# INTS 4575-1: Systems Thinking for the Social Sciences

***Spring 2013***

**General Class Information**

Quarter: Spring 2013

Day and Time: Tuesdays 2:00PM to 4:50PM

Final Examination Period: Tuesday June 4 2:00PM to 3:50PM

Location: Ben Cherrington Hall 309

**Instructor Information**

Name: Dr. Dale S. Rothman

Office Hours: to be arranged in first class session

Office: Ben Cherrington Hall 178 (within the Pardee Center)

Email: drothman@du.edu

**Purpose of the Course**

The purpose of this course is to introduce students to systems thinking as an approach for understanding and analyzing real-world issues. In addition to introducing the basic principles of systems thinking, questions that will be addressed include: Why do systems behave the way they do? Why do systems resist change and often end up getting worse when we try to improve them? How do you find points of leverage within a system? The course will use examples drawn from a range of issues. In doing so, it will illustrate how a systems perspective can allow you to see parallels between seemingly disparate issues. The course will introduce both qualitative and quantitative approaches for analyzing systems, and discuss the benefits and limitations of each. Quantitative, computer-based modeling will be used in the course, but no background is required.

**Approach**

This class is intended to be interactive. The first half of each session will focus on the week’s readings. The second half will be devoted to working with and exploring systems using various tools, including a freely available software package. I will guide you through the material, but be prepared to also learn a lot by working with your classmates.

**Course Materials**

*Main Texts – required and available at the DU Bookstore*

* Meadows, Donella H. (2008) Thinking in Systems: A Primer, White River Junction, VT: Chelsea Green Publishing
* Jervis, Robert. (1997) System Effects: Complexity in Political and Social Life, Princeton: Princeton University Press

*Reference Texts – these are not required, but both are extremely good reference texts and we will be reading excerpts from each.* *If you really want to get into systems thinking, I would certainly recommend purchasing both of these.*

* Sterman, John D. (2000) Business Dynamics: Systems Thinking and Modeling for a Complex World, Boston: McGraw-Hill.
* Railsback, Steven F. and Volker Grimm (2012) Agent-Based and Individual-Based Modeling: A Practical Introduction, Princeton: Princeton University Press.

*Software:*

1. NetLogo –
* Go to <http://ccl.northwestern.edu/netlogo/> and download and install version 5.0.3. If you are using a Mac running Mountain Lion, please be sure to read the special note on the download site.
1. VENSIM PLE
* Download software at <http://www.vensim.com/freedownload.html>
* Download Users Guide at <http://www.vensim.com/ffiles/VensimUsersGuide.zip>
* You may also wish to download further documentation at <http://www.vensim.com/documentation.html>

*Other Readings*

* These are identified in the session descriptions below. All will be easily available through the internet or made available on the class Blackboard site.

*Journals and websites of Potential Interest*

* Systems Research and Behavioral Science
* System Dynamics Review
* Journal of Artificial Societies and Social Simulation
* Systems Wiki - <http://www.systemswiki.org/index.php?title=Main_Page>
* Systems Modelbook - <http://www.systemsmodelbook.org/>

**Use of Blackboard**

I will use Blackboard to help manage the course. This syllabus and any revisions will be posted on the course Blackboard site as will any readings that are not readily available through the library or internet. There will also be periodic announcements related to the class. I will also make grades available through the site.

**Course Requirements and Grading**

Your course grade will be based upon the following components:

* Attendance and participation – 5%
* Homework exercises – 25%
* Quiz – 25%
* Group Project – 45% (initial proposal, revised proposal, final presentation, final paper)

**Attendance and Participation**

You are expected to come to the class having read the assigned material and prepared with questions you have related to it. In addition, there are in-class activities each week, which will involve individual and group work. I strongly encourage mutual learning experiences, so attendance is expected.

**Homework Exercises**

There will be a number of homework exercises. These are designed to give you additional practice working with the system tools introduced in the course.

**Quiz**

There will be a mid-term quiz (≈ 60 minutes) in week 6.

**Group Project**

The group project will involve exploring a topic of interest to you in some depth from a systems perspective. Topics addressed in past years included intrastate conflict (informed by experiences in Bosnia), the Libya uprising, the links between gender, land tenure, and AIDS in Africa, population growth and aging in China, and the effect of sanctions on Iran on nuclear proliferation. You will need to submit an initial project proposal in Week 5 and a revised project description, including an initial model conceptualization in Week 7. Groups will present during the final exam period and the final report will be due at the end of the final exam period, i.e. by 5PM on Thursday, June 6, the day after the finals period ends (you can always turn it in earlier). I will provide more detail on the requirements for the project proposal, description, and final report and presentation.

***Please note that I follow a flexible before/rigid after approach to deadlines. In other words, if you foresee a problem meeting a specific deadline and speak with me beforehand, I will usually be fairly flexible. However, if you wait until the day of the deadline or sometime after, do expect to have deductions taken from your mark for that assignment, the equivalent of one letter grade per day.***

**Mar 26. Session 1: Introduction**

*In this session we will introduce ourselves and take an overview of the course. The readings and activities will set the foundation for the remainder of the quarter. In the activities period, we will make sure everybody gets set up with the software we will be using.*

Readings

* Meadows "Introduction", pp. 1-7.
* Jervis Chapter 1 “Introduction”, pp. 3-28
* Epstein, Joshua M. 2008. “Why Model?” *Journal of Artificial Societies & Social Simulation* 11(4) (October): 4. (available at <http://jasss.soc.surrey.ac.uk/11/4/12.html>).
* Thompson, Nicholas S., and Patrick Derr. 2009. “Contra Epstein, Good Explanations Predict.” (available at <http://jasss.soc.surrey.ac.uk/12/1/9.html>)
* Troitzsch, Klaus G. 2009. “Not All Explanations Predict Satisfactorily, and Not All Good Predictions Explain.” (available at <http://jasss.soc.surrey.ac.uk/12/1/10.html>)
* Tierney, John (2011) “When Energy Efficiency Sullies the Environment”, *NY Times*, 7 March. (available on Blackboard)

Activities – Setting up Software and Simple comparison of System Dynamics and Agent-Based Modeling approaches

**Apr 2. Session 2: System Concepts and Systems Modeling I – Elements, Interactions, and Boundaries**

*In this session we will begin our exploration of basic concepts in systems thinking. We will also discuss and work with causal loop diagrams and other tools for diagraming system structure.*

Readings

* Meadows Chapter One "The Basics", read pp. 11-25.
* Jervis Chapter 2 “System Effects”, pp. 29-91
* Pearl 1997 “The Art and Science of Cause and Effect”, lecture available at http://singapore.cs.ucla.edu/LECTURE/lecture\_sec1.htm
* Epstein, Josh M. 1999. “Agent-based computational models and generative social science.” *Complexity* 4(5): 41-60.

Activities – Learning to Diagram Systems

* Sterman “Causal Loop Diagrams” (pp. 137-169, available on Blackboard)
* Richardson, George P. (1997) “Problems in Causal Loop Diagrams Revisited” (available at <http://www.clexchange.org/ftp/documents/system-dynamics/SD1997-09ProblemsInCLDsRevi.pdf>.)
* Sterman “Stocks and Flows” (pp. 191-217, available on Blackboard)
* Railsback and Grimm “Describing and Formulating ABMs: The ODD Protocol” (pp. 35-45, available on Blackboard)

**Apr 9. Session 3: System Concepts and Systems Modeling II - Feedback**

*This session will continue exploring key systems concepts, with an emphasis on feedbacks. In the activities period, we will start looking at the software.*

Readings

* Meadows Chapter One “The Basics”, read pp. 25-34
* Jervis Chapter 4 “Feedback”, pp.125-176
* Albert Bartlett Lecture - Arithmetic, Population and Energy: watch at (<http://old.globalpublicmedia.com/lectures/461>)

Activities

* Sterman “Numerical Integration” (pp. 903-911, available on Blackboard)
* Look at the sample model and tutorials in the NetLogo 5.0.3 User Manual starting on p.21 and the System Dynamics Guide starting on p.175.

**Apr 16. Session 4: System Concepts and Systems Modeling III – Delays and Characteristic System Behaviors**

*This session will continue exploring key systems concept, with an emphasis on delays.*

Readings

* Sterman “Delays” (pp. 409-437) and “Structure and Behavior of Dynamic Systems” (pp. 107-133)
* Meadows, Chapter Two "A Brief Visit to the Systems Zoo", pp. 35-72.
* Introduction to the Beer Game (available on Blackboard)

**Apr 23. Session 5: The Systems Zoo: Common States, Structures, and Behavior**

*This session will continue our exploration of basic system concepts by examining a variety of simple models.*

Readings

* Meadows, Chapter Three "Why Systems Work So Well", pp. 75-85.
* Meadows, Chapter Four "Why Systems Surprise Us", pp. 86-110.

Activities

* Presentation and Discussion of Project Proposals
* Working with Sample Models

**Apr 30: Session 6: Review of First Half of Course / Common Reasons Systems Surprise Us**

*This session will begin with a quiz on the basic concepts explored thus far in the class. We will spend the remainder of the class playing a classic game in the context of systems thinking.*

* Quiz
* Verbal comments on initial project proposals
* The Beer Game

**May 7: Session 7: System Archetypes/Traps**

*In this session we will begin to put together the building blocks from the first half of the course to explore what are called system traps – archetypical system structures that result in perverse and generally undesirable behavior.*

* Review Quiz #1

Readings

* Meadows, Chapter Five "System Traps . . . and Opportunities", pp. 111-141.
* Wolstenholme, E.F. (2003). “Towards the Definition and Use of a Core Set of Archetypal Structures in System Dynamics,” *System Dynamics Review* 19(1): 7-26. (available online)
* Braun, William. (2002). “The System Archetypes,” available at <http://wwwu.uni-klu.ac.at/gossimit/pap/sd/wb_sysarch.pdf>.

Activities

* Working with Sample Models

**May 14: Session 8: Games against Each Other and Games against Nature**

*In this session we will take a closer look at the Tragedy of the Commons archetype and complement this with a consideration of a similar, yet distinct concept – the Prisoners’ Dilemma*

* Submit revised project proposal

Readings

* Hardin, Garrett. (1968). “Tragedy of the Commons,” *Science* 162 (3859): 1243-1268 and (1998) “The Tragedy of the Commons – Extension,” both available at http://www.garretthardinsociety.org/articles/articles.html; and (1994). “The Tragedy of the Unmanaged Commons,” Trends in Ecology and Evolution 9(5): 199. (available online)
* Ostrom, Elinor, Roy Gardner, and James Walker (1994). *Rules, Games, & Common-Pool Resources*, Ann Arbor: The University of Michigan Press. Chapters 1 and 3 (on Blackboard)
* Nowak, Martin A. (2012). “Why We Help.” *Scientific American* 306 (7): 34-39. (on Blackboard) and (2006). “Five Rules for the Evolution of Cooperation.” *Science* 314 (5805) (December 8): 1560–1563. (available online, fairly technical, focus on main ideas)

Activities

* Working with Sample Models

**May 21: Session 9: Small Differences Can Have Big Effects/History Matters**

*In this session we will take a closer look at the Success to the Successful archetype and look at some related ideas such as path dependence and chaos*

* David, Paul. (1985). “Clio and the Economics of QWERTY.” *American Economic Review* 75(2): 332-337. and (2007). “Path Dependence: A Foundational Concept for Historical Social Science.” *Cliometrica* 1 (2): 91-114. (both available online)
* Pierson, Paul. (2000). “Increasing Returns, Path Dependence, and the Study of Politics,” *American Political Science Review* 94(2): 251-267. (available online)
* Page, Scott E. (2006). “Path Dependence,” *Quarterly Journal of Political Science* 1(1): 87-115. (available online)

Activities

* Working with Sample Models

**May 28: Session 10: Contagion – The Spread of Ideas, Illnesses, and Other Such Things**

*In this session we will explore models related to the spread of diseases and ideas. We will also start to round off the course by thinking about how to intervene in systems.*

Readings

*(In looking at the following three readings, focus on the key ideas and try not to get caught up in the mathematics. In class, we will look at how to avoid some of the math by representing some of these ideas in System Dynamics and Agent-Based Models)*

* Burbeck, Stephen L, Walter J Raine, and MJ Abudu Stark. 1978. “The Dynamics of Riot Growth: An Epidemiological Approach.” *Journal of Mathematical Sociology* 6 (1): 1–22. (on Blackboard)
* Epstein, Joshua M. (1997). *Nonlinear Dynamics, Mathematical Biology, and Social Science*, Addison-Wesley Publishing Company, Inc.: Reading MA. Lecture 4: Revolutions, Epidemics, and Ecosystems: Some Dynamic Analogies (on Blackboard)
* Tsebelis, George, and John Sprague. (1989). “Coercion and Revolution: Variations on a Predator-Prey Model.” *Mathematical and Computer Modelling* 12 (4–5): 547–559. (available online)
* Meadows Chapter Six "Leverage Points - Places to Intervene in a System", pp. 145-165

Activities

* Working with Sample Models

**Final Examination Period (Tuesday June 4, 2PM) Reflections and Presentations**

***ALL STUDENTS ARE EXPECTED TO ATTEND THE COMPLETE SESSION***

*In this final session, we will reflect on the key concepts reviewed in the course and see how these exhibit themselves in the class projects.*

Readings

* Meadows Chapter Seven "Living in a World of Systems", pp. 166-185.
* Sterman, John D. (2002). “All Models are Wrong: Reflections on Becoming a Systems Scientist,” *System Dynamics Review* 18(4): 501-531. (available online)
* Richmond, Barry. (2010). “The Thinking in Systems Thinking: Eight Critical Skills,” in Joy Richmond, Lees Stuntz, Kathy Richmond, and Joanne Egner (Eds.) *Tracing Connections: Voices of Systems Thinkers*, Lebanon, NH: isee systems, inc. pp.3-21. (provided on Blackboard)

Activities

* Presentation and Student Evaluation of Final Projects