TECH 517 Strategic Systems Modeling

Fall 2020
Sept 26-27 & Nov 14-15 (Saturday and Sunday)

(updated June 13, 2020)

COURSE INFORMATION
Course Number: Tech 517
Course Title: Strategic Systems Modeling
Term and Year: Fall 2020
Synchronous Class Meeting: 2 weekends, on Sat/Sun, September 26-27 and November 14-15 at 15:00-20:00 PM (Istanbul Time Zone)
Course Support: Assist. Professor Mahdi Hashemian, CASE Strategy and Management Group

CONTACT INFORMATION

Faculty
Ozge Karanfil, MS, PhD
Assistant Professor of Operations Management and Information Systems
College of Administrative Sciences and Economics, Business Administration
Email: okaranfil@ku.edu.tr
Office Location: Koc University CASE Building
Phone Number: +90 (535) 628 71-90
Office hours: By appointment

Teaching Assistant
TBD
Review Sessions: ***On Request***

Credits
3 credits

COURSE MATERIALS
Required Textbook(s): *None*
Required Readings: *See Class Website*

Recommended Textbook(s):

- Sterman, J. Business Dynamics. Systems Thinking and Modeling for a Complex World. McGraw-Hill, U.S.A., 2000.
- Thinking in Systems, A Primer. Donella H. Meadows. *Edited by Diana Wright. Sustainability Institute.* Chelsea Green Publishing. 2008

- Tracing Connections: Voices of systems thinkers. *Editors: Joy Richmond, Lees Stuntz, Kathy Richmond, Joanne Egner.ISEE Systems Inc. 2010*
- Barlas, Y. "System Dynamics: Systemic Feedback Modeling for Policy Analysis" *in Knowledge for Sustainable Development - An Insight into the Encyclopedia of Life Support Systems, UNESCO-Eolss Publishers, Paris, Oxford, UK. 2002, pp.1131-1175*
- Senge PM. The Fifth Discipline: *The Art & Practice of The Learning Organization. Revised & Updated edition.* New York: Doubleday; 2006. 445 p.

Course Objectives and Scope:

As human beings in an interconnected world, we face a number of complex and seemingly intractable problems including climate change, food security, global poverty and pandemic diseases. Understanding how to address such problems is the first step to solving them. This course offers an introduction to systems thinking and system dynamics modeling as an approach to diagnosing and solving complex business problems. Students will learn about key concepts and modeling tools in systems thinking for better decision making and analysis, and a range of tools to address central concerns and current topics, including: health policy and management, mapping tools for system dynamics, crisis/pandemic management, case studies, sustainability and management simulations.

Systems thinking offers a lens on organizations, environments and human behavior that foregrounds ongoing evolution and conceptualizes them as a non-linear dynamic system. System dynamics modeling is a toolset through which the systems thinking perspective is used to analyze complex sytems behavior. In this class you will learn to visualize a system in terms of the structures and policies that create dynamics and regulate performance. System dynamics allows us to create models (or "micro-worlds") where space and time can be compressed, slowed, and stopped so we can experience the long-term side effects of decisions, systematically explore new strategies, and develop our understanding of complex systems. We use simulation models, case studies, and management flight simulators to develop principles of policy design for successful management of complex strategies. We consider the use of systems thinking to promote effective organizational learning.

The purpose of modeling is to improve our understanding of the ways in which an organization's performance is related to its internal structure and operating policies as well as those of customers, competitors, suppliers and other stakeholders, then use that knowledge to design and implement policies that lead to sustained improvement. During the course you will use several simulation models to explore such strategic issues as fluctuating sales, production and earnings; market growth and stagnation; the diffusion of new technologies; process improvement; the rationality of managerial decision making; project management dynamics, health policy, environmental sustainability, and other topics.

Audience

This course is targeted to master's and doctoral level students at Koc University and Global Network MBA students, who have an interest in systems thinking, modeling, dynamic modeling for policy analysis and sustainibility, and interactive flight simulators. Students should have, or be willing to invest their time to acquire, familiarity with conceptual and (some) technical tools.

Modeling software. Several excellent packages for system dynamics simulation are available commercially, including **iThink**, from High Performance Systems, **Powersim**, from Powersim Corporation, and **Vensim**, from Ventana Systems. All are highly recommended. You may wish to learn more about these packages, as all are used in the business world, and expertise in them is increasingly sought by potential employers. For further information, see the following resources:

iThink: See the isee Systems web site at <www.iseesystems.com>
Powersim: See the Powersim web site at <www.powersim.com>.
Vensim: See the Ventana Systems web site at <www.vensim.com>.

The required modeling software is VensimPLE. In this course, we will be using the Vensim Personal Learning Edition (VensimPLE) by Ventana Systems. VensimPLE is free for academic use, and available for PCs and Macs. Download VensimPLE from http://vensim.com/vensim-personal-learning-edition
Be sure to download the current version from the Vensim website above.

Course Readings
See Reading List below for selected (tentative) readings for each class session. Additional handouts/ readings may be posted on class website before the sessions.

Course Structure
Class sessions will be organized in two major ways:
Synchronous lectures: Students are required to participate and be prepared, using materials provided before the lecture time.
Aynchronous lectures: Supporting class material such as short lecture videos/ handouts will be posted inbetween and before sessions to enhance students understanding of the concepts.

Online workshops will be organized with active learning where students, instructor, and teaching assistant will jointly apply the class concepts using the Vensim modeling software on their laptops.

Class participation
Active learning through class participation and discussion are important components of the course. Students are expected to attend and participate in all synchronous classes on September 26-27 and November 14-15.

Readings
Readings include some "required reading" and additional "elective readings," which are specified on the Reading List and downloadable from the course website. Students are supposed to complete the required reading prior to class, and are encouraged to consult the "elective readings."

Research project outline
Students will be asked to work on a topic of their choice in a group of three or four, where they will need to apply the materials learned during the course. The research project includes a paper and an in-class presentation. The research paper will be about 1,250 words in length, comprise of

no more than 3 tables/figures, and be structured in 3 parts (Introduction, Methods, and Next Steps

for Analysis). It will be double-spaced and use font size 12.

During a short in-class presentation to be scheduled before the end of the course, students will discuss their research outline using slides.

One class session will be dedicated to discussing elaboration and completion of the research project. The final paper will be due the end of the semester.

Grading, Progress and Assessment
The grade for the course will be based on:

- Class attendance (30%)
- Class participation (10%)
- Homework assignments (30%)
- The research project including a paper and an in-class presentation (30%)

Academic Standards and Honesty:

Copying from others or providing answers or information, written or oral, to others is cheating. Copying from another student's paper or from another text without written acknowledgment is plagiarism. Unauthorized help from another person or having someone else write one's paper or assignment is collusion. **Cheating, plagiarism and collusion are serious offences resulting in an F grade and disciplinary action.**

Student Code of Conduct and Academic Grievance Procedure:
• Student Code of Conduct
• Statement on Academic Honesty with Emphasis on Plagiarism
• Academic Grievance Procedure

Course Evaluations
Constructive feedback from students is a valuable resource for improving teaching. The feedback is preferred to be specific, focused and respectful. It should also address aspects of the course and teaching that are positive as well as those which need improvement.

Completion of the evaluation is a requirement for each course.

KOÇ UNIVERSITY

Koc University Graduate School of Business
System Dynamics
Sept 26-27 and Nov 14-15, 2020 ****DRAFT v 0.1JUNE2020****

Saturday, Sept 26	Sunday, Sept 27	Saturday, Nov 14	Sunday, Nov 15
Introductions and Course Outline Ozge Karanfil 15:00-15:10PM	**Tools for Systems Thinking**	**Late, Expensive and Wrong: The Dynamics of Large Projects** **Project Simulator**	**People Express Management Flight Simulator** **People Express**
Introduction to Systems Thinking and Business Dynamics Ozge Karanfil 15:10 - 16:00	Ozge Karanfil 15:00 - 16:00	Ozge Karanfil & Mahdi Hashemian 8:30 - 10:30	Ozge Karanfil 8:30 - 10:30
Break 16:00 - 16:10 pm	Intermittent Breaks	Intermittent Breaks	Intermittent Breaks
Mapping Dynamic Systems Ozge Karanfil 16:10 - 17:10	**Tools for Systems Thinking (cont'd)** Ozge Karanfil 16:10 - 17:10	**Project Management Dynamics** Ozge Karanfil & Mahdi Hashemian 16:10 - 17:10	**People Express Conceptualization and Policy Design** Ozge Karanfil 16:10 - 17:10
Break 17:10 - 17:20	Break 17:10 - 17:20	Break 12:00 - 1:00 pm	Break 12:00 - 1:00 pm
Modeling Dynamic Systems Ozge Karanfil 17:20 - 18:20	**Interactive Climate Policy Simulation or Fishbanks Simulation** TBD 17:20 - 18:20	**Project Management Dynamics (cont.)** 17:20 - 18:20	**People Express Conceptualization and Policy Design (continued)** 17:20 - 18:20
Intermittent Breaks	Intermittent Breaks	Intermittent Breaks	Intermittent Breaks
Simulation Workshop: Exploring Simple Structures **Vensim** Ozge Karanfil & Mahdi Hashemian 18:30 - 19:50	**Climate Interactive Fishbanks**	**Guest Talk: TBD**	**Guest Talk: TBD**
	Guest Talk: TBD 18:30 - 19:50	**Student Group Presentations** 18:30 - 19:50	**Student Group Presentations** 18:30 - 19:50
Daily Wrap Up and Feedback	Daily Wrap Up and Feedback	Daily Wrap Up and Feedback	Daily Wrap and Feedback

26 September 2020

Day 1: Mapping Dynamic Systems

Overview: The opening session introduces the two main mapping tools in system dynamics, *causal loop diagrams* and *stock and flow diagrams*. Working through an example, focused on how public health officials might respond to the outbreak of an infectious disease, we will map the social interactions and structures that can generate an epidemic.

Modeling Dynamic Systems

In today's second session you will have your first experience with the VENSIM software, which you will use to build a formal model that capture the dynamics of an epidemic created by an infectious disease.

Concepts: Causal links: positive and negative links
Causal loops: balancing and reinforcing feedback processes
Stocks and flows

Analyzing Dynamic Systems

Overview: In this session we focus on the process of analyzing a dynamic model. We begin with an extended version of the epidemic model that we developed. Your task is to identify the model's key properties and then use those properties to generate policies that might limit the impact of an infectious disease.

Concepts: Structure Generates Behavior
Tipping Threshold
Policy Robustness

Mapping Dynamic Systems Using Causal Loop Diagrams (Slight Return)

Overview: In the final session of the day we return to the causal loop mapping tools that we introduced in the opening session. We will work through several examples to refine your mapping abilities.

Concepts: Translating text into causal loop and stock and flow diagrams
Linking multiple stock and flow chains
Creating diagrams that capture both feedback and stock and flow structure

27 September 2020

Day 2: Mapping Stocks and Flows

Overview: We begin this session by revisiting the stock and flow mapping tools that we introduced in the opening session. We will work through several examples to refine your ability to map separate stock and flow networks and then to link them together.

Bathtubs, CO2, and Diabetes: Understanding the Dynamics of Stocks and Flows

Overview: Following our practice with the mapping tools, we turn to the dynamics that such systems create. We begin by building intuition for the behavior generated by simple stock and flow networks and then move to more complicated structures. We conclude with two brief cases of how the failure to understand stock and flow dynamics generated significant loss of life and other costs.

Concepts: Graphical integration

Cronin, M., Gonzalez, C., Sterman, J. (2009). Why Don't Well-Educated Adults Understand Accumulation? A Challenge to Researchers, Educators and Citizens. *Organizational Behavior and Human Decision Processes.* 108, 116-130.

Sterman, J. (2008). Risk Communication on Climate: Mental Models and Mass Balance. *Science* **322**: 53-533.

November 14, 2020

Day 3: Capabilities and Pathologies

Overview: In this weekend's sessions we extended our analysis of accidents from the previous class to a more general framework for understanding organizational pathologies. Today's material will both refine your causal loop diagramming skills and introduce you to a set of dynamics that afflict many organizations. Finally, we will show an example of how dynamic analysis can be used to improve real organizations.

Concepts: Better-before-worse and worse-before-better
The capability trap
Tipping behavior
Superstitious learning

Follow Up: Repenning, N. and J. Sterman (2001). Nobody Ever Gets Credit for Fixing Problems that Never Happened: Creating and Sustaining Process Improvement, *California Management Review*, 43, 4: 64-88.

Repenning, N. and J. Sterman (2002). Capability Traps and Self-Confirming Attribution Errors in the Dynamics of Process Improvement, *Administrative Science* Quarterly, 47: 265 - 295.

Rahmandad, H., R. Henderson, N. Repenning (2016). Making the Numbers? Forthcoming in Management Science.

Meet LEW (Late, Expensive and Wrong): Understanding the Dynamics of Project Management

Overview: Executing projects, whether in software, construction, or product development, is one of the key ways that organizations turn strategy into action. This session begins with a discussion of the poor state of project performance in a wide range of industries. Then, through the use of a management flight simulator, you will have the opportunity to experience these dynamics first-hand. We build on that experience to develop a framework to model project dynamics and use it to design and evaluate policies to avoid major cost and schedule overruns. The session concludes with case studies of recent successes using system dynamics to improve project management.

Concepts: Overload
The rework cycle
The "Liar's Club"
The self-confirming attribution error

Follow Up Resources:
Cooper, L. and G. Lee, "Managing the Dynamics of Projects and Changes at Fluor".
Ford, D. & Sterman, J. D. (2003) The Liar's Club: Concealing Rework in Concurrent Development. *Concurrent Engineering: Research and Applications,* 11**,** 211-220.
Repenning, N., P. Goncalves, and L. Black (2001). Past the Tipping Point: The Persistence of Fire Fighting in Product Development, *California Management Review*, 43, 4: 44-63.
Rahmandad, H. and N. Repenning (forthcoming). Capability Erosion Dynamics. Strategic Management Journal.

November 15, 2020

Day 4: Linking Capabilities and Strategy

Overview: Organizational performance emerges from the interplay among a firm's position in its market and the capabilities it has developed to serve that market. In today's sessions we develop a framework to think about these interactions and how they are managed. We begin by considering the case of People Express (PE), an innovative airline that experienced dramatic success followed by an equally spectacular failure. Following our initial discussion, you will have an opportunity of "fly" PE using another management flight simulator. Building on our experience in the game you will then analyze the PE's rise and fall using the tools developed in the course so far.

Concepts: Limits to growth
Integration

Please Prepare: People Express (A): available on Study.Net

KOÇ UNIVERSITY

Özge Karanfil- Bio

Dr. Özge Karanfil is an assistant professor of Operations Management and Information Systems group at Koc University, College of Administrative Sciences and Economics. Dr. Karanfil has international expertise in understanding complex systems with a rare combination of BSc and MSc degrees in Industrial Engineering from Boğaziçi University with strong grounding in operations management, a Master's degree in health sciences from McGill University which has enabled her to develop an understanding of health systems and policy, and a doctoral study in Management Science at MIT, with a focus on system dynamics. At MIT, Dr. Karanfil worked with the leading expert in the world, Prof. John D. Sterman, in the areas of systems dynamics modeling for health policy analysis, modelling socio-dynamic systems, and decision analysis. Her training is multi-disciplinary; she has both collaborated and published with experts in management, systems sciences, health sciences, and engineering to solve complex managerial problems with important policy implications for the societal domain.

Dr. Karanfil completed her Postdoctoral fellowship at Harvard School of Public Health, where her research focused on dynamic modeling of chronic and cardiovascular diseases for Malaysia; obesity and diabetes in the Middle East; global risk factors for disease; and health systems research using complex systems methodologies, such as system dynamics modeling, agent-based modeling, and network sciences. She received the prestigious Yerby Postdoctoral Fellowship sponsored by the Office of the Dean and the Department of Global Health and Population at Harvard School of Public Health (HSPH) in 2017. Her research has been deemed significant enough to be funded by the MIT Sloan School of Management, Harvard School of Public Health, and the HMS Center for Global Health Delivery- Dubai, where she organized an international workshop with researchers from the U.S. and the Middle East. At KU, she received the Koç University Visiting Scholar Fellowship: Awarded by the Center for Middle Eastern Studies (CMES) at Harvard and Koç University, research appointment between July 1- September 30, 2019. Dr. Karanfil aims to produce policy-relevant research by integrating management, systems and health sciences with a strong emphasis on empirical data-driven analysis and modeling. With a background in industrial engineering, management, and health sciences, she is drawn to systemic problems of chronic nature, which encompass typical constraints and approaches with important managerial implications for the societal domain, coming from health or non-health contexts.

ACADEMIC POSITIONS AND TRAINING

Current:
Koç University, Istanbul, Assistant Professor, Operations and Information Systems Group, CASE, September 2018-
Harvard T. H. Chan School of Public Health, Boston, Dept. of Global Health and Population, Visiting Scientist, September 2018-
Past:
Harvard T. H. Chan School of Public Health, Boston, Dept. of Global Health and Population, Yerby Postdoctoral Fellow, 2016-2018. Advisor: Prof. Rifat Atun
Ph.D., Management Science, MIT Sloan School of Management, 2010-2016
Dissertation Title: Why Clinical Practice Guidelines Shift over Time: A Dynamic Model with Application to Prostate Cancer Screening, Link to Ph.D. thesis / Advisor: John D. Sterman
M.Sc., Physiology, McGill University- Center for Nonlinear Dynamics in Physiology and Medicine, 2007
M.Sc. & B.Sc., Industrial Engineering, Boğazici University, 2005 / Advisor: Prof. Yaman Barlas

AWARDS AND HONORS

2232 International Fellowship for Outstanding Researchers, TUBITAK, 2020-2023
Koç -Harvard Fellowship at Center for Middle Eastern Studies-CMES, Faculty of Arts and Sciences, 2019
Co-PI for the Grant submitted to HMS Center for Global Health Delivery-Dubai
Lupina Young Researchers Award, Best paper in Health Applications, International System Dynamics Society, 2017
• w/ Paper: Karanfil, Ozge with Hazhir Rahmandad, Jack Homer and John Sterman, 2017, A Dynamic Model for Understanding Long-Term Trends in Prostate Cancer Screening, *Proceedings of the 35th International System Dynamics Conference*, Boston, MA
Harvard Chan Yerby Fellowship, Dean of Harvard School of Public Health, 2016-2018
Ida M. Green Fellowship, Massachusetts Institute of Technology, 2010
MIT Doctoral Program Fellowship 2010-2016
Dana Meadows Award, Best Student Paper at 24th Int. System Dynamics Conference, 2006
• w/ Paper: Karanfil, Ozge, 2006, A Dynamic Simulator for the Management of Disorders of the Body Water Metabolism, *Proceedings of the 24th International System Dynamics Conference*, Nijmegen, Netherlands
Alma Mater Student Research Grant, McGill University, 2006
PhD Scholarship, TUBITAK, 2005
Best Undergraduate Student Paper, YAEM, 2002
Among Top 200 student, University Entrance Exam, 1997

PROFESSIONAL AFFILIATIONS

Institute for Operations Research and the Management Sciences (INFORMS) 2011 – present
International System Dynamics Society (SDS) 2002 – present
• Guest Editor for the Special Issue of System Dynamics Review on Biomedical Modelling, 2020
• Healthcare Track Chair 2016 – 2017
• Policy Council Elected Member 2015 – 2017
• Health Policy Special Interest Group 2006 – present
• Biomedical Special Interest Group 2008 – present
Society for Medical Decision Making (SMDM) 2014 – present
System Dynamics Research Group, MIT Sloan 2010 – present
Public Health Systems Research (PHSR) 2015 – present
Academy Health (AcademyHealth) 2015 – present
Health Systems Global (HSG) 2017 – present
Socio-Economic System Dynamics Lab (SESDYN) 2002- present

TEACHING

QMBU301. Quantitative Methods for Business Administration, Koç University, Instructor (Spring 19-20)
15.736 Introduction to System Dynamics, MIT Sloan Executive MBA Program, Teaching Assistant (Summer 2013, 2014, 2016)
15.871 Introduction to System Dynamics, MIT Sloan School of Management, Teaching Assistant (Fall 2011, 2013, 2014, Spring 2013)
15.872 System Dynamics, MIT Sloan School of Management, Teaching Assistant (Fall 2011, 2013, 2014, Spring 2013)
ESD74 System Dynamics for Engineers, Systems Design and Management (SDM) Program, MIT, Teaching Assistant (Summer 2011)
1st Annual Institute on Systems Science and Health, Track Assistant in System Dynamics (Spring 2009)
IE 484 Simulation Gaming and Decision Experiments, Bogazici University, Istanbul
IE 306 Systems Simulation, Bogazici University, Istanbul
IE 255 Probability for Industrial Engineers, Bogazici University, Istanbul