivers of Fear-Induced Consumer Avoidance Behaviors Post-Incident

The effects of the terrorist attacks of September 11, 2001 have drawn attention to the psychological consequences of national incidents. Psychological consequences are instantiated by changes in behavior. Changes in behavior can be significant, substantial, and can span a duration that would impact the economy, human safety, and/or infrastructure sectors. This paper describes likely drivers of what is termed “fear-induced avoidance behavior.” Fear-induced avoidance behavior is behavior caused by fear or anxiety of an activity, which then causes avoidance of said activity—a prominent example being many people’s fear-induced avoidance of flying after the terrorist attacks of 11 September 2001. This paper presents a system dynamics model of the driving forces that induce fear avoidance and the forces that assist in system recovery. This model was not based on any specific historical incident to allow for application of the model to multiple types of incidents. Major components of this model include: Consumer needs; Risk perception; and Consumers’ ability to substitute one activity for another (e.g., driving instead of flying). Through the use of the system dynamics framework the authors are able to provide potential non-intuitive policies that could assist in minimizing psychological consequences stemming from national incidents.

Yaw Adom-Mensah

yawadom@gmail.com
Stevens Institute of Technology

Towards an optimal rate of general budget support in developing countries

Developing countries (recipients) and especially countries south of the Sahara have been heavily reliant on foreign (donor) aid for over half a century. Granted, conventional suppositions consider such dependence indispensable. Regardless, there is a widespread consensus among stakeholders that the effects of aid to recipients have not attained their desired results and Africa’s real per capita income today is lower than in the 1970’s leaving many African countries at least as poor as they were forty years ago. Aid fungibility, the phenomena under consideration is mundane; a known but daunting problem to eliminate. In this paper, we propose a first level perspective on the internal dynamics of recipients of these foreign aids. This working model analyzes Agriculture, Healthcare and Education as well as ICTs sectors; enough to fully represent and understand the phenomena under consideration. These selected sectors account for more than 75% of all donor aid to recipients. The goal of our hypothesis is to derive a first level model to be used as a base in developing further thorough model disaggregation of an overall outlook outlining socio-cultural dynamics and more importantly to establish an optimal budget rate proven to minimize fungibility.

Henk A. Akkermans

henk@supplynetworkdynamics.org
Research in Business BV

Kim van Oorschot

kim.v.oorschot@bi.no
BI Norwegian School of Business

Pilot error? Managerial decision biases against concurrency as explanation for delays in new aircraft development programmes

The majority of major aircraft development programmes is very much delayed. This is not only attributable to the technical complexity of these projects. From the literature on safety and human error, we know that the majority of major incidents in dynamically complex settings, such as new aircraft development, is caused by human error. We also know that concurrency between design phases is an effective approach to facilitate team learning and therefore speed up project progress. However, human decision-making literature tells us that people become more risk-averse in settings of high-uncertainty. Therefore, it seems plausible that in new aircraft development programmes, managers opt for less concurrency and that this choice can contribute to the overall project delay instead of preventing it. Based on system dynamics modeling, our research examines the impact of opting for less-than-normal concurrency between development stages in new aircraft development programmes, on overall project duration and costs. Our findings suggest that a greater degree of concurrency will lead to earlier starts of learning curves trajectories downstream, and to earlier feedback to upstream stages, and so lowering first-time-right quality standards actually, counter-intuitively, leads to higher quality levels in development being reached sooner, not later, with major effects on manufacturing completion schedules and aircraft sales later on.

Stephen Alessi

steve-alessi@uiowa.edu
University of Iowa

Birgit Kopainsky

birgit.kopainsky@flury-giuliani.ch
University of Bergen

Erling Moxnes

erling.moxnes@ifi.uib.no
University of Bergen

Teaching Resource Management with Web-Based Models and Multi-Player Games

Given the evidence that management of natural resources is affected not only by the tragedy of the commons but also by managers' misconceptions about dynamics of the resource systems, a multi-user game was developed which is based on a model of fish populations and fishing company economics. This game is one exercise within a new web-based course which teaches resource management through system dynamics models and principles. A pilot test of the game assesses the potential of collaborative (as well as competitive) learning to help learners dispel their misconceptions about dynamics and develop better understanding of good resource management principles. The pilot test also investigates the degree that misconceptions, as well as the commons problem, contribute to management errors.

Victor Alexiev

valexiev@gmail.com
University of Bergen

Measuring Group Model Building Intervention Impact Through Preference Elicitation

This paper addresses a gap in the System Dynamics literature (henceforth SD) concerning the application of judgment models in the course of an SD intervention with the purpose of supporting and measuring the pertinence of this intervention. More specifically it regards the importance and implications of detecting changes in individual participant preference structures in a Group Model Building setting, where consensus-building and shared understanding of a problem situation are a key deliverable. The main propositions of this work are that eliciting individual preferences from participants in the beginning and the end of the intervention can: (1) inform us about potential interpersonal conflicts on a

Pedro Dagoberto Almaguer Prado

pedrodago@gmail.com
Beemprededor

Ramiro Luis Almaguer Navarro

malmaguer@gmail.com
Grupo Sinapsys

Ruth Raquel Almaguer Navarro

ruth_ran@hotmail.com
Grupo Sinapsys

Pedro Dagoberto Almaguer Navarro

pan.dago82@gmail.com
Grupo Sinapsys

Beatriz Eugenia Navarro Vázquez

bety.5505@gmail.com
Beemprededor

Pedro Dagoberto Almaguer Prado

pedrodago@gmail.com
Beemprededor

Ramiro Luis Almaguer Navarro

malmaguer@gmail.com
Grupo Sinapsys

Ruth Raquel Almaguer Navarro

ruth_ran@hotmail.com
Grupo Sinapsys

Pedro Dagoberto Almaguer Navarro

pan.dago82@gmail.com
Grupo Sinapsys

Beatriz Eugenia Navarro Vázquez

bety.5505@gmail.com
Beemprededor

Mónica A. Altamirano

monica5556@hotmail.com
Deltares

Karen Meijer

karen.meijer@deltares.nl
Deltares

value level, and (2) help us detect (measure) the effect of the intervention on the individual preference structures of participants. The paper refers to past efforts in attempting a multi-methodology approach towards the inclusion of preferences in System Dynamics through a combination with judgment models on a simulation level. In contrast to those attempts, this paper suggests that a combination might also be appropriate and more actionable on a group process level. Finally, the paper reviews the applicability of alternative methodologies for measuring individual preferences in a group setting.

POLLEN learning lab to improve the public education system and PISA

The OECD groups 30 member countries committed to democracy and market economy that provides a unique forum for discussion, development and improvement of economic and social policies. OECD's mission is to promote policies designed to: • To achieve a maximum possible expansion of economic growth and employment, and improved living standards of the member countries while maintaining financial stability and, thus, contribute to the development of world economy; • Contribute to healthy and solid economic expansion in countries, both members and non-members who are in the process of economic development; To achieve this, given the results of public education in Mexico, we have taken the first steps to develop a new learning lab that helps us to visualize the impact of our decisions to improve the education system, and avoid the possible, the impact of the unintended consequences of changes in public education policy to be implemented in social, cultural, economic and ecological.

Diabetes Learning Lab - Glucose Concentration Levels in Blood

In this activity, the body reaction in the intake of food will be simulated: Food amount; type of food; when the intake of food took place; how fast the digestion occurs; reaction time of the pancreas; the connection between the blood glucose concentration and the insulin production. The content will also cover the subject between the coordinated and harmonious functioning of the pancreas (which secretes insulin), the liver, and the body's cells (insulin receivers). The Homeostasis: Process that regulates the blood concentration. Together we'll discover the cause-effects cycles that characterize the problem and how they become an important part of the solution. This article will span the effect of pancreas' insulin production in diabetes type I, as well as the cells' glucose uptake and their rejection to insulin, all this with the intention of visualizing how it breaks into the cause-effect cycles that regulates the blood glucose concentration in the body, triggering the imbalance in health.

An exploration of the added value of Systems Analysis and System Dynamics for assessing the importance of innovative concepts

This paper presents the results of a limited exploration of the extent to which System Dynamics is perceived to provide added value to participatory sessions.

Lija van Vliet

lija.vanvliet@deltares.nl
Deltares

Arjen Ros

arjen.ros@copernicos.com
Copernicos Groep BV

Aggeliki Androustoupoulou

ag.andr@aegean.gr
University of the Aegean

Yannis Charalabidis

yannisx@epu.ntua.gr

Euripidis Loukis

eloukis@aegean.gr

John P. Ansah

john.ansah@duke-nus.edu.sg
Duke NUS Graduate Medical School

Robert L. Eberlein

bob@astutesd.com

Sean R. Love

sean.love@duke-nus.edu.sg
Duke NUS Graduate Medical School

James P. Thompson

james.thompson@duke-nus.edu.sg
Duke NUS Graduate Medical School

David B. Matchar

david.matchar@duke-nus.edu.sg
Duke NUS Graduate Medical School

John P. Ansah

john.ansah@duke-nus.edu.sg
Duke NUS Graduate Medical School

David B. Matchar

david.matchar@duke-nus.edu.sg
Duke NUS Graduate Medical School

Sean R. Love

sean.love@duke-nus.edu.sg
Duke NUS Graduate Medical School

Our main aim with this evaluation is to gain insights on whether the development of a software tool to support facilitated group sessions would be worthwhile to pursue and which would be its ideal characteristics. Although the scope of the evaluation was very limited, we have concluded that a flexible tool that allows for interactive expansion and adjustment of system diagrams can be very useful. Such a tool would be different from existing tools such as Powersim, which are more targeted at expert users and quantification. We have presented our first ideas for such a tool and will continue to evaluate participants perceptions while developing this tool in a way that it presents an added value to the joint investigation and evaluation of complex policy problems.

A System Dynamics Model to address Digital Divide in Greece

This paper investigates the potential of evidence based decision making to confront complex government issues. Herein, the development of a System Dynamics model to is outlined as an approach to address the digital divide in Greece. The objective of this development is to demonstrate the need for tools specifically designed towards supporting the policy making procedure. The analysis performed via alternatives scenarios, indicates that policy makers may have an estimation of the impact that specific policy actions on the diffusion of Internet and Communication Technology will cause. Simulation is applied on indicators measured within the i2010 initiative. Nevertheless the scope of the model is limited and needs to be extended in further developments.

Serving the Long-term Care Needs of an Aging Population

A direct consequence of the aging global population is a substantial increase in demand for long-term care (LTC) services. Keeping pace with this rising demand poses a key challenge for health systems and policy-makers. The purpose of this paper is to investigate the impact of growing elderly population on the demand for care and for health-care professionals in the acute and long-term sectors under different policy scenarios, using a simplified, aggregate, policy-oriented System Dynamics model. Results indicate that inadequate supply of long-term care tends to shift service demands to acute care and increases total care needs. This suggests that if policy-makers place more emphasis on demand at acute care venues and less on long-term care of chronic conditions, they are likely to over-build acute care facilities and fill them with patients with long-term care needs.

Simulating the Impact of Long-term Care Policy on Family Eldercare Hours

The objective was to understand the effect of current and future policies on family caregiving hours for older adults by simulating the demand and supply of long-term care for older adults in Singapore. The study used standard system dynamics (SD) methodology. A dynamic hypothesis was developed and potential policy levers to reduce family caregiving hours for older adults (herein eldercare hours) were identified. A conceptual computer simulation model was developed that simulated the reference modes (i.e., the current behavior pattern of key variables).

Rahul Malhotra

rahul.malhotra@duke-nus.edu.sg
Duke NUS Graduate Medical School

Angelique Chan

angelique.chan@duke-nus.edu.sg
Duke NUS Graduate Medical School

Robert L. Eberlein

bob@astutesd.com

This model was presented to stakeholders for critique. After discussion of the model structure and its assumptions, a more complete model was formulated and parameterized to simulate the system behavior. Finally, the model was simulated across multiple iterations and the insights were shared with the stakeholders for further discussion. The principal finding was that family eldercare hours are projected to increase from 32 hours per week at present to 39 hours per week by 2030 if no significant policy actions are taken. SD modeling was useful in providing policymakers with an overview of the levers available to them and in demonstrating the interdependence of policies and system components.

Fernando A. Arenas

faarenas@gmail.com
Universidad ICESI

Stocks of Knowledge and Organizational Performance: A Dynamic Relationship

The relationship between the level of knowledge and organizational performance has been studied by the academic community and is receiving growing attention from decision makers in organizations. However it is not the case of the feedback relationship between performance and the level of knowledge, although this relationship has a dynamic pattern of behavior on both variables. This research poses a conceptual approach that involves a causal model of this feedback relationship, theoretically founded on the resource based view and the behavioral theory of the firm. The methodology involves the design and use of a system dynamics simulation model based on a pharmaceutical company which relates stocks of knowledge, innovation capability, financial performance and investments on knowledge stocks. The concept of “managerial dynamic hypothesis” is defined and used to explain, via the prospect theory, how much managers decide to invest over time on knowledge stocks. Simulations, based on managerial dynamic hypotheses with two different levels of complexity, were carried out. The results show that the more complex the hypothesis is the more stable the investment flow is and a better performance is achieved.

Stefano Armenia

stefano.armenia@uniroma2.it
CATTID Sapienza University of Rome

Andrea Centra

andrea.centra@am.difesa.it
Supreme HQ Allied Powers Europe

Vittorio Cesarotti

cesarotti@uniroma2.it
Tor Vergata University of Rome

Angelo De Angelis

angelo.deangelis@am.difesa.it
College of the Italian Armed Forces

Clarissa Retrosi

clarissa.retrosi@gmail.com
Ufficio Europa

Military Workforce Dynamics and Planning in the Italian AirForce

In the past 15 years the Italian Armed Forces have undertaken a massive change process, trying to transform and modernize the military instrument of power. The abolition of conscription, the consequent “professionalization” of the workforce and a drastic reduction in the overall personnel strength are the main features of this endeavor. With regards to the latter aspect, Human Resource Management and Military Workforce Planning have become of crucial importance in the efforts to meet the requirements introduced by a State Law in 1997. January 1st 2015 is the deadline to reach the target personnel strength for each service and a newly defined internal balance of promotion rates and number of people in every rank. This paper aims at describing where does the Italian Air Force stand in terms of workforce planning and , limiting its insight to the “aircrews” service branch (pilots and navigators), will describe the impact of the above mentioned transformation. Additionally the goal is to explore potential management policies able to guarantee the achievement of the given objectives.

Alberto Stanislao Atzori

asatzori@uniss.it
University of Sassari

David N. Ford

davidford@tamu.edu
Texas A&M University

Luis Orlando Tedeschi

luis.tedeschi@tamu.edu
Texas A&M University

Antonello Cannas

University of Sassari

Policy Modeling for Greenhouses Gas Emissions on Dairy Cattle Sector: the Importance of the Milk Production Improvement

More than 14.5 Billion \$ were spent in US by Federal R&D authority for 2011 for Climate Change. Current focus of animal scientists is to identify the most viable solutions to improve farm profitability and milk production while minimizing the environmental impact of livestock. The main objective of this paper was to use the System Dynamics methodology to: 1) model the importance of the milk production improvement to reduce greenhouses emissions in the dairy cattle sector, and 2) focus a viable policy to minimize the dairy environmental impact. The model consisted of 6 sub-models, as follows: (A) milk market; (B) cows; (C) milk production; (D) energy and feed requirements by the animals; (E) economics; and (F) environmental impact. The last sub-model was aimed to encourage and strengthen the reduction of GHG emissions in dairy cattle farms by improving the milk production per cow. The carbon footprint of milk, (kg of CO₂ emitted /kg of milk), decreased proportionally to the milk production per cow, while the total amount of emissions were highest in the scenarios with highest milk production rate. Policies with public incentives on milk production improvement stimulated the milk consumption rate and reduced the carbon footprint of milk production.

Willem Auping

w.l.auping@tudelft.nl
Delft University of Technology

Erik Pruyt

e.pruyt@tudelft.nl
Delft University of Technology

Jan H. Kwakkel

j.h.kwakkel@tudelft.nl
Delft University of Technology

Analysing the Uncertain Future of Copper with Three Exploratory System Dynamics Models

High copper prices, the prospect of a transition to a more sustainable energy mix and increasing copper demands from emerging economies have not led to an increased attention to the base metal copper in mineral scarcity discussions. The copper system is well documented, but especially regarding the demand of copper many uncertainties exist. In order to create insight in this systems behaviour in the coming 40 years, an Exploratory System Dynamics Modelling and Analysis study was performed. Three different models have been developed representing different views on copper supply and demand. The behaviour of these models shows crisis-like behaviour for the copper price, and often a declining consumption of refined copper. Six different policy options have been explored, individually and in combinations, for their robustness in counteracting undesirable behaviours. The results of these tests are that emphasising recycling, and the development of strategic reserves are potentially helpful.

André Baitello

andre.baitello@gmail.com
Escola Politécnica da USP

Marcelo Ramos Martins

mrmartin@usp.br
Universidade de São Paulo

Organizational learning effects in productivity: a dynamic hypothesis proposal for shipyard learning

The purpose of this paper is to propose a dynamic hypothesis for shipyard learning. From this dynamic hypothesis was developed a system dynamics model that served as a basis for the definition of guidelines that could serve as a basis for policy design in a real shipyard that seeks learning in productivity.

Zahir Balaporiaz

balaporiaz@schneider.com
Schneider National

Mike Zeimer

zeimerm@schneider.com
Schneider National

Games for Learning in Freight Transportation Systems

This paper describes two games developed and in use over the last few years at Schneider National Inc. The first is the Trucking Game which addresses the management of a three node closed loop truckload transportation network. The second is the Dispatch Game which is used to help dispatchers understand how human decision making and optimization work together in their daily dispatch problem. The objective of the paper is to share the history and purpose of each game, the hurdles to take them from concept to general adoption, and their impacts on the business. The paper describes each of the games and how each is played at a high level. Application areas are shared for the Trucking Game. A section on changing beliefs in the use of optimization technology is included for the Dispatch Game. Implementation challenges are also discussed for both games.

Federico Barnabè

barnabe@unisi.it
University of Siena

Cristiano Busco

busco@unisi.it
University of Siena

Maurizio Lambri

m.lambri@gmvconsulting.it
GMV Consulting

Gianfranco Zatta

g.zatta@gmvconsulting.it
GMV Consulting

Matching Role Playing, Balanced Scorecards and System Dynamics modelling in management training: the “Strategic Micro-Factory”

The article is based on the presentation and use of a business game called "Minifabbrica strategica" ("Strategic Micro-Factory"). The aims pursued by this paper are two fold. First the paper aims to show how business games, and more in detail role playing games, may be successfully used in management education, since they provide safe contexts in which is possible to support processes of knowledge elicitation and knowledge sharing, develop collaboration and team-working attitudes among participants, promote forms of individual and organizational learning and improve the ability to take decisions and design managerial policies in complex and dynamic business domains. Second, the paper addresses the problem of measuring and evaluating the performance and the improvements made by the participants to a gaming experience, adopting to this end two specific tools: a performance measurement system (the "Balanced Scorecard") and a System Dynamics model.

Michael Bean

mbean@forio.com
Forio Online Simulations

Developing Business Simulation Games for a Mainstream Audience

Over the past several years, the use of simulations in management education has advanced from an activity performed by a relatively small number of early visionaries to a mainstream offering provided by top business schools. Harvard, MIT, Wharton, INSEAD, London Business School and others offer simulations for use by their own students and by other universities. Harvard Business School Publishing currently features its simulation offerings above those of even its case studies and in the past five years has developed over twenty simulations. The most popular of these simulations have been adopted by hundreds of schools and have been played by hundreds of thousands of students. While many of these simulations are based on system dynamics, faculty use them because they fill a need in their courses not because they use a particular modeling approach. This paper addresses the key factors for simulation adoption in MBA programs, how the simulation development process differs for simulations that are widely used, and future opportunities for system dynamics simulations.

Abby Elizabeth Beck

abbybeck1@gmail.com
University of Nevada Las Vegas

Krystyna A. Stave

krystyna.stave@unlv.edu
University of Nevada Las Vegas

**Understanding Urban Quality of Life and Sustainability:
Model Development and Validation**

This paper expands upon a qualitative study done by Beck and Stave (2011) investigating how to understand the dynamics underlying urban quality of life and sustainability. In the original study, we examined the factors and feedbacks that governed migration in and out of urban areas. Quality of life (QOL) was assumed to be the short term motivator behind migration, while sustainability determined the long term livability of a city. Past studies on these topics all have a common thread: sustainability and QOL both pertain to people's relationship to capital. In this study, we illustrate how these forms of capital interact with a city's population to create in migration and out migration behavior based on the attractiveness of its capital stocks. We monitor the accumulation of different forms of capital to evaluate sustainability and use the distribution of capital as proxy for quality of life. Finally, we provide our experience in validating the model using historic population trends of three American cities.

Asmeret Bier

asmeret.bier@gmail.com
Sandia National Laboratories

**Organizational Participation in Cooperative Cyber
Security**

Cyber attacks pose a major threat to modern organizations. The effectiveness of cyber defense can likely be enhanced if programs are implemented that allow organizations that face similar cyber threats to share information and resources. To begin to understand the potential for cooperation to improve cyber security, we modeled a simple cooperative structure that allows resource sharing between two organizations whose defense teams do a significant amount of redundant work. This model is a first step toward understanding the social and operational issues involved in implementing a program of cooperative cyber defense between organizations.

Sumant Kumar Bishwas

skbiswas.iitd@gmail.com
DMS IIT Delhi

Sushil Sushil

sushil@dms.iitd.ernet.in
Indian Institute of Technology Delhi

**Knowledge Management and Related Emerging Issues in
Organizations: A Systems Thinking using Feedback Loop
Analysis**

Since last two decades, knowledge management has emerged as an important aspect for organizational success and is a matter of interest for many organizations. Initially, it was considered as a stand-alone process and the focus was mostly towards technical aspects but later its relation with other issues has also been realized. Some of the studies are available in case study form to explain the implementation process of knowledge management in any organization. This study is based on the integrated approach of literature review and caselets study method that relate the conceptual thinking with the practical implementation of knowledge management and other related issues in various organizations. Secondary data has been used for this study. Issues like change, culture, innovation and crisis management have been raised with a systems thinking using feedback loop analysis.

Marios Bisilkas

al244114@alumail.uji.es

Jaume I University

Ivan Barreda Tarrazona

ivan.barreda@eco.uji.es

Jaume I University

Aurora Garcia-Gallego

mgarcia@eco.uji.es

Jaume I University

A Model of the Sustainability Requirements Dynamics for New Product Development

The purpose of a product is to satisfy the needs of the people that are going to acquire it. In order to do so, it has to incorporate characteristics and features that fulfill a series of requirements set by users' expectations and external conditions. In this essay, we are focusing on the design process of a new product and examine up to what extent should sustainability considerations as defined from the triple bottom line should be incorporated and when. Results indicate that the most important factors are the reaction of the customers to the sustainability performance of the product and its price. Attention needs to be paid though, as early incorporation can provide either a competitive advantage or considerably hurt profitability. Finally, we discuss effective policies that could induce a permanent shift towards more sustainable operations.

Marios Bisilkas

al244114@alumail.uji.es

Jaume I University

Aurora Garcia-Gallego

mgarcia@eco.uji.es

Jaume I University

Ivan Barreda Tarrazona

ivan.barreda@eco.uji.es

Jaume I University

Services as an Alternative Path to Sustainability

Transition to a service oriented business model makes sense in economic terms; it allows the company to enjoy a triple beneficial effect: a higher profit margin, coming from more transactions, with less uncertainty. In this study we examine whether the transition from a product manufacturing business model to a service-oriented one can be coupled with improved performance concurrently in all sustainability aspects: financial, environmental and social. The interaction between the three components of sustainability can play decisive role in the final viability of the new approach, as they can moderate or intensify the expected financial flows. Identifying the nature of the interactions allows to transform the dangers of a holistic sustainability approach to an attractive business opportunity.

Gustav Bizik

gustav.bizik@lf1.cuni.cz

1st Faculty of Medicine

Marek Susta

m.susta@proverbs.cz

Proverbs Corporation

Cortisol Dynamics in Various Stress-Related Disorders

Post-traumatic stress disorder (PTSD) and other stress-related conditions represent a serious medical burden both on individual and societal level. Accordingly, substantial research effort has been focused on different pathological and clinical aspects of the disorder. As a result, numbers of endocrine, genetic and psychosocial findings in cross-sectional and longitudinal design have been published, without unifying "model". The simulation model we present tries to propose a way how to face this challenge. Supposing the central role of stress response system dynamics (namely "stress hormone" cortisol), the model connects different measurable data allowing more or less individualized simulation over time. A sub-model includes current treatment strategies and their potential impact on cortisol dynamics that seems to be crucial for patients' well-being. Final part of this paper is devoted to an expert system based on the interconnected set of sub-models. Its purpose is to show cortisol dynamics in healthy controls and stress-related disorders in interaction with psychiatric, endocrine and genetic variables and support the clinician's decision process. The simulator now also serves in education of healthcare professionals.

Frank Blaskovich*ftblask@yahoo.com*

Blaskovich Services

Oil Policy Regret Analysis With System Dynamics Models

A simple system dynamics model was used to explore the potential benefits of using regret analysis to develop sensible government energy policies. Regret analysis evaluates the relative impact of unexpected futures to design policies that reduce the risk of losses rather than trying to optimize benefits. It is very useful when it is impossible to assess or agree on the probabilities of future events and, especially, those events that can have a large impact on the system behavior. We focused our attention on understanding the system behavior and the potential benefits that might be derived from this approach, which appears to be previously unreported in the petroleum industry and system dynamics literature. We tested the technique assuming an uncertain future oil price, which was the primary driver of our system model. This allowed us to easily evaluate the impacts of potential government tax policies on the state as well as the oil producer. With other assumptions, there could be many more variables that could impact the results. In that case, more sophisticated techniques may be needed to identify the best policy alternatives.

Chris Browne*systemdynamicsociety@b-ent.net*

Australian National University

Is it Really Greener in the Cloud? An Investigation of Energy Trends in Cloud Computing

Technology is often heralded as a tool to reduce greenhouse gas (GHG) emissions despite a rising global population and increasing global affluence. Cloud computing - a popular method of modern IT deployment - is an emerging demonstration of this mindset. Recent reports claim that businesses can achieve significant reductions in energy consumption, and hence GHG emissions, by shifting their processes to the cloud. These reports rely on largely static models, and provide business with a simple leverage point to achieve immediate GHG reductions. We propose that this well-intentioned action will lead to an increase in absolute energy demand over time. We develop a model that considers recent trends in and between four domains of this problem and identify their key drivers in a business setting. The domains considered are on-site computing, cloud infrastructure, data transport, and device adoption. We identify key feedback loops, and explain that the dominant trends are linked between these domains. We conclude that the trends in these four domains suggest that overall energy demand will increase by moving computing processes to the cloud.

Haley Jones*haley.jones@anu.edu.au*

Australian National University

Paul Compston*paul.compston@anu.edu.au***Fernando Buendia***fernando.buendia@up.edu.mx*

Universidad Panamericana-Campus

Guadal

Expansion Economies: The Growth of the Firm through its Globalization

Using the tools of system dynamics and urn theory, this paper formalizes the theory of expansion economies to explain the globalization of the firms. In order to exploit economies of expansion, manufacturing firms tend to expand their economic activities to different locations, regions and countries. As firms' expansion process is an increasing return mechanism, system dynamics and urn theory can explain path dependence and self-organizing size distribution of global firms.

Fernando Buendia

fernando.buendia@up.edu.mx

Universidad Panamericana-Campus
Guadal

The Reward System in Art Markets: a system dynamics approach

This paper shows that the tools of system dynamics theory can be methodologically useful to provide new insights into art and cultural economics. Specifically, it develops a model of how the reward system in art markets works and cause imbalance allocation of revenues and recompenses. With this, it also proves that system dynamics it is useful to model self-organizing systems.

Lorena Cadavid

dlorenach@gmail.com

Universidad Nacional de Colombia

Financialization of the economy and its impact on entrepreneurship

Deregulation and globalization of financial markets are affecting the internal structure of country economies. So far, the effects that these new dynamics could bring about to the real sector and, in particular, on the level of entrepreneurial economy, are unknown. This paper addresses the interaction between financial and real sectors to different levels of financialization, evaluating their impact primarily on the level of entrepreneurial activity of the Colombian economy. Initially, theoretical concepts associated with entrepreneurship and its importance in economic growth are presented. Subsequently, a theoretical framework of financialization, its relevant causes and consequences are offered. Later, a literature review of simulation models on entrepreneurship and economic is provided. After that, a dynamic hypothesis based on features found in the literature review, as well as key results from the simulation model is discussed. It is concluded that the financialization of the economy decreases entrepreneurship activity through a crowding out effect on skilled labor and financial capital available.

Diana Carolina Ríos

dcrios@unal.edu.co

Gabriel Awad

gawad@unal.edu.co

Enrique Campos-López

enriquecampos@mac.com

Centro de Investigación y Asistencia

Spore: an Action-Learning Support System for Incubating Regional Cooperative Innovation Networks

This paper describes a pilot project for incubating cooperative regional innovation networks around three problematics (water, housing and goat milk production) related with regional sustainable development. Through an incubation process named Problematic-Innovation Cycle (P-I Cycle), participants collectively elaborated a set of increasingly complex set of representations, from ante-narratives and dynamic models to scenarios. Action group learning was facilitated in several settings where systems concepts and tools were applied. Four different approaches –Complex Adaptive Systems, SECI, System Dynamics and Model Based Agent- were applied to model the incubation process. The project took place in Coahuila, a northern Mexican State, with the voluntary participation of stakeholders of each addressed issue. Two types of results were obtained - knowledge systems on each addressed problematic and a set of incubation approaches- which have being incorporated into a State action-driven policy making effort to strengthen the regional innovation system by enhancing social capital as a key stock to launch cooperative innovation efforts.

Alena Urdiales-Kalinchuk

alenaurdiales@gmail.com

Project CRIC-CIATEJ

Arturo E. Inda-Cunningham

inda.arturo@gmail.com

Project CRIC-CIATEJ

Helue I. De la Barrera-Gomez

hbarrerag2003@yahoo.com.mx

Instituto Tecnológico de Saltillo

Avelino Hernández-Corichi

avelinohdz@hotmail.com

State Council of Science & Technology

Laura Milena Cardenas

lauracar@gmail.com
 Universidad Nacional de Colombia

Isaac Dyrer

idyner@yahoo.com
 Universidad Nacional de Colombia

Carlos Jaime Franco

cjfranco@bt.unal.edu.co
 Universidad Nacional de Colombia

Making progress towards defossilisation: modelling low-carbon policy for power generation

The need for regulating greenhouse gases (GHGs) sets out policy challenges as this should preserve a competitive environment within both power generation and energy-intensive industries. There are enormous uncertainties regarding the effect of GHGs on climate change in Latin America and its effect on the structure of the electricity sector in the future. In spite of the obvious threats, these conditions also provide opportunities not yet explored. A low-carbon policy aims at changes regarding: regulation, demand, supply, market structure, management and, in general, the competitiveness of the power generation industry. In this direction, it is not clear what structural changes should be adopted within the electricity sector. Also, what are the opportunities that this policy may offer? This article assesses the effect of GHGs policy on the Colombian electricity sector, based on system dynamics simulation. This paper indicates how emission costs and incentives in the electricity sector induce technology changes towards a low carbon economy.

Augusto Carena

dharmadharmaconsulting.net
 Dharma srl

Midday in Athens. A Socratic Dialogue about Systems

The paper includes the first “day” of a wider dialogue “à la Plato” about systems, under a System Dynamics perspective. Socrates, discussing in the Agora with a young ante litteram manager, practices the art of maieutics in order to elicit and clarify the basic concepts about systems.

Damon Centola

dcentola@mit.edu
 MIT

Dynamics of Behavioral Diffusion

In public health and health product adoption, advertising campaigns frequently rely on “word of mouth” through social networks in order to promote information diffusion about a new product or behavior. Recent advances in network theory have shown how specific topological features of social networks can amplify the diffusion of both disease and information – suggesting that important advances in network epidemiology may also be useful for structuring new product campaigns. However, recent theoretical work also shows that the dynamics of behavioral diffusion in peer-to-peer networks can respond very differently to the topological properties of networks than information or disease. For behaviors that are particularly costly, difficult, or unfamiliar, these differences may be more pronounced. My findings show that many of the campaigns of greatest interest to firms and public health officials and may not benefit from network strategies aimed at the rapid diffusion of information. I present findings from a series of novel experiments designed to study the dynamics of behavioral diffusion in large social networks. The results show a striking effect of network topology on the diffusion of health behavior, contrary to the expectations of classical network theory.

Ricardo Matos Chaim

rmchaim@yahoo.com.br
 University of Brasilia

ERM quantitative risk analysis methods and techniques applied to a small commercial bank

Since modeling and risk management must be viewed as a tool to improve business performance, data and modeling tools are required to support financial risk quantification and capital allocation. Market developments and enhanced

regulations require new techniques in order to improve Asset and Liability Management..Despite the importance of risk evaluation, lack of reliable public information, the singular probabilistic behavior of the return (or the loss) of market and credit risks and the underlying nature of the business leads to a complexity that is difficult to handle without a combination of methods and techniques that could together give a systemic view of the problem. Based on a research over a 10 year data base, a methodology will be detailed to quantify financial risks based on the combination of methods and techniques such as parametric v@r, historical and monte carlo simulations, Bayesian inference and game theory. The aim of the paper is to put together the techniques and describe the usefulness of each one in order to develop a SD policy model that can use many insights and informations from them.

Saikat Chaudhuri

saikatc@wharton.upenn.edu
University of Pennsylvania

Abhijit Mandal

am4096@gmail.com
Cass Business School

High-Value Outsourcing: Impact of Team Structure and Capabilities on Complex and Uncertain Off-shoring 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 Global Delivery Model 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 find that an offshore outsourcing approach based on distinct strategic complementarities can handle sophisticated higher-end work, by adopting a suitable team structure and capability composition. The results bear implications for traditional notions of firm boundaries and organizational forms.

Jeong Hwan Choi

jhchoi@temep.snu.ac.kr
Seoul National University

Seongpil Ko

koert1977@hanmail.net
Seoul National University

Jeong Dong Lee

leejd@snu.ac.kr
Seoul National University

Research on make or buy decision making strategy using system dynamics: Focused on Korea's military improvement project

Strategic decision on the execution of national security improvement project is greatly important for the present and future national security. Though, the importance of strategic decision, decision making process has been executed under one-way thinking framework. This research provides a decision-making tool with make-or-buy approach for the national security improvement policy execution methods: foreign purchase and military R&D project, and, via simulation, confirms dynamic change of military capability index respect to change in ratio of foreign purchase and military R&D. Results of research are as follows. If the ratio of military R&D investment is under 38%, military capability index from military R&D investment can't overtake increasing effect from foreign purchases in the whole life cycle, so easy to be restricted by another country. Applying the model from this research provides an appropriate ratio for short term and long term defense strategy and policy goal, and consequent result of increase in national security capability. Thus, this research model can be effectively utilized for national security improvement project.

Howard Hao-Chun Chuang

hchuang@mays.tamu.edu
Texas A&M University

Rogelio Oliva

roliva@tamu.edu
Texas A&M University

Olga Perdikaki

operdikaki@mays.tamu.edu
Texas A&M University

Retail Sales Generation: A Methodological Comparison of Econometric Estimation and Calibration

We take a production economics perspective to formulate a sales generating function that incorporates traffic and labor in retail stores. The estimation of this function is the basis for the development of a full system dynamics model that will enable managers to take a holistic view on labor planning process. To recover the structural parameters, we compare regression-based estimation and optimization-based calibration. This comparative approach allows us to assess the usefulness and applicability of new econometric estimation paradigms in the context of system dynamics modeling. We conclude by briefly describing possible extensions to our modeling efforts, expected outcomes, and methodological implications in terms of calibration.

Meagan Colvin

m.colvin@wustl.edu
Washington University in St Louis

Peter S. Hovmand

phovmand@wustl.edu
Washington University in St Louis

Students as System Thinkers: Scaling-up and Sustaining Innovations in Schools

Systems thinking/system dynamics (ST/SD) in K-12 education is on the rise. However, a consistent concern raised at training sessions and conferences is how to scale-up ST/SD beyond the individual teacher to reach an entire school or school district. To better understand the dynamics of scale-up of ST/SD, students co-facilitated a one-day group model building (GMB) workshop with teachers, administrators, funders, support staff, and parents. This poster presents the history, design, outcomes, and participant evaluations of the one-day workshop. Participants identified a number of potential barriers to scaling-up ST/SD in schools and prioritized potential actions by feasibility of implementation and likely impact. Specific interventions were developed. Evaluations and comments highlighted the overall success of the workshop and potential of incorporating GMB into K-12 education.

Stan Corcoran

scorcoran@mma.org
Massachusetts Interlocal Insur Assoc

Alan K. Graham

alan.k.graham@alum.mit.edu
Greenwood Strategic Advisors AG

William B. Arthur

bill@ventanasystems.com
Ventana Systems

David W. Peterson

david@ventanasystems.com
Ventana Systems

A Competitor's Strategy Unclothed: How Indirect Measurement Justified Not Fighting an Insurance Price War

The nonprofit Massachusetts Interlocal Insurance Association (MIIA) offers insurance to cities and towns, even when it is unavailable commercially. But earlier, a commercial agency was offering very low premium rates, which had driven all other competitors from the market. He had reached twice MIIA's market share, threatening to become the "emperor" of this market. MIIA had lowered rates also, threatening its financial reserves. But how could the competitor offer even lower prices? What did MIIA need to do to stay in business? Traditional actuarial analyses couldn't answer these questions, but dynamic modeling might. There was good data about MIIA, and sufficient data about the competitor, often estimated from corresponding MIIA characteristics. Competitive intelligence and indirect measurement completed parameterization, and supported robust policy recommendations. In the simulations, the competitor had very small reserves, and claims already in process would burn through what little reserves the low-price strategy had created. That would require abandoning the market. This emperor really had no clothes. Collateral analysis showed that customers were not inherently sensitive to moderate price differences. Thus

encouraged, MIIA began raising its rates, and the competitor's insurers indeed left the market. MIIA's customers continued to get insurance at a stable, reasonable rates.

Dillip Kumar Das

ddas@cut.ac.za

Central University of Technology

Planning and Management of Regional Infrastructure for Tourism Development in Orissa State, India

Infrastructure is highly imperative for tourism development of a tourism resource rich region, which requires plausible planning and management for the development of such infrastructure. In this article, an attempt was made to comprehend the tourism development of a region by considering the influence of three most essential infrastructures, such as, roads, railway and accommodation. For this purpose an integrated System Dynamics model was developed by integrating the effects of road, rail and accommodation infrastructure to the tourism system. It was observed that there would be a multi-fold increase in the tourist flow and revenue generation from tourist receipts along with increase in tourist satisfaction because of enhanced infrastructure provision under perceived simulated scenario. The article also presents a planning and management plan for development of infrastructure in phased manner based on the acceptable simulation results. Thus, a System Dynamics model having the ability to integrate the influences of various infrastructures on the tourism system provides an appropriate tool to predict the various measured indicators reliably and facilitate plausible policy and decision making in perspective planning and management for tourism development. Keywords: Infrastructure; Planning and management, System Dynamics modelling; Tourism development; Tourist satisfaction.

Vincent de Gooyert

v.de.gooyert@fm.ru.nl

Radboud University Nijmegen

Christian Erik Kampmann

cek.ino@cbs.dk

Copenhagen Business School

Revisiting the Roberts-Levin Patient Dropout Model

We review an early system dynamics model of mental health care delivery designed to investigate the premature dropout of patients from therapy (Roberts & Levin, 1976). The purpose of our paper is to a large extent pedagogical: First, using the model as a case, we wish to demonstrate the application of current standards and methods of critical model analysis as an illustration of the development of our field. Second, we propose a series of revisions to the model that illustrate techniques for promoting consistency and stringency in modeling "soft" variables related to human emotions, perceptions and attribution of cause, while remaining as true as possible to the purpose and conceptual framework of the original model. Finally, we consider the implications of the revised model for the questions raised by the original authors. Many of the conclusions of the original work remain intact, but we find that the revised model provides a more consistent explanation of the dropout phenomenon using concepts that are closer to those used in psychotherapy.

André de Groen

awdegroen89@gmail.com

Erik Pruyt

e.pruyt@tudelft.nl

Delft University of Technology

Harry Boumeester

h.j.f.m.boumeester@tudelft.nl

Delft University of Technology

Dutch social housing sector reforms: Exploring the effects on low income households

Social rental housing ought to function as safety net for the lower income groups in the housing system. However, the Dutch housing system has a relatively large social housing stock in relation to other housing systems in Europe – larger than would be required for a safety net for lower income groups. Hence, households which are financially able to purchase market housing occupy social dwellings. The Dutch government proposed four policy changes to improve the accessibility of the social housing market for low income families. The effects of these policy

changes are uncertain due to unpredictable housing move behaviour of households (which is also influenced by economic and demographic uncertainty). A system dynamics model, taking this unpredictability to some extent into account, was created to explore the effects of the policy changes till 2020. Latin Hypercube simulations suggest that these measures improve the allocation of low income households to the social housing sector, while the uncertainty ranges of the absolute number of low income households of in the social housing sector do not differentiate among scenarios.

Alberto De Marco

alberto.demarco@polito.it
Politecnico di Torino

Anna Corinna Cagliano

anna.cagliano@polito.it
Politecnico di Torino

Carlo Rafele

carlo.rafele@polito.it
Politecnico di Torino

Forecasting the Diffusion of a Mobile Service for Freight Distribution

Supply chain management supported by digital services is one of the most promising areas of research that have emerged in the last years since it has a tremendous potential to improve both operational and economic performance. In particular, distribution of freight is a field that lends itself to the application of the latest information and communication technologies to enable quick and safe ordering and delivering activities. However, in order to make new smart distribution services desirable for users and profitable for providers, careful feasibility studies are necessary to evaluate possible strategies to make the diffusion time as short as possible and secure adequate profits. The present work develops a System Dynamics model to capture the mechanisms of the adoption of a mobile service for the distribution of short life cycle products. The model integrates diffusion and supply chain management aspects and is used to devise appropriate policies the service providing company should implement to stimulate the growth of the community of users and to enable rapid business growth.

Kaveh Dianati

kaveh.dianati@gmail.com
University of Bergen

Roland Maximilian Happach

max.happach@gmx.net
European Master Program in System Dyn

The Rise and Fall of the U.S. Homicide Rate towards the End of the 20th Century - A System Dynamics Approach

The goal of this paper is to investigate the underlying structure of the socio-economic system leading to the developments of Homicide Rate in the United States during the last two decades of the twentieth century. Specifically, we focus on the effect of the crack cocaine epidemic, and the arms race among street gangs associated with it, on the mentioned developments. We build a System Dynamic model to study the interconnected fabric of important factors. The analysis shows that the arms race triggered by the growth in crack cocaine market, and the reactive policies directed towards having a more effective police force and a higher number of police can explain the overall pattern of the studied behaviour.

Kaveh Dianati

kaveh.dianati@gmail.com
University of Bergen

Conflict, Cohesion, and Performance in Teams: A System Dynamics Approach

In this paper, I have constructed a System Dynamics model reflecting certain dynamics in teams including conflict, cohesion, and performance. This model is based on a number of interviews and literature on conflict and performance in teams. The main argument of this paper is that performance, different types of conflict, and cohesiveness are all inter-related in a complex network of feedback

loops characterized by accumulations, memory, delays, and nonlinear relationships, and therefore, System Dynamics modeling is a very well-suited methodology to address this topic. To showcase the power of SD in this context, several exemplary insights are presented through simulating a few hypothetical scenarios.

Zerrin Doganca

zerrin.doganca@boun.edu.tr
Bogaziçi University

Ali Kerem Saysel

ali.saysel@boun.edu.tr
Bogaziçi University

An Interview Protocol for Assessing Students' Understanding of Dynamically Complex Environmental Problems

Present study is on development of an interview protocol to assess students' responses on specific, dynamically complex environmental problems. This protocol is designed as an assessment tool for an educational research aiming to teach "Human and Environment" chapter of standart science classes for seventh graders (12-13 year-olds) with systems approach. The research is designed as a quasi- experimental study that enables the researcher to test improvements in general systems thinking skills, competence in dynamic problem solving, and success in standard science achievement tests. Systems literature lacks assessment tools for systems thinking skills in various contexts targeting different age groups. With its original problem context and its specific target age group, proposed protocol will be a contribution to the literature in systems thinking and education. This article includes preliminary results from eight student interviews. Keywords: Systems based education, systems thinking skills, dynamic environmental problems, interview protocol.

Rogério Domenge Munoz

domenge@itam.mx
ITAM

Power Generation Capacity Planning Under Ecological, Security and Economic Criteria: The Mexican Case

There are increasing environmental concerns in México, as in many other countries, regarding the CO₂ emissions tendency, due mainly, to the intensive use of fossil fuel based electric generation. Recently, several laws and amendments have been passed in Mexico with the objective of promoting non-fossil generation technologies, aiming to increase their relative participation in the energy portfolio mix. Although several mid and long term objectives in this regard have been established in Mexico, these would be hard to achieve if the investment capabilities should continue to be directed mainly to fossil fuel thermal technologies, like natural gas on combined cycle plants, and proportionally less, to investment in non-fossil technologies. This article presents and evaluates three scenarios based on a System Dynamics Model, to assess the non-fossil generation capacity investment and timing requirements, in order to achieve both ecological and safety strategic objectives, and at the same time satisfying the electric energy Mexican demand expectations.

Jim Duggan

jim.duggan@nuigalway.ie
National University of Ireland Galway

An Extended SIR Model to Explore the Impact of Syndromic Data Sources on Social Distancing Policy

Epidemics such as seasonal influenza are a major worldwide public health concern, and therefore early outbreak detection and outbreak management are prioritized goals of public health professionals. Syndromic surveillance focuses on discovering the earliest possible indicators of a health problem, and therefore much of the focus is on pre-diagnostic data. Information technology has created

new opportunities for syndromic surveillance, for example, geographical internet search data can now estimate the probability that a random physician visit was related to an influenza outbreak. However, there are also important challenges in adopting this use of new technology, and the potential harmful side-effects (in terms of public confidence) if the real-time data models are not sufficiently robust. This paper presents an exploratory model that captures the dynamics of information quality, and the potential effect of syndromic information quality on social distancing measures.

Jorge A. Durán Encalada

jorgea.duran@udlap.mx
Universidad de las Américas Puebla

Erick R. Bandala

erick.bandala@udlap.mx
Universidad de las Américas Puebla

Alberto Paucar-Caceres

a.paucar@mmu.ac.uk
Manchester Metropolitan University

A System Dynamics Approach to Assess Global Climate Change in Quantity/Quality Water along the U.S.-Mexico Trans-Border Region

Potential impacts of Global Climate Change (GCC) in zones where water is scarce, such as along the US-Mexico border, is and will continue to be a key concern for the sustainability of humanity in the future. Despite its significant repercussions for the development/sustainability of societies living in already arid land, the effect of GCC on water quality has not been studied fully. This paper aims to estimate variation in quality/quantity water due to climate change by assessing its impact on community development in the US-Mexico border region of the Rio Grande/Rio Bravo Water Basin. To estimate variation in different water quality parameters, we use a conservative model with most probable scenarios for temperature/precipitation behavior produced by the 2007 International Panel on Climate Change. Results are then used to analyze current/expected economic and social conditions in the borderland region revealing real water demands and guiding necessary actions for a productive society. To understand the complex interaction of factors governing the quantity/quality of water and their effects on social and economic conditions, a system dynamic model is proposed to simulate, for a 70-year period, policies and decisions that can improve conditions, prevent risks leading to social unrest, and hinder economic development.

Robert L. Eberlein

bob@astutesd.com

James P. Thompson

james.thompson@duke-nus.edu.sg
Duke NUS Graduate Medical School

Chronological Aging in Continuous Time

Aggregate continuous time formulations used in System Dynamics models result in the implicit mixing of individual constituents of levels. Normally, this is acceptable as the heterogeneous nature of model variables implies that some individuals counted in a level's value will pass others and exit earlier. In models with a focus on chronological aging and age-related characteristics this phenomenon, which we call cohort blending, can result in large distortions. Though these distortions can be reduced by using aging chains, they persist in a significant way even when using one-year grouping in the aging chains. As an alternative, we introduce an approach we call "continuous cohorting" in which populations are tracked with cohorts sized the same as the computational interval of the model. This approach eliminates the blending problem with minimal notational and moderate computational burden. The resulting models display quantitative, though limited qualitative, differences from their traditional counterparts and are more easily defensible with demographers and others who study population.

Sibel Eker

s.eker@tudelft.nl

Delft University of Technology

Cornelia van Daalen

c.vandaalen@tudelft.nl

Delft University of Technology

Uncertainties in the Development of Unconventional Gas in the Netherlands

Unconventional gas has raised debates all over the world following its considerable contribution to the natural gas production of some countries such as the US. The Netherlands, which is a prominent gas producer in the Western Europe, also considers unconventional resources as an alternative to conventional production, which is estimated to significantly decline in the next 25 years. However, the development of unconventional gas in the Netherlands is surrounded by several uncertainties. In addition to parameter uncertainties, uncertainties in the boundaries and structures of the models used in the analysis of this future development play an important role. This study aims to investigate the effects of such uncertainties on the production rate of unconventional gas, by combining the Exploratory Modeling and Analysis method with four different SD models. The results show a wide range of production rate possibilities, where the variety is mostly caused by the model uncertainties. This study can be extended with more model alternatives, and the results of this study can be used in further analysis for robust policy making.

Ezzat El Halabi

ezzate.elhalabi@anu.edu.au

Australian National University

Matthew Doolan

matthew.doolan@anu.edu.au

Australian National University

Michael Cardew-Hall

michael.cardew-hall@anu.edu.au

Australian National University

Extracting Variables and Causal Links from Interview Data

This paper presents an approach to extract factors and causal influences from interview data with stakeholders within the Australian automotive recycling system during the model conceptualisation stage of System Dynamics. We first discuss problem articulation in the context of SD. Then provide an overview of how stakeholder interviews were conducted along with how interview data and field notes were processed and analysed. Next, we present the approach which was used to identify the variables and causal links from interview data resulting in a Causal Loop Diagram and a first cut Stock and Flow Diagram. A running example, the automotive recyclers' Workforce dynamics, is also provided. Finally, the difficulties faced and lessons learnt from running the interviews to handling interview data are discussed. The main benefit of the approach presented in this paper is to aid SD practitioners in model conceptualisation when relying on interview data.

Arun Abraham Elias

arun.elias@vuw.ac.nz

Victoria University of Wellington

Saji K. Mathew

saji@iitm.ac.in

Indian Institute of Technology Madras

Offshore IT outsourcing between India and New Zealand: A Qualitative System Dynamics Model

Although both India and New Zealand recognise trade between the two countries as important for their respective economies, the current and past trade in information technology between the two nations has been very low. This research seeks to study this problem situation systemically by analysing the complex interactions of factors responsible for this situation. While most of the literature on IT offshore outsourcing is based on client perspectives, this study takes a service provider perspective. A causal loop model is developed to explain the underlying structure related to this problem situation. Finally, strategies to improve the problem situation are discussed using an analysis of the feedback loops captured in the model.

Shady S. Elmasry

shady23585@yahoo.com
Cairo University

Mohamed Shalaby

mashalaby@aucegypt.edu
Cairo University

Mohamed Mostafa Saleh

m.saleh@fci-cu.edu.eg
Cairo University

A System dynamics simulation model for scalable-capacity manufacturing systems

This research presents a system dynamics SD approach to model and analyze a single stage scalable manufacturing system. The system is exposed to a random demand that is assumed to follow a normal distribution pattern. The main contribution, in this paper, is adding new modules to the existing state of the art of capacity scalability management, in order to bring it near to reality. The proposed modules allow for costs evaluation, scaling capacity on seasonal basis, and applying system breakdowns. A full-fledged simulation model (attached as supplementary material) was developed and tested using Vensim DSS. Two capacity scaling policies are presented, and used to study the effect of the new modules on the system's performance -- where capacity level, inventory level, backlog level and costs are the measures of the system's performance. The results show system dynamics ability to model real conditions that face capacity scaling planners, and present the actual effect of system breakdowns on facility performance. Moreover, this study investigates the impacts of applying seasonal capacity scaling on scalable systems.

James Enos

james.enos@usma.edu
US Military Academy

Learning with Loops: Applying Feedback to Teaching System Dynamics to Undergraduates

This paper examines the effectiveness of different delivery methods for teaching System Dynamics to undergraduate engineering students. The paper presents the findings from a survey of the learning styles of the student population and compares that to the current breakdown of the course content by learning style. It presents the findings of several classroom assessment techniques that were conducted over the course of a semester to evaluate the effectiveness of the delivery methods utilized in the course. The classroom assessment techniques focused on an evaluation of the effectiveness of readings, lectures, labs, and case studies in teaching the material. Additionally, students participated in two self-confidence surveys mid-semester and at the end of the semester, which evaluated their confidence in their ability to accomplish the course objectives and the content delivery methods. Based on this evaluation, the paper presents recommendations for improving the content delivery methods of the course to take advantage of the student population's learning styles.

James Enos

james.enos@usma.edu
US Military Academy

Dynamics of Reconstruction Projects

Ongoing counterinsurgency operations in Iraq present a complex, dynamic environment in which traditional analytical methods struggle to explain the behavior over time. System Dynamics is extremely well suited to analyze this environment as the methodology focuses on understanding the structure of the system and the behavior it creates. This paper proposes a system dynamics model of reconstruction projects for essential services to examine one aspect of this operating environment. One of the many challenges that exist in this environment is determining the proper balance between the use of the Commander's Emergency Response Program (CERP) for small scale and major reconstruction projects. This paper attempts to mitigate this challenge by analyzing the structure of the system, modeling the behavior of the system over time, and proposing policy recommendations to improve the system behavior. Although the model is not calibrated to historical data, it produces behavior consistent with behavior

described in Army doctrine. The causal relationships provide valuable insights into the dynamic behavior of reconstruction efforts and their impact on essential services. With further calibration of the model, leaders can develop and evaluate policy alternatives for capacity development to mitigate the impact of the insurgency.

Aysen Eren

ayseneren@yahoo.com

The Institute of Environmental Science

A System Dynamics Model of a Local Economy with Bi-Currency System

Local communities have no control on national and global monetary systems in spite of the fact that they are hit and damaged by economic crisis, unemployment, and other instability and insecurities caused by them. To overcome these problems, communities depending on their priorities, needs and resources, design their currency and local exchange schemes. The former research has claimed that they stimulate local production, support local businesses, create local jobs, develop sustainable consumption and enhance ecological & social wellbeing. These hypotheses are derived from relatively short-term observations due to fact that this is a new research area. However, a dynamic system modeling of a local currency system with two currencies can provide a valuable and in-depth insight into the system's structure and its behaviors in the long run. I create a dynamic system model of a local economy with a dual primary consumption sector, one representing national chain stores working with the national currency, the other representing local stores working with the both currencies. I formulate a discounted exchanged rates policy, define model components and their interrelations, describe the structure, analyze the possible behaviors, and evaluate this model's impact on the resilience of local economy, on local businesses and on unemployment. This is an exploratory and preliminary study.

Nicolas Escalante

nicolas.escalante@iswa.uni-stuttgart.de

University of Stuttgart

Model Conceptualization for Sustainable Waste and Resource Management Policy Design in Low and Middle-Income Countries

The article sets out to describe the first stages of conceptualization process initiated within the scope of an action research project in the field of waste and residual resource management in a large urban center in a low-income country. For the project it is important to test that the technological concepts developed by the project have the potential of improving waste management in future megacities. This involves evaluating if when implemented, these technological solutions can contribute to the alleviation of the current problematic situation. Additionally, it is important for the project to find out to what extent could the performance (financial, socioeconomic, environmental, etc.) of the waste management system improve as a result from the implementation of the waste management strategies it proposed. For this purpose a set of simulation models is being conceptualized and developed using a modeling methodology (namely System Dynamics), which will allow evaluating how the waste management situation would evolve if a set of strategy options would be introduced. This would be done by comparing the future development of the system in the absence of the strategies (business as usual) with the development of the system in the presence of the strategies. The article presents the first results of model conceptualization and gives an outlook of the activities that will follow.

Martijn Eskinasi*martijn.eskinasi@xs4all.nl*

Netherlands Environmental Assessment

Collected system dynamics works on recent real estate dynamics

System dynamics unmistakably has perfect innate capabilities for helping responsible decision making in an increasingly complex world. But as Forrester (2007) sighed, the system dynamics community is not yet making the change for policy making it should aim at. One possible cause is that many system dynamicists are specialists in the SD method and generalists as regards to the themes involved. As a result, there are few position papers collecting the system dynamics insights of all relevant studies in one particular area of application. The purpose of this paper is providing such an overview of system dynamics works on recent dynamics in global real estate markets.

Gholamreza Eslamifar*eslamifar.reza@gmail.com*

Sharif University of Technology

A system dynamics model to achieve sustainable production of oil in Iran

Oil Exporting Countries may encounter the problem of managing oil production because of changes in the volume of available oil resources and the depreciation of infrastructures. In Iran, on one hand, oil revenues are supposed to cover expenditure of socioeconomic development. On the other hand, based on statistics, its oil wells are in the middle of their life and the industry requires high investment to build-up and maintains infrastructures to produce at the current rate of production. In this paper, a model is presented to capture the realities and complexities of oil production industry. In the model, the oil sector is fragmented into four sectors including production, consumption, revenue and investment sectors. Finally, based on the results of the model, an investment policy to achieve the sustainable production of oil in Iran is proposed.

Amir Mohammad Shirazi*amshirazi25@gmail.com*

Sharif University of Technology

Ali Naghi Mashayekhi*mashayekhi@alum.mit.edu*

Sharif University of Technology

Warren W. Farr*warren3@me.com*

Refrigeration Sales Corporation

Using System Dynamics to Create Durable Business Strategy- US Air Conditioning Industry Case Study

This paper describes the use of system dynamic modeling at Refrigeration Sales Corporation (RSC) to understand United States air conditioning industry dynamics and to determine advantageous business policy changes. The business context, model designs, and the resulting policies and outcomes are described. The described system dynamics models extend Bass diffusion to include replacement sales of a durable good. Within this context, the relatively long useful life of a central air conditioning unit causes a significant contraction in the industry sales rate prior to reaching sustainable replacement sales. Anticipating the contraction and changing company policy accordingly gave RSC a competitive advantage by being prepared to take advantage of the industry changes. This paper adds to the system dynamics body of knowledge by documenting a successful modification and application of pre-existing model structures within the context of an important and valuable durable goods industry. Insights presented in this paper may be applicable to other durable goods industries.

Charles R. Featherston

charles.featherston@anu.edu.au
Australian National University

Matthew Doolan

matthew.doolan@anu.edu.au
Australian National University

A Critical Review of the Criticisms of System Dynamics

This paper presents a review of the criticisms of system dynamics and assesses the validity of these against recent findings in the field. The authors survey the literature critical of system dynamics and review their criticisms using the current understandings in the system dynamics field. This work suggests that there are some pertinent criticisms that have been aimed at system dynamics. These include the apparent disagreements regarding the role of historical data in model confidence building, system dynamics' reductionist perspective and how system dynamics addresses plurality and hierarchy. Overcoming these criticisms require the ever present need for education, communication and theoretical work. It is hoped this paper will strengthen the mandate of system dynamics in the eyes of its critics, assist and improve the field and its general acceptance as a tool of analysis.

Helen Fischer

helen.fischer@psychologie.uni-heidelberg.de
University of Heidelberg

Christina Degen

christina.degen@med.uni-heidelberg.de
University of Heidelberg

Stock-flow failure can be explained by the task design

Stock and flow problems are ubiquitous in nature, ranging from filling water into a tub to the accumulation of CO₂ in the atmosphere. Research on the “stock and flow failure” suggested, however, that even highly educated students have severe difficulties understanding basic stock and flow problems and achieve solution rates as low as 16%. We present the results of an experiment (N = 277) with participants of different ages (range: 18 to 75) and with different educational and professional backgrounds. Participants were asked to solve various stock and flow problems with varying task formats and semantic embeddings. Results indicate that, independent of the semantic embedding of the tasks, (a) stock and flow failure can be largely attributed to specifics of the task format used previously; and (b) significant reductions in error rates can be achieved by only slight changes in the task format (such as presenting the initial stock of stock and flow dynamics). Approx. 80% of all participants arrived at the correct solution when stock and flow problems were presented in a purely verbal task format. Implications for risk communication are discussed.

Andrew Ford

forda@mail.wsu.edu
Washington State University

Thuy Thi Hong Nguyen

thi.nguyen@email.wsu.edu
Washington State University

Allyson Beall

abeall@wsu.edu
Washington State University

Modeling Support for National Park Planning: Initial Results from a Case Study of Glacier National Park

This paper describes the role of systems modeling in the National Parks. The parks have been described as America's Best Idea, and they are celebrating their 100th year anniversary. Systems thinking and systems dynamics can help the parks plan for the second century. The paper begins by contrasting the system perspective with the focus on external factors that often dominates park discussions. The paper then reviews the extensive use of models for parks around the world. The review is conducted with an eye toward the best role for system dynamics. A system dynamics based, integrated modeling system is proposed to address both short-term operations and long-term visitor management. The paper describes initial steps to create such a system at Washington State University. The main case study simulates operational issues at Glacier National Park. The model simulates vehicles, buses and people in the heavily used Going to the Sun Road corridor for a typical day in July. The model is used to show the simulated impacts from the park's shuttle system. The Glacier study demonstrates that system dynamics can address concrete operational questions while providing support for the development of a long-term model for visitor management.

Alan K. Gaynor

agaynor@bu.edu
Boston University

Different Kids—How Typical Schools Are Built to Fail and Need to Change: A Structural Analysis

This article uses computer simulation analysis to illustrate the thesis that the typical American public school is structured in a way that reinforces the entry characteristics of its students so that by the time they graduate after twelve years—if they graduate—students who enter the school in kindergarten or first grade with high “readiness” perform academically better-than-average while students who enter the school with low “readiness” perform worse than average, this creating the well-known and widely discussed “achievement gap.” The conclusion of this argumentation is that this structure must be changed if school reform is to be effective and that it is strong school leadership that over time builds teacher quality and community and parent interest in the school and changes teacher expectations for all students, especially for initially and traditionally low-achieving students. The computer simulation modeling data support the position that, in this way, strong school leadership enhances the quality and intensity of instruction, the closeness of student-teacher relationships, and the rigor of instructional content for all students, thus drawing further advances in student motivation, work effort, and academic performance, and, finally, improving the attractiveness of the school for high quality teachers and continuing the upward cycle.

Nicholas C. Georgantzas

georgantzas@fordham.edu
Fordham University Business Schools

Time out politics: transforming time into space

Sustainable development is absolutely necessary for a viable human future, which corroborates the need for diverse, society-specific cultures across the globe. Cultural diversity enhances the human entelechy in us for personal vitality, institutional invigoration and viable socioeconomic development as well as morality, human integrity, societal solidarity, cooperation and amicable human and organizational relations. The purpose of this research is to test a theoretical sustainable development framework, using the system dynamics (SD) modeling method. The experimental results show how the administrative and political systems in and about all of us live and work transform time into space, through a transition from system structure and dynamics to focusing all attention on one-time events, manifested as systemic discontinuities through time. Cast as a methodological application too, the article also shows the use and benefits of formal SD model analysis.

Arash Golnam

arash.golnam@epfl.ch
EPFL

Ron Sanchez

sanchez@cbs.dk
Copenhagen Business School

Gorica Tapandjieva

gorica.tapandjieva@epfl.ch
EPFL

Alain Wegmann

EPFL

Choosing the Right Tool for the Job: A Framework to Compare the Effectiveness of Problem Structuring Methods in System Dynamics

The understanding embedded in the mental models of participants in organizations is considered a crucial source of information for building system dynamics models. However, System Dynamics (SD) as a modeling methodology has not developed a standard way of eliciting and recording such understanding. Currently several methods of elicitation known as problem structuring methods (PSMs) are employed in the SD community to facilitate problem situation conceptualization in group model building (GMB). Despite a growing literature on the application of PSMs, very limited research has been undertaken to assess

and compare the relative effectiveness of alternative PSMs. In this paper, we apply theoretical insights from cognitive science, in particular Cognitive Fit Theory, and visual notation analysis to suggest the characteristics of a PSM that are likely to be cognitively effective in conceptualizing problem situations in building system dynamics models. We then provide a preliminary report on an exploratory laboratory test of our predicted characteristics on four PSMs that are widely used by the SD community: (i) Causal Loop Diagrams (CLDs), (ii) Influence Diagrams (ID), (iii) Cognitive Maps, and (iv) (Magnetic) Hexagons. In the problem situation conceptualization used in our test, IDs were found to have the highest cognitive effectiveness, followed by CLDs, (Magnetic) Hexagons, and Cognitive Maps.

Mauricio Gomez Diaz

maugomez@mit.edu
MIT

Navid Ghaffarzadegan

navidg@gmail.com
MIT

Richard C. Larson

rclarson@mit.edu
MIT

Unintended Effects of Changes in NIH Appropriations: Challenges for Biomedical Research Workforce Development

The U.S. government doubled NIH appropriations between 1998 and 2003, aiming to foster research activities in biomedicine. However, several indicators demonstrate that the impact of the increase fell short of expectations and triggered unintended negative effects. Compared to pre-doubling conditions, researchers now spend more time writing grant proposals, leaving less time for research. Paradoxically, the probability with which a grant proposal is accepted for funding deteriorated sharply after the doubling. The average age of first-time NIH grant recipients has increased by almost a decade since the early 70's, while the percentage of biomedical doctorates securing tenured positions drops. These trends represent a threat to the quality and stability of the U.S. biomedical research workforce. Using system dynamics, we test the hypothesis that a sudden and temporary increase in research funds can result in unintended long-term effects hampering research discoveries and workforce development. A simulation model is developed using the available literature and calibrated to replicate historical trends. The model is then used to perform experiments that test the effects of changes in certain parameters or policies. The outcomes of these experiments provide policy insights that can help improve the effectiveness of NIH funding and its impact on the workforce.

Dieter Gramlich

gramlich@dhbw-heidenheim.de
DHBW Baden-Wuerttemberg Cooperative St

Mikhail O. Oet

Federal Reserve Bank

Systemic Financial Feedbacks - Conceptual Framework and Modeling Implications

Different approaches to model feedbacks in financial systems are assessed based on requirements for the conceptualization of the feedback dynamics. Given the non-linear, behavior driven, and interconnected characteristics of systemic financial feedbacks (SFFs), modeling concepts from System Dynamics (SD) theory provide appropriate and attractive features. Surprisingly, few SD models exist to explain systemic financial feedbacks. The scarcity of SD modeling for SFFs may be attributed to the lack of required economically-sound foundations for theoretical modeling. This paper considers a conceptual framework for SFFs that emerges from the synthesis of formal principles of economics and SD. In doing so, this study links existing SFF models to concepts of SD and provides suggestions for further modeling.

Winfried K. Grassmann

grassman@cs.usask.ca
University of Saskatchewan

Jin Zhang

jin.zhang@usask.ca
University of Saskatchewan

Roland Dyck

roland.dyck@usask.ca
Univ of Saskatoon College of Medicine

Nathaniel Osgood

osgood@alum.mit.edu
University of Saskatchewan

A System Simulation Model for Type 2 Diabetes in the Saskatoon Health Region

We describe a System Dynamics model for analysing trends and evaluating interventions with regards to type 2 diabetes. The model includes both normoglycemic and hyperglycemic components. The normoglycemic part is broken down according to weight into normal weight, overweight and obese stocks, all indexed by age, sex and ethnicity, the last consisting of Registered Indian and others. The hyperglycemic part consists of two streams, diagnosed and undiagnosed, both divided according to the severity of hyperglycemia and complications, starting with prediabetes, and with particular attention to progression of macrovascular complications. As for the normoglycemic section, all stocks in both streams are indexed according to age, sex and ethnicity. The model was carefully calibrated, using a methodology discussed here. Some projections and policy suggestions are presented.

Stefan Grösser

stefan.groesser@unisg.ch
Bern University of Applied Sciences

Roman Tschupp

roman_tschupp@mckinsey.com
McKinsey & Company

Quality of System Dynamics Research: Evidence and Recommendations for Model-Based Studies

Forrester once stated that the current quality of system dynamics work is far from reaching the quality of work to which we should be aspiring. In this paper, we take on the challenge to quantify Forrester's statement by providing an extensive analysis of model-based system dynamics studies. We sample 191 papers from 2006 to 2010 and analyze them by an evaluation scheme with 32 items. Up to our knowledge, this research is the largest assessment of system dynamics papers ever undertaken. The analysis uncovered that the efforts (1) for model validation, (2) for definition of model purpose, (3) for the discussion and analysis of policies, and (4) for model documentation is low both for publications at the conference and in the System Dynamics Review. In general, the quality score is higher for papers published in the journal, however, from an educated perspective, one might wonder that the degree of quality in basic aspects, e.g., definition of model boundary, is not higher in the journal. The paper discusses possible explanations for the situation and provides practical implications. It concludes by ways for future research to arrive at quality improvements in model-based system dynamics studies.

Andreas Größler

a.groessler@fm.ru.nl
Radboud University Nijmegen

Jürgen Strohhecker

j.strohhecker@fs.de
Frankfurt School of Finance and Mgt

Tangible Stock/Flow Experiments -- Addressing Issues of Naturalistic Decision Making

The purpose of this paper is to investigate whether stock/flow failures persist in naturalistic decision making environments. A tangible stock/flow experiment is used in this study, which asks participants to pour a certain amount of water into a glass through a funnel in an as short time as possible. Findings are that people on average do not perform better in a tangible stock/flow task than in a computerized or paper-based test of a comparable task. In addition, individual performance in the tangible task cannot be related to performance in a similar paper-pencil stock/flow task. An implication of this study is that naturalistic stock/flow tasks are as difficult for humans to control as more abstract tasks. Further research should address individual differences between the two modes of task (tangible vs.

paper-based). A limitation of this study is the usage of one tangible stock/flow task only. The value of this paper lies in the combination of a standard test with a tangible experiment addressing the same cognitive capabilities.

Hans-Christian Haag

hans-christian.haag@ids.uni-stuttgart.de
University of Stuttgart

Meike Tilebein

meike.tilebein@ids.uni-stuttgart.de
University of Stuttgart

Integrating System Dynamics in a Strategic Foresight Process for Firms in Production Networks

Firms have long used strategic foresight to adjust to fast changing business environments and increasing uncertainties. While strategic foresight on a corporate level is rather common, approaches addressing the network perspective are still rare. Documented attempts within the last few years to combine different foresight methods indicate a need for integrated approaches. Methods to communicate and discuss future thoughts between strategists and decision makers engaged in foresight processes gain importance. The goal of this paper is threefold. First, to present a strategic foresight approach that evaluates key drivers of future changes. This evaluation is conducted based on a firm's business model by considering the network perspective. Second, the application of the approach is shown with focus on the development of a system dynamics model during a group model building process. Third, a generic system dynamics model for performing strategic foresight in production networks is introduced.

Stian Blackstad Hackett

stian.hackett@geog.uib.no
University of Bergen

Fuel taxes as an energy saving policy – potential misperceptions of dynamic effects

A road fuel tax is generally considered to be a cost-efficient policy instrument that internalizes some of the external costs of driving such as air pollution, greenhouse gas emissions, congestion and noise, and may also stimulate conservation and gradually improve the fuel economy of the car fleet. They are however often unpopular among the public, even when there is popular support for the principle of governmental policy to mitigate pollution and to reduce energy consumption. This study examines whether the opposition towards fuel taxes may partly be caused by misperceptions of some of their time-dynamic effects. First, we discuss the potential for misperceptions. Second, we use survey data from the United Kingdom to test the null hypothesis that the prospect of future oil scarcity will not change people's attitude towards fuel taxes, while also testing whether respondents consider the effect of fuel taxes on fuel economy. We find that the opposition towards fuel taxes is strong and unchanged in a scenario of future oil scarcity, and we do not find evidence indicating that the effect of taxes on fuel economy is not considered. The results suggest that normative value positions or other misperceptions may be better explanatory factors.

Andreas Hadjis

a.hadjis@euc.ac.cy
European University Cyprus

George Nathaniel Papageorgiou

g.papageorgiou@euc.ac.cy
European University Cyprus

Planning via System Dynamics Models; Strategy Dynamics of Market Evolution

Realizing the importance of developing an integrated approach for effective Product Life Cycle (PLC) Management this paper examines the use of the system dynamics approach to capture the market evolution structure. After going through a review on Product Life Cycle Management and the System Dynamics approach a holistic model of market evolution is developed involving the most important components of the business environment problem situation such as the buying process, PLC characteristics, Customer Satisfaction and plausible Marketing Strategies. The model is further assessed on a number of dimensions such as its

ability to emulate the evolution of the product through the stages of the PLC, and the ability of the model to provide valuable information for formulating effective strategies.

Caner Hamarat

c.hamarat@tudelft.nl
Delft University of Technology

Erik Pruyt

e.pruyt@tudelft.nl
Delft University of Technology

Jan H. Kwakkel

j.h.kwakkel@tudelft.nl
Delft University of Technology

Adaptive Policymaking under Deep Uncertainty: Optimal Preparedness for the next pandemic

The recent flu pandemic in 2009 caused a panic about the possible consequences due to deep uncertainty about an unknown virus. Overstock of vaccines or unnecessary social measures to be taken were all due to uncertainty. However, what should be the necessary actions to take in such deeply uncertain situation where there is no or very little information available? For uncertain and complex future, adaptivity and flexibility should be the main aim for designing robust policies. Here, we propose an iterative approach for designing adaptive and robust policies in the presence of deep uncertainty. A crucial part of this approach is the use of monitoring systems that provide the adaptivity and flexibility of the policy design. In the monitoring system, signposts to track specific information are defined. Specific values of these signposts are called triggers and they are triggered when pre-specified conditions occur in the system. The specification of trigger values is crucial for the policy performance but has not been studied in depth. Here, we use robust optimization to optimize the trigger values. This paper shows that our proposed approach with robust optimization improves policy design in deeply uncertain and complex situations where very little information is available.

Kanar Hamza

kdizyee@gmail.com
European Master Program in System Dyn

Karl M. Rich

Norwegian Institute of Intern Affairs

David Wheat

dwheat@wheatresources.com
University of Bergen

The role of system dynamics approaches in aquatic disease management: an application to sea lice control in Norway

Different methodologies have been used to model the epidemiology and economics of aquaculture diseases, including input-output models, benefit-cost analysis, linear programming, simple spreadsheet-based models, compartment models based on differential equations, and spatial models. Despite the advantages that each of these different models provide, there is a need to develop a more integrated approach to the epidemiology and economics of disease that better represents and captures existing feedback mechanisms, interventions to control aquatic disease, and the economic consequences of these interventions on producer behavior. System dynamics modeling approaches have utility in this context. While they have been used to model terrestrial animal diseases, their application in fisheries has been limited to questions of stock management. In this paper, we apply system dynamics modeling in the context of sea lice control in Norwegian farmed salmon. Separate models of sea lice and salmon growth evolution were designed and integrated to capture the feedbacks between them. Preliminary proof-of-concept simulations were run to highlight the benefits of the approach.

Oliver Handel

oliver.handel@gmail.com
Universidade Nova de Lisboa

Aziiz Sutrisno

aziiz.sutrisno@gmail.com
European Master Program in System Dyn

Dynamic Aging Population in Germany: A case study about demographic change

Recent trends in demographic changes in Germany mainly because of rapid population ageing represented as increasing ratio of older population over total population, have become a major problem for the German government. They are

worry if recent trends continues it would cause massive disturbance in Germany socio-economic system, starting from vast amount of pension fund government have to pay to immerse fall of countries GDP. Therefore, by using System Dynamics approach this paper offers systemic point of view on how population structure changed in Germany; it explain why fertility rate in Germany stays low and how economic indicators would trigger changes in population structure. Moreover, it also illustrates feedback effect from population age structure to economic indicators. The result shows that current trends will continue and will not dampen if there is no adequate policy intervention from government. Hence, this paper offers set of policy measures to stabilize increasing ratio of older population. By opening more immigration opportunity for productive age workers, increasing child incentives, increasing pension age, and promoting gender equality as a set of policy measures might exhibit a better result to stabilize the population age structure. This policy measures effect shows desirable result toward expected behavior.

Roland Maximilian Happach

max.happach@gmx.net

European Master Program in System Dyn

Guido Arjan Veldhuis

g.veldhuis@gmx.net

Radboud University Nijmegen

Jac A. M. Vennix

j.vennix@fm.ru.nl

Radboud University Nijmegen

Étienne A. J. A. Rouwette

e.rouwette@fm.ru.nl

Radboud University Nijmegen

Group Model Validation

In this paper we report if and how validation is integrated in the different participatory approaches in System Dynamics. After this we present an analysis of 86 case studies to create a picture of how validation is conducted and reported in the field. We found that validation is hardly described as an integrated part of any participatory modeling approach. Furthermore, the process of validation and the end-result is rarely reported on in any case study. We propose a framework for group model validation that is aimed at balancing individual mental models, group mental models and real world logic and data. Based on the tension between these three factors we developed a preliminary approach to participatory structure validation. This procedure is focused on generating a productive amount of cognitive conflict in order to confront the structure of the model with all available information. The outcome is increased structure validity, documentation of limitations and increased understanding of the reasoning underlying the model's structure.

John Hayward

jhayward@glam.ac.uk

University of Glamorgan

Model Behavior and the Strengths of Causal Loops: Mathematical Insights and a Practical Method

Quantifying the strength of causal loops on a stock can help bring insights into the relationship between model structure and behavior. This paper uses mathematics to derive loop strengths in a number of generic small models using the relationship between the second and first derivative from the Pathway Participation Metric method. The loop strengths are plotted in a System Dynamics (SD) simulator together with the stocks to help explain behavior in the Limits to Growth, Predator-Prey, Diffusion and SIR models among others. Issues such as loop dominance, flow dominance and the change of polarity of higher order loops are used to explain behavior. In particular the identity of the causal loops in the Diffusion and SIR models are discussed and compared with previous work. Finally a numerical method for computing loop strengths and identifying dominant loops within an SD simulator is presented and applied to the Yeast Model. It is hoped that the paper will inspire others to use loop strengths in their analysis and understanding of SD models.

Marko Hell

marko.hell@efst.hr
University of Split

Garaca Željko

garaca@efst.hr
University of Split

Marija Tudor

marija.tudor@gmail.com
Split City Teatar

Benjamin Heslop

ben.heslop@gmail.com

System Dynamics Modelling of Balanced Scorecard

Today's innovation economy, simple cause-effect relationships and linear thinking makes difficult to deal with the networked world. Today's business requires nonlinear and interactive activities that consider the entire system, not only the direct and visible factors. This paper shows how to use system dynamics approach in order to upgrade the BSC methodology in the strategic plan implementation. This approach allows managing strategic plan implementation including constraints caused by availability of resource and delay in cause-consequence chain of strategic objectives.

Modelling Collaboration to optimise Innovation

Innovation fuels economic growth through 'creative destruction' of stagnant companies, rewarding those willing to embrace change. Often requiring a combination of diverse knowledge, structural impediments prevent efficient transfer of knowledge between agents. Past policies of intellectual property protection lead to delays and mistrust while new approaches remain marginally effective. This paper is a first approach by the author to understand, evaluate and improve collaborative performance of agents such as companies and universities. It is shown that a holistic understanding of collaboration should inform market-based policies that promote innovation. It has been found that a collaboration 'system' consists of five parameters that can be traced back to fight/flight response circuitry of the human brain. When the model is examined for 1st order feedbacks, the emerging structure balances forces resisting change with those that reinforce it. The parameter 'Identity' is found to be critical in driving collaborative success, with the remaining four linked in a ring of 'self-stabilising' feedback. This interpretation of collaborative behaviour delivers a systemic and pragmatic understanding of innovation, replacing what had previously been aspirational and anecdotal. With it, the author constructs policy intended to grow economies by liberating their under-employed capacity.

Monika Heyder

heyder@eifer.org
European Institute for Energy Research

Alessandra Götz

goetz@eifer.org
European Institute for Energy Research

Susanne Schmidt

schmidt@eifer.org
European Institute for Energy Research

Maria Sipowicz

maria.sipowicz@eifer.org
European Institute for Energy Research

Pablo Viejo Garcia

pviejo@eifer.org
European Institute for Energy Research

Climate Change Actions in the Urban Context: A Tool for Decision Makers

In the attempt to combat climate change and to foster sustainable development the local authorities play a crucial role. They are trying to bundle political actions to reduce their local greenhouse gas emissions (GHG). But the interactions and influences of such actions on the city system are rarely visible and have been hardly investigated as of today. This evokes the difficulty for local decision makers to define appropriate measures. This paper presents the prototypical implementation of a city tool dedicated to support the decision making process for local authorities. The focus is on the final energy consumption and GHG emissions emerging from the residential sector (space heating, electricity, domestic hot water), the transport sector and the tertiary sector (including energy demand on heating, air conditioning and electricity). As well integrated are mitigation measures influencing these sectors. The prototype helps to gain first insights in the long-term effects of the local climate action plans on city systems. It does not only analyze, but also sensitize the user for the process and the different factors evoking GHG emissions. Thus it will enhance closing the gap between academics and decision makers. The urban model has been developed exemplary on the "Region Mulhousienne", France.

Akhmad Hidayatno

akhmad.hidayatno@ui.ac.id
Universitas Indonesia

Armand Omar Moeis

armand.moeis@gmail.com
University of Indonesia

Nuzul Achjar

achjar@ipem-feui.org
University of Indonesia

Aziiz Sutrisno

aziiz.sutrisno@gmail.com
European Master Program in System Dyn

Communicating Complexity in Indonesia's Electricity Economics and Market Development Using System Dynamics Based Game

Fast growing electricity demand in Indonesia has threatened country's economic development pace. However, government owned Electricity Company cannot cope with this growing demand. As a result they rely on Independent Power Producer (IPP) which harm government budget. In the mean time, government realizes this growing issue and tries to do something by building more power plants. On the other hand, their plan on building new coal and oil based power plant is meeting a lot of resistance from NGO and parliament. On top of it, government cannot afford continue funding electricity from IPP. The situation is increasingly become worse if government does nothing about the issue. Therefore, understanding and smooth communication is needed to provide solution for the issue. A system dynamics based game is built to foster communication between stakeholders, in order to help them visualize dynamics and feedback loop inside Indonesia's electricity system. In the first development phase the game tested on group of students and showed good result on improving their understanding on current electricity issues.

Gary B. Hirsch

gbhirsch@comcast.net
Creator of Learning Environments

Jack B. Homer

jhomer@comcast.net
Homer Consulting

Bobby Milstein

bobby@hygeiadynamics.net
Fannie E Rippel Foundation

John Sterman

js Sterman@mit.edu
MIT

Christina Ingersol

cking1@mit.edu
MIT and Fannie E Rippel Foundation

Leigh Scherrer

lscherrer@rippelfoundation.org
Fannie E Rippel Foundation

Laura Landy

llandy@rippelfoundation.org
Fannie E Rippel Foundation

Elliott S. Fisher

elliott.s.fisher@dartmouth.edu
Dartmouth Medical School

ReThink Health Dynamics: Understanding and Influencing Local Health System Change

Health system reform is a national priority in the U.S., but it is increasingly being pursued through a mosaic of local initiatives. More and more concerned leaders in cities, towns, and regions across the country are working within their local health systems to achieve better health, better care, lower cost, and greater equity. Such ambitious and widely dispersed ventures, however, are hard to plan, unwieldy to manage, and slow to spread. Further progress could occur if diverse stakeholders were better able to play out intervention scenarios, weigh trade-offs, set aside schemes that are unlikely to succeed, and enact strategies that promise the most robust results. Through the Rippel Foundation's ReThink Health initiative, veteran leaders and creative methodologists are learning what it takes to spark and sustain system-wide improvements in different settings. Interactive simulation modeling and game-based learning support innovators by bringing greater structure, evidence, and creativity to the action planning process. In this paper we provide an overview of the ReThink Health Dynamics simulation model by providing a summary of its structure, intervention options, data sources, user interface, experiences in pilot sites, initial insights, evaluation plan, and possibilities for further development and diffusion.

Gary B. Hirsch

gbhirsch@comcast.net
Creator of Learning Environments

Khalid Saeed

saeed@wpi.edu
Worcester Polytechnic Institute

Karl McCleary

karl.mccleary@unos.org
United Network for Organ Sharing

Kevin Myer

kevin.myer@unos.org
United Network for Organ Sharing

Yu-Feng Ho

hyfarch@ms32.hinet.net
Chaoyang University of Technology

Hsiao-Lin Wang

whl1435@hotmail.com
Chaoyang University of Technology

Cheng-Chih Liu

chisester@gmail.com
Chaoyang University of Technology

Stig C. Holmberg

shbg@ieee.org
C8labs

Daniel M. Dubois

daniel.dubois@ulg.ac.be
Université de Liège

Peter S. Hovmand

phovmand@wustl.edu
Washington University in St Louis

Alissa Nelson

alissa.d.nelson@gmail.com
Washington University in St Louis

Deceased Donor Potential for Organ Transplantation: A System Dynamics Framework

Organ transplantation is a lifesaving procedure for many people. However, the lack of organs from deceased donors makes it unavailable for many additional people who need it. A commissioned study was undertaken to estimate deceased donor potential in the US. Organ procurement and transplantation take place in the context of a complex system of organizations and policies. This system can both constrain and enhance the realization of deceased donor potential. A system dynamics model is being developed to help identify how that system's behavior affects the availability of deceased donor organs and how particular strategic policy options might increase the number available for transplantation. The structure and data sources for the model are described along with illustrative tests of those strategic options.

System Dynamics and Genetic Artificial Neural Network Models for the Monitoring and Early Warning of Urban Housing Market

The problem of empty houses in Taiwan continues to concern the public. The Government currently conducts housing survey to detect the number of empty houses every year. But, no systematic analysis of the monitoring and early warning programme has been undertaken to improve the situation. This study formulated dynamics and genetic artificial Neural Network models for the monitoring and early warning system stimulating. Several strategy scenarios were conducted. The research findings showed that economic strategy has a more positive and profound impact than financial one; combined strategy often has a better policy assessment compared to a single strategy. The method developed in this study is a comprehensive and systematic approach to achieve the sound housing market in Taiwan. Keywords: System dynamics, Genetic artificial neural network, Monitoring and early warning, Urban housing market.

SDA: System Dynamics Simulation of Inter Regional Risk Management Using a Multi-Layered Model with Delays and Anticipation

Even in inter regional risk management phenomena of retardation and adaptation play an important role in the interplay between different logical management levels. In this paper it is demonstrated that an System Dynamics (SD) approach may be very suitable for modeling and simulating such phenomena. In some situations, however, SD approaches and modeling tools may pose some unnecessary restrictions on the procedure. Hence, the authors recommend a pragmatic and flexible attitude towards the choice of approach and tools.

Understanding Social Determinants from the Ground Up

Social determinants of health explain significant variations in public health and represent potentially important leverage points for community mobilization and social action. Social determinant variables and their causal relationships can be highly subjective and context-specific, and thereby add to the overall dynamic

Kenneth Carson

kcarson@dom.wustl.edu

Washington Univ School of Medicine

complexity of a system. Group model building (GMB) is one approach to understanding social determinants by including otherwise marginalized voices in the modeling process. GMB can potentially increase mobilization and social action, and lead to better models. How this claim happens is often unclear and confounded by the fact that GMB is itself a dynamically complex system. This paper presents a theory of GMB in the form of a system dynamics simulation model. Results illustrate the relative importance of modeler expertise, initial problem selection, and participation. Implications for future research and practice are discussed with specific attention to the design of community based group model building projects.

Peter S. Hovmand

phovmand@wustl.edu

Washington University in St Louis

Designing Public Health Dissemination and Delivery Systems

Matthew W. Kreuter

mkreuter@gwbmail.wustl.edu

Washington University in St Louis

There is increasing recognition in public health that achieving population level impact from even the successful translation of basic research to effective interventions is inherently challenging. Only a small percentage of initial interventions ever get implemented and of those very few do so at scale. A number of efforts have sought to reduce the research-practice gap in public health. This paper adds a promising tool to this endeavor by introducing the use of system dynamics for the design of public health dissemination and delivery (D&D) systems. We do so through two case studies. The first shows the role that system dynamics played in assessing the relative impact of different designs for a D&D system, while the second shows how system dynamics was used to help develop a conceptual framework of factors influencing the performance of a D&D system. Together, both projects highlight the contributions that relatively simple models can make in dissemination science and practice through the design, testing, and evaluation of public health D&D systems.

James W. Dearing

james.w.dearing@gmail.com

Kaiser Permanente IRH

Christopher Ryan Hughes

cryhughes@gmail.com

Erasmus Mundus System Dynamics Program

Movie Model: an SD/ABM model of box-office performance

The objective of this study is to explain the variance in box-office revenue between movies by developing a simulation model that forecasts expected revenue as a function of a dynamic diffusion structure, the movie's intrinsic attributes, the movie's release strategy, and the competitive environment the movie is released into. The research will develop a dynamic model of consumer adoption in the marketplace for movies. Movie producers, distributors, and exhibitors could use this model to guide their marketing and distribution decisions in order to optimize their revenue. Academics in the marketing and management sciences can use insights from this research to further advance marketing decision models in other industries. (working paper).

Edward Haksing Ip

eip@wakehealth.edu

Wake Forest Univ School of Medicine

Agent-based modeling of College Drinking Behavior and mapping of feedback mechanism of alcohol reduction

Mark Wolfson

mwolfson@wakehealth.edu

Wake Forest Univ School of Medicine

Alcohol use is prevalent among college students in the US and is the leading cause of many alcohol-related consequences such as injury, driving under influence, and sexual assault. The problem of college drinking involves complex individual, social, and cultural factors. By viewing college drinking as a complex system problem, this paper describes two components necessary for the full development of a simulation-based dynamic agent model for alcohol use in

Douglas Easterling

dveaster@wakehealth.edu

Wake Forest Univ School of Medicine

Erin Sutfin

esutfin@wakehealth.edu
Wake Forest Univ School of Medicine

Kimberly Wagoner

kwagoner@wakehealth.edu
Wake Forest Univ School of Medicine

Jill Blocker

jblocker@wakehealth.edu
Wake Forest Univ School of Medicine

Kathleen Egan

kegan@wakehealth.edu
Wake Forest Univ School of Medicine

college. The first component is a basic agent-based model that explores the dynamic of college drinking. The second component discusses the use of system dynamic modeling to explore the causal relationship between various personal/environmental factors and alcohol consumption. The paper also discusses important leverage points for intervention strategies, especially in the context of targeting both high-risk and low- to medium-risk drinkers in college.

Hazhir Rahmandad

hazhir@vt.edu
Virginia Tech

Shyu-Huei Chen

schen@wakehealth.edu
Wake Forest Univ School of Medicine

Michael Joffe

m.joffe@imperial.ac.uk
Imperial College London

Competition Between Firms – System Dynamics and Other Approaches

The role of system dynamics in modelling economic systems has been under-appreciated. As well as the balancing feedback of the market mechanism, the occurrence of bubbles is widely seen as a reinforcing feedback phenomenon, but it is less widely understood that the tendency to exponential growth in successful modern economies is likely to represent a distinct type of reinforcing feedback. This paper presents a system dynamics model of an arms race between competing firms based on cost competition, which displays the property of reinforcing feedback: a price fall by one firm encourages the other to invest so as to reduce its unit costs and thence its price. The other firm then responds in kind. Under these circumstances, the unit cost and price of both firms show a steady decline that mimics the historic decline in real input required to make a given product, e.g. as measured by the number of labour hours. This depends on both firms being able to reduce its unit cost, but is robust to other changes. The ability to produce the same output with reduced real inputs is equivalent to generating a larger output from the same resources, and is one source of economic growth.

Klaus John

kd@john-weltmer.de
Chemnitz University of Technology

Linking Economic Modeling and System Dynamics: A Basic Model for Monetary Policy and Macroprudential Regulation

The financial crisis shifted the focus of monetary policy. Whereas before the crisis the main goal of using monetary policy instruments was to keep the inflation rate low after the crisis policy makers put much emphasis on stabilizing the financial system. The economic literature has started to elaborate on the issue of macroprudential regulation only recently. Financial turbulences, by their very nature, constitute a complex dynamic phenomenon. Hence, an analysis employing tools of system dynamics should help to improve our understanding of the underlying feed-backs. In order to link economic reasoning and the systems approach a model of financial behavior developed by Stein is introduced and used to create building blocks for a basic dynamic simulation model.

Jasmin Kaiser

kaiser@is.tu-darmstadt.de
TU Darmstadt

Peter Buxmann

buxmann@is.tu-darmstadt.de
TU Darmstadt

Toward a Dynamic View on Client Dependence in IS Outsourcing Relationships: A Qualitative System Dynamics Approach

When companies disregard to manage their dependence in exchange relationships, they leave themselves vulnerable to opportunistic behavior by their partner. However, organizational dependence is subject to various mechanisms that additionally turns it into a dynamic concept. The dynamic nature of dependence is an under-researched topic, though, especially when it comes to dependence in information systems outsourcing relationships. This paper draws on five client- supplier relationships in an outsourcing setting to explore the dynamic behavior of client dependence in detail. A causal loop diagram is developed to provide client companies insights into hazardous mechanisms at place when outsourcing the development and maintenance of their information systems to external parties.

Florian Kapmeier

florian.kapmeier@hs-heilbronn.de
Heilbronn University

Jörg Gerigk

joerg.gerigk@de.pwc.com
PricewaterhouseCoopers

“Small changes can cause big problems over time”: Insights from a Systems Thinking Intervention on Ecosystems with 4th graders

System Dynamics education in K-12 has become an important mission within the community of System Dynamicists. This paper presents a scriptorium for conducting a four-hour systems thinking intervention on ecosystems for 4th graders. We used a three step approach: A general introduction to stocks and flows using the bathtub game serves as the basis for discussing the ongoing dynamics of global warming. A second application to an ecosystem is the classic predator-prey relationship. For discussing the kids' learnings we do not only present immediate feedback but also the feedback gathered three months after. Finally, we reflect on insights from this intervention.

Özge Karanfil

karanfil@mit.edu
MIT

Revisiting the Dynamics of Collapse: Globalization, Economic Growth & Rising Inequalities in the 19th century Ottoman Empire

This paper adopts a systemic perspective to reexamine a topic that has already received considerable attention in economic history: Economic growth and rising inequalities of the 19th century. According to systems theory, internal structure is the main cause of dynamic behavior, and here it refers to economic and social organization. First we discuss economic growth theories and the “convergence” hypothesis of neoclassical economic theory and compare it to institutional theory, which employs an approach that is similar to system dynamics. The institutional theory of socioeconomic development is based on a principle of “circular and cumulative causation”. Accordingly, the play of forces in the market work towards increasing inequalities between regions and people. We then try to explain economic growth, dependence and emerging inequalities of the 19th Century Ottoman Empire from the perspective described in the first part. Trade, capital movements and migration will be examined as sources of regional and social inequality. Finally we compare experiences of Turkey and Egypt to

emphasize the relationship between external forces and internal structure. We demonstrate that the mainsprings of growth and inequality should be sought in internal factors; in the land and the people, and in the system of social and economic organization.

Dmitri N. Kavtaradze

kavtaradze@spa.msu.ru
Moscow State University

Elena Likhacheva

lihacheva@spa.msu.ru
Moscow State University

Dmitry Katalevsky

dkatalevsky@yahoo.com
University at Albany

Simulation Games as a Bridge towards System Dynamics Thinking

Simulation games were accessible way to reach system dynamics (SD) vision, language and practical skills in cultural context of Russia. Since “Fishbanks Ltd.” and “Stratagem” were the early birds in Soviet high education system, SD was accepted, first, in games, and digested intellectually later. The second wave of simulation games in the middle of 70th gave a push to the development of SD, that was represented by the book “The Limits to Growth” and by lectures and educational activity of Prof. Dennis Meadows. In 1998 and in 2011 two original textbooks in Russian were published by V. Sidorenko and by D. Katalevsky respectively. Several SD simulation models and games were developed by M. Kryukov, D. Kavtaradze, V. Sidorenko, and D. Katalevsky.

Bas Keijser

baskeijser@me.com
Delft University of Technology

Jan H. Kwakkel

j.h.kwakkel@tudelft.nl
Delft University of Technology

Erik Pruyt

e.pruyt@tudelft.nl
Delft University of Technology

How to Explore and Manage the Future? Formal Model Analysis for Complex Issues under Deep Uncertainty

Formal Model Analysis (FMA) covers a group of methods and techniques to study structure-behaviour relations in best-estimate models. That is, FMA aims to identify the structural causes for the particular dynamics of a single best-estimate model. Under deep uncertainty, the notion of a best-estimate model is however troublesome. Then Exploratory Modelling and Analysis (EMA) can be used to handle deep uncertainty. Through EMA, an ensemble of models is created and analysed. This paper argues that FMA can strengthen EMA by assisting in generating plausible dynamics, exploring and analysing future worlds, identifying plausible policy levers and exploring and comparing various policy options under deep uncertainty. The generation of plausible dynamics is facilitated by deliberately changing model structures that have a large effect on the model behaviour. The other three ways of strengthening EMA rely on identifying the model structure that determines desired or non-desired model behaviours. We illustrate the combination of EMA and FMA using Ford’s Loop Deactivation Method to explore and analyse the behaviours generated by a generic model of the scarcity of minerals and metals.

David Keith

dkeith@mit.edu
MIT

John Sterman

js Sterman@mit.edu
MIT

Jeroen Struben

jeroen.struben@mcgill.ca
McGill University

Understanding Spatiotemporal Patterns of Hybrid-Electric Vehicle Adoption in the United States

Over 2 million hybrid-electric vehicles have been sold in the United States since their introduction over a decade ago. Diffusion is not uniform: sales are clustered in particular regions such as the West Coast, around Washington DC and north into New York and New England. Several theories seek to explain spatial clustering in social networks, including demographic homophily, social contagion and regional differences in marketing exposure. Here we explore the extent to which each of these theories explains the observed clusters in adoption patterns. We develop a formal model of spatial technology diffusion capturing the flow of information among regions through people’s social networks. The model is applied to the case of the diffusion of the Toyota Prius hybrid-electric vehicle in

the United States. We discuss applications of the findings, including implications for the development of effective public policies for government agencies, effective marketing and distribution strategy for auto OEMs, and implications for the emerging market for electric vehicles and EV recharging infrastructure.

Merrill Stephen Kendall

steve_kend@yahoo.com
Fusion IO

The Wizard of Oz & System Dynamics' Application to System Test

Introducing System Dynamics(SD) to solve a complex problem is difficult in two ways: 1) modeling the problem behavior, and 2) selling this approach as a desirable alternative to past troubleshooting methods. Adding the new concept of SD to the problem-solving mix often results in resistance. The perception is that other solutions worked in the past and there isn't time to learn new methods. This classic Limited Growth Archetype is best managed by addressing the balancing loop factors that limit adoption of change. In other words, the change agent needs to identify opponents and change their minds. In this paper I suggest that there is another way: provide the concepts and lessons without recipients being aware. SD was introduced to a system test organization at a large corporation. The net result was the implementation of System Dynamic modeling behind the scenes so that test management and test leads used the results and had discussions with Engineering and Program Management without them being aware that those discussions were based on the SD problem-solving concept. This paper describes the approach that was used to introduce and apply SD tools to the system test process.

Michael S. Kennedy

michael.kennedy@beds.ac.uk
University of Bedfordshire

System Dynamics Models of Information Systems Investment Appraisal

A number of papers have been published describing various System Dynamics (SD) models of the Information Systems Investment Appraisal Process from several academic and professional viewpoints. This paper builds on previous papers that provided a catalogue and classification of this work in order to highlight potential areas of research in this field of study and to identify system archetypes at different hierarchical levels and discover new ones. This paper builds on the earlier taxonomy by describing some significant models developed by the author and others.

Deepali Khetriwal

sinha.deepali@gmail.com
University of St Gallen

Application of System Dynamics to Assess Mass Flows of Waste Electrical and Electronic Equipment (WEEE)

The consumption and disposal of electrical and electronic equipment forms a dynamic system. This paper applies system dynamics methodology to assess mass flows of end-of-life equipment. In the paper, two modelling approaches to forecasting disposal of consumer durables are discussed, namely the "delay model" approach and the "reverse diffusion model" approach. Applying the same dataset on the disposal of cathode ray tube personal computer monitors in Switzerland to both the approaches, the estimates and forecasts of the models are compared against real system data. The comparison provides an opportunity to discuss further improvements to both modelling approaches.

Rolf Widmer

rolf.widmer@empa.ch
EMPA

Markus Schwaninger

markus.schwaninger@unisg.ch
University of St Gallen

Lorenz Hilty

lorenz.hilty@empa.ch
EMPA

Karan Khosla

karankhosla@gmail.com
EarthSafe Products and Services

“Strategy Dynamics of a Social Enterprise in India” – Impacts of System Dynamics on conventional strategy formulation

This paper presents a systems-based method for developing a strategic expansion plan for a leading social enterprise that delivers Internet-facilitated vocational training in rural India. A System Dynamics model was built to complement the main spreadsheet model prepared for the strategy exercise. The SD model provides a flexible testing environment that permits a clearer view of the dynamic elements of the business plan and enables the assumptions of a broader set of stakeholders to be incorporated. Most businesses rely on static spreadsheet modeling to design long-term strategies and action plans; this paper describes the importance of identifying, building and maintaining resources that generate revenue or social good, and effectively managing those resources that add costs. In particular, this paper focuses on the effect of delays in “progression pathways” (which are essential business processes to build service capacity) on the performance of the organization.

Karsten Kieckhäfer

k.kieckhaefer@tu-bs.de
Technical University of Braunschweig

Katharina Wachter

k.wachter@tu-bs.de
Technical University of Braunschweig

Joachim Axmann

joachim.axmann@volkswagen.de
Volkswagen AG

Thomas Stefan Spengler

t.spengler@tu-bs.de
Technical University of Braunschweig

Model-based Decision Support for Future OEM Power- train Portfolios: Academic Solutions for Practical Requirements

Meeting 21st century’s challenges of climate change and scarcity of crude oil requires the transition to alternatively powered vehicles, such as electric vehicles. As a consequence, car manufacturers have to integrate these vehicles into their product portfolios. Decisions have to be made about, for instance, the power-train to be offered in specific vehicle models and their times of introduction. This is a complex decision making task, especially due to high uncertainties about the future development of the market demand for alternatively powered vehicles. We here discuss how the application of system dynamics and agent-based simulation can contribute to manage the transition to alternatively powered vehicles from a manufacturer’s perspective. To this end, we present practical requirements on a model-based decision support and a scientifically novel simulation approach to fulfill these requirements. The simulation approach was developed in cooperation between university and industry. It integrates a system dynamics model with an agent-based discrete choice model to simulate aggregated system behavior and individual consumer choices based on industrially proved data. We show that our novel approach meets users’ requirements and can offer multiple benefits for decision making in industry. We discuss how these benefits can be exploited in future.

Amy A. Kim

ahimkim@tamu.edu
Texas A&M University

Vahid Faghihi

savafa@tamu.edu
Texas A&M University

Amir R. Hessami

hessami_amir@tamu.edu
Texas A&M University

Designing Perpetual Sustainability Improvement Programs for Built Infrastructures

The impacts on energy generation and use on sustainability, increasing energy demand, and declining natural resources have made energy improvements a top priority for many organizations. But adequate financing for sustainability improvement projects for built infrastructures is not available. The Paid-From-Savings approach can leverage savings to pay for energy improvements. Although well established and adopted by many organizations, an incomplete understanding of the dynamics of these revolving fund programs hinders their effective and

David N. Ford

davidford@tamu.edu
Texas A&M University

efficient use. In the current work the Harvard Green Campus Initiative and a Texas A&M University sustainability improvement programs were used to develop a dynamic model of a revolving sustainability fund. The validated model is used to test the effectiveness of three project planning strategies and two finance alternatives. Results indicate that with adequate funding it was most advantageous to proceed with all projects as quickly as possible and that with insufficient initial funding the best strategy depended upon the program objectives (e.g. earliest completion, largest fund, minimum negative fund balance). Contributions to sustainability and system dynamics modeling and future research opportunities are discussed.

Dong-Hwan Kim

sddhkim@cau.ac.kr
Chung Ang University

Institutional political dynamics: political cycles between the liberal and the conservative

Khalid Saeed

saeed@wpi.edu
Worcester Polytechnic Institute

Although many system dynamicists point out the close relationship between institutional economics and system dynamic, the relationship between institutional political theory and system dynamics approach is not fully appreciated yet. We developed a system dynamics model to investigate theoretical propositions of institutional politics. Our system dynamics model showed how the endogenous mechanism can explain political changes as well as orders. Although the causal structure is simple, our model could show a complex behavior of political competition. Several simulation results imply that some unexpected changes in election and power competition may come from the endogenous systems rather than from exogenous shocks.

Deniz Koca

deniz.koca@chemeng.lth.se
Lund University

Using Casual Loop Diagrams & Systems Analysis to Explore Alternative Climate Change Adaptation Strategies in Seyhan River Basin

Harald Sverdrup

harald.sverdrup@chemeng.lth.se
Lund University

Within a UN Joint Programme titled “Enhancing the Capacity of Turkey to Adapt to Climate Change” a systems approach workshop was carried out in Adana, Turkey with broad stakeholder participation. The participants applied systems thinking approach, causal loop diagramming methodology and systems analysis to examine the potential impacts of projected climatic changes on natural ecosystems and socio-economical systems, as well as to explore the alternative adaptation strategies to cope with the potential negative outcomes of the climatic change in Seyhan River Basin. This paper synthesizes the outcomes of this workshop, identifies major climate change impacts and clarifies the priority adaptation measures for managing climate change vulnerability in the Seyhan River Basin. Availability and quality of water, and their implications for the region are considered to be the major priority area by the workshop participants. Results suggest that there is need for adaptive measures with an integrated water management perspective considering:

- Availability and supply of ground/surface water to maintain natural ecosystems, the goods and services they provide, agricultural productivity and food security;
- Efficient use of water for agricultural, residential and industrial purposes;
- Drought and flood management;
- Capacity building among the regional stakeholders in terms of climate change impacts and adaptation measures.

Birgit Kopainsky

birgit.kopainsky@flury-giuliani.ch
University of Bergen

Maria Saldarriaga

maria.saldarriaga@uib.no
University of Bergen

Assessing understanding and learning about dynamic systems

One of the main goals of system dynamics models is to improve decision making in dynamic systems. This paper addresses the question of how we can measure what people understand about dynamic systems and what benefit people get from exposure to system dynamics models. For this purpose, we use existing literature about assessing understanding and learning in system dynamics to reflect on outstanding research questions in this area. Learning about dynamic systems requires restructuring of existing knowledge into new knowledge as well as re-use of such new knowledge over time and in different contexts. Existing approaches in system dynamics use elements of dynamic systems to represent knowledge. They thus provide a benchmark for expert knowledge and give indications about the gap between novices and experts. However, they do not provide a theory for further investigating how this gap can be closed. In a second part, we therefore analyze the learning sciences literature for elements that can be useful for the development of a theory about the acquisition, retention, and transfer of knowledge about dynamic systems. We describe first elements of such theory and illustrate how they can help in the design and assessment of dynamic decision making interventions.

András Kóvári

andriskovari@gmail.com
Delft University of Technology

Erik Pruyt

e.pruyt@tudelft.nl
Delft University of Technology

Prostitution and Human Trafficking: A model-based exploration and policy analysis

This paper deals with prostitution-related human trafficking. After a brief introduction into the problem of prostitution-related human trafficking, this study focuses on the Dutch policy debate. A first dynamic simulation model is presented based on the problem situation in the Netherlands intended to explore the field and give more understanding about the effects of proposed policies. Using this simulation model a short policy analysis is carried out uncovering the dynamics of the system leading to some preliminary conclusions. Finally it is argued that deep uncertainties exist in this problem field and this is just the first model from various plausible models that are currently developed. An in-depth exploration of the uncertainties related to many of the parameters, functions and structural assumptions will be performed using Exploratory System Dynamics Modeling and Analysis.

Svetlana V. Kovriga

sv.kovriga@mail.ru
Institute of Control Science of RAS

Nina Abramova

ninaabramova@mail.ru
Institute of Control Science of RAS

Criterial Approach to Verification at Cognitive Mapping of Ill-Structured Situation Dynamics

Increasingly popular cognitive mapping of complex and ill-structured situations dynamics carries risks for validity of end results both because of cognitive complexity of situations and features of modern cognitive map languages. To cope with typical human-induced formalization risks, verification of cognitive maps is proposed, based on the open system of more or less local expert criteria of absence of risks and direct errors in the map. Comparison of processes of model construction in system dynamics and cognitive mapping as well as analysis of processes of model understanding and mastering show that human-induced risk problems in system dynamics and cognitive mapping have much in common. Presented types of risks and criteria for their detection during verification of cognitive maps refer to early stages of modeling, when translating primary

representations to a formal language has not passed into the phase of quantitative parameters definition, be it objective data or expert estimations. Similarity of early stages of modeling either with signed cognitive maps or causal loop diagrams as the intermediate language gives hope for integration of ideas improving end results validity and cross-fertilization between system dynamics and cognitive mapping, with the first steps seen today.

Michael Krail

michael.krail@isi.fraunhofer.de
Fraunhofer ISI

Wolfgang Schade

w.schade@isi.fraunhofer.de
Fraunhofer ISI

Reducing the Climate Impact of Transport – Technologies and Policies for Road Transport

Assessing impacts of policies and strategies to reduce CO₂ emissions from road transport requires an integrated modeling approach. System Dynamics suits perfectly as methodology to simulate the dynamics determined by feedbacks between transport, energy, economic and environmental systems. The ASTRA model incorporates these capabilities. The paper at hand describes the structure and the dynamics of the ASTRA model and zooms into the vehicle fleet model. The dynamics considered in the technological diffusion model is explained in detail. Finally, the paper presents a set of different scenarios which should create a common understanding on the complexity of the transport and energy system and the potential contribution of policies and technologies to reduce the carbon footprint of car transport.

Jill A. Kuhlberg

jkuhlberg@brownschool.wustl.edu
Washington University in St Louis

Peter S. Hovmand

phovmand@wustl.edu
Washington University in St Louis

Gautam N. Yadama

yadama@wustl.edu
Washington University in St Louis

Transdisciplinary Learning in Rural India: Reflections and Considerations from an Intensive Two-Week Course

The potential for using system dynamics to address and design solutions for social problems has been established. However few opportunities are available for social work, public health, and engineering students to apply systems dynamics methods in real-world settings working in transdisciplinary teams. This poster describes a transdisciplinary two-week intensive course in rural India applying system dynamics to better understand watersheds and dryland villages. The poster highlights the course structure and team teaching approach; advantages and challenges to the intensive course format and transdisciplinary teaching and learning; lessons learned that can be applied to future intensive courses and semester long courses to accelerate and enhance student learning.

André Kühn

andre.kuehn@isi.fraunhofer.de
Fraunhofer ISI

Simon Gloeser

simon.gloeser@isi.fraunhofer.de
Fraunhofer ISI

System-Based Feedback Analysis of E-Mobility Diffusion in China

In the passenger car sector purchasing decisions are driven by economic factors and acceptance. Based on cost analysis, the factors which can be dedicated to different technologies are fuel costs and purchase price. The decision to buy a new car is always accompanied by a cost comparison of each alternative. This leads to a compilation of costs for each technology in terms of negative utility. The decision process is solved by a Logit-Model. The realization within a system dynamics model allows the modeling of feedback loops. As opposed to earlier studies on future car market in which the availability of key raw materials for alternative drives was not taken into account the model presented in this paper gives an example on how to simulate feedback effects from raw material markets on the diffusion of emerging technologies. For this purpose, taking cobalt as an example, the effect of increasing battery production on raw material demand and pricing is analyzed including the feedback of higher battery prices on the

development of electro mobility. This is realized by simulating two scenarios with and without the raw material feedback loop and a subsequent comparison of the results.

Ashwani Kumar

ashwk@yahoo.com

National University of Singapore

Kwong Meng Teo

kwongmeng@alum.mit.edu

National University of Singapore

Amedeo Odoni

arodoni@mit.edu

MIT

A Systems Perspective of Cycling and Bike-sharing Systems in Urban Mobility

Urban mobility is a prevalent problem in many cities around the world. Cycling offers a fast and cheap transportation option for short-distance trips, with smaller carbon and physical footprint than driving a car. Cycling can also encourage a modal shift from private car to public transport by providing efficient last mile connections. This has led to a renewed interest to promote cycling in cities, manifesting in a growing number of bike-sharing projects with larger bicycle fleets. However, the economic sustainability of these bike-sharing systems has not been demonstrated. Moreover, city governments may invest resources in bike-sharing projects at the expense of developing policies or infrastructure to improve cycling safety and convenience. We take a systems perspective to study how bike-sharing and other policies can influence cycling as a transport mode in the urban mobility problem. We observe that while bike-sharing projects may increase cycling level and generate public demand for better cycling infrastructure in the short run, loss-making bike-sharing projects can discourage the infrastructure investments over the long-run, thereby hampering cycle adoption. Public funds should not be invested in bike-sharing programs at the cost of cycling infrastructure. Instead, governments should facilitate economically viable bike-sharing systems by the private sector through adoption of appropriate policies. Investments in cycling infrastructure should come first.

Martin H. Kunc

martin.kunc@wbs.ac.uk

Warwick Business School

System Dynamics and Innovation: A complex problem with multiple levels of analysis

System Dynamicists employ two principles to modeling different problems: feedback processes and stock and flows. Innovation processes can be observed and modeled at diverse level of analysis: industry, product, organization and processes. Each of these levels implies observing innovation problems with different theoretical lenses although they are strongly interrelated. The paper presents a review of the approaches followed by diverse practitioners on the use of System Dynamics in innovation. The initial evaluation of the literature suggests that system dynamicists have not followed system hierarchical principles to model innovation processes. Consequently, the results from one level, e.g. innovation processes, cannot be directly translated into the level above, e.g. industry dynamics. Future directions for research are suggested.

Martin H. Kunc

martin.kunc@wbs.ac.uk

Warwick Business School

Modeling Start-ups using System Dynamics: Towards a generic model

In system dynamics, different scholars have proposed templates to analyze similar problems, e.g. Peter Senge's archetypes. However, there are not generic system dynamics models of businesses. This paper attempts to develop a generic model for managing start-ups based on two common businesses, internet services and

management consultants, with the aim to provide a template for entrepreneurs to start developing a system dynamics model of their own firms. The different experiments with the generic model suggest that long term management of key staff and cost optimizing are the right strategies to overcome the high rate of failure during the first 5 years of operation of start-ups.

Jan H. Kwakkel

j.h.kwakkel@tudelft.nl
Delft University of Technology

Jos S. Timmermans

j.s.timmermans@tudelft.nl
Delft University of Technology

Exploratory system dynamics: a directed search for limits to global water use

Rockström et al. (2009) introduced the concept of a safe operating space for humanity that will not push the planet out of the 'Holocene state'. Establishing the limits of this operating space is ongoing for various earth bound systems. Estimates of these limits are plagued by uncertainty. In case of the limits to the world water system, these uncertainties arise out of conflicting models, regional variations, limitation of expansion of water use through financial and institutional capacity, uncertainty about the realization and efficiency of trans-boundary water transfers, and interdependency between the water system and other earth systems. This paper aims at investigating the limits to global freshwater use. To this end, the behavior of a System Dynamic model of the world water balance is explored across a wide variety of uncertainties. Active non-linear testing is used to identify the best case and worst case for water stress and world population. We find counter intuitive results related to the occurrence of maximum water stress, conclude that global limits can be investigated with a spatially aggregated model and are strengthened in our hypotheses that exploratory modeling adds to the understanding of complex and uncertain issues in a way that predictive approaches cannot.

Jan H. Kwakkel

j.h.kwakkel@tudelft.nl
Delft University of Technology

Jill H. Slinger

j.h.slinger@tudelft.nl
Delft University of Technology

A System Dynamics Model-Based Exploratory Analysis of Salt Water Intrusion in Coastal Aquifers

Coastal communities dependent upon groundwater resources for drinking water and irrigation are vulnerable to salinization of the groundwater reserve. The increasing uncertainty associated with changing climatic conditions, population and economic development, and technological advances poses significant challenges for freshwater management. The research reported in this paper offers an approach for investigating and addressing the challenges to freshwater management using innovative exploratory modeling techniques. We present a generic system dynamics model of a low lying coastal region that depends on its groundwater resources. This systems model covers population, agriculture, industry, and the groundwater reserve. The system model in turn is coupled to a powerful scenario generator, which is capable of producing a comprehensive range of plausible future scenarios. Each scenario describes a unique future pathway of the evolution of population, the economy, agricultural and water purification technologies. We explore the behavior of the systems model across a wide range of scenarios and analyze the implications of these scenarios for freshwater management in the coastal region. In particular, the results are summarized in a decision tree that provides insights into the expected outcomes given the various uncertainties, thus supporting the development of effective policies for managing the coastal aquifer.

Daniel Lafond

daniellafond@hotmail.com
Université Laval

Ashley Beattie

ashley.beattie@gmail.com
Canadian Naval Reserve

Michel B. DuCharme

michel.ducharme@drdc-rddc.gc.ca
Defence R&D Canada

Sébastien Tremblay

sebastien.tremblay@psy.ulaval.ca
Université Laval

Collaborative Decision Making in a Simulated Stability Operations Exercise: A Prototype Decision Support Tool

We report the results of a collaborative decision making exercise using a simulated stability operations task. The exercise allowed Canadian Forces personnel to experience first-hand the benefits and challenges of taking an integrative decision making approach (i.e., with information and resource sharing) compared to a stovepipe approach (no communication and partial view of the whole system). While teams generally achieved greater mission success in the integrated condition, they could only partially cope with the complexity of such an endeavor. A training session on systems thinking and collaborative design generally improved integrated planning effectiveness. We designed a decision support tool capable of suggesting an effective integrated course of action based on qualitative information about system structure and effects. The tool essentially relies on an innovative 'action-oriented' cross-impact matrix and decision matrix that jointly allow deriving a viable resource allocation given a range of intervention options. The prototype tool aims to be simple and generic for use in real-life applications. The system's inputs are based on simple user judgements (i.e., mental models). We show that the tool provides solutions superior to most human teams. Future research will test the generalization of the approach and assess human ability to refine the tools' solutions.

Carmen Y. J. Lee

yinjenlee@gmail.com
Duke NUS Graduate Medical School

James P. Thompson

james.thompson@duke-nus.edu.sg
Duke NUS Graduate Medical School

Robert L. Eberlein

bob@astutesd.com

The cause of growing foreign-trained nurse concentration and its impact

Working with a group from Singapore's Ministry of Health we were presented with the dilemma of an ever increasing fraction of foreign nurses despite efforts to increase domestic nurse training capacity. To understand why this might occur we developed a model embodying the hypotheses put forward by the group. The resulting model shows how drifting goals and a focus on rates instead of levels can lead to the observed behavior. We find that as foreign nurse hiring increases, the pressure to educate domestic nurses decreases. Thus, as the burden to reduce a nurse shortage gradually shifts to an external supply of trained nurses, longer term domestic training capacity dissipates. Establishing a fixed desired fraction of foreign nurses keeps the focus on maintaining domestic training capacity. In addition, with an enrollment that is based on the stock values of students and domestic nurses, average residence time of domestic nurses, and delays in training, the system demonstrates greater stability.

Man-Hyung Lee

manlee@cbu.ac.kr
Chungbuk National University

Nam Hee Choi

drnhchoi@ut.ac.kr
Korea National University of Transport

Won-Gyu Ha

wgha@etri.re.kr
Electronics and Telecom Research Inst

Jong-Hoon Yoo

cleona@naver.com
Chungbuk National University

Should Korea's Barn Swallows Be on the Red List of Threatened Species?: Population Dynamics Combined with Ecological Changes

The barn swallow (*Hirundo rustica*) is the most wide spread species of swallows in the world. It is even evaluated as a "Least Concern (LC)" on the IUCN (International Union for Conservation of Nature) Red List. Unlike the global trends, nonetheless, Korea has lost ninety-nine percent of its population over the last two decades. Nowadays Korea's barn swallow is near endangered and threatened with extinction. Applying system dynamics tools, this study hopes to divulge why these dramatic changes in the barn swallow population have occurred in Korea. Specifically, it explores structural characteristics of the barn

swallow population changes and attempts to develop alternative policy guidelines. Following the introductory explanation, Chapter II explains the behavioral patterns of the barn swallow, focusing on feeding and breeding. In order to survey the historical trends of the barn swallow population, it analyzes major ecological changes in Korea, covering mostly unfavorable habitats of the barn swallow. In Chapter III, top priority is given to devising systems thinking models of the homing instinct, and clarifying major impact factors. Next, Chapter IV presents simulated findings derived from stock-flow modeling works. Here, policy options are tested with the prototype models and their derivatives. Finally, a series of policy alternatives are proposed in the conclusion.

Armin Leopold

armin.leopold@unibw.de

University of Federal Armed Forces

Bo Hu

bo.hu@unibw.de

Universität der Bundeswehr München

Klaus Arto

klaus.arto@gmx.de

Universität der Bundeswehr München

Irina Dolgoplova

irina.dolgoplova@gmail.com

Baikal National University of Economic

Germany's Electricity Industry in 2025: Evaluation of Portfolio Concepts

Combining System Dynamics model simulation and data analysis long-term development of electricity industry can be observed and anticipated regarding its reliability and total production cost under different assumed scenarios. In particular, different portfolio concepts to mitigate GHG emissions and to reduce fossil resource consumption are evaluated based on our highly aggregated electricity production and consumption model. Generally speaking, this innovative System Dynamics approach has not been widely used as a tool for optimizing asset structure of an energy portfolio yet. Nevertheless we favor a renewable load management concept which aims at the reshaping of load profile to fit the renewable electricity production output profile. In this context accurate forecasts of both load and production profiles are prerequisite for a well functioning load management. In the case of Germany our preliminary results show that a renewable load management concept may reduce the total production cost up to 2.7 B€/year or 4.80 €/MWh in 2025 while improving mitigation of GHG emissions from 31.2% to 34.7% (compared to 1990).

Christian M. Lerch

christian.lerch@isi.fraunhofer.de

Fraunhofer ISI

Thomas Schmall

thomas.schmall@isi.fhg.de

Fraunhofer ISI

Matthias Gotsch

matthias.gotsch@isi.fraunhofer.de

Fraunhofer ISI

Linking Innovation and Service Productivity - An analysis of interactive effects in knowledge-intensive business services

The productivity of services has recently become the subject of intensive research. While most contributions here have focused on developing measurement concepts, so far little is known about the dynamics of productivity in service companies. Because productivity tends to increase if the service delivery process is enhanced and improved, there seems to be a link between incremental service innovations and the productivity of services. Therefore, this article analyzes the interaction of innovations and productivity over time in knowledge-intensive business services (kibs). A simple system dynamics model was constructed to examine these dynamics and interactions over the life cycle of an exemplary knowledge-intensive business service offer. First the system structure is developed using literature analysis. Second, several simulation runs and experiments are conducted, to obtain a deeper understanding of the interactions of service innovations and productivity. The paper closes with findings and conclusions.

Ilya Levin

ilia1@post.tau.ac.il
Tel Aviv University

Tzur Levin

tzurlevin@gmail.com
Tel Aviv University

Hybrid Models in Developing System Thinking

Hybrid models, consisting of the interacting continuous and discrete processes, form an emerging field in science and engineering. Such models, combining stock-flow and state-diagram representations, should serve a part of the system education curriculum. The present paper reports an experiment in which undergraduate students were asked to choose between a hybrid and a continuous solution for a number of predefined problems. Results of the experiment show that the hybrid approach is more preferred by students with relatively low ability of dynamic thinking. We discuss the meaning of the results in terms of analyzing and improving mental models, and also discuss several contexts in which the hybrid approach enriches system thinking.

Anson Kin Tat Li

akt.li@auckland.ac.nz
University of Auckland

Tiru S. Arthanari

t.arthanari@auckland.ac.nz
University of Auckland

Yuhua Zhou

zhouy7@gmail.com
University of Auckland

Leveraging Supply Chain Relationships – A System Dynamics Perspective

Good inter-business relationships is the key to achieving supply chain objectives such as maximising customer value and reducing transaction costs, thus maximising profits. This study investigates existing theory in supply chain relationship improvement. By integrating factors that contribute to supply chain coordination using systems theory and methodology, potential long-term leverages are proposed, along with the mapping of patterns of improvement over time. Such leverages provide insight for devising supply chain relationship strategies in an efficient manner, instead of tackling improvement initiatives on a multitude of factors in isolation, as commonly featured in supply chain literature. The proposed dynamics are validated by business practitioners, whose comments and opinions are further analysed to compare and contrast with the theoretical implications. Key findings suggest that information is a top priority success factor in supply chain relationships, facilitated by appropriate implementation of information technology. However, such leverage has different impact on performance, trust, and commitment among business partners at different stages of collaboration.

Anson Kin Tat Li

akt.li@auckland.ac.nz
University of Auckland

Kambiz E. Maani

k.maani@uq.edu.au
University of Queensland

A Supply Chain Paradox

Supply chain collaboration is the key to success in business. A major challenge in such collaborations is the dilemma between locally optimized quick solutions and the more systemic, long-term but 'slow-acting' approaches. Such dilemma in business collaborations has been contemplated in supply chain management research, illustrating their respective benefits and disadvantages. In light of the findings from literature, this study investigates the dynamics of this dilemma using an integrated perspective, utilizing both theories and case studies in supply chain relationships and collaborations. The archetypical dynamics and behavior of relationships over time are modeled, proposing an ever-evolving framework of supply chain collaborations. Along with the model, a prototype of a supply chain collaboration simulation model is also presented, as a customizable environment for policy testing and demonstration of different supply chain collaboration approaches. This model may also be used for training purposes as Microworlds.

Thomas Logtens

tom_logtens@hotmail.com
Delft University of Technology

Erik Pruyt

e.pruyt@tudelft.nl
Delft University of Technology

Govert Gijsbers

govert.gijsbers@tmo.nl

Societal Aging in the Netherlands: Exploratory System Dynamics Modeling and Analysis

Mismanagement of societal aging is an important threat to health care systems, social security systems, and the economy of many nations. A System Dynamics simulation model related to societal aging in the Netherlands and its implications for the Dutch welfare system is used here as a scenario generator for Exploratory System Dynamics Modeling and Analysis - a System Dynamics-based approach for exploring and analysing deeply uncertain dynamically complex issues and testing policy robustness many plausible futures. Key concerns derived from this exploratory research are (i) the existence of plausible futures with severe labour scarcity, especially in health care, (ii) unsustainable evolutions of health care costs, and (iii) insufficient labour productivity, especially in health care. Our analysis shows that labour productivity may be cause of and cure for many of the undesirable evolutions. We conclude that (i) sufficient increases in labour productivity in health care as well as labour productivity in general without pinching the necessary workers in care are needed, and (ii) sufficiently raising the retirement age only helps if both the willingness to work longer and the willingness to keep older employees increase. These conclusions are derived from systematic data analysis which is fully documented in the appendix.

Luis López

luis.lopez@incae.edu
INCAE Business School

Roy G. Zúñiga

roy.zuniga@incae.edu
INCAE Business School

The Dynamics of a Judicial Service Supply Chain: A case study

In this paper we explore behavioral issues, coupled with temporary capacity imbalances that could influence the characteristics that a service supply chain may assume in the long run. We look at a service chain in which processing times by human agents are endogenously determined by what constitutes an acceptable and credible backlog, but implicit incentives, particularly within a formal hierarchy, may also impinge upon throughput rates at certain stages of the supply chain when agents are trying not to overwhelm downstream stations with excess work. We explore these issues in the context of a managerial intervention in a judicial service supply chain. Using data from a detailed case study we develop a preliminary model and discuss some results.

Thomas S. Lowry

tslowry@sandia.gov
Sandia National Laboratories

Sean A. McKenna

samcken@sandia.gov
Sandia National Laboratories

Teklu Hadgu

thadgu@sandia.gov
Sandia National Laboratories

Elena Kalinina

eakalin@sandia.gov
Sandia National Laboratories

Using System Dynamics for Uncertainty Analysis and Integrated Risk Assessment in Geothermal Energy Development

We present a system dynamics model called 'GT-Mod' for assessing the development and management of geothermal energy production. The model simulates the entire geothermal energy cycle by representing the major components as a set of connected sub-systems that include the power plant, the injection well, the geologic reservoir, the production well, the surface feeder and distribution pipes, the pumps, and the economics. GT-Mod uses a Latin Hypercube Monte-Carlo approach to propagate uncertainties in various input parameters to calculate the systems' thermal and power performance over the lifetime of the project and to assemble a probability distribution of the levelized cost of electricity (LCOE) that is used to estimate the integrated risk as a function of input uncertainty. Integrated risk is the summation of the product of consequence and probability over all probabilities and represents a comprehensive

metric for benefit analysis that includes the full range of uncertainties in a particular problem. GT-Mod is also used to bound viable solution spaces and to identify areas of uncertainty that have the greatest influence on risk. An example based on a hypothetical but realistic geothermal site is presented that demonstrates the models application and highlights the suitability of the system dynamics approach.

Johannes Luger

johannes.luger@unisg.ch
University of St Gallen

Alexander Zimmermann

alexander.zimmermann@unisg.ch
University of St Gallen

Stefan Grösser

stefan.groesser@unisg.ch
Bern University of Applied Sciences

The Dynamics of Ambidextrous Decision Making

Managerial ambidexterity has become an important concept in recent research. However, prior studies fail to provide conclusive theoretical insights on how managers' individual abilities and preferences interact with organizational-level rules and restrictions to develop firm-level ambidexterity and secure superior long-term performance. Based on system dynamics modeling, we simulate this interaction and the underlying feedback processes under different environmental conditions. The simulation experiments suggest that managerial ambidexterity may only lead to firm-level ambidexterity under moderate environmental conditions. Counter-intuitively, we provide insights that, for stable (or dynamic) environments, an individual's inclination biased towards exploration (or exploitation) may be more beneficial for firm-level ambidexterity and long-term performance.

Ignacio J. Martínez-Moyano

imartinez@anl.gov
University of Chicago

Stephen H. Conrad

shconra@sandia.gov
Sandia National Laboratories

Andrew Cox

andrew.cox@dhs.gov
Department of Homeland Security

M. Samsa

msamsa@anl.gov
Argonne National Laboratory

Modeling Aviation Security Processes: Dynamics of the Introduction of New Technology in a Complex Socio-technical System

We model the introduction of new technology in a complex socio-technical system in aviation security processes. The objectives of the study reported here are to (1) examine the system impacts of the introduction of the new technology on the operational baseline of aviation security and (2) identify levers that may help maximize system performance when new technology is deployed. Understanding the underlying characteristics of system behavior is vital to designing procedural enhancements for new technology deployment. Although the study was conducted by examining a specific type of technology, the findings and recommendations can be applied to the introduction of new technology or procedural implementation in general.

Ignacio J. Martínez-Moyano

imartinez@anl.gov
University of Chicago

Charles M. Macal

macal@anl.gov
Argonne National Laboratory

David L. Sallach

Argonne National Laboratory

Energy Security Dynamics

As part of a process to model the emergence of strategic movements among actors, we investigate the interplay between nation state instability and energy security. We hypothesize that state instability leads to changes in energy production capacity utilization and to energy price volatility further fueling instability. We model the production, transport, and use of energy in an archetypical country setting focusing on oil and its derivatives. Additionally, we consider the effect that energy use and revenue goals have on utilization. Although the model is highly aggregate and stylized, we use publicly available data to populate model parameters and to characterize functional relationships between variables of interest.

Ignacio J. Martínez-Moyano

imartinez@anl.gov
University of Chicago

M. Samsa

msamsa@anl.gov
Argonne National Laboratory

An Action-Perception Theory of Trust and Confidence in Government

An action-perception theory of trust and confidence in government is presented. In this theory, building on prior work on the dynamics of trust and confidence in government (Martinez-Moyano, Samsa, Baldwin, Willke and Moore 2007; Martinez-Moyano and Samsa 2008), we explore dynamic drivers of trust and confidence in government by focusing on how judgments about the state of the system and decisions derived from these create, shape, and iteratively reshape the perceptions of multiple agents in the system leading to modifications in expectation levels and, ultimately, changes trust and confidence. Additionally, we explore the implications of such a model in the context of system resilience.

Georgia Mavrommati

geomavro@msu.edu
Michigan State University

Kostas Bithas

kbithas@eesd.gr
Panteion University

Panayiotis Panayiotidis

ppanag@ath.hcmr.gr
Hellenic Center of Marine Research

A System Dynamics Bioeconomic Model for Ecologically Sustainable Economic Development in Coastal Ecosystems

Development of methodological tools of coupling human and natural systems is the main challenge of the emerging field of sustainability science. The current paper proposes a System Dynamics Bioeconomic Model (SDBM) of coupling urban and coastal systems under the environmental objectives imposed by the Water Framework Directive. We developed a SDBM that connects the pollutant loads produced by urban systems' socioeconomic activities with biological quality elements reflecting the ecological condition of coastal ecosystems. This model enables quantitatively coupling of anthropogenic stressors (produced by the urban system) to the abundance of macrophytes (biological indicator of coastal system). Our case study focuses on the receiving waters of Athens Metropolitan area which is a typical example of a Mediterranean coastal city with high population density. This framework can inspire the development of other methodologies applicable to other types of ecosystems with different sources of pollution.

Richard McDowall

richard.mcdowall@gmail.com
University of Bergen

How Do “Short Sharp Shock” Punishments Affect the Prison Population? A System Dynamics Study of the London Riot Sentences.

UK prisons have been overcrowded for over 15 years, and the prison population continues to rise at a faster rate than prison capacity. The rising prison population has been attributed to harsher sentencing rather than a real increase in crime. Yet calls for “short sharp shocks” for offender groups, continue to be made without reference to prison capacity. The London rioters are one of these offender groups and are used here as a case study. Though the numbers of rioters facing prison are a small fraction of the prison population we are interested in how the punishment of the rioter's will affect the prison system as a whole. We analyse the pathways of the rioters using a system dynamics model designed to provide a dynamic hypothesis for the growth of the UK prison population. The paper considers non-linear dynamic feedbacks related to the certainty and severity of punishment, and the problems of rehabilitation implementation caused by capacity constraints.

Xiang Meng

xm2137@columbia.edu
Columbia University

Nathaniel Osgood

osgood@alum.mit.edu
University of Saskatchewan

Design of the System Dynamics Longitudinal Analysis System: Quantifying the Hidden Trajectories of System Dynamics Models

The purpose of this document is to demonstrate a new set of algorithms which utilize dynamic programming techniques to solve two typical longitudinal statistics for aggregate population models. The paper first discussed some significant values of longitudinal statistics for system dynamic model calibrations and individual history-targeted interventions. It also addressed the current limitations of people who are facing difficulties in order to access the underlying dynamics of individual health patterns within populations. A detailed example of how to quantify the hidden trajectories for a basic SIR (non-linear) model has been demonstrated in this paper. The future work may involve in developing more algorithms to identify the trajectory statistics and implement one or more GUI-based software systems to permit application of algorithms.

Balagopal G. Menon

balagopalgmenon@yahoo.com
Indian Institute of Technology

Biswajit Mahanty

bm@hijli.iitkgp.ernet.in
Indian Institute of Technology

D. Rama Rao

ramarao@naarm.ernet.in
Natl Acad of Agriculture Research Mgt

Assessment of Technical Manpower Requirements in Agriculture Sector in India

The aim of this paper is to develop an integrated demand-supply model to forecast the requirements of technical manpower in the Indian agriculture sector. Technical manpower has played an important role in achieving self sufficiency in food grain production in India. At the current levels of operations itself, there is shortage of technical manpower at various levels of the agriculture sector. Drawing on system dynamics methodology, a causal model is initially developed which is subsequently transformed to a dynamic simulation model that captures the dynamics of manpower demand-supply interactions. The simulation results show technical manpower shortages in agriculture sector in India. A policy of 50 percent increase in the intake capacity of the technical institutions is proposed which is thereafter evaluated with anticipated sectoral growth rates of 3 per cent and 4 per cent respectively. The policy was found to alleviate the shortage of technical manpower substantially for both the scenarios. However, the policy makers need to make further interventions in balancing the technical manpower supply and demand in the long run.

Birute Mikulskiene

birute.mikulskiene@mruni.eu
Mykolas Romeris University

Birute Pitrenaite

Mykolas Romeris University

Participatory policy modelling for operational policy stream: the stakeholders and public administration perspective

An introduction of the participatory element into the existing policy making scheme challenges the whole policy making practice, since unmanageable stakes have a risk to mask the proper distribution of interests and hide needs wider of the society. The particular interest of this research is to describe participatory modeling procedures and construct the model by means of system dynamics that capacitate an input of policy stakeholders via a rational balance of interest expression in policy making and policy administration streams. The primary intention is to use these modeling techniques for the description of participatory procedures and apply them to governance of wider public policy issues. The model primarily is targeted to introduce such mechanisms to the policy making

process that enable control of the completeness of the stake representation and to balance the stake representation. Equally the model has to protect policy makers from narrow interest advocacy against the public interest.

Peter M. Milling

pmilling@bwl.uni-mannheim.de
Mannheim University

Andreas J. Harbig

andreas.harbig@greenwood-ag.com
Greenwood Strategic Advisors AG

Leonard A. Malczynski

lamalcz@sandia.gov
Sandia National Laboratories

Erik Pruyt

e.pruyt@tudelft.nl
Delft University of Technology

Craig A. Stephens

craig.stephens@greenwood-ag.com
Greenwood Strategic Advisors

Nicole Zimmermann

zimmermann@wivi.uni-siegen.de
University of Siegen

Nobuaki Minato

minato.nobuaki@sdm.keio.ac.jp
Keio University

Risako Morimoto

r.morimoto@esc-toulouse.fr
Toulouse Business School

Iman Mohammed

i.s.mohammed@tudelft.nl
Delft University of Technology

Erik Pruyt

e.pruyt@tudelft.nl
Delft University of Technology

Shaping the Future of System Dynamics: Challenges and Opportunities

This session will examine the progress of the field, asking questions about where we should be going next and how we should get there. The session will begin with a Socratic dialogue aimed at giving some thoughts about how to expand the field beyond its current position and how to draw more attention to its powerful ideas. This will be followed by contributions from a range of people drawn from across the system dynamics community. They will speak about their personal experiences on: what drew them into the field; what they see as its strengths and weaknesses; what they feel needs to be done to advance the discipline of system dynamics. A chaired discussion amongst all participants will then open up to include the audience. The session is designed as an opportunity for all conference attendees to consider our field and to contribute their thoughts and opinions on how its future might be shaped.

System Dynamics Analysis on a Management of Airline-Airport Coexistence with a Load Factor Guarantee

We discussed a management of Airline-Airport coexistence for a sustainable air transport system. Governments provide various financial supports for unprofitable regional airways when the airways are essential for local life and economy but providing inefficient subsidies are often criticized worldwide. This paper aims to examine the validity of Load Factor Guarantee (LFG) scheme in which an airline and an airport mutually agree with the load factor of a flight and the airport would compensate for the discrepancy between the actual and the agreed load factor. We analyzed the LFG management using the data of Noto Airport and All Nippon Airways (ANA) from 2005 to 2011. Examining several scenarios with System Dynamics, we found that LFG would be effective to maintain regional airways when combined with appropriate level of subsidy. The results illustrated that only having annual negotiation on a target load factor cannot balance the benefits between an airline and an airport and thus does not sustain the mutualism. Integral management of LFG and monthly demand adjustment is the key to success for the airline-airport coexistence. The SD model can be applicable to airways worldwide and contribute to better design and management of a regional air transport system.

Speeding Up Energy Transitions: Gaming Towards Sustainability in The Dutch Built Environment

The paper explores the relevance and use of games for speeding up the energy transition in the Dutch built environment. Since the transition of the Dutch energy system with the current policies is much slower than required given the urgency of the foreseeable problems and the substantive system delays. There seems to be

Anne-Marije Jeanette Zwerver*annemarije@hoflandmilieu.nl*

a need for experimentation with innovative policy instruments, governance mechanisms, and systemic conditions. This paper includes applied emphases upon two topics as well as illustrations of the usefulness of games as tools for getting a grip on the energy transition. In this context, a conceptual model has been developed to illustrate the possible causes of the aforementioned slow transition in the built environment. Furthermore, we discuss the potential roles of games for managing the transition in the built environment and illustrate with an interactive experimental game developed for hypothesis testing and learning purposes. Finally, based on the results of the game we explore the possibilities for future research.

Edoardo Mollona*emollona@cs.unibo.it*

Università degli Studi di Bologna

Interpreting unfolding paths of privatisation in the steel industry.

The paper addresses the pattern of change in state intervention in steel industry and the unfolding path of privatisation in steel production. The dynamics and the determinants of privatisation have been extensively analysed. Political, institutional and economic factors have been investigated as precursors, or impediments, to privatisation. The research has often been vacillating between an emphasis on context-specific elements and a the investigation of pressures operating at global level. Indeed, untangling context-specific and global forces in explaining observed empirical paths of privatisation has usually put researchers on to two distinct avenues: cross-sectional statistical analysis, which is often poor of longitudinal breadth, or in-deep narratives, which is often hardly to rigorously reconnect to observed empirical paths and to generalise to different specific contexts. In the paper, to both maintain longitudinally-oriented and empirically-guided explanations, we propose a third avenue. We use computer simulation to interpret longitudinal dynamics of state ownership. By using this approach, we generate a number of hypotheses concerning the relationship, and the interaction, between global political pressures and context-specific forces in shaping observed path of privatisation in the steel industry.

Abiodun Suleiman Momodu*abiodun.momodu@yahoo.com*

Obafemi Awolowo University

Timothy Oyedepo Oyebisi*tooyebisi@yahoo.com*

Obafemi Awolowo University

T. O. Obilade*tobilade@yahoo.com*

Obafemi Awolowo University

Modelling the Nigeria's Electric Power System to Evaluate its Long-Term Performance

The study presents a System Dynamic model of the Nigeria electric power system. The model was developed with a view to using it to evaluate the long-term performance of the system. Both primary and secondary sources were employed to collect the system's baseline information. Results from this formed input to develop a four-sector-model in Vensim software for the long-term evaluation of the NEPS. Leverage points in the model were identified from the validated model using data from 2005 to 2009 in the Base Run. The system behaviour, based on two other scenarios (Scenario 1 representing improved basic level of consumption and Scenario 2 representing industrialization target), was then evaluated on a timeframe of 50 years starting from 2009. The study concluded that Compounded Annual Growth Rate (CAGR) and Economic Growth Rate (EGR) were the most critical policy leverage intervention points for NEPS improvement within the next 50 years.

M. Hashem Moosavi Haghighi

musavee@gmail.com
Ministry of Agriculture

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. **Keywords:** System Dynamics, Rural Employment, Agricultural Production, Unemployment Problems, Agricultural Sector, Rural Emigration, Fars Province, **JEL Classification:** J08, J21, J23, J64, Q13, Q18.

J. Bradley Morrison

morrison@mit.edu
Brandeis International Business School

The Efficiency Trap in Process Improvement and the Critical Role of Learning by Doing

This paper considers the problem of sustaining process improvement activities. We focus on the challenges arising when resources are constrained. We develop a system dynamics model of process improvement when the same people must do both production and process improvement. The model incorporates learning by doing so that the productivity of doing improvement activities grows as workers accumulate experience. Simulation analysis highlights the tradeoff between production and improvement and demonstrates a tipping point that demarcates enduring high production levels. Results show that policy orientations that emphasize efficiency of first-order improvement are likely to fail to yield lasting benefits while policies that favor learning lead to sustained superior performance.

Santiago Movilla Blanco

sbl042@uib.no
University of Bergen

Analysis of adaptation processes to offset the climate change effects on farming systems in Kenya

Climate change will have a major impact on food security in Sub-Saharan Africa and adaptation to climate change requires a major transformation process of smallholder agriculture. A considerable body of research explores adaptation strategies for agriculture. However, there is not an overview of existing adaptation options working in concert and their impacts, neither how to prioritize these options. The proposed project contributes to the acceleration of the adaptation process by combining the fields of climate change, agriculture, and food security with the field of System Dynamics for policy design. This combination results in an innovative methodology for building capacity to effectively manage adaptation to climate change. In this case the project will include the development of a simulation model for farming systems in Kenya. The model integrates existing

knowledge and data collected during field work. It results in a simplified but illustrative impact assessment tool that visualizes the short and long term impact of adaptation options on food security under different climate change scenarios.

Erling Moxnes

erling.moxnes@ifi.uib.no
University of Bergen

Sustainable development: from discounting to simulation

Management of global natural resources is important for sustainability. Two questions are central: what are the welfare effects of different resource policies, and how should one choose between different welfare developments over time? There are methodological challenges related to both macroeconomic analysis of policy effects and choice involving distribution over time, i.e. discounting. There is also a democratic challenge related to the complexity of macroeconomic analysis and discounting. To overcome or reduce these challenges a simulation approach is proposed and discussed. Its potential for democratic choice is tested on a subset of the UK population.

Erling Moxnes

erling.moxnes@ifi.uib.no
University of Bergen

The Tragedy of Overshoots

Understanding historical overshoots is vital for policy-making, not least when assessing potentials for future global overshoots. For this purpose a simple, unifying theory of overshoots is described and discussed for a variety of observed overshoots. For undesired and avoidable overshoots, misperception at some level must be a major cause. Laboratory experiments support this hypothesis and point to dynamics as the main complicating factor. The theory suggests that misperceptions may cause global overshoots both because of climate change and scarcity of cheap fossil energy. New generations of simulation models are needed to study overshoots, test policies for sustainable development, and to aid information dissemination.

Matthias Otto Müller

matthias.mueller@ikaoe.unibe.ch
Greenwood Strategic Advisors

How can the Diffusion of Energy-Efficient Renovations be Accelerated? Policy Implications from a System Dynamics Modeling Study

Silvia Astrid Ulli-Beer

silvia.ulli-beer@psi.ch
Paul Scherrer Institut

We report on modeling work that shows how the market, technology, civil society and the state govern the diffusion of energy-efficient renovations in Switzerland's stock of residential, multifamily buildings. The particular focus of this article is on the policy implications that we drew from an extensive System Dynamics modeling study. We conclude that energy efficiency is important yet not sufficient in order to reach the goals of a 1-ton-CO₂-society by 2100. In addition to promoting energy efficiency, Switzerland should aim for a widespread decarbonization of heating systems. We discuss what kind of instruments can be used to address various intervention levers in order to accelerate the diffusion of energy-efficient renovations. We propose two regulations that could serve as a framework for ambitious long-term decarbonization efforts. And finally, we propose a service innovation that could assist building owners in complying with the ambitious regulations required.

Ahmet Mutallip

ahmetmutallip@hotmail.com

Bogaziçi University

Hakan Yasarcan

yasarcanh@yahoo.com

Bogaziçi University

A Parametric Analysis of the Effect of a Material Supply Line Delay in Stock Management

It is known that the presence of a supply line delay may lead to unwanted oscillatory stock behavior. It is also well known that fully considering the supply line in the ordering decisions, which means using the same adjustment time for stock adjustment and supply line adjustment terms, prevents unwanted oscillations. The effect of using the same or different adjustment times is relative. Therefore, in the literature, it is suggested that a weight coefficient should be used instead of explicitly using two separate adjustment times. This weight is simply equal to stock adjustment time divided by supply line adjustment time and it is named as weight of supply line. In this paper, we defined one more decision parameter that we call relative aggressiveness, which is equal to acquisition delay time divided by stock adjustment time. The existence or non-existence of stable or unstable oscillations is a function of the order of the supply line delay structure, weight of supply line, and relative aggressiveness. Usually, acquisition delay time and order of the supply line delay structure are not decision parameters; weight of supply line and stock adjustment time are. In this paper, we aim to give more insight to the readers about the selection of these two important parameters.

Yosuke Nakajima

y.nakajima.mobile@gmail.com

Keio University

Toshiyuki Yasui

t.yasui@z2.keio.jp

Keio University

Yoshiaki Ohkami

ohkami@sdm.keio.ac.jp

Keio University

Naohiko Kotake

kohtake@sdm.keio.ac.jp

Keio University

Modeling a Policy for Managing Polio Vaccine in Japan: Scenario Planning Based on System Dynamics

This research is to provide a methodology for making policy scenarios based on the system dynamics. The authors deem this new methodology would be a useful tool for policymakers to make policy scenarios. As for the case study, this research deals with the policy scenarios for managing polioviruses in Japan as an example. This methodology includes both the simulation part of using System Dynamics and the conversation part related to Scenario Planning. Through using this methodology, we had structural understanding of the problem with the visible simulation results and conversation with member which was focusing on the parameters that would be a part of suggested scenarios. This methodology is expected to improve the public deliberations for making policy scenario based on data.

Morteza Nazari

morteza.nazari.iri@gmail.com

Sharif University of Technology

Ali Naghi Mashayekhi

mashayekhi@alum.mit.edu

Sharif University of Technology

Modeling Arabian Upraise, a System Dynamics Approach: Egypt case study

Revolutionary movements have always served as focal points for social and political scientists' scrutiny. Controversially, despite all efforts the field still seems impotent in predicting the impending collapse of regimes rather uprising of the corps. This paper argues that, the problem has ensued from flawed perception of the systematic, endogenous and dynamic nature of social interactions; and Using a "system dynamics model," tends to both elucidate the internal interactions of the phenomena, and evoke the time series behavior of the key factors shaping the outcome. With the structured model in hand, we then proceed to analyze the policies executed and see how they failed their purpose in taking stranglehold over the insurgent movements.

Morteza Nazari

morteza.nazari.iri@gmail.com
Sharif University of Technology

Masoomeh Khandan

masoomeh.khandan@gmail.com
Asemaan

Stories For Teaching Systems Thinking: Development and Implementation Guide

Stories have shown to be very beneficial in teaching complex concepts to children, including system thinking. However, few stories for teaching systems thinking have been developed; indeed it seems that there exists a gap between writers and system practitioners, as writers don't know how to develop stories containing systems thinking concepts. Hence, Asemaan's experience of writing and teaching systems thinking stories to k-12 students is presented in a structured and integrated framework as a guide for writing and telling these stories. Also, the study proposes some ideas around deficiencies of current written and oral language structures of conveying systems thinking concepts and quality of tasks conducted in the class while telling stories.

Felix Neugebauer

fexgebauer@gmail.com

Taylor Ruling Brazil – a System Dynamics Model for Monetary Policy Feedback

The paper introduces a system dynamics Taylor rule model for monetary policy feedback between the real interest rate, inflation and GDP growth for the 2004 to 2011 period in Brazil. The nonlinear Taylor rule for interest rate changes considers gaps and dynamics of GDP growth and inflation as well as monetary policy sluggishness. The results outline a high degree of endogenous feedback for monetary policy and inflation, while GDP growth remains strongly exposed to exogenous economic conditions. Furthermore, stocks of absolute monetary policy flows provide a new mean for assessing empirical monetary policy moves. The stocks show that Brazilian monetary policy has been more driven by growth than by inflation considerations in the period under investigation. Moreover, simulation exercises highlight the potential effects of the new BCB strategy initiated in August 2011 and also consider a recession avoidance Taylor rule. In total, the strong historical fit of the Taylor rule model calls for an application of the model to other economies.

Charles F. Nicholson

cfn1@cornell.edu
Cal Poly State University

David Parsons

dparsons@utas.edu.au
University of Tasmania

Dynamic Analysis of Policy Options for Mexico's Sheep Sector

The demand for sheep meat in the populous central region around Mexico City has grown rapidly in recent years. To assess the impacts of potential "regional development" policy options, a dynamic model of Mexico's sheep sector with regional and producer group disaggregation is developed that incorporates interactions between herd dynamics, feed dynamics, market inventories of sheep meat and prices for sheep meat and animals. The model is used to assess the outcomes for commercial and tras patio (backyard, small-scale) Mexican sheep producers and sheep meat consumers of three growth assumptions and two intervention alternatives: a variable cost subsidy or the implementation of a stylized health intervention. Model simulations indicate that the dynamics of growth dominate the policy responses; the principal beneficiaries of producer

subsidy and animal health interventions are Mexican sheep meat consumers. Commercial sheep producers will experience increases in cumulative net margin, but tras patio producers will be made worse off than they would have been in the absence of interventions. The Mexican sheep system thus exhibits two characteristics of dynamically complex systems: unintended consequences and policy resistance, with broader implications for interventions in agriculture-based livelihood systems.

Stephen Olu Ogunlana

s.o.ogunlana@hw.ac.uk
Heriot-Watt University

Decent Work: Modelling of workers' willingness to work in construction

Construction employment is sometimes considered not 'decent' and a mere exploitation of cheap labour. This paper investigates what makes workers willing to be employed in construction and how their jobs can be improved. Qualitative data gathered from case study and interviews conducted in Thailand and a review of literature helped to develop a System Dynamics model to investigate workers' willingness to work in construction. The investigation reveals that insecure and inadequate income, necessity for severe physical exertion, exposure to health and safety hazards, exposure to poor living conditions, requirement for separation from family, lack of free time and gender discrimination erode workers' quality of life and reduce their willingness. The pressure to generate income and satisfaction resulting from fulfilment of certain higher level needs increase willingness. Possible actions by construction companies such as limiting overtime hours, optimum provisions for accommodation and welfare facilities, safety and health measures, skills development and gender equality could improve workers' willingness and their life.

Camilo Olaya

colaya@uniandes.edu.co
Universidad de los Andes

Models that Include Cows: The Significance of Operational Thinking

The unconscious application of sophisticated tools, and in particular the popular reverence to data as the source of knowledge, seems to be the rule in many scientific activities in which the application of tools replaces thinking and data analysis replaces understanding. In this respect, system dynamics has much to offer, though sometimes it is tricky to appreciate its full value and scope. One of its trademarks is known as "operational thinking". This paper underlines that operational thinking drives a distinct epistemic posture. This posture, unlike traditional scientific practice that seeks to explain the world by means of data analysis, intends to understand the world in terms of its operations. In this paper I explore the significance of such a posture for the domain of human systems, I highlight its epistemic value in particular with respect to the prevalent observational approach to science, the Humean problem of induction and determinism. Operational thinking means to recognize that human systems do not obey laws to be discovered by observation and data analysis, instead, it acknowledges agency, that is, the fact that a social system is the result of the consequences of actions taken by free decision-makers.

Marta Ormazabal

mormazabal@tecnun.es
Tecnun - University of Navarra

Eliot Rich

rich@acm.org
University at Albany

Jose Mari Sarriegi

jmsarriegi@tecnun.es
Tecnun - University of Navarra

Exploring Environmental Management Evolution through Maturity States and Behavior Over Time Graphs

This paper hypothesizes that successful corporate environmental management proceeds through a series of characteristic stages independent of industrial context. Our classification proposes six different maturity states: Environmental Compliance, Training, Systematization, ECO2, Eco-Innovation and Leading Green Company. Through collaborative modeling and surveys we develop a causal structure and behavior mode of an evolutionary process.

Nathaniel Osgood

osgood@alum.mit.edu
University of Saskatchewan

Yuan Tian

yut473@mail.usask.ca
University of Saskatchewan

15 Things System Dynamics can Learn from Software Development

While System Dynamics involves a diverse set of issues outside the scope of software development, one of the key outcomes of the System Dynamics process is software artifacts, in the form of simulation models. Many of the principles and concerns of software development more generally apply by extension to the development of System Dynamics models. In recent decades, the software development field has benefited greatly from a series of process-based and technologies to make the production of software artifacts more reliable, more timely, and more predictable. Within this paper, we argue that System Dynamics projects can benefit from adoption of processes and techniques in software development, and discuss some of the adaptations required to take best advantage of such approaches.

Peter Otto

ottop@union.edu
Union Graduate College

Effects of Extrinsic Motivation on Crowdsourcing Participations: A Theoretical Causal Model

The objective of this paper is to develop a dynamic theory of extrinsic motivation on crowdsourcing participation. Crowdsourcing initiatives are becoming an increasingly important organizational form to gain access to new knowledge and to leverage existing knowledge. By establishing a crowdsourcing system, an organization will gain valuable learning opportunities to acquire knowledge and to enhance its competitiveness. The degree with which crowdsourcing platform facilitate collaboration is dependent on the motivational drivers for individuals to enlist and the collaborative strategies adopted by the organization. These collaborative strategies may include financial incentives, recognition as well as resource alignment to support crowdsourcing initiatives. In order to gain insights into the dynamics of crowdsourcing system we propose a simulation model to test different conditions influencing the outcome of crowdsourcing initiatives. The results can improve our understanding of the key factors that influence the motivation of individuals to participate in crowdsourcing platforms. We conclude the paper with a discussion for guidelines to assess and manage the sustainability of crowdsourcing systems.

Mohammad Saleh Owlia

owliams@yazduni.ac.ir
University of Yazd

Hossein Dastkhan

hosseindastkhan@gmail.com
Javad University College

An Application of System Dynamics in Electricity Supply Systems: Case of Yazd Regional Electricity Company in Iran

Due to the existing complexities in the new energy systems, energy programming is known as an essential task for the governments in different countries. Among different techniques in energy programming, system dynamics is a valuable technique in the simulation of complex systems and analysis of their existing dynamism. In this paper, the electricity generation system is considered as a comprehensive dynamic model to analyze the results of different scenarios and policies. The effectiveness of the model in handling the dynamism of the system and analyzing the policies is validated with a real case in province of Yazd in Iran. For this purpose, 5 different scenarios and policies are analyzed based on different technical, economical and environmental indices. The results show that the balanced growth and the environment-oriented policies have represented the best results among different policies. Even though the application is to the Iranian Case, the implications are much wider, especially in developing countries.

Onur Özgün

onur.ozgun@boun.edu.tr
Bogaziçi University

Yaman Barlas

ybarlas@boun.edu.tr
Bogaziçi University

Systemic Complexity of a Growth Management Game: Comparative Analysis of Decision Heuristics and Experimental Results

In this study, using different versions of a growth management game involving two different complexity factors, we compare performances of heuristic rules with experimental results. We present a method for obtaining a statistical distribution of scores resulting from a given simulated decision heuristic, which can be used to compare against and assess experimental gaming results. The method is based on the idea of generating vast number of scores by stochastically simulating a given decision rule and obtaining the resulting score distribution. We use this method to compare scores from different game versions whose scores are essentially not comparable, and to see how the score distributions change from one game version to another. In simulations, we first use a simple random "decision rule" and then develop a more intelligent hill-climbing heuristic. The results show that when the games involve delay, human subjects do not perform better than the random heuristic—a primitive rule composed of a sequence of random decisions. On the other hand, in nonlinear games, subjects outperform the random heuristic and their scores fit better the score distribution of the hill-climbing heuristic. We also demonstrate how the score distribution from random heuristic can be used as a reference performance measure.

Onur Özgün

onur.ozgun@boun.edu.tr
Bogaziçi University

Yaman Barlas

ybarlas@boun.edu.tr
Bogaziçi University

Effects of Delay, Nonlinearity and Feedback on the Overall Complexity of a Stock Management Game

The aim of this study is to test statistically the effects of delay, nonlinearity and feedback factors on the complexity of a stock management task. The task requires the player to bring the inventory to a target level and keep it there. Each of the individual complexity factors brings different challenges to the game. Using a slightly modified Latin square experimental design, we test the factors at different strength levels. We use two measures of game complexity: game scores and players' subjective difficulty ratings. The results show that, with respect to the

simple base game, delay and nonlinearity create worsening in game performances. Also, with increased delay duration, delay order and nonlinearity, subjects' performances deteriorate. However, feedback does not deteriorate the game performance. Furthermore, increased feedback strength even improves scores, due to a technical side effect on the performance measure. All subject groups exhibit learning by repeated trials. Nevertheless, there is also evidence that delay prevents transfer of learning to other game versions. The subjective complexity ratings of the players yield parallel results, the overall correlation of game scores with the subjective difficulty ratings being +0.59.

George Papachristos

men8gp@gmail.com
University of Patras

**Case study and system dynamics research:
Complementarities, pluralism and evolutionary theory
development**

This paper explores the complementary use of system dynamics and case study research methodology for process theory development. The rationale for this is provided on the grounds of the limitations of human cognition, particularly in understanding the evolution of complex non linear systems and processes in time. This poses difficulties when attempting to arrive at causal mechanisms for phenomena of interest with some confidence. Viewing research as an evolutionary process where better explanations are continuously sought, generated, selected and retained, simulation can be of use both in increasing the range of alternatives considered and serving as a concrete background against which the selection process takes place, thus facilitating the attainment of a satisfactory level of system understanding. Modelling and simulation has the added benefit of providing a documented artifact through which conclusions are reached and consequently it allows for replication or at least a thorough review.

George Papachristos

men8gp@gmail.com
University of Patras

**System dynamics modelling for assessing promotion
strategies of biofuels used in land transportation**

This article presents the development and use of a system dynamics model of the interactions of the food commodities and biofuels production systems. The principal aim is to develop a sense of the mechanisms responsible for the impact of biofuels on the production output and prices of food commodities. The model and the associated discussion are confined to biofuels for the transportation sector of the European Union. Simulations of the model with incentive policies for promoting biofuels in the European Union showed that beyond a certain point, the rate at which biomass production expands can be problematic with regard to land availability for agricultural products grown for human consumption. Nevertheless, simulations indicated that process technology increasing the productivity of biofuel production can act as a balancing factor.

Emmanuel D. Adamides

adamides@mech.upatras.gr
University of Patras

**Ozone Depleted and Depletion of Cooperation: Model-
based Management Assessment to Make Collective Action
Sustainable Overtime**

This paper assesses the capability of cooperation -based on trust- to support collective action to be, aiming at mitigating the Ozone Depletion Crisis. We developed a System Dynamics model to assess the Ozone Crisis. We conclude

Jorge Andrick Parra Valencia

japarra@unab.edu.co
Universidad Autónoma de Bucaramanga

Isaac Dynner

idyner@yahoo.com
Universidad Nacional de Colombia

that initial conditions determine path dependence conditions for trust and cooperation effects, which require additional complementary mechanisms to achieve sustainable cooperation for overcoming the Ozone Crisis. We propose better understanding the inertia of chlorofluorocarbons (CFC) accumulation and their effect on cooperation to efficiently overcome the crisis.

Jorge Andrick Parra Valencia

japarra@unab.edu.co

Universidad Autónoma de Bucaramanga

Isaac Dyner

idyner@yahoo.com

Universidad Nacional de Colombia

Can We Reverse the Atmospheric CO₂ Concentration Trend Using Cooperation? Model-based Management for Effective Cooperation

The reversibility of the Effects of Green House Gases is a hot topic among scholars nowadays. We tested if cooperation is efficient to overturn the current CO₂ Concentration Trend in the atmosphere – this, we approach as a large-scale social dilemma. We developed a System Dynamics model to find the conditions required to achieve effective cooperation that may contribute to reverse the current CO₂ concentration trend. Simulation experiments show that initial conditions of trust and information delays are determinant to attain cooperation in the direction of reducing the CO₂ concentration trend.

Kiavash Parvan

kparvan@umd.edu

University of Maryland

Hazhir Rahmandad

hazhir@vt.edu

Virginia Tech

Ali Haghani

haghani@umd.edu

University of Maryland

Estimating the impact factor of undiscovered design errors on construction quality

Construction projects are complex as they include many activities which influence and interact with each other at different stages. The impact of design phase undiscovered rework on construction phase quality has been hypothesized as influential in project dynamics by many. However few empirical studies have measured this impact. In this paper we develop a simple system dynamics model, estimate it using data from 18 construction projects, and validate the model on a validation set of 15 projects. The model provides good fit for the calibration set and strong predictive power on the validation set. It also allows us to estimate the impact of undiscovered design changes on construction phase quality, which appears to be notable.

Alberto Paucar-Caceres

a.paucar@mmu.ac.uk

Manchester Metropolitan University

Diane Hart

d.hart@mmu.ac.uk

Manchester Metropolitan University

Ricardo A. Rodríguez-Ulloa

ias@iasvirtual.net

Instituto Andino de Sistemas

Using Soft Systems Methodology and System Dynamics in Mining Operations in Peru: Initial Findings for a Boundary Critique

We introduce the use of Ulrich's Critical Systems Heuristics to organize second order critical reflexion in systems practice and action research. The paper draws on critical systems thinking and illustrates its application in the context of an intervention using Soft Systems Methodology (SSM) and Systems Dynamics (SDy) to evaluate the environmental impact of mining operations in southern Peru. The paper argues that by combining some of SDy and SSM stages, much can be gained in a systemic intervention to tackle complex social situations. We sketch the context in which the systemic intervention was carried out reporting on the initial SSM and SDy stages to outline a 2nd order boundary critique tool for systemic interventions.

David W. Peterson*david@ventanasystems.com*

Ventana Systems

Mariano Blanc*mariano.blanc@durofelguera.com*

Duro Felguera

Money Multiplier Dynamics and Banking Liquidity Cycles

Banking crises are commonly assumed to be driven by external events such as speculative bubbles, imposed on a normally stable banking system. To the contrary, this paper presents evidence that liquidity cycles and crises can arise naturally from the most basic structure of the banking system itself. The stability of a banking system can depend not only on the reserve requirements, but also on the relative magnitudes of other fundamental parameters, such as the lifetime of loans, the lifetime of deposits, and the time banks take to convert available liquidity into loans. Under realistic parameter values, a banking- regulatory system itself may generate spontaneous oscillations of sufficient amplitude to cause crises.

Angele Pieters*angele@angelepieters.com*

Tilburg University

Care & Cure Combined: Using Simulation to Develop Organization Design Theory for Health Care Processes

The health care sector is facing a multitude of problems at the same time: rising costs, increase in patients with lifelong diseases, and unsatisfying quality. There is a prominent role for conditions that require a combination of simple (care) and complex (cure) activities. These conditions require different provider expertise; one offering care expertise or more general, preventive monitoring, and the other offering cure expertise, or more specialized, medical monitoring/intervention. In organization design theory the focused factory concept is presented as a way of organizing such processes. However, the application of this concept does not always work well. For decennia, Dutch perinatal care is organized according to the focused factory concept, but recently there has been considerable debate with regard to its performance. Research has shown that the design of the Dutch perinatal care system might not be the right one (Pieters, Van Oirschot, & Akkermans, 2010). In response to its problems, the sector is seeking alternative organization designs. In this paper simulation modeling is used to evaluate these different organization design experiments. From these simulations, we seek to build organization design theory for this type of conditions (Davis, Eisenhardt, & Bingham, 2007; Schwaninger & Grösser, 2008).

Kim van Oorschot*kim.v.oorschot@bi.no*

BI Norwegian School of Business

Henk A. Akkermans*henk@supplynetworkdynamics.org*

Research in Business BV

Roberto Max Protil*roberto.protil@ufv.br*

Federal University of Viçosa

Strategic Control of Agro-Industrial Cooperatives: A Strategic Map Proposal

This article discusses about the design of a qualitative model of strategic implementation and control in agro-industrial cooperatives. Based on the concepts of Balanced Scorecard - BSC and System Dynamics - SD, and considering the corporate features of cooperatives as people societies and not capital societies, the article proposes a strategic map, which presents up variables that represent the critic processes in strategic management for these organizations, as well as identifying causal relations hypothesis between the variables. From the concepts of BSC, the map is built with the four traditional perspectives: financial; customers; internal process; growth and learning; and adding two other important perspectives: the social perspective and the member relationship perspective. From the concepts of SD, the map is qualitatively built, predicting the complexity of strategic control, in accordance to the need of conciliation and balance of economic goals between the organization and its members. From the proposed strategic map, the goal is to proceed with the research, defining new indicators of each variable in the map, as well as its adaptation and application towards

Reginaldo Ferreira Barreiros*rfbarreiros@uol.com.br*

Universidade Estadual de Ponta Grossa

Roberto Max Protil

roberto.protil@ufv.br
Federal University of Viçosa

John Leno C. Santos

johnlenocastro@gmail.com
Federal University of Viçosa

Francisco CC. Cassuce

francisco.cassuce@ufv.br
Federal University of Viçosa

Newton Paulo Bueno

npbueno@ufv.br
Federal University of Viçosa

Roberto Max Protil

roberto.protil@ufv.br
Federal University of Viçosa

Alfredo Benedito Kugeratski Souza

alfredoks@gmail.com
SESCOOP/OCEPAR

Erik Pruyt

e.pruyt@tudelft.nl
Delft University of Technology

Jeroen Coumou

j.coumou@amc.uva.nl
University of Amsterdam

cooperatives, through the action-research method. The qualitative model can also serve as a conceptual basis for future parameterization and simulation of a quantitative model.

Analyse Of Tax Competition In Brazil Using the System Dynamic Approach

The present study analyzes the systemic interaction of tax competition in Brazil, aiming to identify the elements that perpetuate this practice and its effects on the economy. It should be noted that according to the system model, the results obtained with the tax competition is not even optimal condition for the less favored resource region (Northeast). Since, upon the incursion of specific investments in infrastructure (in the same amount of tax waivers), the behavior of GDP, infrastructure and revenue would be higher in this region. For this reason, it is evident that the sub-national level (decentralized) the only alternative industrial policy for the less affluent is the granting of tax incentives. However, this type of policy is effective palliative and temporary and does not constitute, per se, a sustainable policy to fix the route of economic concentration. It remains thus to the central government to put policies in place to increase the attractiveness of these regions for private investment. Otherwise, these regions do not have incentives to reduce tax competition.

Economic Evaluation of Agronomic Research In Agricultural Cooperatives: Proposal of a Dynamic Scorecard Model

The scope of this work is to develop an instrument for the economic evaluation of agricultural research in the productive chain of wheat and its impact in the profitability of agricultural cooperatives. A conceptual model was developed using the balanced scorecard and system dynamics methodologies. In the development of the model all processes involved in the productive chain of wheat agricultural research were initially mapped. Furthermore, a BSC strategic map was developed, explaining the objectives and indicators of the cooperative. Finally, using the system thinking approach, a modeling was driven seeking enlargement of the problem systemic vision. The resulting model developed in this work allowed a better understanding of the complex relationships between research and agricultural production, making it easier to analyze the process and the decision of new investments in research on the part of managers and analysts of agricultural cooperatives.

Developing Scenarios for Deeply Uncertain Dynamically Complex Risks: Exploring Plausible Futures of Lyme Disease

Lyme disease poses an uncertain dynamic threat to many people and public health systems. However, rather different perspectives related to the societal impact of Lyme Disease exist. Thousands of plausible evolutions of lyme disease are generated using different System Dynamics models of Lyme Disease and are studied in this exploratory study with new data analysis techniques in order to assess the risk posed by Lyme disease, in this case to the Dutch population and the Dutch health care system. The risk is scored in the Dutch National Risk Assessment framework adapted to deeply uncertain dynamically complex risks,

and mapped in a new type of risk diagram developed for uncertain complex risks in order to compare the risk posed by Lyme disease to many other plausible risks. Scenario discovery techniques are used to identify a small set of representative scenarios that could be used for subsequent capability analysis.

Erik Pruyt

e.pruyt@tudelft.nl

Delft University of Technology

Caner Hamarat

c.hamarat@tudelft.nl

Delft University of Technology

Jan H. Kwakkel

j.h.kwakkel@tudelft.nl

Delft University of Technology

Integrated Risk-Capability Analysis under Deep Uncertainty: an Integrated ESDMA Approach

In an ever more complex and uncertain world, integrated risk-capability analysis methodologies that allow dealing with increasing degrees of complexity and deep uncertainty are needed more than ever before. Today, some governments and organizations use scenario approaches, risk assessment methods, and capability-based planning, but few have truly integrated risk-capability approaches, and almost none use integrated risk-capability approaches appropriate for deeply uncertain complex risks. However, many important risks are particularly dynamically complex and deeply uncertain. This paper presents and illustrates a novel integrated risk-capability analysis approach for deeply uncertain dynamically complex risks, and discusses near future developments. As such, it illustrates a multi-method consisting of Exploratory Modeling and Analysis, Exploratory System Dynamics Modeling, Scenario Discovery and Selection, and MCDA, and discusses the use of Robustness Optimization for simultaneous all-hazard capability-based planning.

Erik Pruyt

e.pruyt@tudelft.nl

Delft University of Technology

Jan H. Kwakkel

j.h.kwakkel@tudelft.nl

Delft University of Technology

A Bright Future for System Dynamics: From Art to Computational Science and More

This paper presents a bright future for quantitative System Dynamics Modeling. This future relates to all major issues and grand challenges which all happen to be dynamically complex and deeply uncertain. Combining System Dynamics Modeling and Exploratory Modeling and Analysis allows one to generate, explore and deeply analyze tens of thousands of plausible scenarios related to such deeply uncertain dynamically complex issues, and to design and test adaptive policies over all plausible scenarios. By doing so, the art of System Dynamics becomes the computational science of System Dynamics. This innovative approach is explained in this paper starting from the core of System Dynamics modeling, and is illustrated with three real world applications (pandemic shocks, resource scarcity, and energy transitions). However, more is needed than the brightest analysts and the best analyses for decision makers to decide and take action when facing uncertain complex issues: that is what experiential System Dynamics gaming is needed for. Only when heart and mind are aligned will knowledge and understanding become effective. The use of experiential System Dynamics gaming for conquering the heart of decision makers is illustrated with real world examples too.

Erik Pruyt

e.pruyt@tudelft.nl

Delft University of Technology

Making System Dynamics Cool IV: Teaching & Testing with Cases & Quizzes

This follow-up paper presents cases and multiple choice questions for teaching and testing System Dynamics modeling. These cases and multiple choice questions were developed and used between January 2012 and April 2012 a large System Dynamics course (250+ BSc and 40+ MSc students per year) at Delft University of Technology in the Netherlands. The cases presented in this paper

could be useful for teaching and testing introductory/intermediate System Dynamics courses at universities as well as for self study. For these cases, students need to develop simulation models, answer multiple choice questions related to their models, as well as open questions related to their modeling and model use. Second, the use of multiple choice questions and quizzes for teaching and testing System Dynamics understanding and modeling skills is discussed and illustrated. Finally, changes to the System Dynamics curriculum enabled by further development of the teaching/testing approach of the Introductory System Dynamics Course are discussed.

Muhammad Azeem Qureshi

mazeemqureshi@yahoo.com

Oslo and Akershus University College

Pål I. Davidsen

pal.davidsen@geog.uib.no

University of Bergen

Conceptualizing Human Centered Development -The Case Pakistan

This paper presents a system dynamics based macroeconomic model of the Pakistan. The model comprises of population, human development, production, international trade and system of national accounts, and public finance modules. Conscious efforts have been made to achieve the best possible blend of standard long-run theories and country-specific features to model underlying system structure of human centered development in Pakistan by focusing on long-term dynamics. The tracking performance of the model is evaluated. Empirical investigation of a number of topical macroeconomic issues utilizing model simulations have shown the model to be useful which would be extended to address 'spatial' dimension of socioeconomic planning issues of Pakistan. The model helps to better conceptualize the underlying system structure to bring in a broad-based improvement in the human condition without forgoing economic growth. It highlights the need to mobilize cost effective resource generation and suggests that priority be given to allocation of public finance to human development and not the economic services and infrastructure confirming that human development and economic growth are interdependent and intertwined in feedback processes which are mutually reinforcing and that human development is not only an end in itself but is a means to achieve higher productivity as well. This challenges the very basis of continued disregard of human development by public finance managers of Pakistan.

Stefan Raaijmakers

s.raaijmakers@fm.ru.nl

Radboud University Nijmegen

Hubert Korzilius

h.korzilius@fm.ru.nl

Radboud University Nijmegen

Etiënne A. J. A. Rouwette

e.rouwette@fm.ru.nl

Radboud University Nijmegen

Jac A. M. Vennix

j.vennix@fm.ru.nl

Radboud University Nijmegen

The effect of individual characteristics of decision making and judgment on stock-flow performance

Extending the line of research on stock-flow performance we examined the impact of personality characteristics on task performance. It was assumed that the need for cognition, the need for closure and the preference for intuition and deliberation would relate to individual variations in task performance differentiated into the dimensions heuristic reasoning, task effectiveness (number of correct answers) and task efficiency (time needed to perform the task). It was found that the need for closure did not relate to any of the task performance dimensions, while the preference for deliberation related positively with task effectiveness, and the need for cognition positively with task effectiveness and negatively with heuristic reasoning. Although all three constructs possess a rather explicit temporal dimension, the examined needs and preferences appeared not to be correlated with the time needed to perform the stock-flow task. Further research is needed to substantiate the findings of the current study and to elaborate on the precise relation between needs and preferences and stock-flow information processing as well as to refine the concept of task effectiveness.

Mohammad Hussein Rafiei Sakhaei

rafiei.m.ee@gmail.com
Sharif University of Technology

Masoud Jabbari

jabbari.m.sh@gmail.com
Sharif University of Technology

Modeling the Impacts of Middle East and North Africa Unrest on the Global Oil Price

Social and political phenomena of the Middle East and North Africa (MENA), as the main oil producer region, are of the crucial importance. In this paper, we will try to give a better model of the oil markets and the factors that are important in determining the oil price. The previous models take into account the interactions of the supply and demand forces of the market to determine the oil price. However, in our model, we will consider another important factor as well, namely the Naked Fear in the oil markets, which mainly reflects the several concerns in the supply and demand parts of the oil trade. After studying the various causal loops, by means of simulating the model, we will show that the predictions for the trends of oil price made by our model, concords with the real data that have been observed. Furthermore, the model provides a way for testing some policies and solutions proposed for reducing the fluctuations of the oil markets due to the social unrests in the region, in addition to their influences on the global economy.

Hazhir Rahmandad

hazhir@vt.edu
Virginia Tech

Modeling the dynamics of human body growth and maintenance

Detailed individual level simulation models are needed for better policy analysis to combat the costly obesity trends. Current models largely focus on adulthood and do not capture variations across individuals. In this paper I develop a simple simulation model spanning the full life cycle of an individual that captures both weight changes and growth in height. The model is tested for consistency with growth charts, robustness under different energy intake scenarios, and consistency with other empirical sources including a previous model from the literature and the experience of a lost ocean traveler. The results suggest the model structure is capable of capturing the key trends in growth and weight dynamics, however better data sources are needed to estimate a few of the model parameters empirically.

Hazhir Rahmandad

hazhir@vt.edu
Virginia Tech

John Sterman

jsterman@mit.edu
MIT

Reporting Guidelines for Simulation-based Research in Social Sciences

Reproducibility of research is critical for the healthy growth and accumulation of reliable knowledge, and simulation-based research is no exception. However, studies show many simulation-based studies in the social sciences are not reproducible. Better standards for documenting simulation models and reporting results are needed to enhance the reproducibility of simulation-based research in the social sciences. We provide an initial set of Reporting Guidelines for Simulation-based Research (RGSR) in the social sciences, with a focus on common scenarios in system dynamics research. We discuss these guidelines separately for reporting models, reporting simulation experiments, and reporting optimization results. The guidelines are further divided into minimum and preferred requirements, distinguishing between factors that are indispensable for reproduction of research and those that enhance transparency. We also provide a few guidelines for improved visualization of research to reduce the costs of reproduction. Suggestions for enhancing the adoption of these guidelines are discussed at the end.

Weijia Ran

wran@albany.edu
University at Albany

A System Dynamics Approach to Exploring Sustainable Tourism Development

Tourism is an important industry in many developing countries. In the past few decades, the issue of how to minimize the negative effects of tourism on natural and cultural environments and maximize its positive effects on economic development has been a major topic for tourism researchers and practitioners. Successful tourism-related policies not only can deliver economic benefits to communities, regions, and countries, but also can facilitate their sustainable economic, environmental, and cultural development. Within this context, it is important for policy-makers to incorporate sustainable initiatives into tourism-related policy making. The question of how policy-makers can incorporate sustainable initiatives into tourism-related policy making in a way that will allow them to develop implementable policies and achieve sustainable tourism is, however, not a simple question to answer. Since tourism practices are depicted as processes that reflect different competing interests and values, in order to incorporate sustainable initiatives into tourism-related policy making and achieve sustainable tourism, the first step should be understanding different competing interests and values and their possible contributions to sustainable tourism. This study is aimed at contributing to this area by investigating tourism stakeholder groups' interests and values and their influences on tourism development through a system dynamics approach.

George P. Richardson

gprichardson@albany.edu
University at Albany

Sliding Goals in Student Achievement?

The sophistication of schools texts has been declining for more than 100 years in the U.S. Coincidentally, student capabilities and measured verbal achievement have been declining, certainly since the 1950s and probably since 1900. This investigation built a tiny model representing the famous sliding goals archetype tracing back to Forrester's Market Growth paper, and fit the model beautifully to the data. The fit is very dramatic and persuades everyone who sees it that the sophistication of texts and student SAT verbal scores are linked in a sadly sliding long-term pattern. But the fit, derived by robust and correct procedures, is fundamentally flawed, and the lovely fit to data is grossly misleading. This presentation will reveal the entire sad story, with implications for wise practice in the field.

Robert Rieg

robert.rieg@htw-aalen.de
Aalen University

Dynamics of value-based management – – does shareholder value cause short-termism?

Shareholder Value (SHV) and value-based management (VBM) are blamed for causing short-termism of investors and managerial myopia. Empirical evidence states decreased holding periods of stocks by investors, increased discount rates and widespread adoption of earnings management. While this supports the existence of short-termism and myopia, it does not clarify its causes. What is missing is: do shareholder value and value-based management cause short-termism in the behavior of investors and managers? The paper uses System

Dynamics to model both concepts and to try to explain short-termism and myopia as endogenous outcome of these concepts. The main result is, that, given uncertainty of outcomes of managerial action managers will have incentives to engage in short-termism. Since SHV raises target hurdles which increases pressure on managers, short-termism is a direct consequence of SHV itself. The contribution to the debate on short-termism is to better understand the role of SHV and VBM in explaining short-termism and to direct future empirical research as well as advancing modeling of SHV and VBM.

Laurent Rochat

laurent@innovationatelier.com
Innovation Atelier

Ann van Ackere

ann.vanackere@unil.ch
HEC Lausanne

The impact of competitive interactions on category penetration and purchase frequency of mature FMCG categories

Many fast moving consumer goods (FMCG) categories like laundry detergents, diapers or cereals are mature and rather stable, so the interest is high for manufacturers to make diagnostics on the category and their brand to find growth opportunities. Attempts to model mature category dynamics have mostly been based on probabilistic models. The most famous one is the “NBD-Dirichlet” model, which was first presented in 1984 and has subsequently triggered significant research in the area. The model has limitations as it assumes stable marketing and promotional activity and stable category dynamics. This paper uses a system dynamics model to relax some of these stability assumptions and explain how competitive dynamics impact the total category penetration, purchase frequency and volume size over time.

Lewlyn L. R. Rodrigues

rodrigusr@gmail.com
Manipal University

Farahnaz Golrooy Motlagh

farahgm@gmail.com
Islamic Azad University

Deepak Sreedhar Ramesh

deepak.sr1185@gmail.com
Manipal Institute of Technology

Vasanth Vasudeva Pandubettu

Kamath
kamath.vasanth@gmail.com
Manipal University

System Dynamics Model for Remanufacturing in Closed Loop Supply Chains

This paper is an application of model-based management in remanufacturing environment, under a dichotomous situation of environmental protection at lower cost of manufacturing, in order to ensure sustainability. Reverse logistics in a remanufacturing scenario can be very challenging due to the increased number of exogenous factors such as uncertainties in quantity, quality and timing of returns. The work was carried out in an electronic equipment remanufacturing industry. The focus of this paper is on identifying and selecting the variables and establishing the relationships between them to simulate the influence of recollection effort and remanufacturing time on raw material requirements, serviceable inventory, distributors’ inventory, reusable products, remanufacturing rate, environmental consciousness, remanufacturing cost, and total cost of manufacturing. Validation of the model and numerical experimentation has been carried out to authenticate the results. The results indicate that sustainability can be ensured only on long term basis and the remanufacturers should not aim at short term profits.

Lewlyn L. R. Rodrigues

rodrigusr@gmail.com
Manipal University

Farahnaz Golrooy Motlagh

farahgm@gmail.com
Islamic Azad University

Sunith Hebbar

sunithhebbar@rediffmail.com
Manipal University

Vasanth Vasudeva Pandubettu Kamath

kamath.vasanth@gmail.com
Manipal University

Eduard Romanenko

eduardromanenko@gmail.com
Central European University

Crtomir Rozman

crtomirrozman1@gmail.com
University of Maribor

Karmen Pazek

karmen.pazek@uni-mb.si
University of Maribor

Andrej Skraba

andrej.skraba@gmail.com
University of Maribor

Jernej Turk

jernej.turk@uni-mb.si
University of Maribor

Miroljub Kljajić

miroljub.kljajic@fov.uni-mb.si
University of Maribor

System Dynamics Based Perspective to Reliability Centered Maintenance

The paper proposes a System Dynamics model for manufacturing system with specific focus on studying the influence of dynamic responses of machine failure on the production system. Machine failures affect adversely inventory levels, backlogs, and production costs. Simulation results in this research have depicted that a reduction in failure rate increases the production rate, decreases the work in progress, reduces the production costs, and results in a considerable decrease in the backlog levels. Even though these outcomes are obvious to some extent, the prediction on how the variance occurs is of specific interest to the manufacturers, so as to optimize the production process. Model validation has been carried out by superimposing the actual values on the predicted and the variation is well within the range. A flow chart has been developed for effective maintenance strategy based on Reliability Centered Maintenance, and also, Root Cause Analysis undertaken in this research has identified the bottlenecks of manufacturing which has lead to the suggestions for improvement.

Employing System Thinking for Building Shared Vision in a Youth-led NGO

The paper describes how system thinking archetypes were employed for solving a persistent problem of a youth-led NGO in Russia (Model United Nations of the Russian Far East). Even though the projects conducted by MUNRFE branch in Vladivostok within the previous six months had reached their targets, there was always an implicit concern over the way those projects were conducted. Throughout a one-day systems thinking workshop the presidential team elaborated the archetype called "Dissatisfaction with successful projects". The archetype made explicit an important mental model: MUNRFE 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.

Determination of Effective Policies for Ecological Agriculture Development with System Dynamics – Case Study in Slovenia

In this paper the system dynamics model of organic farming development in order to support decision making is presented. The system incorporates relevant variables, which affect the development of the organic farming. The model seeks answers to strategic questions related to the level of organically utilized area, levels of production and crop selection in a long term dynamic context and will be used for simulation of different policy scenarios for organic farming and their impact on economic and environmental parameters of organic production at an aggregate level. Using the model several scenarios were performed.

Tom Rust*tom.rust@va.gov*

Worcester Polytechnic Institute

Khalid Saeed*saeed@wpi.edu*

Worcester Polytechnic Institute

Isa Bar-On*ibaron@wpi.edu*

Worcester Polytechnic Institute

Oleg V. Pavlov*opavlov@wpi.edu*

Worcester Polytechnic Institute

Re-designing policy and process in health care service delivery: a system dynamics case study

The Veterans Administration faces growing dissatisfaction with the delivery of one of its key services, Compensation and Pension (C&P). This paper focuses on the system surrounding the administration of C&P exams, which determine the extent of a veteran's service-related disability. Many VHA facilities nation-wide are experiencing increasing service delays, along with reductions in exam quality and patient satisfaction. A system dynamics model was developed to determine the relationships between operational policies, management decisions, and process outcomes, and calibrated with data from one New England-area VA hospital. Simulation of system performance under various demand scenarios reveal the extent of the implicit trade-off between resource flexibility, clinic utilization rates and patient wait-times. These scenarios are used to develop strategic policies to improve resource allocation and increase timeliness under highly variable demand conditions. Furthermore, alternate staffing models were tested against historic demand patterns, providing quantitative evidence for system redesign.

Alexander V. Ryzhenkov*ryzhenko@ieie.nsc.ru*

Institute of Economics SB RAS

Insights into Income Policy for Enhancing Employment and Stability of Capital Accumulation

This paper reveals how the deterministic non-linear Lordon – Goodwin model (LGM- I) endogenously generates cycles of absolute and relative over-accumulation of capital similar in important aspects to the Marx industrial cycle. This model hyperbolizes acuteness of accumulation crises. By correcting functional relations for implicit rate of capital accumulation, the present paper transforms LGM-I into LGM-II. Scenario I of sluggish stabilization at a low level of employment is based on a refined model LGM-II. Scenario II is a futile attempt to achieve hastily a substantially higher level of employment than in scenario I by policy optimization within the same improper social structure of accumulation. This paper revises original equations for profit sharing and bargaining wage terms and offers an upgraded model of capital accumulation LGM- III where a growth rate of total profit depends positively on a gap between the target and current employment ratios. The latter policy rule does not cause over-shooting of profit and under-shooting of wage in satisfying scenario III unlike ill-defined policy rule in scenario II rooted in LGM-I and LGM-II. The Structural Control Theory has helped in the policy design phase. A qualitative analysis of local stability for non-linear models is extended by exposing transients to distant attractors.

Arman Sadreddin*arman.sadreddin@gmail.com*

Isfahan University of Technology

Jamshid Parvizian*jparvizian@gmail.com*

Isfahan University of Technology

The crises of water and population: The case of central Iran

This paper is about the shortage of water resources in the central part of Iran - Isfahan while the region faces rapidly growth of the population. The study utilizes the system dynamics approach. The model consists of the following three main parts: water consumption, water resources and population. We will account for the current policies and the current population growth rate in hope of preventing a catastrophic failure in less than two decades from now. So, emigration, birth control policies and major changes in the consumption style are evaluated.

Erico Resende Santos

erico.santos@gmail.com
University of Bergen

Pål I. Davidsen

pal.davidsen@geog.uib.no
University of Bergen

Modelling Ethanol Supply, Demand and Price in the Brazilian Macro Economy

The Brazilian program for sugarcane ethanol has been greatly successful since its inception about 40 years ago. But the road has been bumpy and today there are still major problems with price, supply and demand stability. This paper describes a research with the objective to propose policies by the government to stabilise and foster the Ethanol market in Brazil. The policies are tested by simulation. For that purpose a system dynamics model was built and calibrated to mimic the industry. Once the model is considered robust, it is used to test several proposed policies under different macroeconomic scenario forecasts. Historical evidence and the simulations suggest that the dynamics in the system are highly important in defining prices and other important variables. As one example, periods of high growth tend to negatively influence productivity after five to six years via a decreased investment in crops renovation which may create long term cycles. The effects of long term dynamics are mixed with several short and long term cycles typical of commodities markets and the combination increases complexity exponentially. Simulation can be a crucial tool for understanding causality and planning sound policies for the medium to long terms.

Mohammad Dehghani

Saryazdi

ie.dehghani@gmail.com
University of Yazd

Mohammad Saleh Owlia

owliams@yazduni.ac.ir
University of Yazd

Jamal Hosseini Azabadi

hosseini.j@gmail.com
IUST

A System Dynamics Approach for Knowledge Management and Business Excellence: An Application in Iran

One of the excellence enablers is KM . In order to evaluate the KM processes, a comprehensive model is required, which should be able to capture all aspects of KM. One of such models is KMAT . This research exploits system dynamics in order to measure the effects of KM on business excellence with a combination of KMAT and EFQM .Relationships between KM and EFQM are analyzed and demonstrated by means of the literature reviews, expert interviews and system dynamics .The results of this study could be useful for knowledge management planners and managers in organizations.

Burkhard Schade

burkhard.schade@googlemail.com
European Commission

Future Development of 2nd generation Biofuels in Transport considering Learning Rates

The aim of this paper is to illustrate the biofuel model BioPOL and its new developments, to describe a set of scenarios, in which BioPOL was applied and to discuss the results of the scenarios. BioPOL was developed and applied within the several European projects, among them TRIAS, PREMIA, HOP!, iTREN-2030 and GHG TransPoRD. This paper refers to the latter project GHG TransPoRD. The BioPOL model delivers detailed outcomes for the different types of biofuels with regard to production capacity and produced volumes, costs and well-to-wheel emissions of greenhouse gases. Furthermore, it includes advanced 2nd generation pathways from ligno-cellulosic feedstock. An important issue of BioPOL is the improved way in which learning for 2nd generation is considered. The paper refers to the work carried out in the GHG TransPoRD project. GHG-TransPoRD developed a reference scenario and a set of GHG emission scenarios varying the technical measures to reduce GHG emissions. In these scenarios, BioPOL was applied together with energy model POLES and the transport model ASTRA. The model set derives detailed results on transport performance,

economic indicators (e.g. GDP), vehicle stocks, energy demand, fuel consumption and GHG emission. This paper focuses on the energy demand, the fuel consumption and the consumption of different biofuel types.

Martin F. G. Schaffernicht

martin@utalca.cl
Universidad de Talca

Camilo Olaya

colaya@uniandes.edu.co
Universidad de los Andes

Modeling as Autonomous System: Varela Meets Darwin

This paper posits mental modeling as autopoietic systems of ideas based on processes of selection. A thought experiment is proposed to illustrate the argumentation. After reviewing the essential features of selection theory and mental models, we present modeling as driven by a process of variations and selections. We then show how the deliberate process of model development fosters the generation of mental variety and transfers the locus of selection from external to internal. We deduce that modeling, as far as it succeeds in framing successful actions, is a selective advantage; however, as such it may only play out over generations. If mental models are autonomous and enactive systems, the use of selection theory to describe their evolution is fruitful. We believe both theoretic bodies to be useful for further investigating how model develop in minds and how internal selectors can be designed such as to reduce the need for external selection.

Martin F. G. Schaffernicht

martin@utalca.cl
Universidad de Talca

Stefan Grösser

stefan.groesser@unisg.ch
Bern University of Applied Sciences

Learning to Think in Circles: Improving Mental Models of a Dynamic System

This paper addresses the learning of feedback-thinking. Feedback-thinking is the ability to perceive circular causal relationships. Untrained individuals are known to misperceive feedback dynamics that experienced feedback-thinkers perceive with ease. What are the changes in perception of feedback that are triggered by an introduction course on system dynamics? We report on an experiment in the context of a business case study. We represent mental models of dynamic systems (MMDS) by variables, links and feedback loops. Then, we compare MMDS by using an innovative method. We found that most of the management students in our experiments perceive feedback loops after a training intervention. However, many of the variables, links, and feedback loops that are perceived stem not from the case study description; it seems that they originate from the imagination of the individuals. This suggests that becoming a feedback-thinker is a learning process and begs the question if there are different stages of expertise. For further research, we suggest to study the performance of feedback-thinkers with different level of systems dynamics expertise and domain knowledge. By this, we detail our understanding of how feedback-thinking can be learned.

Peter Schlyter

peter.schlyter@natgeo.su.se
Stockholm University

Ingrid Stjernquist

ingrid.stjernquist@natgeo.su.se
Stockholm University

Harald Sverdrup

harald.sverdrup@chemeng.lth.se
Lund University

Handling complex environmental issues. Group modeling as a deliberative platform at the science-policy-democracy interface

The Swedish Environmental Protection Agency had identified poor progress towards the Parliamentary Environmental Objectives (PEOs) for the Swedish mountainous. Group modelling with stakeholders was carried out during a one year period. A total of about 40 stakeholder attended the group modelling sessions. In total four modelling sessions were performed. From a process point of view we note that: A/ Some stakeholders were not communicating (and in some cases barely on speaking terms) before the first modelling session.

Modelling provided a platform for dialogue as; B/ CLD modelling allowed all stakeholders to participate on an equal basis; C/ Modelling efficiently defused old conflicts as focus was shifted towards processes rather than the goals of any given stakeholder; D/ All participants gained a better understanding of the mountain environment and identified previously unidentified causes for stakeholder conflicts and poor PEO achievement. Models were documented, collectively peer reviewed and continuously revised. The project resulted in: 1/ A joint stakeholder based and uncontested analysis based on CLD-models of the social, economic and environmental dynamics in the Swedish mountains was developed; 2/ A stakeholder based proposal for a research programme was developed; 3/ A larger report describing the project by the Swedish EPA.

Lukas Schmid

lukas.schmid@fhsg.ch
FHS St Gallen

Justus Gallati

justus.gallati@fhsg.ch
Univ of Applied Science St Gallen

Katrin Huegel

katrin.huegel@fhsg.ch
Univ of Applied Science St Gallen

Marcel Loher

marcel.loher@fhsg.ch
FHS St Gallen

Success Dynamics - a Concept for building System Dynamics Models as Decision Support within Strategic Management

Successful corporate action requires a comprehensive recognition of the relevant cause-effect relationships. In combination with the mental models of decision-makers, and as a complement to static instruments for business management, system dynamics simulation models provide valuable support. However, due to the usually experienced big effort and the demand of specific modelling knowledge the use of such models is not yet widespread within management. In order to give medium-sized companies in particular access to such simulation models, a practice-oriented concept was developed, enabling the design and implementation of system dynamics models as to support decision-making within strategic management. Within the framework of an empirical case-study, simulation models were developed for and implemented in four production companies. In order to make the modelling process as simple, efficient, effective and relevant as possible, a practical procedure was derived out of the case studies. This procedure describes the entire modelling process encompassing the initial process of structuring the mental models, the development of quantitative simulation models, as well as the analysis of various scenarios. The concept is based on generic model components, assembled to form a fundamental model structure (backbone) in order to facilitate and to accelerate the modelling process.

Susanne Schmidt

schmidt@eifer.org
European Institute for Energy Research

Tobias Jäger

tobias.jaeger@eifer.org
European Institute for Energy Research

Ute Karl

ute.karl@eifer.org
European Institute for Energy Research

The Transition of the Residential Heat Market in Germany - A Dynamic Simulation Approach

This paper presents a dynamic simulation model for the study of the residential heat market in Germany with regard to the European energy targets for the year 2020. It describes the model properties and specifies the dynamic structures of the demand side based on housing units and of the supply side which is formed by heating systems. An initial model validation indicates the appropriateness of the model assumptions. Five policy scenarios are introduced which take into account different measures for the promotion of renewable and innovative heat generation technologies and obligations for energy-efficient renovation of buildings. The discussion of the scenarios shows that with the given set of policies, the EU targets for heat demand reduction and CO₂ emission mitigation in the residential sector would not be met, while the envisaged share of renewable and innovative technologies seems to be achievable.

William Schoenberg*wasbridge@gmail.com*

Forio Online Simulations

Michael Bean*mbean@forio.com*

Forio Online Simulations

Designing Simulations for use in Higher Education

Forio Online Simulations has been developing and designing web-based simulations since its founding in 2001. During that time Forio has developed through experience a generalized and repeatable process for designing and developing successful simulation based e-learning products. In this paper the authors discuss this process, giving specific examples and project timelines that can be applied to other simulation based development. The authors cover topics such as initial idea generation, management of scope, and how to apply the iterative development methodology successfully during both the simulation design and development phases.

Markus Schwenke*markus.schwenke@unisg.ch*

University of St Gallen

Stefan Grösser*stefan.groesser@unisg.ch*

Bern University of Applied Sciences

Different Concepts of Dynamics in Strategy Research

The aim of our paper is to review strategic management literature for their understanding of dynamics. The increasing amount of strategic management studies that discuss dynamic issues beg the question about the underlying conceptual meaning of dynamics. What concept of dynamics do these studies imply? It is the objective of the paper to conceptualize and categorize the understanding of dynamics which has been used in the field of strategic management.

Rodney J. Scott*rodney.scott@gmail.com*

University of Queensland

Robert Y. Cavana*bob.cavana@vuw.ac.nz*

Victoria University of Wellington

Donald Cameron*donald.cameron@uq.edu.au*

University of Queensland

Kambiz E. Maani*k.maani@uq.edu.au*

University of Queensland

Evaluation of group model building in a strategy implementation context: a New Zealand government case study

This paper presents the results of a group model building intervention to support the implementation of an organisation strategy in a New Zealand government department. Four separate three-hour 'qualitative system dynamics' workshops were conducted with department employees. Many authors have advocated the use of systems thinking in strategy development, but few have specifically explored its use to support strategy implementation. The strategy implementation literature reports similar success factors to the outcomes reported in group model building, suggesting potential applicability. A range of survey methods were used to evaluate changes in communication quality, insight, consensus and commitment to conclusions, which are associated with effective strategy implementation. Post-workshop survey results showed significant increases in all four outcome areas. Comparing work samples from before and after the workshops showed new insights and increased consensus. This paper represents work in progress, as not all of the survey tools used have been fully validated. Further research on the study cohort at the later date may provide insight into the longevity of the reported changes.

Michael Sechrist*msechrist@gmail.com*

Harvard University

The Dynamics of Undersea Cables: Emerging Opportunities and Pitfalls**Chintan Vaishnav***chintanv@mit.edu*

MIT

Cyberspace is built on physical foundations that support the "virtual" manifestations we know of and use in everyday computing. Physical infrastructure can include wired, fiber optic, satellite and microwave links, as well as routing equipment. An often overlooked but critical part of the Internet

Daniel Goldsmith

daniel.goldsmith@paconsulting.com
PA Consulting

Nazli Choucri

nchoucri@mit.edu
MIT

infrastructure is undersea communication cable links. Undersea cables are the technology of choice to move large amounts of data around the world quickly. In the U.S., approximately 95% of all international Internet and phone traffic travel via undersea cables. Nearly all government traffic, including sensitive diplomatic and military orders, travels these cables to reach officials in the field. The problem, however, is that the undersea cable infrastructure is susceptible to several types of vulnerability, including: rising capacity constraints, increased exposure to disruption from both natural and man-made sources, and emerging security risks from cable concentration in dense geographical networks (such as New York and New Jersey, and places like Egypt/Suez Canal.) Moreover, even under normal working conditions, there is a concern whether governance-as-usual can keep up with the future growth of Internet traffic. In this paper, we explore the impact of these problems on the dynamics of managing undersea cable infrastructure.

Simon Shepherd

s.p.shepherd@its.leeds.ac.uk
Institute for Transport Studies

Chandra Balijepalli

n.c.balijepalli@leeds.ac.uk
University of Leeds

A dynamic model of two competing cities: the effects of competition on tolls and land use

In this paper we model the impacts of competition between cities when considering demand management strategies on both the optimal tolls and business and residential location choices. The work builds on earlier work which studied competition in a small network using a static equilibrium approach. That work showed that while both cities have an incentive to charge alone, once they begin, they are likely to fall into a Nash trap or prisoner's dilemma where both cities are worse off. Our research extends this by setting up a system dynamics model which includes all modes and longer term location responses. The model is used first to study an isolated city and a simplified welfare function is used to determine the optimal toll around the central area and its impacts on location decisions and other transport indicators. 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 study the impact on the optimal tolls set by the cities and how the game develops between cities of equal size and amenity. The impact on location decisions and other transport indicators are presented along-side the implications for regulation and the development of cities within regional partnerships.

Heather Skaza

heaska77@gmail.com
University of Nevada Las Vegas

Kent Crippen

kcrippen@coe.ufl.edu
University of Florida

Kristoffer Carroll

kcarroll@interact.ccsd.net
Clark County School District

Exploring Barriers to Implementing System Dynamics Tools for K-12 Sustainability Education

STEM education continues to move up the national priority list with the broad goal of creating STEM-literate learners, able to make sustainable decisions. To this end, systems thinking tools and system dynamics simulations provide a valuable means for helping students think about complex environmental problems. This study, completed in a school district that has adopted a curriculum for 9th grade science that includes system dynamics models, reports on the results of a Web-based survey regarding the use of systems tools in science classrooms and teachers' understanding of the tools available to them. Teachers identified barriers to implementing systems simulations as both computer access and their own understanding. A test of teachers' understanding of systems principles reveals inconsistencies in the way they interpret models, based on their understanding of the system. Response themes were verified with a follow-up focus group and the additional themes of suggestions for model use and using

models with English Language Learners were captured. Strategies for addressing these issues with professional development are provided. This study focuses on the adoption of system dynamics as a technology and framework that has potential to be effective across disciplines in helping students and teachers communicate about complex global problems.

Andrej Skraba

andrej.skraba@gmail.com
University of Maribor

Radovan Stojanovic

stox@ac.me
University of Montenegro

Simon Berkowicz

berkowi@vms.huji.ac.il
Hebrew University of Jerusalem

Raffaele de Amicis

raffaele.de.amicis@graphitech.it
Fondazione GraphiTech

Giuseppe Conti

giuseppe.conti@graphitech.it
Fondazione GraphiTech

Doron Elhanani

e.d.n@usa.net
EMESCO

Davorin Kofjac

davorin.kofjac@fov.uni-mb.si
University of Maribor

Valerijs Skribans

skriban@inbox.lv
Riga Technical University

Modeling of the Air-Pollution Emergency Situations Control and Geographical Information Processing for Rescue Decision Making

GEPSUS, decision support system for handling hazardous air pollutant releases was developed based on a Gaussian simulation model of air pollution dispersion using MATLAB. For the Gaussian model the following assumptions apply: a) the smokestack emission is constant and continuous, b) flat homogeneous terrain, and c) the wind speed is constant. It is assumed that in the main wind direction, x , advection dominates over diffusion and dispersion. A detailed outline of the system integration is provided, which includes aspects of hydro-meteorological data, eco-toxicological data, Geographical Information Systems (GIS), user input, and system output including a description of threat zones and evacuation plans using a geo-browser. The Gaussian air-pollution dispersion simulation model is linked to the GIS by generating the output in KML file format. Several simulation scenarios were considered using meteorological data sets of wind speed, wind direction and ambient temperature. The developed simulation model and decision support system is intended to facilitate rapid emergency response for both deliberate and accidental air pollution releases. System dynamics model is developed to address the crisis mitigation issues.

European Union Economy System Dynamic Model Development

The formation of the EU is the one of the biggest political-economic events of the last 50 years. EU development process is still incomplete, with still evolving EU economic foundations and financial system. The aim of study is to develop EU economy functioning SD model, taking into account main economic indicator changes of EU countries since EU enlargement. Study result – author divides countries into several groups, based on their economic specifics. For these groups in the paper the first attempt to develop EU economy system dynamic model is undertaken. General scheme of EU economy SD model is shown, new EU member economic integration model is developed. Model is tested only for one EU country, Latvia. Results of paper show failure of mechanism of EU operations. The available mechanism contradicts EU principles; it doesn't promote the cohesion in EU, but quite opposite- leads to solving problems of well-developed EU countries at the expense of developing countries. In the given conditions the example of Latvia shows that there is no possibility to overcome the system crisis. These circumstances specify necessity of changes in EU internal migratory policy, in principles of developing countries' support, in distribution of means, taking into account internal migration.

Alireza Soloukdar

a_soloukdar@hotmail.com

Central Tehran Brnch Islamic Azad Univ

Designing and Analysis a Dynamic Model of World Class Manufacturing in Iranian Automotive Industry

World Class Manufacturing (WCM) has attracted the attention of many manufacturing industries and operation strategists. Lack of clarification of relationships among widely spreading elements of manufacturing process and poor attention to non-linearity and time delays, all are the main reasons that some companies may be far away from developing a comprehensive and advantageous model in a WCM system. The purpose of this paper is designing and analysis a dynamic Model of WCM system to develop a proper strategy which changing the current situation into a WCM situation would be possible in the future By the Dynamic Balanced scorecard (DBSC) methodology as well as clarifying deficiencies of classical balanced scorecard, a systematic model of WCM has been presented through causal loop and stock & flow diagrams. This research has been carried out as a case study in the Iran Khodro Co.(IKCO), We've used Vensim software for designing and analyzing our model after entering related data, parameters, and equations. Some strategies have been presented through analyzing the scenario and running the simulation model.

Marta Somogyvari

somogyv@videant.hu

University Pécs

Ex Ante and Ex Post Sustainability of Energy Choices

The challenge of sustainability has reached everybody. The concept is mostly used as a normative concept but has too many interpretations. System dynamics provides a reasonable method to avoid the intragenerational and intergenerational subjectivity of this term. The formal approach reveals not only the boundaries and the causal structure of the examined system but although the hidden presuppositions of the modeler. "Ex ante" sustainability will be ensured by the modeling procedure, since sustainability means that the chosen variables in the system with a particular model-structure are in the preferred range in the specific period of time. "Ex post" sustainability, as the judgment of "next generations", can be reached only if the model includes the changing preferences of future observers. The problem of ex ante and ex post sustainability will be demonstrated with a model of the energy system in a "small world". The decision-makers face the situation how to allocate the finite fossil energy reserve between energy efficiency retrofit of buildings and development of renewable energy potential. This is a realistic dilemma because they have to satisfy although the operating energy demand of the world and they do not know how much fossil energy is still available.

Marta Somogyvari

somogyv@videant.hu

University Pécs

Heating or Transporting

Greenhouse production in Mediterranean regions is a very profitable business. Nowadays European supermarkets are full of agricultural products from this area. The newest trend is combining aquaculture and hydroponics: fish and vegetable production in one system. It is also possible to produce these products in greenhouses in Continental climate, but it needs much more energy. However, a question has arisen: which production type needs more energy: produce products in Mediterranean regions and transport it to the heart of Europe, or produce it in Europe with more energy? This paper compares these two possible ways, building up a system dynamic model for an aquaponics greenhouse production in a Continental climate.

Tibor Kiss

kisst@ktk.pte.hu

Faculty of Business and Economics

Viktor Kiss

kissv@ktk.pte.hu

University Pécs

József Vajda

vajdaj@witech.pmmf.hu

University Pécs

Pietro Sorci

pietro.sorci@libero.it
University of Palermo

Dealing with Public Debt Burden: A System Dynamics Approach to Implement Sustainable Financial Policies in the Italian State

In the last decades in several mature democracies the problem of debt emerged as a violation of intergenerational equal treatment due to high expenditures concentration and dilution of costs by mean of debt creation. So far this issue has been analyzed from a statistical and a socio-economic perspective, which identified the high political interference as the main dysfunction of country debt management. There are no studies which frame the issue by focusing on State institutions as performance-oriented organizations, according to this perspective such organizations have to respect dynamically trade-off between development and the debt reduction through a mix of levers such as: funds acquisition/reduction, interest rate and financial leverage. System dynamics can be successfully used as an instrument to support Government in keeping control over the key variables affecting debt changes and implementing a sustainable policy. In the paper three kinds of policies are recommended: the reduction of expenses and increase of receipts in the short term to drastically reduce the debt amount; the opportunity to exploit the financial leverage in the long term. Such approach implies a change of perspective, looking at Italy as a performance-oriented organization in which a proper financial management serves economic development and not vice versa.

M. Dolores Soto-Torres

lolasoto@eco.uva.es
Universidad de Valladolid

Ramon Fernández-Lechón

ramonfer@eco.uva.es
Universidad de Valladolid

Pedro Fernández Soto

PricewaterhouseCoopers

Road safety strategies: An analysis with system dynamics

This paper constructs a system dynamics model in order to analyze the evolution over time of the number of traffic accidents in a generic region in which different scenarios are possible. Mainly, a set of three instruments is used to fight against them: information campaigns, traffic legislation and a monitoring system. The structure of the model is assembled by considering two aspects. First, the influence of the instruments on the causes of the traffic accidents and then, the structure takes into account how authorities adapt the intensity of the instruments in according to certain target. The simulation model integrates several non-linear relationships and delayed links in addition to two random elements. A Monte-Carlo simulation is employed to obtain significant paths of traffic accidents under different scenarios and public strategies. The simulation results exhibit how the instruments work in every scenario and its global efficiency. The best solution is not always the same. Sometimes, the lower number of traffic accidents requires that the instruments are used continuously, but on occasions, it is obtained when the instruments are used intensively. Then, under a tight budget, the implementation of a public road safety strategy requires a special analysis of costs and efficiency.

M. Dolores Soto-Torres

lolasoto@eco.uva.es
Universidad de Valladolid

Ramon Fernández-Lechón

ramonfer@eco.uva.es
Universidad de Valladolid

Pedro Fernández Soto

PricewaterhouseCoopers

Interrelations Between Demography and Economy: The Decline of Fertility Rate, an Analysis With System Dynamics

The main aim of this paper is to study the impact on birth rate of specific public policies: subsidies to childbearing and public consumption. The analysis is framed in an developed economy in which fertility choices and economic decisions are interconnected. In particular, the study relies on overlapping generations, habit

formation in consumption and endogenous fertility rate. This last factor is directly explained by the preference for children, the economic capacity of young people and the stylized fact of unemployment. The outcome is a versatile system dynamics model that is adapted for the Portuguese economy from 2000 to 2011. Two counterfactual exercises differentiated from the employment distribution but with identical alternatives of public spending are implemented in the simulation model. The results show two divergent aspects: the births do not vary if the public consumption increases but, the births increase when the costs of childrearing are subsidized even if the public consumption is high. These results also indicate that the subsidies are not sufficient to curb the decreasing trend of births. In addition to them, it is required a sustainable economic growth. Key words: Fertility, Consumption, Unemployment, System Dynamics, Simulation.

Peter Stasinopoulos

peter.stasinopoulos@anu.edu.au
Australian National University

Paul Compston

paul.compston@anu.edu.au

Haley Jones

haley.jones@anu.edu.au
Australian National University

Policy Resistance to Fuel Efficient Cars and the Adoption of Next-Generation Technologies

We present a stock-and-flow model that describes the growth in the fuel consumption of the Australian car fleet despite persistent policy intervention by government, compliance and technology innovation by automakers, and shifts in transportation preferences by travellers. To this model, we add processes that describe the adoption by automakers of aluminium bodies-in-white (BIWs) and battery-electric (BE) powertrains, and the competition between automakers of these next-generation technologies and conventional technologies. The model shows that, in the future, growing congestion and declining oil availability could cause the fuel consumption of the car fleet to decline, despite growth in the size of the car fleet. Under these conditions, the adoption of aluminium BIWs could cause fuel consumption to decline further. Also, the adoption of BE powertrains could cause energy (fuel and electricity) consumption to decline faster, down to a point, but then increase the long-term transportation energy consumption by encouraging travellers to continue to drive cars rather than shift to public transportation. These results suggest that congestion, the price of petrol, and the availability of fuel have high leverage for influencing car- fleet fuel consumption. Also, next-generation technologies have lower leverage, but this leverage could be enhanced by a competitive market environment.

Krystyna A. Stave

krystyna.stave@unlv.edu
University of Nevada Las Vegas

What Can Students Learn from Simple Simulations about Accumulations?

This paper presents the second phase of research about designing and testing the effect of systems simulations for building systems understanding. It builds on work presented last year in which we used a paired experiment in an introductory level college course to examine the effect of a simulation on understanding of simple accumulation principles. Previous results showed significant differences in some measures of understanding of systems principles but also highlighted issues with simulation design, comparability of subject groups, and measures of systems understanding. In this phase, we revised the simulation, learning measures, and study design. All students used the simulation and we compared the extent to which students interacted with the simulation with their performance on a set of systems thinking measures. Pre-test/ post-test measures showed strong improvement in understanding of accumulations principles.

John Sterman

jssterman@mit.edu
MIT

Web-based Simulations for Strategy and Sustainability: The MIT Sloan LearningEdge Management Flight Simulators

The MIT Sloan School of Management has created a set of interactive, web-based management flight simulators to teach key ideas in business, strategy, sustainability and related fields. These simulations are freely available to anyone through the MIT Sloan LearningEdge portal (mitsloan.mit.edu/MSTIR/SYSTEM-DYNAMICS). Here I describe four simulations now available: Salt Seller (a multiplayer commodity pricing simulation); Eclipsing the Competition (learning curves, using the solar photovoltaic industry as the example); Platform Wars (competition in the presence of network externalities using the video game industry as the context); and Fishbanks (the Tragedy of the Commons in the context of renewable resource management, updating the classic game by Dennis Meadows). Each simulator teaches important concepts in management, strategy and/or sustainability. Each is grounded in a particular industry or firm, and comes with original case studies or briefing material describing the strategic challenges in these settings. Through these simulations, students, executives, policymakers and others can explore the consequences of different strategies so they can learn for themselves about the complex dynamics of difficult issues in a variety of important settings. I describe their purpose and use, illustrate their dynamics, and outline the instructor resources available for each.

Ingrid Stjernquist

ingrid.stjernquist@natgeo.su.se
Stockholm University

Harald Sverdrup

harald.sverdrup@chemeng.lth.se
Lund University

Peter Schlyter

peter.schlyter@natgeo.su.se
Stockholm University

Salim Belyazid

salim@belyazid.com
Belyazid Communications and Consulting

Deniz Koca

deniz.koca@chemeng.lth.se
Lund University

Ulrika Jönsson-Belyazid

ulrika@belyazid.com

Searching for the magnificent mountain landscape – environmental management in the Swedish mountain areas

To reach a sustainable society where the environmental problems are solved, Sweden has formulated 16 Parliamentary Environmental Objectives. It is assumed that all sectors and stakeholders will take responsibility for reaching the national environmental objectives. The need to develop management tools for complex systems initiated a project to map structures and interactions between stakeholders and to analyse how processes within the objective influence governance and the ability to achieve desired outcomes. The project used system analysis and group based conceptual modelling included a social adaptive learning process. The research process involved 40 stakeholder representatives interacting over seven workshops. The diagrams were continuously and collectively peer-reviewed allowing all stakeholder attitudes to be obvious for the participants. The main findings were 1) the current focus of the MML objective on environmental sustainability was too narrow and that a broader perspective including social and economic sustainability was needed; 2) chosen indicators are not sufficiently comprehensive and only partially indicating if the objective is reached and the process of public participation has been dysfunctional; 3) the current management lack respect for local perspectives and 4) the locally perceived legitimacy of authorities is low due to previous actions and experiences.

Athor Subroto

athorsu@yahoo.com
University of Indonesia

Understanding Complexities in Public Policy Making Process Through Policy Cycle Model: A System Dynamics Approach

This paper is aimed to explore theoretically the complexities and the reality in the policy making process from the point of view causality relationships among the components or actors within the system. The complexities' exploration in the paper is based on the model of the policy cycle that is widely discussed in the public policy and public administration literatures. The sense of reality surrounding the policy-making process is perceived from some study cases that have been observed from Australia and Indonesia literature. Simulation throughout the paper revealed different complexities and some pitfalls in each stage of the policy cycle model on which should be given a proper attention from the policy stakeholder. The paper tried to construct a different approach to understand the reality and embrace the complexities of the policy-making process in order to present a starting point for an open discussion in public policy field. The effort could be a learning tool for the public policy maker to build good awareness and understanding on their roles in the complex relationship and inter-dependent environment. Eventually, the paper hopefully can fill the gap between policy cycle model theory and the complexity in the real situation of the policy-making process.

Athor Subroto

athorsu@yahoo.com
University of Indonesia

Using System Dynamics Approach to Support Sustainable Growth Of Small And Medium Enterprises' Quantity In Indonesia

This paper has objectives to discuss and propose policies such as; first, from operational side: providing market information in order to give more access for market demand, market capacity. This strategy will in the long term lead to a better production planning. Second, from the financing side: using profit-sharing principle of financing (PSP) to cope with such dynamics behavior in order to support a sustainable quantity growth of SMEs. Simulation conducted in this paper has implemented two policy levers, which are first; a production coordination system through information sharing and second; financing mechanism with PSP contract for Small Enterprises (SEs). The paper also shows the added value creation of PSP principle in economy and minimization of the agency risk with double layers referencing method. This paper re-emphasizes first; the use of production coordination to support positive growth number of SMEs especially to prevent collapse after experiencing overshoot growth, and second; proposes a financing mechanism for SMEs based on PSP principle to prevent SMEs from the operational failure. This paper also proposes the use of double layer referencing system to minimize agency risk in the area of PSP contract agreement.

Toru Suetake

ts178051@yahoo.co.jp
Japan Futures Research Center

SD Model of Romeo and Juliet

Adaptation of SD mainly focuses on management and environment aspects, and successes to get enormous reputations from results. However, adaptation of SD is not limited on these areas, but disseminating to psychology and military science recently. Author believes such adaptation should be wider to other fields too. Continuous of such adaptation, this paper tries to build SD model for study

literature with quantitative explanation and understanding. William Shakespeare's "Tragedy of Romeo and Juliet" is one of best works in his early age. Similar story also looked in other literatures in other countries including works of Chikamatsu Monzaemon in Japan and opera Tristan and Isère. Added more, "Romeo and Juliet" was adapted to other forms of arts and literatures including Broadway musical "West Side Story". However, adaptation of SD to literature is not so easy, specially literatures these focus winding nature of people such as "Macbeth" and "Othello", in later works of Shakespeare, or describes people's behavior on rational environment in works of Kafka and Murakami Haruki. SD Modeling of "Romeo and Juliet" is comparatively easy for avoid consideration of such difficulty, as author find. In this paper, author also discusses technical issues and way of thinking for modeling literature.

Harald Sverdrup

harald.sverdrup@chemeng.lth.se
Lund University

Deniz Koca

deniz.koca@chemeng.lth.se
Lund University

Christer Granath

Lund University

Modelling the gold market, explaining the past and assessing the physical and economical sustainability of future scenarios

By using an integrated dynamic model we are able to reconstruct the supply and gold price of the past (1920-2010) and this is used to predict the future supply of gold to the market and to make a forecast of the gold price 2010-2100. The model was validated against field data for the period 1920-2010 and it performs well. The simulation results show that the market is fundamentally driven by supply and demand, but that derivatives trade and speculations have affected the market significantly to create large short term variations in price. In the long term, the model predicts a shift from high-grade ores to low-grade deposits as the main supply source in the next 50 years, but that recycling will become the most important source of gold to the market. The authors predict a significant tightening of the gold market, with rising prices and a decreased derivatives trade as compared to trade in the physical commodity. The model shows clearly that forward and derivatives trade create less stability and increase price fluctuations, but that they cannot prevent the long term trend from basic fundamental factors to set the long term levels.

Harald Sverdrup

harald.sverdrup@chemeng.lth.se
Lund University

Vala Ragnarsdottir

vala@hi.is
University of Iceland

Thomas Ragnar Wood

thomas.wood@gstt.nhs.uk
Guy's Hospital and St Thomas Hospital

Ulrik Sverdrup

ulrik.sverdrup@gmail.com
Lund University

Modelling the initiation, progress, symptoms, expressions and possible treatment of multiple sclerosis

Methods of systems analysis were applied to the illness multiple sclerosis (MS). By mapping causality among the many causes affecting multiple sclerosis, we have been able to show that it is a systemic illness, with multiple interacting causes and mechanisms. By using causal-loop diagrams we synthesized a systemic picture of MS in which the role of allergies, pathogens, molecular mimicry, venous vascular dynamics, membrane stability, immune system, and oxidants-antioxidant dynamics were integrated. There are important components that make up MS: 1. The root cause: Permeable blood-brain barrier (BBB) and transmission of provocative substances into the brain 2. Triggers of inflammation, oxidation and immune responses: a. Antibodies attachment to myelin surfaces and oligodendrocytes b. Immune system provoking substances creating antibodies c. Leakage of blood into the brain through the permeable BBB promoting oxidants. 3. Reinforcing and linked loops keeps the MS system running: a. Oxidant cycle b. Immune cycle c. Scarring cycle The different mechanisms are linked together into an integrated model for the disease. The model outputs show good correlation with observed data. The model was used to derive a strategy for treatment, and several scenarios were investigated.

Harald Sverdrup

harald.sverdrup@chemeng.lth.se
Lund University

Peter Schlyter

peter.schlyter@natgeo.su.se
Stockholm University

Modeling the survival of Athenian owl tetradrachms struck in the period from 526 BC to 42 AD, from 526 BC to the present

The TETRA-model has been built to predict the modern occurrence of ancient Athenian tetradrachm silver coins in quantitative terms, based on their original minting volumes an antiquity and the processes of their loss and destruction, as well as the process of finding them in modern times. The conceptual model was developed as causal loop diagrams and flow charts, based on Athenian silver mining dynamics, the minting process, the circulation in trade and finance in ancient Athens, rates of wear and loss of coinage, corrosion of coins in the buried state, modern retrieval rates and dynamic turnover in the numismatic market, as well as deposits into collections and museums. A systems dynamics model was programmed in the STELLA modeling environment and implemented for 500 years of Athenian coin production (526 BC to 42 AD) and preservation and retrieval until the present (526 BC to 2010 AD). The TETRA model was tested against independent estimates of past and present coin volumes, treasure finds, museum stocks. The model seems to work well in tests against independent estimates. The approximate number of coins surviving until today for the different types such as archaic owls, classical owls, transitional owls, heterogeneous owls and new style owls were predicted well within the estimates derived through other means and museum inventories ($r^2=0.82$).

Harald Sverdrup

harald.sverdrup@chemeng.lth.se
Lund University

Deniz Koca

deniz.koca@chemeng.lth.se
Lund University

Vala Ragnarsdottir

vala@hi.is
University of Iceland

The WORLD model: Peak metals, minerals, energy, wealth, food and population

A new global systems model (WORLD) was assembled to analyse natural resource scarcity as a continuation of the model used in Limits-to-Growth (World3). WORLD is underpinned with burn-off rates and Hubbard's curves so that a complete overview can be obtained. The WORLD model includes a global population module and an economic model. It connects extraction and recycling of resources, land use, soil availability, food production and population with economic growth and decline and societal stability. Our analysis shows that the underpinning natural resources for the current world economic system have either peaked or will peak in the next four decades. If we continue on the same path as today the resources will become scarce within this century. We also show that natural resource scarcity will lead to "peak wealth", "peak population", "peak infrastructure", "peak costs", "peak problems" and possibly "peak civilization" unless some urgent measures are systematically taken throughout the world. The creation of money from conversion of resources and work, as well as the current extensive borrowing from the future, causes concerns that peak resources may lead to "peak wealth" and the end of the golden age we currently have for developed nations.

Shinsuke Takahashi

shinsuke.takahashi.hg@hitachi.com
Hitachi Ltd

Water Cycle Analysis System Dynamics Model for Designing Optimal Water Reclamation Scheduling

A water cycle analysis System Dynamics model for designing an optimal reclaimed water production scheduling is proposed. A water cycle has various types of water flow and storage, so System Dynamics is suitable for modeling and simulating it. In addition, by using System Dynamics modeling software, various

types of models for water cycle analysis can be modeled comparatively easily and used to design an optimal scheduling. The model must be able to analyze water quality and energies for water distribution and treatment as well as water flow and storage in order to schedule optimal production. It therefore consists of three components: water flow, water quality, and energy models. We constructed a water flow model that can handle various types of water flow. The Energy model computes the energy consumption of the pumps and blowers used in water distribution and water treatment systems, and the water quality model computes the water quality of treated wastewater and reclaimed water. Our constructed model was used to schedule water reclamation production to reduce the energy consumed during the water reclamation process and to ensure high quality of the reclaimed water. Simulation results showed that the proposed model is effective for designing an optimal scheduling.

Yutaka Takahashi

takahasi@isc.senshu-u.ac.jp

Senshu University School of Commerce

Nobuhide Tanaka

770566@gakushuin.ac.jp

Gakushuin University

Fallacy of “Decomposition”: Cooperation rather than Competition inside Organizations

In general, competition in markets stimulates companies to survive and make better products at lower cost. Through this process, effectiveness is increased and innovations happen. These results are also desired inside companies and other business organizations. Therefore, many organizations introduced a competition mechanism into their organization inside. However, the expected good results have not always appeared. Competitions inside are not magic wands to make people employees. Indeed, workers have been stimulated in some contexts and some of them have improved their performance eagerly. Nevertheless, the performances of whole organizations have often failed to elevate. This paper shows that cooperation based on professionalism inside organization is more important than competition inside. System dynamics models and simulation results in this paper explain that macro mechanism, like a markets’ one, cannot be employed as micro mechanism. This kind of mechanism import failure should be called fallacy of “decomposition.”.

Togay Tanyolac

caloynat@gmail.com

Bogaziçi University

Hakan Yasarcan

yasarcanh@yahoo.com

Bogaziçi University

Control Heuristics for Soft Landing Problem

In this paper, we developed two different control heuristics for the soft landing problem. The first heuristic is adapted from the mass spring damper model using the similarity of the equations of the soft landing model given in this paper to the equations of the mass spring damper model; both models can be reduced to a second order linear differential equation. The second one is a bang-bang heuristic that first allows the spacecraft to fall freely, but after a critical point is reached, it uses the reverse force thruster at its maximum power until the touchdown. Bang-bang heuristic minimizes the time needed to land. However, it may crash the spacecraft in the presence of an error in the parameter estimates, or an error in the velocity or height readings, or an overlooked factor such as a delay in changing the level of the force created by the reverse force thruster, which is known as actuator delay. The mass spring damper based control heuristic requires a longer landing time, but it is more robust compared to the bang-bang control heuristic in the sense that it is less sensitive to the errors in parameter values, errors in readings, and presence of an actuator delay.

James P. Thompson

james.thompson@duke-nus.edu.sg
Duke NUS Graduate Medical School

John P. Ansah

john.ansah@duke-nus.edu.sg
Duke NUS Graduate Medical School

Carmen Y. J. Lee

yinjienlee@gmail.com
Duke NUS Graduate Medical School

Robert L. Eberlein

bob@astutesd.com

Strategic implications of workplace policies on nursing capacity planning

Human resource requirements planning for nursing capacity has traditionally focused on expected utilization or demand and largely ignored the complex workplace policies. The approach taken in this research emphasizes the interaction of policies affecting compensation, work intensity, task satisfaction and career progression on hiring and retention – the flows that determine the stock of nurses. Based on research conducted with Singapore Ministry of Health, we describe how policy changes influence employment levels at care venues over a strategic time horizon. To answer three research questions posed by experienced planners and managers, we employ a System Dynamics model to test and explain the implications of alternative policy choices.

Juan Pablo Torres

j.p.torres@warwick.ac.uk
University of Warwick

Supporting an internationalisation strategy using System Dynamics Modelling

The aim of this paper is to show how modelling and simulation can support a deliberate strategy of internationalisation. I show details and experiences of developing a system dynamics model with a small wine company to structure and evaluate its internationalisation strategy prior to implementation. From this process it emerged that the cognitive ability of the manager visualizing the outcome of his strategic actions is limited due to the difficulty in measuring feedback processes conclusively during strategy design processes. (4746 words).

Jeff W. Trailer

jtrailer@csuchico.edu
California State University Chico

Strategic Planning Model & Tools for a State University College

Presented here are strategic planning tools used at a State University, College of Business. Four distinct tools are presented: The Strategic Initiative Scoring Model, which communicates how the college strategic planning execution projects fit the strategic priorities of the University's mission statement & strategic plan; the college Strategic Risk Planning Matrix, which describes both risk assessments and risk management plans; the college Strategic Planning (SD) Model, which is used by administrators to assess impacts from proposed or mandated changes in budgets, admissions, Student-Faculty Ratio targets, and faculty hiring/attrition; and the Strategic Performance Indicator matrix, used to monitor performance and drive the creation of new projects to be assessed in the Strategic Initiative Scoring Model.

Ya-tsai Tseng

ytseng@thu.edu.tw
Tunghai University

A System Dynamics Model of Evolving Supply Chain Relationships and Inter-firm Trust

Wei Yang Wang

wyang@cc.kuas.edu.tw
National Kaohsiung Univ of Applied Sci

Inter-firm trust is an essential element in supplier relationship that shapes the collaboration and coordination between suppliers and buyers. In this paper, we use system dynamics as an approach and perspective to analyze the evolutionary process of supply chain collaboration. Use a valve manufacturing firm as an illustrative case, this paper illustrates how a buyer firm in a networked supply

chain unexpectedly harmed the inter-firm trust between the buyer and its suppliers that further resulted in the collapse of the relationships among them. Based on the quantitative system dynamics model developed, this paper argues and shows that supply chain relationships may be more complex than the consideration of transaction costs. Path dependency of the make or buy decision may exist and drive a supply chain to evolve over time. Buyers and suppliers' rational decisions to reduce their own risks and to optimize efficiency may not only interfere with the benefits of the other side but also entrap a long existed supply chain to collapse. From the economic perspective, how to balance the time required for capacity expansion and the time for suppliers to develop new customers is of the essence in such a vulnerable supply chain setting.

Ufuk Turen

uturen2011@gmail.com
Turkish Military Academy

Yunus Gokmen

ygokmen@kho.edu.tr
Turkish Military Academy

Hakan Dilek

hdilek@kho.edu.tr
Turkish Military Academy

Yavuz Ercil

ercil@gmail.com
Turkish Military Academy

Is Ability of Solving Complex Stock-Flow Problems Associated with Ability of Solving Simpler Ones? An Experiment in Turkey

There are many studies exploring the reasons behind failures in solving generic system dynamics (SD) problems such as stock-flow (SF) failure. Although they reach some limited associations, they do not find any significant cognition related factor explaining the variation in failures except the positive impact of visual saliency of the problem displays. In present study we put forward the question "Does cognitive problem solving capability improve progressively?" So, we prepare a performance sheet including two parts. First part consists of simpler SF problems and second part contains more complex ones. Then we ask these questions to motivated undergraduate industrial engineering students. Sample of participants consists of two groups. First group is SD educated and second group is not SD educated. We see that while some individuals are performing well in solving more complex SD problems, others are performing well in simpler ones, and ability to solve more complex problems is not dependent on performance in solving simpler ones. But we find associations between capabilities of solving two different more complex SF problems each other. We also see that SD education increases the capability of solving more complex SF problems but does not affect the capability of solving simpler SF problems.

Akira Uchino

uchino@isc.senshu-u.ac.jp
Senshu University School of Commerce

Kinya Machida

machida@surugadai.ac.jp
Surugadai University

Accounting Dynamics -- Rethinking about Theoretical Framework

Accounting Dynamics (AD) is a methodology of accounting as social science. We studied Accounting Dynamics from 1982 to 1994. We first proposed the concept of Accounting Dynamics on International System Dynamics Conference in 1987. We interrupted the study for a long time, because there were some difficulties to develop the real Accounting Dynamics models. The concept is still reasonable and so attractive that we have reviewed Accounting Dynamics again. This is first step to restart the project and show you Accounting Dynamics in order to organize the SIG. This paper shows what is "Accounting Dynamics" clearly.

Takuro Uehara

takuro@pdx.edu
Portland State University

Yoko Nagase

ynagase@brookes.ac.uk
Oxford Brookes University

Using System Dynamics to Contribute to Ecological Economics

This paper demonstrates the usefulness of the system dynamics approach to the development of ecological economics, the study of the interactions between economic systems and ecological systems. We build and analyze an ecological

Wayne Wakeland

wakeland@pdx.edu
Portland State University

economic model: an extension of a population–resource dynamics model developed by Brander and Taylor and published in American Economic Review in 1998. The focus of the present paper is on the model building and analysis to contribute to theory building rather than eliciting policy implications from the model. Hence, this is an example of model-based theory building using system dynamics. Our analysis sheds light on several problems with this type of ecological economics model that can be attributed to three commonly taken approaches to model building and analysis by traditional economics: simplification through the use of exogenous variables, equilibrium thinking, and a focus on the so-called balanced growth path. To solve these problems ecological economic models should adopt approaches that are not prevalent in traditional economics such as taking an endogenous point of view and allowing for out-of-equilibrium (adaptation) which are key principles of the system dynamics method.

Muhammad Aman Ullah

m.aman@auckland.ac.nz
University of Auckland

Enhancing the Understanding of Corruption through System Dynamics Modelling

Tiru S. Arthanari

t.arthanari@auckland.ac.nz
University of Auckland

Over the past few decades, many studies of corruption have been carried out. These studies have mainly focussed on specific characteristics such as: economic issues, legal issues, social propositions, impact on national development, and in relation to economic policy. The rationale of this research is to build initial system dynamics models of corruption, so that these models can extend our understanding of corruption and act as an input to future policy making on corruption. System dynamics modelling allows researchers to discover ‘hidden’ dynamics. Moreover, system dynamics enables the analyst an increased level of flexibility, as system dynamics modelling uses both theoretical understanding, as well as empirical data collection. Indeed, as a result of this study, we can offer an explanation that uncovers the underlying factors that address the dynamics of corruption, social, economic, political, judicial and cultural factors in case of any developing country, which can be applied with some modifications for developed world. In this we try to determine problem of corruption in societies by incorporating very complex and different social, cultural and even religious aspects that were mostly untouched in system dynamics studies in past. Systems dynamics model of corruption developed in this study would be of use to policy makers and non-governmental organisations in understanding the complex nature of corruption.

Anson Kin Tat Li

akt.li@auckland.ac.nz
University of Auckland

Silvia Astrid Ulli-Beer

silvia.ulli-beer@psi.ch
Paul Scherrer Institut

Assessing threads and opportunities of induced technology change: Long and short term cycles in the carmaker industry

Benjamin Boksberger

benboksberger@hotmail.com
Paul Scherrer Institut

This paper introduces the industrial transformation model applied to the carmaker industry. We analyze the interaction between supply and demand as well as policy regulations supporting the diffusion of advanced vehicle technologies. It allows to assess prospectively threats and opportunities of induced technology changes for industries. The simulation exercise provides evidence that smart governance approaches involving concerted entrepreneurial and political decision making can avert severe industrial crisis of adjustment during phases of socio-technical transitions. The overall cycle pattern seems to play out over a time period of 50 years. It is strongly influenced by the climate policy regime and the innovation investment behavior of firms. It results in a sectoral boom phase once the transition towards near zero emission vehicles has been mastered. The policy induced technology change pattern is comparable to the long wave theory in

Manuel Bouza

manuel.bouza@comvation.com
Paul Scherrer Institut

Alexander Wokaun

alexander.wokaun@psi.ch
Paul Scherrer Institut

terms of its duration and the argument, that deep structural causes are innovation processes in whole technological systems. Moreover, we have identified the drivers of single short term cash cycles. Differences between cash inflow and outflow over time that are triggered by strategy and policy changes explain short term fluctuations.

Mauricio Uriona Maldonado

mauricio.uriona@gmail.com

Federal University of Santa Catarina

Ricardo Pietrobon

rpietro@duke.edu

Duke University Medical Center

Gregorio Varvakis

grego@deps.ufsc.br

Federal University of Santa Catarina

Elias Cesar Araujo de Carvalho

ecacarva@gmail.com

Duke University

A Preliminary Model of Innovation Systems

The Innovation System (IS) approach is a conceptual framework used by scholars and policy makers to describe the scientific and technological structures and processes that influence economic development. The current literature offers a wide variety of models representing IS making difficult to choose the most appropriate one to inform and formulate policy. This article aims at summarizing and aggregating the wide range of models into one single meta-model that could allow a more comprehensive understanding of the structure - components and linkages - of an IS and offer rigorous and timely assessments of the evidence base to inform decision and policy makers. Thus, a preliminary structured model of a Regional Innovation System is developed and formalized through the use of a system dynamics simulation model that depicts changes in the linkages and its knowledge flows over time. The model might be used in future research in analyzing specific Innovation Systems.

Bert L. P. J. van Nistelrooij

b.vannistelrooij@fm.ru.nl

Radboud University Nijmegen

Étienne A. J. A. Rouwette

e.rouwette@fm.ru.nl

Radboud University Nijmegen

Ilse Verstijnen

iverstijnen@cvz.nl

Dutch Health Care Insurance Board

Jac A. M. Vennix

j.vennix@fm.ru.nl

Radboud University Nijmegen

Power-leveling as an effect of group model building

Use of power concerns a relatively unexplored area within group model building (GMB) assessment studies. In this paper we apply social exchange theory to explore the effect of GMB on the use of power by the participants. According to this theory, differences in power between two participants influence their communicative exchange process; the larger the power difference between two participants the less likely they are to interact and vice versa. This use of power hinders the design of optimal solutions which requires the unique expertise of all participants. It is hypothesized that the act of facilitation within GMB-sessions helps to reduce the use of power by participants. We call this effect 'power-levelling'. If the hypothesis of power-levelling through facilitation holds, it may explain why group model building is helpful in designing better solutions. The research was conducted in a field setting at the Dutch Health Care Insurance Board (CVZ), where regular meetings and GMB meetings were compared. The first results are supportive for the hypothesis, however, more data are required.

Suzanne van Staveren

savanstaveren@hotmail.com

Radboud University Nijmegen

Inge L. Bleijenbergh

i.bleijenbergh@fm.ru.nl

Radboud University Nijmegen

Hubert Korzilius

h.korzilius@fm.ru.nl

Radboud University Nijmegen

Jac A. M. Vennix

j.vennix@fm.ru.nl

Radboud University Nijmegen

A problem of a shortage of female managers or a problem of a surplus of male managers?

This paper aims to add knowledge about solving stock-flow failure, in particular in the field of personnel policies, by incorporating the effect of framing, a concept from the psychological field, in decision-making on a stock-flow task. The framing-effect is the effect that the formulation of a problem has on one's understanding of and actions towards that problem. Participants to a system dynamics inventory task seem to react differently to a problem when it is formulated in different frames, which in turn might have an effect on the degree of stock-flow failure of the participant. Participants had to perform a variation of the female professors task, namely a managers task from a male perspective and a managers task from a female perspective, in which the question asked was the same but the frame of the tasks differed. It appeared that the participants with the

managers task from the male perspective recommended more extreme number on average in their reasoning than the participants with the managers task from the female perspective. There was no difference in stock-flow failure between the groups of participants.

Guido Arjan Veldhuis

g.veldhuis@gmx.net
Radboud University Nijmegen

Hubert Korzilius

h.korzilius@fm.ru.nl
Radboud University Nijmegen

Seeing with the Mind - The Role of Spatial Ability in Inferring Dynamic Behaviour from Graphs and Stock and Flow Diagrams

Several experiments have shown that, when predicting the behaviour of stocks and flows, many subjects rely on the erroneous 'correlation heuristic'. They seem to assume that the output of a system should look the same as the input. Based on similar experiments with kinematics graphs we hypothesize that spatial ability explains variance on tasks involving accumulation. We propose that spatial ability might also generate other important differences between people, such as their ability to infer behaviour from diagrams. We tested participants on two dimensions of spatial ability: visualization and spatial orientation. In an experiment we found that the visualization dimension has a positive effect on performance in various systems thinking inventory tasks and a negative effect on the likelihood that the participant selects a response typical for correlation heuristic reasoning. The positive relation to performance was also present for tasks in which stock behaviour had to be inferred from text and diagrams. Furthermore, we found that people are not persistent in their use of the correlation heuristic between different types of tasks. Males and females did not differ in their spatial ability, but, males did perform better on almost all stock and flow tasks.

Neus Vila-Brunet

nevib5@gmail.com
Community Policy Analysis Center

How Can Mitigation and Adaptive Capacities to Climate Change Be Best Enhanced in Spain? A Human Values Evolutionary Approach

Climate change (CC) mitigation and adaptation are preeminent goals of the European Union (EU) because there is a need to produce and consume in harmony with the global ecosystem that sustains us. To achieve those goals, the EU has set a target of ten percent green house gas emissions reduction in the agricultural sector relative to 2005 levels by 2020. The development of optimal strategies to meet that goal is the responsibility of each individual country, which suggests that country-specific research on the topic is needed for policy makers. Spain presents a unique setting for the study of optimal CC strategies because its agricultural sector is diverse and highly threatened by CC. This paper develops a continuous dynamic model in order to elucidate the current and emergent relationships and behaviors between the agricultural sector and its direct natural resources, human capital and social capital. The final aim is to identify efficient CC mitigation and adaptation strategies for the short and long run that consider the relationships between economic, natural and social systems. The model structure is based on the Spanish AgroSAM (social accounting matrix), extended with natural resource, human capital and social capital satellite accounts, and converted into a general disequilibrium model.

Wayne Wakeland

wakeland@pdx.edu
Portland State University

Alexandra Nielsen

alexan3@pdx.edu
Portland State University

Teresa Schmidt

tds@pdx.edu
Portland State University

System Dynamics Modeling of Medical Use, Nonmedical Use and Diversion of Prescription Opioid Analgesics

The objective of the study was to develop a system dynamics model of the medical use of pharmaceutical opioids to treat pain, and the associated diversion and nonmedical use of these drugs. The model was used to test the impact of simulated interventions in this complex system. The study relied on secondary data obtained from the literature and from other public sources for the period 1995 to 2008. In addition, an expert panel provided recommendations regarding model parameters and model structure. The behavior of the resulting systems level model compared favorably with reference behavior data ($R^2=.95$). After the base model was tested, logic to simulate the interventions was added and the impact on overdose deaths was evaluated over a seven-year period, 2008-2015. Principal findings were that a prescriber education intervention reduced total overdose deaths, while reducing the number of persons treated with opioid analgesics. A “popularity” intervention sharply reduced nonmedical overdoses. We conclude that the system dynamics modeling approach shows promise for evaluating potential policy interventions to ameliorate the adverse outcomes associated with the complex system surrounding the use of opioid analgesics to treat pain.

Shoujin Wang

786121244@qq.com
Shanghai University

Ying Qian

iris_qian@hotmail.com
Shanghai University

Yuening Li

liyuening1990@hotmail.com
Shanghai University

Shengxin Chen

sxchen@smmu.edu.cn
The Second Military Medical University

Customer Lifetime Value Promotion Strategy Analysis Based on System Dynamics Model

Customer lifetime value (CLV) is the core content of customer relationship management. With the increasingly fierce market competition, more and more enterprises realize the importance of maintaining long-term strategic partnership with customers. In this paper, we established a system dynamics model of CLV and use SF Company as an example. The model simulation results showed that the intensity of competition, price levels and investment levels all affect CLV. Reducing the intensity of competition can increase the CLV. More investment will raise service quality and then promote CLV. Reducing the price level increases CLV in the short term. However, in the long run, less income leads to less profit and less investment which can decrease CLV.

Wei Yang Wang

wyang@cc.kuas.edu.tw
National Kaohsiung Univ of Applied Sci

To Grow or Not to Grow? A Multiple-Cases Study on the Growth Dynamics in Medical Care Software Firms

This study empirically demonstrates that software firms in a niche market with relatively short-life cycle may experience a similar growth pattern that firm grows after a period of performance deficit. A system dynamics model is built to capture the essential interactions across industry- and firm-levels. It is found that the growth trajectory of worse-before-better offers an explanation of the high exit rate in software industry in which small and medium enterprises are the majority. Furthermore, it is also found that though activities of market development and service and activities of product development and enhancement were important in pursuing survival and growth, software firms with different attitudes towards growth emphasized differently on these activities by different human resource management and allocation policies. In this paper, we argue, and show, that entrepreneur's attitude towards growth and his or her adopted growth strategies

determine how worse to experience and the extent to grow. This is significant to system dynamists because it shift our attention from traditional growth dynamics exploration to the observation and explanation of why firms experience growth or failure differently. The difference of growth among software firms and its implications is deliberately discussed.

Kim D. Warren

kwarren@london.edu
London Business School

Understanding and Managing the Threat of Disruptive Events to the Critical National Infrastructure

Concern about the vulnerability of utility networks, (electricity gas and water) and other infrastructures, including transport and telecommunications, to environmental, terrorist and other threats has increased in recent years, motivated both by a perceived increase in such threats and by recognition that the commercial pressures and regulation of companies operating these infrastructures could unintentionally have increased that risk. Powerful simulation tools already help utility operators assess the physical consequences of disruptive events on their networks, whilst others have helped increase their capability to respond efficiently when such events occur. However, better understanding is needed of the relationship between operational, commercial and regulatory pressures, the strategic choices these lead to on the part of infrastructure operators and the long-run consequences for the resilience of these systems and hence for service continuity. This paper describes a high- level model portraying these relationships, and early findings from testing alternative strategies, both over the long and short term.

Jessica Westbrook

jwestbr@sandia.gov
Sandia National Laboratories

Leonard A. Malczynski

lamalcz@sandia.gov
Sandia National Laboratories

System Dynamics of the Competition of Municipal Solid Waste to Landfill, Electricity, and Liquid Fuel in California

Increasing concern regarding the cost, security, and environmental impact of fossil fuel energy use is driving research and investment towards developing the most strategic methods of converting biomass resources into energy. Analyses to date have examined theoretical limitations of biomass-to-energy through resource availability assessments, but have not thoroughly challenged competing tradeoffs of biomass conversion into liquid fuel versus electricity. Existing studies have focused on energy crops and cellulosic residues for biomass-to-energy inputs, however the conversion of these biomass resources is often less energetically efficient compared to fossil energy sources. Waste streams are beginning to be recognized as valuable biomass to energy resources. Municipal solid waste (MSW) is a low-cost waste biomass resource with a well-defined supply infrastructure and does not compete for land area or food supply, making it a potentially attractive renewable feedstock for energy conversion. The Waste Biomass to Energy Pathway model (WBEM) described here demonstrates a system dynamics approach to analyze the impact of converting MSW biomass to either bioelectricity or liquid fuel. The WBEM incorporates macro-scale feedback from supply chain costs, energy sector impacts, and greenhouse gas (GHG) production within the competing pathways of MSW to 1) landfill, 2) electricity, and 3) liquid fuel within California.

David Wheat*dwheat@wheatresources.com*

University of Bergen

Modeling Fertility in Lithuania: A Preliminary Report

The two-decade decline in Lithuania's population continues unabated, with deaths exceeding births and emigrants outpacing immigrants. The population pattern raises serious issues for policy makers, as an aging population puts pressure on health care facilities and the pension system, and as a shrinking workforce requires an acceleration in labor productivity improvements. This paper addresses one aspect of the demographic problem—fertility—with a model that is part of a larger system dynamics model of Lithuania's demography and economy. Here, the focus is on explaining Lithuania's low fertility rate, which plunged below replacement level in 1991 and hovers around 1.5 births per woman today. This paper presents the first system dynamics model of the low-fertility problem in Lithuania, and builds on demographers' distinction between distant and proximate effects on fertility. Simulation results challenge the conventional wisdom about the prevalence of contraceptive usage in Lithuania.

Philipp Wunderlich*p.wunderlich@fm.ru.nl*

Radboud University Nijmegen

Using system dynamics to analyze innovation diffusion processes within intra-organizational networks

The purpose of this study is to introduce system dynamics as a methodology to analyze intra-organizational innovation diffusion processes. Therefore, a purely algebraic model is replicated and analyzed in a system dynamics environment before it is extended by relaxing the restrictive assumption that intra-group diffusion and inter-group diffusion take place consecutively. The findings of this study suggest that the parallel occurrence of intra-group and inter-group diffusion can change the outcome of the diffusion process significantly. In addition, system dynamics is used to illustrate and analyze the complex dynamics of the diffusion process. The interplay between the self-reinforcing dynamics of intra-group diffusion and the balancing dynamics of inter-group diffusion is heavily influenced by the structure of the network between groups. The simulations suggest that adopter-dominated groups should be connected to each other, while non-adopter-dominated groups should be isolated in order to increase the probability and speed of successful innovation diffusions. Major limitations of the study are that only one network structure between groups was examined and that all groups are considered to be homogeneous.

Andreas Größler*a.groessler@fm.ru.nl*

Radboud University Nijmegen

Modeling the Nuclear Fuel Cycle: Agent Based Approach

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

Abdellatif M. Yacout*yacout@anl.gov*

Argonne National Laboratory

Guilhem Blanchard*guilhemblanchard@gmail.com*

École Polytechnique

Temitope Taiwo*taiwo@anl.gov*

Argonne National Laboratory

Neetu Yadav

neetu.21.yadav@gmail.com
Indian Institute of Technology

Sushil Sushil

sushil@dms.iitd.ernet.in
Indian Institute of Technology Delhi

Mahim Sagar

mahim@dms.iitd.ac.in
Indian Institute of Technology

Dynamics of Strategic Initiatives and Expected Performance: An Application of Flexible Strategy Game-card

Business performance measurement and management has become a multi-million dollar industry. In the competitive and dynamic business environment, existing performance management frameworks have a limited mechanism to measure and manage the business dynamics. An evolving performance management framework named as flexible strategy game-card intends to support whole cycle of strategy formulation and execution and highlights to develop a integrated and dynamic view of performance management. This paper is an attempt to develop a system dynamics based performance management game taking flexible strategy game-card as a basis. This model has been developed in the context of one of the Indian telecom service provider firms. The performance measures have been identified on the basis of S-A-P-P (Situation-Actor-Process-Performance) framework, the causal links and feedback loops are identified, strategic initiatives and decisions have been identified. With the help of STELLA 9.1.4 software, a system dynamics based performance management game has been developed which helps the enterprise to analyze the impact of strategic initiatives on their performance and the likely coming performance results are being displayed. The model has been validated in a limited manner. The outcome is to provide a performance management model which helps to understand dynamics of strategic initiatives and expected performance.

Kaoru Yamaguchi

kaoru3@muratopia.org
Doshisha University

On the Monetary and Financial Stability under A Public Money System - Modeling the American Monetary Act Simplified

Our economies are currently facing systemic failures of financial and debt crises. To overcome these, an alternative public money system is proposed by the American Monetary Act. This paper is the third one that examines the feasibility of the public money system. First and second papers have focused on the liquidation of government debt. This paper explores monetary and financial stability under the public money system in comparison with the current debt money system, by constructing a simplified macroeconomic model. It is found through simulation that monetary and financial instability is built into the current debt money system and “booms and depressions” become inescapable. On the other hand, true monetary and financial stability is shown to be accomplished under the public money system.

Yang Yang

youngsun@istic.ac.cn
Instit of Scientific and Tech Studies

Hefeng Tong

thf2003@istic.ac.cn
Instit of Scientific and Tech Studies

Xu Zhang

zhangx@istic.ac.cn
Instit of Scientific and Tech Studies

Simulating the Impact of Different Control Policy on Private Car in Beijing: A System Dynamics Approach

Considering more economic means should be taken in future instead of the current new car restriction policy in Beijing which has been criticized for its unfairness. Different policy effect on private car in Beijing should be simulated to help transport policy makers make decision. The system dynamic model is built for analysis of private cars under different policies in Beijing. Firstly, by dividing the model into three sub modules including population, economic, and private car, the private car ownership was calculated based on micro-level personal income and automobile annual costs. Secondly, the private car numbers, age distribution,

new car sales, and scrappage during the year of 2000-2020 were analyzed based on the simulation result. Finally, the effect of different policies on private cars ownership and new car sales in Beijing was showed through scenario analyze.

Hakan Yasarcan

yasarcanh@yahoo.com
Bogaziçi University

Togay Tanyolac

caloynat@gmail.com
Bogaziçi University

A Soft Landing Model and an Experimental Platform as an Introductory Control Design Tool

This paper presents a soft landing model and an experimental platform. The aim of the modeling effort is to transparently represent the process of landing a spacecraft on the surface of a celestial body. The process of landing is a challenging task because there are two main contradictory performance criteria to be met simultaneously; the landing duration should be as short as possible, but at the same time crashing the spacecraft to the surface should be avoided. If the only criterion was to prevent crashing the spacecraft, that would not be difficult to achieve by slowing down the landing process. However, long landing duration necessitates extensive use of fuel, which should also be avoided. As a summary, the main goal in the soft landing problem is to land the spacecraft as gently and as fast as possible. The model and the modeling process presented in this paper will serve as a modeling case to be used in teaching. Based on the soft landing model presented in this paper, we also developed a platform for simulation experiments. Our simulation-based discovery learning environment can be used to introduce dynamic complexity. It can also be used as an introductory control design tool for physics, engineering, and interested social sciences students.

Mustafa Yavas

mustafayavas88@gmail.com
Bogaziçi University

Gizem N. Bacaksizlar

ngizembacaksizlar@gmail.com
Bogaziçi University

Financial Sustainability of Social Security Institutions in the Presence of Aging Populations

The purpose of this study is to build an experimental platform for scenario and policy analyses of social security institutions that deploy pay-as-you-go schemes as the financing method. To realize this aim, system dynamics methodology is utilized and a generic dynamic simulation model is constructed. Afterwards, the financial sustainability of the social security institution in Turkey, as a susceptible country for its aging population, is investigated via scenario and policy analyses. The results show that (i) irrespective of scenarios and policies, aging phenomenon is quite dominant and a serious threat to financial sustainability, (ii) informal sector plays a crucial role in the financial sustainability of social security systems, and (iii) a hybrid policy combining increase in retirement age, premiums and decrease in informal sector ratio seems to be the most promising one among the other policies. Future research involves modeling the fully funded scheme complementing this study to enable the public policy makers to compare and contrast the two financing methods comprehensively.

Gönenç Yücel

gonenc.yucel@boun.edu.tr
Bogaziçi University

A novel way to measure (dis)similarity between model behaviors based on dynamic pattern features

This paper presents a novel way of quantifying pattern-wise (dis)-similarity between two time-series data. The approach filters out all numerical information from a given time-series data, and generates a qualitative description of it in terms of atomic behavior modes. The comparison of two data-series, hence the similarity calculation is based on these qualitative descriptions. Different from early examples in the field, the proposed approach focuses purely on pattern features, and does not require to be trained for a fixed set of patterns beforehand.

During preliminary tests, it is observed that the algorithm performs very well, and the computational cost in terms of time is quite low. Using the proposed (dis)-similarity calculation, it is possible to present model results in a more objective and quantified manner. Apart from that, such a quantification enables the use of advanced computational techniques in various phases of the modeling cycle.

Emad Zilouchian

ezilouchian@gmail.com
McGill University

Arturo Cardenas Martinez

arturo.cardenas@mail.mcgill.ca
McGill University

Saeed Koochak-Yazdi

saeed.koochakyazdi@mail.mcgill.ca
McGill University

Hani Murad

hani.murad@mail.mcgill.ca
McGill University

Industry Analysis: The Fastener Supply Chain in Aerospace Industry

In a highly regulated industry as the Aerospace is impossible to have suppliers entering and leaving as they please. Entry barriers raise the importance of understanding the behavior of the entire supply chain system ranging from turbine engines to fasteners; any part can force the plane production to stop when there is a supply shortage. Nowadays, every purchasing order placed by Aerospace OEMs to high-tech suppliers is followed thoroughly. In contrast, fasteners fall in the category of nuts and bolts for their “simplicity” and high volumes and often they are taken for granted. This paper focuses on the fastener supply chain, developing a system dynamic model to show insights of its behavior and to set the base for a further improvement analysis.

Meetings, Special & Convened Sessions

Listed alphabetically by Session name

Anson Kin Tat Li

akt.li@auckland.ac.nz
University of Auckland

Australasia Chapter Annual Meeting

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. Nominations will be called for President. The ever-growing base of members of the Australasian Chapter has been pursuing our existing and new realms of research and activities in 2011-2012. 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, the systemic anti-tobacco campaign in New Zealand is moving on full steam ahead, 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 highschool levels, gaining momentum for the promotion of systems perspectives in education for all. We’re looking forward to seeing you all at St Gallens.

Joanne C. Egner

jegner@iseesystems.com
isee systems

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.

Erik Pruyt

e.pruyt@tudelft.nl
Delft University of Technology

Benelux Chapter Annual Meeting

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

Jim L. Rogers

rogers.james@amgresults.com
Advance Management Group LLC

Biomedical Roundtable and First Biomedical SIG Annual Meeting

In this two hour meeting, Dr. Ed Gallaher and Jim Rogers will continue a conversation among twenty individuals interested in biomedical system dynamics that was conducted in the 2011 conference in Washington. The Washington conversation created a list of approximately fifteen areas of study that would be of interest to the respective participants. It is our intent in this meeting to lay out the structure of the newly formed (February 2012) Biomedical System Dynamics Special Interest Group, to share methods and means of communication group members can use throughout the year, to establish our principles of operation, and to identify priorities. Practitioners interested in biomedical applications, with skill levels ranging from novice to master, are invited to attend and participate in this exciting new group.

Edward J. Gallaher

ejgallaher@frontier.com
Applied System Dynamics

Geoff McDonnell

gmcdonne@bigpond.net.au
UNSW

Özge Karanfil

karanfil@mit.edu
MIT

Warren W. Farr

warren3@me.com
Refrigeration Sales Corporation

Ricardo Matos Chaim

rmchaim@yahoo.com.br
University of Brasilia

Isaías Custódio

icustodio@usp.br
Universidade de São Paulo

Aldo Zagonel

zagonel@aol.com
Attune Group Inc

Brazil Chapter Annual Meeting

The annual business meeting will be divided into four parts of 15 minutes each: 1) personal introductions; 2) evaluation of the Brazilian presence in St. Gallen; 3) election of two new officers, one entailing a partial two-year term and the other a full three-year term; and 4) discussion of plans for the near future (2012- 2013). 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.

Roberta L. Spencer

system.dynamics@albany.edu
System Dynamics Society

Etiënne A. J. A. Rouwette

e.rouwette@fm.ru.nl
Radboud University Nijmegen

Ignacio J. Martínez-Moyano

imartinez@anl.gov
University of Chicago

Edward G. Anderson

edward.anderson@mcombs.utexas.edu
University of Texas

R. Joel Rahn

jrahn@sympatico.ca

Robert Y. Cavana

bob.cavana@vuw.ac.nz
Victoria University of Wellington

Conference Debriefing

All are welcome to attend this meeting to talk about what worked and what needed improvement at the conference. Also, please remember to complete and return the conference survey. Post-conference you may complete our online survey at: http://fmru.qualtrics.com/SE/?SID=SV_5ngpHFkiU2878Z6.

Conflict, Defense, and Security SIG Roundtable and Annual Meeting

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

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 has been submitted for inclusion in the conference. The winner receives a cash award, a conference registration and an allowance for travel expenses.

Economics Chapter Roundtable and Annual Meeting

The Economics Chapter annual meetings are dedicated to welcome new members, discuss the past years events and the coming year's themes, and to determine the new president elect. At the Washington DC conference, discussion centred on a implementing a model repository; assessing interest in a special issue on Economics for SDR; and improving communication between members by a collaborative newsletter. This year we will: 1. Introduce new members and catch up with current members. 2. Conduct the AGM business, appoint an 'executive committee' and new officers for the chapter. 3. Discuss the following important item: "Will economists ever embrace system dynamics? In other words, is there anything about system dynamics that is inherently anti-economics that would prevent economists from embracing it? Would there ever be such a subfield of economics called "system dynamics economics" or "feedback economics" (just like "behavioral economics")." 4. Discuss contributions for an edited book, provisionally called "Feedback Economics" linking System Dynamics and Economics. Bob Cavana, Mike Radzicki and David Wheat have agreed to be the co-editors of this special collection, which will include invited papers, 'classical' works and papers generated by an international 'call for papers'. We look forward to seeing you all at St Gallen in July!

Michael S. Kennedy

michael.kennedy@beds.ac.uk
University of Bedfordshire

Carol Frances

carolfrances100@hotmail.com
Claremont Graduate University

Richard Langheim

richlangheim@gmail.com
Ramapo College of New Jersey

P. Jeffrey Potash

jpotash@ciesd.org
CIESD

Education Roundtable and Education SIG Annual Meeting

The Education SIG continues to pursue its twin interests in 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 sessions 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).

Isaac Dyner

idyner@yahoo.com
Universidad Nacional de Colombia

Stian Blackstad Hackett

stian.hackett@geog.uib.no
University of Bergen

Energy Roundtable and Energy SIG Annual Meeting

The Energy Special Interest Group brings together system dynamics practitioners within the energy field. This year's Energy SIG meeting and Energy roundtable discussion are combined into a single event with two parts: In the annual SIG meeting (part 1) we will discuss practical issues and the future role of the SIG. In the roundtable discussion (part 2), we will focus on the issue of system dynamics modeling applied to energy issues, and feature a discussion / workshop about the current state of the field of energy economics. We will start with a few brief, prepared introductions to the topic from a few participants and then finish with an open discussion.

Asmeret Bier

asmeret.bier@gmail.com
Sandia National Laboratories

Leonard A. Malczynski

lmalcz@sandia.gov
Sandia National Laboratories

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.

Robert L. Eberlein

bob@astutesd.com

Roberta L. Spencer

system.dynamics@albany.edu
System Dynamics Society

Getting to Know the System Dynamics Society

This event gives newer conference attendees an opportunity to learn more about the Society and 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.

Erik Pruyt

e.pruyt@tudelft.nl

Delft University of Technology

Health Policy Special Interest Group Annual Meeting

The Health Policy Special Interest Group formed more than nine years ago and has grown to around 300 members (of whom about 120 Society members). We are a worldwide SIG with active collaborations that use dynamic analyses to advance major policy initiatives. Regardless of whether you are new to the field or a veteran modeler, we welcome your participation in exchanging ideas about how SD can better engage and support health policy leaders around the world. HPSIG will run a poster session, a Sunday Session (an Annual Meeting followed by the Lupina Award presentation(s)). The Annual Meeting will be devoted to exchanging information regarding recent and current Health Policy work and activities, explore possible collaborations, and elect new office bearers.

Akira Uchino

uchino@isc.senshu-u.ac.jp

Senshu University School of Commerce

Japan Chapter Meeting

Japan Chapter Meeting We are pleased to inform you that Japan Chapter Meeting will be held in St. Gallen Conference. Join all the attendants who are interested in Japan and Japan Chapter. We are looking forward to seeing you and talking fun. Japan Chapter was founded in 1990. In 1995, Japan Chapter held The International System Dynamics Conference hosted by Gakushuin University in Tokyo. As Research activities, Japan Chapter publishes an annual journal and holds regular research meetings and annual symposiums. We always welcome System Dynamics members or users who visit Japan. Several System Dynamics researchers have already had meetings hosted by Japan Chapter. Contact us without hesitation. Akira Uchino, the head of Japan Chapter.

Jack B. Homer

jhomer@comcast.net

Homer Consulting

Jay Wright Forrester Award Ceremony

The Jay Wright Forrester Award is presented as often as once annually for the best contribution to the field of System Dynamics during the preceding five years. The recipient receives a commemorative plaque and US\$5,000. Papers, articles, books, research or consulting reports, theses or other written material that have been published or are in publishable form in the English language, in the original or after translation, are eligible for consideration. Winner(s) will be announced at the conference by Jack B. Homer, Chair.

Dong-Hwan Kim

sddhkim@cau.ac.kr

Chung Ang University

Korea Chapter Annual Meeting

In this meeting, we hope that system dynamicists who have interests in Korea Chapter get together and share personal and academic information. Although system dynamicists in Korea have several domestic meetings, this chapter meeting can give a unique opportunity to meet abroad.

Gloria Pérez Salazar

gloria.perez@itesm.mx

Tecnológico de Monterrey

Latin America Chapter Annual Meeting

The Latin-American Chapter meeting that will place at the 30th International Conference in St. Gallen 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 10th. Latin-American System Dynamics Conference which will take place in Buenos Aires, Argentina, November 21-23, 2013.

Wayne Wakeland

wakeland@pdx.edu
Portland State University

**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.

Jim Duggan

jim.duggan@nuigalway.ie
National University of Ireland Galway

Model Analysis Roundtable and SIG-MA Annual Meeting

The Special Interest Group on Model Analysis (SIG-MA) focuses on the development, use and advancement of formal model analysis methods in System Dynamics. These methods currently include: Pathway Participation Metric, Ford's Behavioural Analysis and Eigenstructure-based methods, amongst others. The focus of this group is not so much on the validity of model equations as, given the equations, how can they best be analyzed and interpreted back to reality. The activities of SIG-MA also includes the further development of tools for model analysis and clear communication of their use (and benefits) in applications. The SIG-MA is open to all system dynamicists interested in formal analysis.

Jack B. Homer

jhomer@comcast.net
Homer Consulting

Modeling Assistance Workshop

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

Roderick H. MacDonald

rod@isdps.org
Initiative for SD in the Public Sector

Leonard A. Malczynski

lamalcz@sandia.gov
Sandia National Laboratories

Newcomer Orientation

This is a special event for newcomers (first-time conference attendees) scheduled for either a half hour on Sunday afternoon or at Monday lunchtime (refer to the conference schedule). 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.

David C. Lane

d.c.lane@lse.ac.uk
London School of Economics

Robert L. Eberlein

bob@astutesd.com

Roberta L. Spencer

system.dynamics@albany.edu
System Dynamics Society

Andrew Ford

forda@mail.wsu.edu
Washington State University

Outstanding Service Award Announcement

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

Chris Browne

systemdynamicssociety@b-ent.net
Australian National University

Nicolas Escalante

nicolas.escalante@iswa.uni-stuttgart.de
University of Stuttgart

PhD Colloquium

The PhD Colloquium is a whole day event for students to present and discuss their current research about foundations, techniques, and applications in the area of system dynamics. Junior and senior system dynamics practitioners and academics meet here every year to exchange ideas about students' projects in an inspiring international and open-minded atmosphere. Plenary presentations by students at the colloquium will identify common problems encountered by student researchers in their theses. Presentations are followed by a discussion session, providing a unique opportunity for learning among all attendants, and particularly for young researchers. Combined with a workshop and poster session, we expect the all-day colloquium to be an exciting and insightful event. Everyone is more than welcome to join the PhD Colloquium. It is a great opportunity to meet students from around the world and exchange ideas. More information is available at www.systemdynamics.org/chapters/student. Any questions about participating in the colloquium can be directed to phdcolloquium@systemdynamics.org.

David W. Lounsbury

david.lounsbury@einstein.yu.edu
Einstein College of Medicine Yeshiva

Ralph L. Levine

leviner@msu.edu
Michigan State University

Psychology Roundtable and Psychology SIG Annual Meeting

Our roundtable will focus on epistemological issues of including psychological constructs in formulation, simulating, and validating system dynamics (SD) models. We will discuss the epistemological basis of SD models in general, with emphasis on social and psychological variables. Psychological variables and social processes can (1) be used in dynamic models to lead to better understanding of the causes of the problem and (2) can enhance the field of psychology by developing dynamic models of social processes, per se. A variety of strategies for integrating psychological and other information variables will be presented, with general discussion about the utility of iterative deliberation via group model building and other qualitative research techniques.

Red Ribbon Event and SD Career Link Bulletin Board

The goal of this event is to allow job-seekers as well as attendees with job-finding resources or job opportunities to easily connect and network. It is not a Job Fair with scheduled interviews. A red ribbon on a name badge identifies the participant as approachable and that s/he is prepared to spend time providing guidance and support to job-seekers. We encourage job-seekers to approach red ribbon-wearers throughout the conference. Additionally, the SD Career Link Bulletin Board will be available for organizations that would like to post a job opening or a company profile.

Natalia N. Lychkina

lychkina@guu.ru

State University of Management

Russian Chapter Annual Meeting

The Russian Chapter of the System Dynamics Society was created several years ago. The Chapter has taken up various activities in the sphere of SD in Russia and internationally. The members of Russian Chapter annually take part in major international conferences, such as International Conference of System Dynamics Society (Athens, Albuquerque, Seoul, Washington, DC), IMMOD, etc. In the year 2011 The Russian Chapter of the System Dynamics Society has become a member of the Federation of European Simulation Societies (EUROSIM). Today there is a certain interest in system dynamics and simulation modeling from both business and government organizations. We are ready to respond to these challenges in cooperation with our international colleagues. The chapter plans to carry out co-programs on simulation modeling and system dynamics, seminars and workshops, master degree programs, write monographs, and participate in some activities within the recently established National Simulation Modeling Society. Joint educational projects at the leading Russian universities and business schools, such as State University of Management, Moscow State University, Skolkovo projects, as well as international projects, are also planned. We welcome the members of System Dynamics Society to strengthen cooperation with the Russian Chapter and are ready to provide our support.

Stephen Alessi

steve-alessi@uiowa.edu

University of Iowa

Birgit Kopainsky

birgit.kopainsky@flury-giuliani.ch

University of Bergen

Session Summary: Simulation and Gaming

This session explores state-of-the-art applications of system dynamics for simulations and games in teaching and learning. The papers describe theoretical foundations of the design and use of simulators and instructional games, discuss methodological developments, and present empirical evidence regarding their application in several fields.

Pamela Shelley

pshelley@wpi.edu

Worcester Polytechnic Institute

Linda Morecroft

lem@alum.mit.edu

Spouses' Lounge

A spouses' lounge will be available during the entirety of the conference. This gives new spouses a chance to meet others and returning spouses the opportunity to reconnect. The lounge will be an easy meeting spot for some informal touring, a site for relaxation after a busy day of helping with the conference, and a place to make friends. An initial meeting will be held on Monday morning well in advance of the Monday St. Gallen City Tour. Approximate time will be between 9:00 to 10:00 a.m. Light refreshments will be provided by Worcester Polytechnic Institute for the kickoff on Monday morning. Please join us on Monday!

Onur Özgün

onur.ozgun@boun.edu.tr

Bogaziçi University

Student Chapter Annual Meeting

All students are welcome to join the meeting (whether they are members of the chapter or not). During this meeting, last year's leadership group members will present last year's activities. We will also exchange ideas, discuss new ways of collaboration and determine new year's leadership group. Please join the meeting if you are interested in being involved in chapter activities or just curious about the chapter.

Justus Gallati

justus.gallati@fhsg.ch

Univ of Applied Science St Gallen

Lukas Schmid

lukas.schmid@fhsg.ch

FHS St Gallen

Swiss Chapter Annual Meeting

The activities of the Swiss Chapter of the International System Dynamics Society are currently focused on the regular chapter meetings. Exchange opportunities are combined with special presentations of individual researchers and practitioners. A special interest is devoted to combinations with other modelling paradigms and/or other software packages to address complex problems. The PhD colloquium which is a unique opportunity in Switzerland for many PhD students using system dynamics in their research to share their work with other students and with peers will be continued. New initiatives are related to system dynamics in education. An intensified exchange in system dynamics with regard to education is expected to become a focal point in the activities of the Swiss chapter. To support this initiative our website has been made more interactive (www.systemdynamics-swisschapter.ch). However, it turned out that due to the small number of participants in Switzerland these interactive features are not used very frequently. As a consequence we think about linking more with other exchange platforms. Hosting the international conference in 2012 in Switzerland is a special event for our chapter and we are looking forward to many opportunities for fruitful exchange. Justus Gallati, Lukas Schmid (co-presidents of the Swiss chapter).

Stefano Armenia

stefano.armenia@uniroma2.it

CATTID Sapienza University of Rome

System Dynamics Italian Chapter (SYDIC) Annual Meeting

SYDIC started a new path since the Nijmegen ISDC, also thanks to innovative tools now available to members. A new website, newsletter, forum, all have contributed to spread knowledge over the net about SD, achieving the goal of raising new members. Practitioners, professionals and academics can now find a way to discuss about common interests and research. The Chapter activities during the year will be discussed and future steps to manage the chapter will be planned. For the period July 2011 - June 2012 the SYDIC (SYstem Dynamics Italian Chapter) 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 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.

David N. Ford

davidford@tamu.edu
Texas A&M University

System Dynamics Society Business Meeting

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

David N. Ford

davidford@tamu.edu
Texas A&M University

The use of the Society's capacity development funding: the Brazilian Chapter experience

Martin F. G. Schaffernicht

martin@utalca.cl
Universidad de Talca

The members of this panel will overview the Society's policy that provides financial support for capacity development for its Chapters and discuss the first experience tapping on this resource. On November 14-15, 2011, the Brazilian Chapter promoted a two-day workshop on advanced techniques in System Dynamics, using Jay Forrester's (1968) Market Growth Model as a platform for applied learning. Paulo Gonçalves, Associate Professor at the University of Lugano, Switzerland, served as the instructor. The participants had previous SD expertise and all regarded the workshop as valuable. Entry and exit questionnaires were collected and a workshop evaluation will be reported. The members of the panel will include Society Officers, the workshop instructor and organizers, and one or more of the workshop participants. We welcome a broad discussion on how this resource can be put to use most effectively to support regional chapters, particularly those outside of the main hubs of SD education and practice.

Paulo Gonçalves

paulo.goncalves@usi.ch
University of Lugano

Ricardo Matos Chaim

rmchaim@yahoo.com.br
University of Brasilia

Aldo Zagonel

zagonel@aol.com
Attune Group Inc

Ignacio J. Martínez-Moyano

imartinez@anl.gov
University of Chicago

Tools for System Dynamics Roundtable

System Dynamics modelers use different tools to develop their work. In many cases, modelers use tools beyond what the core SD software packages provide in order to run their models in different platforms (Web, iOS, Android, Java), to integrate modules built separately, to analyze and gain insight into their models, to create easy-to-navigate documentation, etc. Several projects have focused on open-source approaches to developing tools for SD. This roundtable will focus on 1) discovering the needs of SD modelers/practitioners that are not currently met, 2) listing the current tools (bring your favorites!), 3) discussing how the community might move forward to closing the identified gaps.

Travis Franck

tfranck@alum.mit.edu
Climate Interactive

Robert Muetzelfeldt

r.muetzelfeldt@ed.ac.uk
Simulistics Ltd

Mark J. Bragen

bragen@anl.gov
Argonne National Laboratory

Chapter & SIG Poster Presentations

Listed alphabetically by Chapter or Special Interest Group name

Anson Kin Tat Li

akt.li@auckland.ac.nz

University of Auckland

Australasia Chapter

A collage of Australasian system dynamics work submitted by practitioners, educators and students from the South Pacific. The ever-growing base of members of the Australasian Chapter has been pursuing our existing and new realms of research and activities in 2011-2012. 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, the systemic anti-tobacco campaign in New Zealand is moving on full steam ahead, 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 highschool levels, gaining momentum for the promotion of systems perspectives in education for all. We're looking forward to seeing you all at St Gallens.

Erik Pruyt

e.pruyt@tudelft.nl

Delft University of Technology

Benelux Chapter

The Benelux Chapter of the System Dynamics provides a platform for information exchange and cooperation for anyone interested in System Dynamics with a clear link to Belgium, the Netherlands, or Luxembourg. The Benelux Chapter Poster Session gives information regarding the chapter and how to join, and provides an overview of recent System Dynamics activities in the Benelux. So talk to some current members at the poster, join, and attend the third 2012 meeting (see chapter meeting) dedicated to information exchange between (potential) members regarding (i) work in progress, new projects, and future opportunities, (ii) great ideas, excellent plans, exciting activities, and brilliant strategies for the chapter, (iii) recent and future developments and possible cooperation in our educational programs. The chapter meeting at the conference also offers new (current) members the opportunity to get to know current (new) members present at the international SD conference.

Jim L. Rogers

rogers.james@amgresults.com

Advance Management Group LLC

Edward J. Gallaher

ejgallaher@frontier.com

Applied System Dynamics

Geoff McDonnell

gmcdonne@bigpond.net.au

UNSW

Biomedical Special Interest Group

The Biomedical System Dynamics Special Interest Group, formed in February 2012 aspires to facilitate collaboration among modelers and practitioners from all areas of medical practice, education, and research. These collaborations will be aimed at developing dynamic insight into the basic biomedical sciences: physiology, biophysics, pharmacology, biochemistry, and others. We have three long-term goals: 1. Develop a core set of models and teaching materials to serve as a foundation for the study of biological dynamics. 2. Incorporate ST/SD into

Özge Karanfil

karanfil@mit.edu
MIT

Warren W. Farr

warren3@me.com
Refrigeration Sales Corporation

everyday practice within laboratory and clinical research environments. 3. Translate new insights into practical and effective clinical protocols. We have identified the following areas of potential interest: immunodynamics, cancers/autoimmune disorders, drug delivery systems, pain management, individual psychiatric interventions, addiction physiology, sleep disorders, stress response, weight dynamics, chronic disease progression, alternative and complimentary medicines (CAMs), receptor dynamics, body fluid electrolytes, developing clinical applications, teaching pharmacokinetics using ST/SD, integrating BMSD in Continuing Medical Education, adverse drug events, antimicrobial resistance, and food borne pathogens. Our initial vehicle for communication is a linked in group named "Biomedical System Dynamics Special Interest Group". If you are interested in joining the group, please contact Ozge Karanfil at karanfil@MIT.EDU. Please direct other questions to Jim Rogers at Rogers.James@amgresults.com.

Isaías Custódio

icustodio@usp.br
Universidade de São Paulo

Ricardo Matos Chaim

rmchaim@yahoo.com.br
University of Brasilia

Aldo Zagonel

aldo@attunegroup.com
Attune Group Inc

Brazil Chapter

The representatives of the Chapter will present a poster containing information similar to the annual report submitted to the Society: membership, past activities (2011-2012), and future plans (2012-2013). Past activities include the 2nd regional conference and an advanced-techniques workshop, both held in November of 2011. Future plans include efforts to consolidate and expand the group of Brazilians interested in System Dynamics, identify and promote works in Portuguese and/or works dealing with Brazilian issues. Near term future activities include participation in the X CLDS in Buenos Aires in November of 2012, as well as the organization and promotion of a smaller, high-quality event in Sao Paulo in the first semester of 2013. Other ongoing efforts include refinements and elaboration of our webpage, survey of bibliographical references and courses in System Dynamics in Brazil or in Portuguese, establishing institutional partnerships, and pursuing potential sponsors.

Haiyan Yan

yanhelen@163.com
Shanghai Institute of Foreign Trade

China Chapter

China Chapter celebrated system dynamics 30 year's in China and Development Institute of Tongji University 10 year's anniversary. About 200 participants gathered on Dec 17th, 2011. A chronology of the events in the 30 years was prepared to retrospect the history of system dynamics development in China since Prof. Wang Qifan engaging in System Dynamics at MIT in 1981. Dr. Qian Ying summarized the cooperative master program of SD in Norway which has been initiated since 1996 by Professor Wang and Professor Davidsen. Associate Prof. Zhang Xiandong concluded that the successful accomplishment of two programs (MIT-China Management Education and Erasmus-China Ph.D Cooperation) has made a positive influence on Chinese universities into internationalization. Professor Xu Bo, the chairman of System Dynamics Professional Committee attended the fourth session of the eighth council meeting of Systems Engineering Society of China, held in Beijing in Feb, 2012. The 1st summer school on System Dynamics will be offered by Shanghai Institute of Foreign Trade in July 2012. It plans to host 30 participants from different universities around China. The purpose of this summer school is to provide an academic exchange platform for System Dynamics related students and popularize the application of System Dynamics in China.

Ignacio J. Martínez-Moyano

imartinez@anl.gov
University of Chicago

Edward G. Anderson

edward.anderson@mcombs.utexas.edu
University of Texas

Conflict, Defense, and Security Special Interest Group

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

Robert Y. Cavana

bob.cavana@vuw.ac.nz
Victoria University of Wellington

Economics Chapter

The Economics Chapter aims to make SD related contributions to economics in research, professional practice and education. It is a geographically dispersed chapter. Members use a discussion list to keep in contact. The main meeting point is the international conference with the "economic dynamics" thread and the yearly meeting. Applications have tended to be in the areas of money, banking and finance on the one hand and in economic development on the other. Other members have made theoretical contributions based upon the particular methodological viewpoint of SD. Still other members develop contributions to education in economics, micro-economics and other economic areas. Geographic dispersion brings with itself the challenge to sustain dialog and collaboration. Since the 2010 annual meeting at Seoul, the idea to develop a special issue in Economics for the SDR has gained further support, with Bob Cavana, Mike Radzicki and David Wheat agreeing to be the co-editors. This idea has now progressed into a decision being made to co-edit a book on 'Feedback Economics' which will include invited papers, 'classical' works and papers generated by an international 'call for papers'. We are looking forward to advancing the planning and preparation for this edited collection at the current conference.

Michael S. Kennedy

michael.kennedy@beds.ac.uk
University of Bedfordshire

Carol Frances

carolfrances100@hotmail.com
Claremont Graduate University

Richard Langheim

richlangheim@gmail.com
Ramapo College of New Jersey

P. Jeffrey Potash

jpotash@ciesd.org
CIESD

Education Special Interest Group

The Education SIG continues to pursue its twin interests in 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. This Poster describes our activities. Please come to the E-SIG sessions 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.

Stian Blackstad Hackett

stian.hackett@geog.uib.no
University of Bergen

Energy Special Interest Group

The Energy SIG poster will include a short overview of SIG member publications and applications of system dynamics within the energy field in the last year.

Asmeret Bier

asmeret.bier@gmail.com
Sandia National Laboratories

Leonard A. Malczynski

lamalcz@sandia.gov
Sandia National Laboratories

Environmental Special Interest Group

The Environmental Special Interest Group is interested in systems involving 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. Members will be available during the poster session to discuss the SIG, environmental issues, and any other topics of interest.

Florian Kapmeier

florian.kapmeier@hs-heilbronn.de
Heilbronn University

German Chapter

The German Chapter advances networking and collaboration among system dynamicists in Germany. The Chapter has 115 members per end of April 2012 (of which 6 are corporate members and 5 are student members) and keeps more than 300 interested researchers, managers, and students updated through its e-mail newsletter. System Dynamics colloquia and roundtables are regularly organized in Frankfurt/Main. These events provide a basis for meeting fellow system dynamicists and for discussing modeling projects. On June 21-22, 2012, the Chapter's 6th Annual Meeting is held in Frankfurt/Main. 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. More information on the activities of the German Chapter is available from our website at <http://www.systemdynamics.de> (in German).

Erik Pruyt

e.pruyt@tudelft.nl
Delft University of Technology

Health Policy Special Interest Group

The Health Policy Special Interest Group formed more than nine years ago and has grown to around 300 members (of whom about 120 Society members). We are a worldwide SIG with active collaborations that use dynamic analyses to advance major health policy initiatives. Regardless of whether you are new to the field or a veteran modeler, we welcome your participation in exchanging ideas about how SD can better engage and support health policy leaders around the world. HPSIG poster session will provide more information about the SIG and how to join it.

Karan Khosla

karankhosla@gmail.com
EarthSafe Products and Services

India Chapter

The SDS India Chapter, now its second year, is coming up with innovative ways of spreading System Dynamics into diverse fields of consulting, policy making and academia - The St. Gallen conference would be a perfect time to share ideas and think of collaborative projects.

Dong-Hwan Kim

sddhkim@cau.ac.kr
Chung Ang University

Korea Chapter

This poster is to introduce activities of Korean Chapter of system dynamics last year. We hold six monthly meetings and two conferences (winter and summer conference) per year. We published four academic journal per year and books. Also we have an education program for ten days at February in Seoul. In this poster, we hope that we can explain our activities and future plan in detail.

Gloria Pérez Salazar

gloria.perez@itesm.mx
Tecnológico de Monterrey

Latin America Chapter

The Latin-American Chapter, a positive feedback loop, has the mission to help the SD-community grow in the Spanish speaking countries. Founded in 2003, it has Latin-American members from Mexico to Chile, as well from Spain and a growing number of Spanish speakers living in other countries. Since 2003, the annual meeting allows practitioners to gather and newcomers to get in to touch; we have been in Mexico, Chile, Colombia, Argentina and Brasil so far. These conferences are the base of our positive feedback loop: each year the number of works submitted and presented is increased. Since 2005, the Spanish Revista de Dinámica de Sistemas (<http://dinamica-sistemas.mty.itesm.mx>) publishes two numbers per year. The sisTEMAS newsletter and a mail list allow keeping in touch. During 16-18 November, the 9th Latinamerican Conference took place in Brasilia, Brasil, organized by Universidad de Brasilia (<http://www.sdsbrazil.org/congreso.htm>) and the next conference will take place in Buenos Aires, Argentina, November 21 through 23, 2013. If you like to join us please contact Gloria Pérez (gloria.perez@itesm.mx).

David W. Lounsbury

david.lounsbury@einstein.yu.edu
Einstein College of Medicine Yeshiva

Psychology Special Interest Group

The Psychology SIG is a venue for discourse and learning about ways of integrating psychological processes into system dynamics models and to apply system dynamics methodology to the formation of psychological theories. Psychology SIG members seek to promote the following interests and aims: (1) To build psychological and social constructs and processes into more classical system dynamics models, including community-level models, where such constructs and processes would help in understanding the underlying dynamic problem of interest; (2) To develop new molecules or mini-models of psychological processes to promote deeper understanding of existing psychosocial and behavioral theories and to generate new psychological and behavioral theories of psychosocial and behavioral dynamics; (3) To apply system dynamics to a wide range of clinical, public health and community problems to improve therapies and interventions for individuals, couples, families, groups, and communities. The Psychology SIG welcomes the participation of Society Members from diverse disciplines in the social and behavioral sciences, the helping professions (e.g., medicine, nursing, and social work), as well as the basic sciences.

Ralph L. Levine

leviner@msu.edu
Michigan State University

Natalia N. Lychkina

lychkina@guu.ru
State University of Management

Russian Chapter

The Russian Chapter of the System Dynamics Society was created five years ago. The main objectives of the Chapter are the propagation of system dynamics in Russian-speaking educational and expert communities, providing information in

Russian and English, sharing experience between members of the Chapter, making contacts with business and research institutions, and the support of System Dynamics Society activity in Russia. The members of Russian Chapter annually take part in major Russian and international conferences, devoted application of simulation modeling of social and economic systems. They are “Simulation Modeling: Theory and Practice-IMMOD” in St. Petersburg, “Theory and Practice of System Dynamics” in Apatity, “Government in the XXI Century”, “Modernization of the economy and society” (Section “The Usage of systematic approach in strategic planning: Russian and foreign experience”) in Moscow. Several universities introduced educational programs developed and organized by The Russian Chapter of the System Dynamics Society members, such as Lomonosov Moscow State University, State University of Management, National Research University Higher School of Economics. Among other achievements of the Russian Chapter are the books written by the members of the Society: N. Lychkina “Simulation modeling of economic processes” and D. Katalevsky’s book “Fundamentals of management simulation modeling and system analysis”. Please visit the Chapter’s website www.sysdynamics.ru.

Onur Özgün

onur.ozgun@boun.edu.tr
Bogaziçi University

Student Chapter

Student Chapter aims to encourage networking and collaboration among system dynamics students around the world. The major activity of the chapter is the PhD Colloquium that is held one day before the System Dynamics Conference. The colloquium is a unique opportunity for students to receive feedback from the top experts of the field and to share ideas. Besides the colloquium, we try to keep a live interaction among students by means of our website, newsletter, email group and social media. We would like to invite all students to keep in touch and get involved!

Justus Gallati

justus.gallati@fhsg.ch
Univ of Applied Science St Gallen

Lukas Schmid

lukas.schmid@fhsg.ch
FHS St Gallen

Swiss Chapter

System dynamics in Switzerland is applied to various topics ranging from energy, economy, agriculture, health, to industrial processes. With regard to energy the focus is on providing decision support for a transition towards a more sustainable energy system. Applications in economy focus on various areas such as agriculture, management systems, and the analysis of influence factors for a sustainable success of an enterprise. Applications in health include the analysis of the health care system as well as of specific diseases and disease control measures in hospitals. Here, as well as in other applications, a combination with other modelling paradigms (in particular with agent-based modelling), has been undertaken. Applications in industrial processes focus on optimisations of the production. The combination of system dynamics with other (modelling) approaches and in particular with the involvement of a wider (virtual) community is of specific interest of many researchers and practitioners in the Swiss chapter. Teaching initiatives include a number of Universities and Universities of Applied Sciences in Switzerland.

Stefano Armenia

stefano.armenia@uniroma2.it
CATTID Sapienza University of Rome

SYstem Dynamics Italian Chapter (SYDIC)

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

way to discuss about common interests and research. The Chapter activities during the year will be discussed and future steps to manage the chapter will be planned. For the period July 2011 - June 2012 the SYDIC (SYstem Dynamics Italian Chapter) Policy Council will present the main activities of SYDIC members both in the Academic (Universities & Reseach centers) and in the Consulting (Private & Public Administration) areas as well as will help planning next year events/workshops and in general Chapter activities. The annual report of the Chapter members is presented by a 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.

Douglas McKelvie

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

John Swanson

john.swanson@sdgworld.net
Steer Davies Gleave Ltd

UK Chapter

2012: The UK Chapter has regular meetings in the UK, and annually at the international conference. In February we held the 2012 Annual Gathering, with a theme of 'Exploring Alternative Futures'. The event consisted of key-note speakers (Richard Stevenson, Emanuele Campiglio and Maurice Glucksman), a hands-on workshop using a simulation (led by Bob Thurlby and Kim Warren), an update on the latest software developments and the PhD poster session. Congratulations to the Symmetric Partnership who won the Steer-Davis Gleave prize for the best UK application of system dynamics. Our thrice-yearly evening networking events have continued. If you are based in the UK and not already on our membership list (membership is free) then please do join on our website and see what we have to offer. There are between 80 and 100 members active in SD in the UK and we have more than 400 people on our mailing list.

Workshops

Listed alphabetically by Workshop name

Aldo Zagonel

aldo@attunegroup.com
Attune Group Inc

Mohammad T. Mojtahedzadeh

mohammad.mojtahedzadeh@boeing.com
The Boeing Company

Ricardo Matos Chaim

rmchaim@yahoo.com.br
University of Brasilia

Lorena Cadavid

llorenach@gmail.com
Universidad Nacional de Colombia

A hands-on, case-study demonstration of the modeling process, from problem definition to policy implications

This workshop will introduce sensitivity simulation, calibration to data, and model testing, in the context of developing and using a formal theory for the “societal life cycle of cigarette smoking.” We will go through the process of model development and use, building and testing a small feedback-rich model, to explore its modes of behavior and adequacy in explaining and addressing a dynamic problem. Active participation in this workshop will help with the following learning objectives: the elements to defining a dynamic problem, including reference modes of behavior; formulation and simulation of a feedback-rich model using Vensim® PLE, including using Synthesim and user-defined graphs; approaches to testing and evaluation, for the purpose of a) model refinement and b) confidence building in insights and recommendations; to conduct sensitivity simulations, with emphasis on distinguishing different patterns of behavior versus realizations; to conduct model calibration using empirical data

(time permitting, computing and interpreting statistical measures of “goodness of fit”); how to relate model behavior to the structure of the system and to explain endogenously the patterns of behavior produced by the model; to extend model-based learning to policy insights and implications.

Requirements : Participants should bring: Laptop or be prepared to pair up with someone who has one. Preinstall Vensim PLE (or DSS): <http://www.vensim.com/venple.html>. Advanced Reading: We will upload a syllabus with reading and supporting materials (optional). Level: Everyone.

Kaoru Yamaguchi

kaoru3@muratopia.org
Doshisha University

An Introduction to Macroeconomic Modeling - Accounting System Dynamics Approach

Macroeconomics is one of the core subjects in social science and behaviors of macroeconomy such as the recent financial and debt crises affect all of us. With the help of system dynamics method, this workshop tries to explore the macroeconomic system structure and its complex behaviors by introducing a step-by-step construction of macroeconomic models based on the accounting system dynamics approach. Specifically, participants will learn the following modeling methods: double-entry booking/accounting system dynamics (which is itself helpful for business modeling), money supply by the central bank and creation of credit process through a fractional reserve banking system, Keynesian macroeconomic models, including IS-LM model and an integrated macroeconomic model of real and monetary sectors. All models are distributed in the class, which run on Vensim Model Reader, a free shareware for PC and Mac. Participants are recommended to download it and bring their laptops. Yet no knowledge of Vensim Software is required, not to mention economics. Running the models step-by- step, participants are invited to the world of macroeconomic system, and explore a complex structure of macroeconomic behaviors, through simulation, with their own working hypotheses of macroeconomic scenarios.

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

Thomas Fiddaman

tom@vensim.com
Ventana Systems

Building and Analyzing Models with Vensim

This hands-on workshop will introduce the basics of building and analyzing a feedback model using Vensim. The class will center around a variation of Dennis Meadows' commodity model, or another similar classic. Participants will reconstruct portions of the model in order to master the mechanics of building simple stock-flow structures and exploring positive and negative feedback behavior. We will create a simple control panel for the model. Then we will use those tools to work through a critique of the model, making on-the-fly changes to the structure and parameters, and exploring the implications of decision rules. Participants will walk away with a basic understanding of the process of building a model with Vensim, using it to gain policy insight, and assessing model quality.

Requirements : Participants should bring: Laptop with a copy of Vensim installed - free Vensim PLE is fine (download from <http://www.vensim.com/freedownload.html>). Arrive 15 minutes early if you want to install a trial copy of Vensim DSS from one of our USB keys. Advanced Reading: None . Level: Everyone.

Thomas Fiddaman

tom@vensim.com

Ventana Systems

Calibration and Optimization in Vensim

This workshop will introduce the process of optimizing dynamic feedback models using Vensim. We will look at two uses for optimization: calibration and identification of good policies. We will work with a simple market model to estimate parameters consistent with data, and then develop a marketing policy that works well in the calibrated market. The workshop will focus primarily on practical aspects of optimization, but will introduce enough theory to give participants insight into the fundamentals of the process.

Requirements : Participants should bring: Laptop with a copy of Vensim Pro or DSS installed. Arrive 15 minutes early if you want to install a trial copy of Vensim DSS from one of our USB keys. Advanced Reading: None . Level: Intermediate.

Michael Bean

mbean@forio.com

Forio Online Simulations

William Schoenberg

wasbridge@gmail.com

Forio Online Simulations

Creating and Publishing Online Simulations

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

Requirements : Participants should bring: Laptop would be helpful but is not strictly required. Advanced Reading: None. Level: Everyone.

Joanne C. Egner

jegner@iseesystems.com

isee systems

Jeremy Merritt

jmerritt@iseesystems.com

isee systems

Creating Simulations for the Web with STELLA and iThink

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

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

Alena Beloshapko

alena@xjtek.com
XJ Technologies

Andrei Borshchev

andrei@xjtek.com
XJ Technologies

Vladimir Koltchanov

vladimir.koltchanov@emsyss.fr
EMSYSS

Getting Started With AnyLogic and Multimethod Simulation Modeling Workshop

At this workshop we will introduce you to AnLogic - 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 new features of AnyLogic 6.7 such exporting optimization and calibration experiments as standalone applications and how to integrate AnyLogic models with external Java applications. Attendees will be given a CD with a trial version of AnyLogic 6.7 for Windows, Mac and Linux. You can bring your laptop and follow the presenter, or just watch.

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

Leonard A. Malczynski

lamalcz@sandia.gov
Sandia National Laboratories

Getting Started with Powersim Studio

Powersim Studio can improve your business strategies with dynamic simulation to build graphical models using System Dynamics; run what-if scenarios, optimize or do risk analysis; seamlessly integrate to MS Excel, SAP etc.; and integrate your models in existing applications. This 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.

Requirements : Participants should bring: Laptop with Windows operating system. Advanced Reading: If you do not own the software please download the free 30 day version of Powersim Studio Demo at http://www.powersim.com/main/products___services/download/demo/ or the time unlimited Powersim Studio Express at <http://powersim.com/main/about/news/new-product-edition-studio-9-express/>. Level: Everyone.

Joanne C. Egner

jegner@iseesystems.com
isee systems

Karim J. Chichakly

kchichakly@iseesystems.com
isee systems

Getting Started with STELLA and iThink

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

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

Kim D. Warren

kwarren@london.edu
London Business School

Helping non-SD professionals and students gain the benefits of system dynamics, easily and quickly.

System dynamics has long struggled to be adopted by non-specialists, so modelling is rarely attempted by people without extensive SD training, even though they would gain considerable value from doing so. To show more people the benefits of SD, we need approaches and tools that connect with what they do, and make it easy for them to get started - both with the thought-process and basic model-building. This workshop will take participants through a process for achieving this. Starting with information on a real-world case, we will practice a mapping and modelling process that shows the logical relationships in the system, the insights that users can gain from that picture, and simple model-building they can do. The process will show how simulation must (and can) be set alongside real-world information on the actual history and forecast future behaviour of situations - exactly the type of problem that non-SD-specialists want to understand and manage better. It will also show how easily this can be taught, both to students and working professionals, and outline facilities available to help instructors achieve this.

Requirements : Participants should bring: Participants will benefit from sharing access (2-3 person groups) to a laptop with internet access. Advanced Reading: None Level: Everyone.

Diana Fisher

diana.fisher2@frontier.com
Portland State University

Introducing Change over Time Lessons for Math and Science Pre-College Classes

Central to understanding dynamic phenomenon is understanding change over time patterns. In school, these patterns are formally introduced using symbolic representations which are often not intuitive to students. Activities that introduce some of the simple behavior patterns in a more intuitive manner will be introduced, followed by the stock/flow modeling structure that will capture the important components that produce the given pattern of change. Then these structures can be used together to study more realistic (but still simple) systemic problems appropriate for undergraduate students. Participants should expect to participate in the activities and follow up by building the models. Please bring a laptop.

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

John M. Richardson

jrich@american.edu
Lee Kuan Yew School of Public Policy

Learning by Doing - A Path to Creating Original System Dynamics Modeling Projects

Rehan Ali

rehancanbefound@gmail.com
National University of Singapore

In this workshop, we will demonstrate teaching system dynamics modeling using a method that Prof. Richardson has developed, in which students are taken through a progression consisting of the following modelling projects: • Introduction – Kaibab Plateau • Intermediate – Replication • Advanced – Original The core of this methodology is the belief that the best way to learn modeling is by practicing it from the first day of class, with a gradual progression in content and difficulty. This process of learning-by- doing guides students, in the course of one semester, through three cases of increasing complexity, with students taking

increasing responsibility for understanding, defining, and modeling a problem. Each step is chosen because it supplements the learning done in the previous step. For example, in the Kaibab Plateau exercise, each sector builds upon the previous one by adding new variables or functions. The replication modeling exercise introduces students to “real world” models produced by system dynamics practitioners and encourages students to understand, duplicate, and then extend the models. This exercise is then expanded in the original modeling project into students developing their own models based on problems they wish to investigate, which can then be used for thesis or dissertation work.

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

John D. W. Morecroft

jmorecroft@london.edu
London Business School

Metaphorical Models for Managing the Transition from Industrial Growth to Sustainability

Overshoot in processes of growth is common. "To overshoot means to go beyond limits inadvertently, without meaning to do so" (from *Beyond the Limits* 1992). In this workshop we use small metaphorical models and simulators to examine overshoot in global industrial growth and the process of managing the global transition to a sustainable society. We revisit the scenario conditions in World Dynamics required for sustainability. Using a small model of a regulated fishery we examine the role of regulation in creating a sustainable future.

Requirements : Participants should bring: Laptop and memory stick. Advanced Reading: *Metaphorical Models for Limits to Growth and Industrialisation*. This paper (forthcoming in “Systems Research and Behavioral Science”) provides a background for the workshop and a discussion about the purpose and use of metaphorical models. There is also an excerpt from Chapter 9 of “Strategic Modelling and Business Dynamics” that provides formulations for a model of a harvested fishery with endogenous investment. Level: Everyone.

Diana Fisher

diana.fisher2@frontier.com
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 demonstrated and can also be viewed at www.ccmamodelingsystems.com. New materials in the third edition (oscillations, transfer of loop dominance, mapping systems in the news,...) of this book will be presented.

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

Kim D. Warren

kwarren@london.edu
London Business School

Christina Spencer

christina@strategydynamics.com
Strategy Dynamics Ltd

NEW : Sysdea online modeling for educators, students, practitioners and non-SD professionals (replacing MyStrategy)

This session will demonstrate the new Sysdea online application for system dynamics modelling. Designed to make the method easy and accessible for people with no previous exposure to SD, Sysdea is a web-based application, needing no software installation, so is platform-independent. Models can be instantly shared with anyone, even if they have no account, making the application ideal for use in teaching and model-discussion in organisations.

Requirements : Participants should bring: Participants wishing to try the application will need a laptop with internet access, though this is not essential. Advanced Reading: None. Level: Everyone.

Ignacio J. Martínez-Moyano

imartinez@anl.gov
University of Chicago

Mark Jusko

jusko@anl.gov
Argonne National Laboratory

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

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

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

Index

Authors, Presenters and Facilitators

A		Berkowicz, Simon95	Compston, Paul29, 98
Aamir, Munaf S.20	Bier, Asmeret27, 117, 127	Conrad, Stephen H.67	Conti, Giuseppe.....95
Abramova, Nina.....59	Bishwas, Sumant Kumar27	Corcoran, Stan.....33	Coumou, Jeroen.....82
Achjar, Nuzul50	Bisilkas, Marios.....28	Cox, Andrew67	Crippen, Kent94
Adamides, Emmanuel D.79	Bithas, Kostas.....68	Cronrath, Eva-Maria.....17	Custódio, Isaías115, 125
Adom-Mensah, Yaw.....20	Bizik, Gustav.....28		
Ahmad, Salman18	Blanc, Mariano81	D	
Akinyemi, Olasunkanmi Oriola18	Blanchard, Guilhem.....111	Darton, Richard C.17	Das, Dillip Kumar34
Akkermans, Henk A.21, 81	Blaskovich, Frank.....29	Dastig, Martin R.....17	Dastkhan, Hossein.....78
Alessi, Stephen21, 121	Bleijenbergh, Inge L.....107	Daidsen, Pål I.84, 90	de Amicis, Raffaele.....95
Alexiev, Victor21	Blocker, Jill52	De Angelis, Angelo24	de Carvalho, Elias Cesar Araujo107
Ali, Rehan.....134	Boksberger, Benjamin106	de Gooyert, Vincent17, 34	de Groen, André.....34
Almaguer Navarro, Pedro Dagoberto22	Borshchev, Andrei.....133	De la Barrera-Gomez, Helue I.....30	De Marco, Alberto35
Almaguer Navarro, Ramiro Luis22	Bosslau, Mario17	Dearing, James W.52	Degen, Christina.....42
Almaguer Navarro, Ruth Raquel22	Boumeester, Harry.....34	Dianati, Kaveh.....35	Dilek, Hakan105
Almaguer Prado, Pedro Dagoberto22	Bouza, Manuel.....106	Doganca, Zerrin.....36	Dolgopolova, Irina64
Altamirano, Mónica A.22	Bragen, Mark J.123	Domenge Munoz, Rogerio36	Doolan, Matthew38, 42
Anderson, Edward G.116, 126	Browne, Chris.....29, 120	Dubois, Daniel M.51	DuCharme, Michel B.63
Androutsopoulou, Aggeliki23	Buendia, Fernando.....29, 30	Duggan, Jim36, 119	Durán Encalada, Jorge A.....37
Ansah, John P.23, 104	Bueno, Newton Paulo.....82	Dyck, Roland45	Dyner, Isaac31, 79, 80, 117
Arenas, Fernando A.24	Busco, Cristiano26		
Armenia, Stefano.....24, 122, 129	Buxmann, Peter54	E	
Arsenijevic, Jelena.....18		Easterling, Douglas52	Eberlein, Robert L.
Arthanari, Tiru S.....65, 106	C	23, 37, 63, 104, 117, 120
Arthur, William B.....33	Cadavid, Lorena30, 130	Egan, Kathleen52	Egner, Joanne C.114, 132, 133
Arto, Klaus64	Cagliano, Anna Corinna35	Eker, Sibel.....38	El Halabi, Ezzat.....38
Atzori, Alberto Stanislao25	Cameron, Donald.....93	Elhanani, Doron95	Elias, Arun Abraham.....38
Auping, Willem25	Campos-López, Enrique30	Elmasry, Shady S.39	Enos, James39
Awad, Gabriel.....30	Cannas, Antonello25	Ercil, Yavuz105	
Axmann, Joachim57	Cardenas Martinez, Arturo114		
	Cardenas, Laura Milena.....31		
	Cardew-Hall, Michael38		
	Carena, Augusto31		
	Carroll, Kristoffer94		
	Carson, Kenneth51		
	Cassuce, Francisco CC.82		
	Cavana, Robert Y.93, 116, 126		
	Centola, Damon.....31		
	Centra, Andrea.....24		
	Cesarotti, Vittorio24		
	Chaim, Ricardo Matos.....		
31, 115, 123, 125, 130		
	Chan, Angelique.....23		
	Charalabidis, Yannis.....23		
	Chaudhuri, Saikat32		
	Chen, Shengxin109		
	Chen, Shyu-Huei52		
	Chichakly, Karim J.....133		
	Choi, Jeong Hwan32		
	Choi, Nam Hee63		
	Choucri, Nazli93		
	Chuang, Howard Hao-Chun33		
	Colvin, Meagan33		

Index

- Eren, Aysen 40
Escalante, Nicolas 40, 120
Eskinasi, Martijn 41
Eslamifar, Gholamreza 41
- F**
- Faghihi, Vahid 57
Farr, Warren W. 41, 115, 124
Featherston, Charles R. 42
Fernández Soto, Pedro 97
Fernández-Lechón, Ramon 97
Fiddaman, Thomas 131, 132
Fischer, Helen 42
Fisher, Diana 134, 135
Fisher, Elliott S. 50
Ford, Andrew 42, 120
Ford, David N. 25, 57, 123
Frances, Carol 117, 126
Franck, Travis 123
Franco, Carlos Jaime 31
- G**
- Gallaher, Edward J. 115, 124
Gallati, Justus 92, 122, 129
Garcia-Gallego, Aurora 28
Gaynor, Alan K. 43
Georgantzas, Nicholas C. 43
Gerigk, Jörg 54
Ghaffarzadegan, Navid 44
Gijsbers, Govert 66
Gloeser, Simon 18, 60
Gokmen, Yunus 105
Goldsmith, Daniel 93
Golnam, Arash 43
Gomez Diaz, Mauricio 44
Gonçalves, Paulo 123
Gotsch, Matthias 64
Götz, Alessandra 49
Graham, Alan K. 33
Gramlich, Dieter 44
Granath, Christer 101
Grassmann, Winfried K. 45
Groot, Wim 18
Grösser, Stefan 45, 67, 91, 93
Größler, Andreas 45, 111
- H**
- Ha, Won-Gyu 63
Haag, Hans-Christian 46
Hackett, Stian Blackstad 46, 117, 126
Hadgu, Teklu 66
Hadjis, Andreas 46
Haghani, Ali 80
Hamarat, Caner 47, 83
Hamza, Kanar 47
Handel, Oliver 47
Happach, Roland Maximilian 35, 48
Harbig, Andreas J. 70
- Hart, Diane 80
Hayward, John 48
Hebbar, Sunith 88
Hell, Marko 49
Hernández-Corichi, Avelino 30
Heslop, Benjamin 49
Hessami, Amir R. 57
Heyder, Monika 49
Hidayatno, Akhmad 50
Hilty, Lorenz 56
Hirsch, Gary B. 50, 51
Ho, Yu-Feng 51
Hoffer, Erin 17
Holmberg, Stig C. 51
Homer, Jack B. 50, 118, 119
Hosseini Azabadi, Jamal 90
Hovmand, Peter S. 33, 51, 52, 60
Hu, Bo 64
Huegel, Katrin 92
Hughes, Christopher Ryan 52
- I**
- Inda-Cunningham, Arturo E. 30
Ingersol, Christina 50
Ip, Edward Haksing 52
- J**
- Jabbari, Masoud 85
Jäger, Tobias 92
Joffe, Michael 53
John, Klaus 53
Jones, Haley 29, 98
Jönsson-Belyazid, Ulrika 99
Jusko, Mark 136
- K**
- Kaiser, Jasmin 54
Kalinina, Elena 66
Kamath, Vasanth Vasudeva Pandubettu 87, 88
Kampmann, Christian Erik 34
Kapmeier, Florian 54, 127
Karanfil, Özge 54, 115, 124
Karl, Ute 92
Katalevsky, Dmitry 55
Kavtaradze, Dmitri N. 55
Keijser, Bas 55
Keith, David 55
Kendall, Merrill Stephen 56
Kennedy, Michael S. 56, 117, 126
Khandan, Masoomeh 75
Khetriwal, Deepali 56
Khosla, Karan 57, 127
Kieckhäfer, Karsten 57
Kim, Amy A. 57
Kim, Dong-Hwan 58, 118, 128
Kiss, Tibor 96
Kiss, Viktor 96
- Kljajić, Miroљjub 88
Ko, Seongpil 32
Koca, Deniz 58, 99, 101, 102
Kofjac, Davorin 95
Koltchanov, Vladimir 133
Koochak-Yazdi, Saeed 114
Kopainsky, Birgit 21, 59, 121
Korzilius, Hubert 84, 107, 108
Kotake, Naohiko 74
Kóvári, András 59
Kovriga, Svetlana V. 59
Krail, Michael 60
Kreuter, Matthew W. 52
Kugeratski Souza, Alfredo Benedito 82
Kuhlberg, Jill A. 60
Kühn, André 60
Kumar, Ashwani 61
Kunc, Martin H. 61
Kwakkel, Jan H. 25, 47, 55, 62, 83
- L**
- Lafond, Daniel 63
Lambri, Maurizio 26
Landy, Laura 50
Lane, David C. 120
Langheim, Richard 117, 126
Larson, Richard C. 44
Lee, Carmen Y. J. 63, 104
Lee, Jeong Dong 32
Lee, Man-Hyung 63
Leopold, Armin 64
Lerch, Christian M. 64
Levin, Ilya 65
Levin, Tzur 65
Levine, Ralph L. 120, 128
Li, Anson Kin Tat 65, 106, 114, 124
Li, Yuening 109
Likhacheva, Elena 55
Liu, Cheng-Chih 51
Logtens, Thomas 66
Loher, Marcel 92
López, Luis 66
Loukis, Euripidis 23
Lounsbury, David W. 120, 128
Love, Sean R. 23
Lowry, Thomas S. 66
Luger, Johannes 67
Lychkina, Natalia N. 121, 128
- M**
- Maani, Kambiz E. 65, 93
Macal, Charles M. 67
MacDonald, Roderick H. 119
Machida, Kinya 105
Mahanty, Biswajit 69
Malczynski, Leonard A. 70, 110, 117, 119, 127, 133
Malhotra, Rahul 23
Mandal, Abhijit 32

- Martínez-Moyano, Ignacio J. 67, 68, 116, 123, 126, 136
Mashayekhi, Ali Naghi 41, 74
Matchar, David B. 23
Mathew, Saji K. 38
Mavrommati, Georgia 68
Mbasuen, Timothy S. 17
McCleary, Karl 51
McDonnell, Geoff 115, 124
McDowall, Richard 68
McKelvie, Douglas 130
McKenna, Sean A. 66
Meijer, Karen 22
Meng, Xiang 69
Menon, Balagopal G. 69
Merritt, Jeremy 132
Mikulskiene, Birute 69
Milling, Peter M. 70
Milstein, Bobby 50
Minato, Nobuaki 70
Moeis, Armand Omar 50
MohammadShirazi, Amir 41
Mohammed, Iman 70
Mojtahedzadeh, Mohammad T. 130
Mollona, Edoardo 71
Momodu, Abiodun Suleiman 71
Moosavi Haghighi, M. Hashem 72
Morecroft, John D. W. 135
Morecroft, Linda 121
Morimoto, Risako 70
Morrison, J. Bradley 72
Motlagh, Farahnaz Golrooy 87, 88
Movilla Blanco, Santiago 72
Moxnes, Erling 21, 73
Muetzelfeldt, Robert 123
Müller, Matthias Otto 73
Murad, Hani 114
Mutallip, Ahmet 74
Myer, Kevin 51
- N**
- Nagase, Yoko 105
Nakajima, Yosuke 74
Navarro Vázquez, Beatriz Eugenia 22
Nazari, Morteza 74, 75
Nelson, Alissa 51
Neugebauer, Felix 75
Nguyen, Thuy Thi Hong 42
Nicholson, Charles F. 75
Nielsen, Alexandra 109
- O**
- Obilade, T. O. 71
Odoni, Amedeo 61
Oet, Mikhail O. 44
Ogunlana, Stephen Olu 76
Ohkami, Yoshiaki 74
Ólafsdóttir, Anna Hulda 18
Olaya, Camilo 76, 91
- Oliva, Rogelio 33
Oliveira, Tiago Cravo 18
Ormazabal, Marta 18, 77
Osgood, Nathaniel 45, 69, 77
Otto, Peter 77
Owlia, Mohammad Saleh 78, 90
Oyebisi, Timothy Oyedepo 71
Özgül, Onur 78, 122, 129
- P**
- Pagoni, Eirini Grammatiki 19
Panayiotidis, Panayiotis 68
Papachristos, George 79
Papageorgiou, George Nathaniel 46
Parra Valencia, Jorge Andrick 79, 80
Parsons, David 75
Parvan, Kiavash 80
Parvizian, Jamshid 89
Paucar-Caceres, Alberto 37, 80
Pavlov, Oleg V. 89
Pavlova, Milena 18
Pazek, Karmen 88
Perdikaki, Olga 33
Pérez Salazar, Gloria 19, 118, 128
Peterson, David W. 33, 81
Pieters, Angele 81
Pietrobon, Ricardo 107
Pitreñaite, Birute 69
Potash, P. Jeffrey 117, 126
Prottil, Roberto Max 81, 82
Pruyt, Erik 25, 34, 47, 55, 59, 66, 70, 82, 83, 115, 118, 124, 127
- Q**
- Qian, Ying 109
Qureshi, Muhammad Azeem 84
- R**
- Raaijmakers, Stefan 84
Rafele, Carlo 35
Rafiei Sakhaei, Mohammad Hussein 85
Ragnarsdóttir, Vala 101, 102
Rahmandad, Hazhir 52, 80, 85
Rahn, R. Joel 116
Ramesh, Deepak Sreedhar 87
Ramos Martins, Marcelo 25
Ran, Weijia 86
Rao, D. Rama 69
Retrosi, Clarissa 24
Rich, Eliot 77
Rich, Karl M. 47
Richardson, George P. 86
Richardson, John M. 134
Rieg, Robert 86
Ríos, Diana Carolina 30
Rochat, Laurent 87
Rodiqi, Ilir 19
Rodrigues, Lewlyn L. R. 87, 88
- Rodríguez-Ulloa, Ricardo A. 80
Rogers, Jim L. 115, 124
Romanenko, Eduard 88
Ros, Arjen 22
Rouwette, Étienne A. J. A. 48, 84, 107, 116
Rozman, Crtomir 88
Rust, Tom 89
Ryzhenkov, Alexander V. 89
- S**
- Sadreddin, Arman 89
Saeed, Khalid 51, 58, 89
Sagar, Mahim 112
Saldarriaga, Maria 59
Saleh, Mohamed Mostafa 39
Sallach, David L. 67
Samsa, M. 67, 68
Sanchez, Ron 43
Santos, Erico Resende 90
Santos, John Leno C. 82
Sarriegi, Jose Mari 77
Saryazdi, Mohammad Dehghani 90
Saysel, Ali Kerem 36
Schade, Burkhard 90
Schade, Wolfgang 60
Schaffernicht, Martin F. G. 91, 123
Scherrer, Leigh 50
Schlyter, Peter 91, 99, 102
Schmall, Thomas 64
Schmid, Lukas 92, 122, 129
Schmidt, Susanne 49, 92
Schmidt, Teresa 109
Schoenberg, William 93, 132
Schwaninger, Markus 56
Schwenke, Markus 93
Scott, Rodney J. 93
Sechrist, Michael 93
Shalaby, Mohamed 39
Shelley, Pamela 121
Shepherd, Simon 94
Sihombing, Lukas B. 19
Sipowicz, Maria 49
Skaza, Heather 94
Skraba, Andrej 88, 95
Skribans, Valerijs 95
Slinger, Jill H. 62
Soloukdar, Alireza 96
Somogyvari, Marta 96
Sorci, Pietro 97
Soto-Torres, M. Dolores 97
Spencer, Christina 136
Spencer, Roberta L. 116, 117, 120
Spengler, Thomas Stefan 19, 57
Spiegel, Markus 19
Stasinopoulos, Peter 98
Stave, Krystyna A. 27, 98
Stephens, Craig A. 70
Sterman, John 50, 55, 85, 99
Stjernquist, Ingrid 91, 99
Stojanovic, Radovan 95

Index

Strohhecker, Jürgen 45
 Struben, Jeroen 55
 Subroto, Athor 100
 Suetake, Toru 100
 Sushil, Sushil 27, 112
 Susta, Marek 28
 Sutfin, Erin 52
 Sutrisno, Aziiz 47, 50
 Sverdrup, Harald 58, 91, 99, 101, 102
 Sverdrup, Ulrik 101
 Swanson, John 130

T

Taiwo, Temitope 111
 Takahashi, Shinsuke 102
 Takahashi, Yutaka 103
 Tanaka, Nobuhide 103
 Tanyolac, Togay 103, 113
 Tapandjieva, Gorica 43
 Tedeschi, Luis Orlando 25
 Teo, Kwong Meng 61
 Thompson, James P. 23, 37, 63, 104
 Tian, Yuan 77
 Tilebein, Meike 46
 Timmermans, Jos S. 62
 Tong, Hefeng 112
 Torres, Juan Pablo 104
 Trailer, Jeff W. 104
 Tremblay, Sébastien 63
 Tschupp, Roman 45
 Tseng, Ya-tsai 104
 Tudor, Marija 49
 Turen, Ufuk 105
 Turk, Jernej 88

U

Uchino, Akira 105, 118
 Uehara, Takuro 105
 Ullah, Muhammad Aman 106
 Ulli-Beer, Silvia Astrid 73, 106
 Urdiales-Kalinchuk, Alena 30
 Uriona Maldonado, Mauricio 107

V

Vaishnav, Chintan 93
 Vajda, József 96
 van Ackere, Ann 87
 van Daalen, Cornelia 38
 van Nistelrooij, Bert L. P. J. 107
 van Oorschot, Kim 21, 81
 van Staveren, Suzanne 107
 van Vliet, Lija 22
 Vargas, Vanessa 20
 Varvakis, Gregorio 107
 Veldhuis, Guido Arjan 48, 108
 Vennix, Jac A. M. 48, 84, 107
 Verstijnen, Ilse 107
 Viejo Garcia, Pablo 49
 Vila-Brunet, Neus 17, 108

W

Wachter, Katharina 19, 57
 Wagoner, Kimberly 52
 Wakeland, Wayne 105, 109, 119
 Wang, Hsiao-Lin 51
 Wang, Ranran 19
 Wang, Shoujin 109
 Wang, Wei Yang 104, 109
 Warren, Kim D. 110, 134, 136
 Wegmann, Alain 43

Westbrook, Jessica 110
 Wheat, David 47, 111
 Widmer, Rolf 56
 Wokaun, Alexander 106
 Wolfson, Mark 52
 Wood, Thomas Ragnar 101
 Wunderlich, Philipp 111

Y

Yacout, Abdellatif M. 111
 Yadama, Gautam N. 60
 Yadav, Neetu 112
 Yamaguchi, Kaoru 112, 131
 Yan, Haiyan 125
 Yang, Yang 112
 Yasarcan, Hakan 74, 103, 113
 Yasui, Toshiyuki 74
 Yavas, Mustafa 113
 Yoo, Jong-Hoon 63
 Yücel, Gönenç 113

Z

Zagonel, Aldo 115, 123, 125, 130
 Zatta, Gianfranco 26
 Zeimer, Mike 26
 Željko, Garaca 49
 Zhang, Jin 45
 Zhang, Xu 112
 Zhou, Yuhua 65
 Zilouchian, Emad 114
 Zimmermann, Alexander 67
 Zimmermann, Nicole 70
 Zúñiga, Roy G. 66
 Zwerver, Anne-Marije Jeanette 70