15.871 Introduction to System Dynamics (H1)
15.872 System Dynamics II (H2)

Fall 2015

General information

**Background**

15.871 (Introduction to System Dynamics) is a 6 unit course meeting in H1.
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 combine the two. 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, or careers using system dynamics.

**Schedule**

The H1 Introductory class runs from 9 September to 14 October:
- Section A meets Monday and Wednesday, 1:00-2:30pm in E62-262
- Section B meets Monday and Wednesday, 2:30-4:00pm in E62-276
- Section C (Sloan Fellows): Monday and Wednesday, 1:00-2:30pm in E51-145
- Section D (Sloan Fellows): Monday and Wednesday, 2:30-4:00pm in E51-145

The H2 class, System Dynamics II, meets from 26 October to 9 December:
- Section A meets Monday and Wednesday, 1:00-2:30pm in E62-262
- Section B meets Monday and Wednesday, 2:30-4:00pm in E62-276

**Instructors**

15.871 (H1)
- Hazhir Rahmandad (sections A and B), E62-462
  617.258.8912, hazhir@mit.edu
- John Sterman (sections C and D), E62-436
  617.253.1951, jsterman@mit.edu

15.872 (H2)
- Hazhir Rahmandad, E62-462
  617.258.8912, hazhir@mit.edu

**Office hours**

By Appointment

**Course administrators**

Jocelyn Climent, E62-431
617.258.5583
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Teaching Assistants

Fei Gao feigao@mit.edu
Andy Friedl friedl@mit.edu
Sarah Nolet, svnolet@mit.edu
Katie O’Connor, klo@mit.edu
Katy Shaw, kshaw@mit.edu

Please use sd-ta-fall2015@mit.edu to contact the TA team.

Recitations

TAs will lead a weekly review session to answer questions about assignments in progress, present related materials, and discuss solutions to past assignments.

In H1 three recitations take place on Fridays 8:30-10:00am in E62-250, 10:00-11:30am in E62-250 and 2:30-4:00pm in E51-315. Students in any of the sections can join any of the recitations. Plans for drop-in office hours will be announced by the TAs. The first recitation session is on Friday, Sept. 11th.

For H2, two recitations will take place on Fridays from 10:00-11:30am in E62-250 and 2:30-4:00pm in E51-315.

FAQs

A document containing the frequently asked questions is updated regularly by the TAs and is highly recommended as your first stop for finding the answer to your questions. This document is at: https://docs.google.com/document/d/1IKrt9_bwdENA-JCOcGEGUhnD8k9jGfHTcyx4d3vlbA/edit

TA Office Hours

Mondays, 4-5pm, E62-426 (10/12 session moved to 10/13)
Tuesdays, 10am-12pm, Room TBD
Wednesdays, 11am-12pm, E62-329
Thursdays, 2:30-3:30pm, E62-326
The rooms and time are subject to change. Check stellar for latest updates.

Grading

Assignments: 75%
Class participation: 10%
Peer evaluation 15%

Assignments should be submitted electronically, using Stellar. Assignments are due by 5:00pm on the due date – you should never skip class to complete an assignment. Each assignment is graded on a 10-point scale. A minimum of two points will be forfeited for assignments turned in late. Assignments handed in more than one class late receive no credit. This policy is strictly enforced.

Peer Evaluation
Some assignments will be done in teams of three. To form or join a team use the following online spreadsheet: https://docs.google.com/spreadsheets/d/13-4cemMzEPRsS1uA7h07HpTMS_3SU6r9bk1OJddpAz8/edit#gid=1615874025

At the end of the course, you will have the opportunity to evaluate your teammates. The Peer Evaluation is confidential. You will assess how well your teammates contributed to your team’s assignments and your individual learning. Specifically, each member of a team will assign a total of 21 points to the other two members of the team. As a result team peer evaluation will produce differences in grades only within teams. The best strategy is to do your best on each assignment, to help your teammates understand the concepts, and to create a constructive, supportive environment that enhances everyone’s learning.

Website

We use Stellar to post course materials online. Once the Stellar site is restricted to participants, non-MIT students must be added by the course administrator or TAs, or via the MIT Registrar, to gain access to the site.

The site contains the syllabus, assignments, simulation models, readings, helpful tips, software access, and other useful information. We use it to send emails with assignment hints, 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.

https://stellar.mit.edu/S/course/15/fa15/15.871/
https://stellar.mit.edu/S/course/15/fa15/15.872/

Coursepack

Readings are posted on Stellar, but you must also purchase some required material online via Study.Net; see below.

Handouts

Available on the class Stellar site. Any extra hard copies will be placed outside the instructors’ offices near E62-436.

Academic standards

We expect the highest standards of academic honesty and behavior from all participants in class. Please go to http://bit.ly/1hO6fUR, the Sloan Values website, which presents standards for individual and group work, requirements for citing the work of others (proper referencing to avoid plagiarism) and personal conduct in the classroom and as a member of our community. 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.

Course objectives and scope

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

Accelerating economic, technological, social, and environmental change challenges managers to learn at increasing rates. Today’s economy requires us to design and manage complex systems where dynamic complexity is unavoidable, thanks to 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 by representing and assessing dynamic complexity. It also requires tools that 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. In these system dynamics courses 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.

**Course materials**

The required text is *Business Dynamics*.


Additional readings are required. Articles and case studies as assigned will be made available via Stellar, with the exception of the People Express case which you must buy from the MIT Sloan vendor, Study.Net. Instructions on our course Stellar site explain how to do this.

The syllabus notes the days for which readings are to be prepared (NOTE: before the class in which we discuss them). It 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’). Additional readings will be handed out on an occasional basis.

In addition, we will use modeling software. Several excellent packages for system dynamics simulation are available, 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. The current version is 6.3. It is free for academic use and is available for Windows and Mac. VensimPLE comes with sample models, help engine, and a User’s Guide, all available from <http://vensim.com/free-download/>. The first class assignment will provide a tutorial on Vensim. You may also watch two short tutorial videos with basics of model development and analysis mechanics on Vensim’s website: http://vensim.com/building-a-simple-vensim-model/ and http://vensim.com/running-models-with-vensim-ple-and-the-model-reader/

**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 of VensimPLE from the website above. Vensim models on the textbook CD will work with it.

**Prerequisites and admission to the class**

No prior computer modeling experience is needed.

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

### NOTE: subject to change

<table>
<thead>
<tr>
<th>Date</th>
<th>Class</th>
<th>Topic</th>
<th>Reading Due</th>
<th>Assn Out</th>
<th>Assn Due</th>
</tr>
</thead>
<tbody>
<tr>
<td>9/9</td>
<td>W 1</td>
<td>Introduction: Purpose and concepts of system dynamics</td>
<td>Read <em>Business Dynamics</em> [BD], Ch. 1 and <em>Classroom Values in Practice</em></td>
<td>#1</td>
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<tr>
<td>9/14</td>
<td>M 2</td>
<td>System Dynamics Tools Part 1: Building a model</td>
<td>Read <em>BD</em>, Ch. 3.1-3.4 Skim 3.5</td>
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<tr>
<td>9/16</td>
<td>W 3</td>
<td>System Dynamics Tools Part 2: Problem definition and model purpose; feedback and causal loop diagrams</td>
<td>Read <em>BD</em>, Ch. 5.1-5.4</td>
<td>#2 #1</td>
<td></td>
</tr>
<tr>
<td>9/21</td>
<td>M 4</td>
<td>System Dynamics Tools Part 3: building theory with causal loop diagrams</td>
<td>Read <em>BD</em>, Ch. 5.5-5.7, Skim Chapter 4</td>
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<tr>
<td>9/23</td>
<td>W 5</td>
<td>System Dynamics Tools Part 4: Mapping the stock and flow structure of systems</td>
<td>Read <em>BD</em>, Ch. 6 (Skim sections 6.2.7-6.2.9, 6.3.4, 6.3.6)</td>
<td>#3 #2</td>
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<tr>
<td>9/28</td>
<td>M 6</td>
<td>System Dynamics Tools Part 5: Dynamics of stocks and flows</td>
<td>Read <em>BD</em>, Ch.7</td>
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<tr>
<td>9/30</td>
<td>W 7</td>
<td>System Dynamics Tools Part 6: linking feedback with stock and flow structure</td>
<td>Skim <em>BD</em>, 8.1, 8.2.1, 8.2.2, 8.3, 8.4</td>
<td>#4 #3</td>
<td></td>
</tr>
<tr>
<td>10/5</td>
<td>M 8</td>
<td>Industry dynamics and diffusion models Network externalities, complementarities, and path dependence</td>
<td><em>BD</em>, 9.3-9.4 <em>BD</em> Ch. 10 (Skim 10.2)</td>
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<tr>
<td>10/7</td>
<td>W 9</td>
<td>Interactions of Operations, Strategy, and Human Resource Policy: The case of People Express</td>
<td>Prepare for case discussion <em>People Express (A)</em></td>
<td>#5 #4</td>
<td></td>
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<tr>
<td>10/13</td>
<td>T 10</td>
<td>NOTE: Tuesday class Guest Lecture: Mark Paich <em>System Dynamics at General Motors and beyond</em></td>
<td>Barabba et al. 2002 (OnStar)</td>
<td></td>
<td>#5</td>
</tr>
<tr>
<td>10/14</td>
<td>W 11</td>
<td>Lessons from People Express. Course wrap up and evaluations.</td>
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<tr>
<td>Date</td>
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<td>10/26 M</td>
<td>1</td>
<td>System Dynamics in Action: Re-engineering the supply chain in a high-velocity industry</td>
<td>Read <em>BD</em>, Ch. 11 (Skim sections 11.6, 11.7).</td>
<td>#1</td>
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<tr>
<td>10/28 W</td>
<td>2</td>
<td>Managing Instability Part 1: Formulating and testing robust models of business processes</td>
<td>Read <em>BD</em>, Sections 13.1, 13.2.1-13.2.9, 13.3 and 13.4</td>
<td>#2</td>
<td>#1</td>
</tr>
<tr>
<td>11/2 M</td>
<td>3</td>
<td>Managing Instability Part 2: The supply line and supply chains</td>
<td>Read <em>BD</em>, Sections 17.1, 17.2 and 17.3</td>
<td>#3</td>
<td></td>
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<tr>
<td>11/4 W</td>
<td>4</td>
<td>Managing Instability Part 3: Forecasting and Feedback: Bounded Rationality or Rational Expectations?</td>
<td>Read <em>BD</em>, Ch. 16</td>
<td>#4</td>
<td>#3</td>
</tr>
<tr>
<td>11/9 M</td>
<td>5</td>
<td>System Dynamics in Action: Applications of System Dynamics to Environmental and Public Policy Issues</td>
<td>Read Meadows, et. al., “Limits to Growth - 30-Year Update, Ch. 8” (excerpts), Meadows, “The Global Citizen” (selections)</td>
<td>#5</td>
<td>#4</td>
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<tr>
<td>11/11 W</td>
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<td>Veterans Day, No Classes</td>
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<tr>
<td>11/16 M</td>
<td>6</td>
<td>Boom and Bust: Real Estate, Shipbuilding, Commodities, Financial Markets</td>
<td>Read BD, Sections 17.4 and 17.5; Skim “Forecasting Turning Points in Shipping Freight Rate”</td>
<td>#6</td>
<td>#5</td>
</tr>
<tr>
<td>11/18 W</td>
<td>7</td>
<td>Cutting corners and working overtime: Service quality management</td>
<td>Read BD, Sections 14.1-14.4</td>
<td>#7</td>
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<tr>
<td>11/23 M</td>
<td>8</td>
<td>Service Quality Dynamics: Customer Service at Dell</td>
<td>Read Sterman and Sen, “Customer Service at Dell”</td>
<td>#8</td>
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<tr>
<td>11/25 W</td>
<td>9</td>
<td>Analytical methods for system dynamics modelers</td>
<td>Read Intro chapter to Analytical Methods for Dynamic Modelers Skim BD Ch. 21</td>
<td>#9</td>
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<tr>
<td>11/30 M</td>
<td>10</td>
<td>Meet LEW: Late, expensive, and wrong: The dynamics of project management</td>
<td>Read <em>BD</em>, Sections 2.3 and 6.3.4; NY Times article: <a href="http://nyti.ms/17Q9Ewc">http://nyti.ms/17Q9Ewc</a></td>
<td>#10</td>
<td>#6</td>
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<tr>
<td>12/2 W</td>
<td>11</td>
<td>Project Dynamics Modeling in the Real World</td>
<td>Read BD, Ch. 2.3, Cooper and Lee</td>
<td>#11</td>
<td>#7</td>
</tr>
<tr>
<td>12/7 M</td>
<td>12</td>
<td>Getting Things Done: Firefighting, capability traps, and death spirals</td>
<td>Read Repenning and Sterman, “Nobody Ever Gets Credit for Fixing Problems that Never Happened”</td>
<td>#12</td>
<td></td>
</tr>
<tr>
<td>12/9 W</td>
<td>13</td>
<td>System Dynamics in Action: The implementation challenge Conclusion: How to keep learning. Follow-up resources. Career opportunities. Course evaluations.</td>
<td>Read <em>BD</em>, Ch. 22</td>
<td>#13</td>
<td>#8</td>
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</tbody>
</table>