



Massachusetts Institute of Technology
Sloan School of Management

15.871 Introduction to System Dynamics
15.872 System Dynamics II

Fall 2008

GENERAL INFORMATION

- Background:** 15.871 (Introduction to System Dynamics) is a 6 unit course meeting in H1.
871 & 872 15.872 (System Dynamics II) is a 6 unit course meeting in H2. Together they constitute the introductory sequence in system dynamics. You can take 871 alone or both 871 and 872. Successful completion of both 871 and 872 is a prerequisite for advanced courses in system dynamics, work as an RA or TA in the field, as well as careers using system dynamics.
- Schedule:** Section A: Monday and Wednesday, 8:30 – 10:00 in E51-345.
Section B: Monday and Wednesday, 10:00 – 11:30 in E51-345.
- Instructor:** John Sterman, E53-351, 617.253.1951 (v), 617.258.7579 (f), jsterman@mit.edu
- Office hours:** My door is always open to students, or make an appointment by email.
- TAs:** Joe Hsueh joehsueh@mit.edu
Kawika Pierson kawika@mit.edu
Avijit Sen avijit@mit.edu
Ellen Tompsett tompsett@mit.edu
- TA Sessions:** The TAs will lead a weekly review session in which they will answer questions about assignments in progress and discuss solutions to past assignments. There are two recitations: Friday, 10:00 – 11:30 and Friday, 14:30 – 16:00, both in E51-325. You may attend either one. The first session will be Friday, Sept. 5.
- Grading** Assignments: 85%
Emphasis: Class participation: 15%
- Each assignment is graded on a 10-point scale. Two points will be forfeited for assignments handed in late. Assignments handed in more than 1 class late will receive no credit. *This policy will be strictly enforced.*
- Web Site:** We will be using Stellar <<http://stellar.mit.edu/S/course/15/fa08/15.871ab>> to post course materials online. Non-MIT students can access Stellar after being added by the course administrator. The site contains the syllabus, assignments, simulation models, reading list, helpful hints, software access, and other useful information. We will use it to send emails with information such as hints for assignments, schedule changes for TA sessions, etc. You can also use the site to find partners for group assignments, or to pose questions to the class as a whole.
- Handouts:** Available on the class Stellar site. Any extra hard copies will be available outside the instructors' offices.

Objectives and Scope

Why do so many business strategies fail? Why do so many others fail to produce lasting results? Why do many businesses suffer from periodic crises, fluctuating sales, earnings, and morale? Why do some firms grow while others stagnate? And how can a firm identify and design high-leverage policies, policies that are not thwarted by unanticipated side effects?

Accelerating economic, technological, social, and environmental change challenge managers to learn at increasing rates. And we must increasingly learn how to design and manage complex systems with multiple feedback effects, long time delays, and nonlinear responses to our decisions. Yet learning in such environments is difficult precisely because we never confront many of the consequences of our most important decisions. Effective learning in such environments requires methods to develop systems thinking, to represent and assess such *dynamic complexity* – and tools managers can use to accelerate learning throughout an organization.

15.871 and 872 introduce you to system dynamics modeling for the analysis of business policy and strategy. You will learn to visualize a business organization in terms of the structures and policies that create dynamics and regulate performance. System dynamics allows us to create ‘microworlds,’ management flight simulators 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. Case studies of successful strategy design and implementation using system dynamics will be stressed. We consider the use of systems thinking to promote effective organizational learning.

The principal 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. 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; the use and reliability of forecasts; the rationality of business decision making; and applications in health care, energy policy, environmental sustainability, and other topics.

Students will learn to recognize and deal with situations where policy interventions are likely to be delayed, diluted, or defeated by unanticipated reactions and side effects. You will have a chance to use state of the art software for computer simulation and gaming. Assignments give hands-on experience in developing and testing computer simulation models in diverse settings.

No prior computer modeling experience is needed.

Those on the wait list, those who did not register through the Sloan bidding system, and listeners are welcome only if space permits (in that order).

Texts and Software

Required Text:

1. Sterman, J. (2000). *Business Dynamics: Systems Thinking and Modeling for a Complex World* (Text and CD-ROM). Irwin/McGraw Hill. ISBN 0-07-238915X. (Available at the MIT Coop.)
2. Occasional articles and case studies (to be made available via Stellar).

The syllabus notes the days for which these readings should be prepared (NOTE: *before* the class in which we discuss them). Additional readings will be handed out on an occasional basis. The syllabus also indicates which sections of the text you should be sure to read to learn the material you will need to do the assignments, and which sections you can skim (NOTE: ‘skim’ ≠ ‘skip’).

In addition, we will be using 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>.

In this course, we will be using the **Vensim** Personal Learning Edition (**VensimPLE**) by Ventana Systems. VensimPLE is free for academic use. VensimPLE is available for Windows only. However, Mac users with Intel-based Macs can easily run Vensim using a PC emulator such as Parallels, VMWare, or Darwine. VensimPLE comes with on-line user’s guide and help, and also a folder of demo models. Download VensimPLE from <www.vensim.com/venple.html>.

NOTE: The disc that comes with the *Business Dynamics* textbook includes a version of VensimPLE. However, the version available online is newer and has enhanced functionality. Be sure to download the current version from the Vensim website above. All the Vensim models on the text CD work with the new version.

15.871/15.872 SCHEDULE

(subject to change)

Date		Class	Topic	Reading Due	Assn Out	Assn Due
9/3	W	1	Introduction: Purpose, tools and concepts of system dynamics	Read <i>Business Dynamics</i> [BD], Ch. 1	#1	
9/8	M	2	System Dynamics Tools Part 1: Problem definition and model purpose; intro to causal mapping	Read BD, Ch. 3, Ch. 4		
9/10	W	3	System Dynamics Tools Part 2: Building theory with causal loop diagrams	Read BD, Ch. 5 (Skim sections 5.4, 5.6)	#2	#1
9/15	M	4	System Dynamics Tools Part 3: Mapping the stock and flow structure of systems	Read BD, Ch. 6 (Skim sections 6.2.7, 6.2.8, 6.2.9, 6.3.4, 6.3.6)		
9/17	W	5	System Dynamics Tools Part 4: Dynamics of stocks and flows	Read BD, Ch. 7	#3	#2
9/22	M		<i>NO CLASS: MIT HOLIDAY</i>			
9/24	W	6	Growth Strategies Part 1: Modeling innovation diffusion and the growth of new products	Read BD, Ch. 8; Ch. 9.1 (Skim 9.1.2, 9.1.3); 9.2, 9.3 (Skim sections 9.3.5 - end)		
9/29	M	7	Growth Strategies Part 2: Network externalities, complementarities, and path dependence	Read BD Ch. 10 (Skim section 10.2)	#4	#3
10/1	W	8	Growth Strategies Part 3: Modeling the evolution of new medical technologies	<i>Please Prepare:</i> Homer 1996/1984, "The Evolution of a Radical New Technology: The Implantable Cardiac Pacemaker"		

Date		Class	Topic	Reading Due	Assn Out	Assn Due
10/6	M	9	Interactions of Operations, Strategy, and Human Resource Policy: People Express	<i>Please Prepare:</i> People Express (A)	#5	#4
10/8	W	10	<i>Guest Lecture:</i> System Dynamics at General Motors (Dr. Mark Paich)	TBA		
10/13	M		<i>NO CLASS: Columbus Day Holiday</i>			
10/15	W	11	Managing Hyper Growth: Lessons from People Express. END OF 15.871	TBA		#5
10/20-10/24			<i>Sloan Innovation Period: No Classes</i>			
10/27	M		<i>15.872 begins: see next page</i>			

NOTE ON ACADEMIC STANDARDS

We expect the highest standards of academic honesty and behavior from all participants in class. The course Stellar site, <<http://stellar.mit.edu/S/course/15/fa08/15.871ab>>, contains an important document describing academic standards at MIT Sloan. The document discusses standards for citing the work of others (proper referencing to avoid plagiarism), and standards for individual and group work. Please be sure to read this document. If you have any questions about standards and expectations regarding individual and team assignments, please ask us after you have read the standards and before doing the assignments.

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Date		Class	Topic	Reading Due	Assn Out	Assn Due
10/27	M	1	System Dynamics in Action: Re-engineering the supply chain in a high-velocity industry	Read BD, Ch. 11 (Skim sections 11.6, 11.7).	#1	
10/29	W	2	Managing Instability Part 1: Formulating and testing robust models of business processes	Read BD, Sections 13.1, 13.2.1-13.2.9, 13.3 and 13.4		
11/3	M	3	Managing Instability Part 2: The Beer Game (Bullwhip) Effect	Read BD, Sections 17.1, 17.2 and 17.3	#2	#1
11/5	W	4	Managing Instability Part 3: Forecasting and Feedback: how (not) to forecast	Read BD, Ch. 16		
11/10	M		<i>NO CLASS: MIT HOLIDAY</i>			
11/12	W	5	Cutting corners and working overtime: Service quality management	Read BD, Sections 14.1-14.4	#3	#2
11/17	M	6	Managing Instability Part 4: Business cycles, real estate crises and speculative bubbles	Read BD, Sections 17.4 and 17.5		
11/19	W	7	<i>Guest Lecture:</i> Jay W. Forrester	Read Forrester, <i>From the Ranch to System Dynamics: An Autobiography</i>		
11/24	M	8	System Dynamics in Action: Applications of System Dynamics to Environmental and Public Policy Issues	Read Meadows, "The Global Citizen" (selections)		

Date		Class	Topic	Reading Due	Assn Out	Assn Due
11/26	W	9	Process Improvement and the dynamics of organizational change	TBA	#4	#3
12/1	M	10	Overcoming the service quality death spiral	TBA		
12/3	W	11	Late, expensive, and wrong: The dynamics of project management	Read BD, Sections 2.3 and 6.3.4		
12/8	M	12	Project management (cont.): Firefighting in new product development	TBA		
12/10	W	13	System Dynamics in Action: The implementation challenge Conclusion: How to keep learning. Follow-up resources. Career opportunities. Course evaluations	Read BD, Ch. 22		#4

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