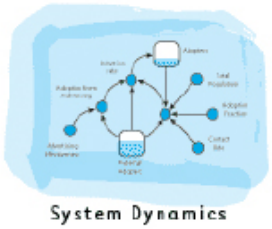
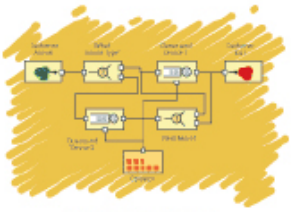
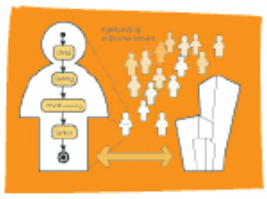
SOC125/PPOL 225

# Simulation and Modeling in the Social and Policy Sciences

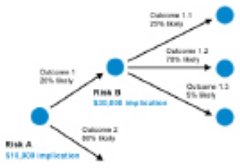

System Dynamics


Discrete Event

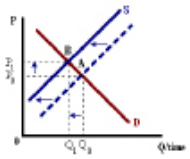

Agent Based

Instructor: Dan Ryan • Lecture: Tu-Th 9:30 - 10:45 • Lab/workshop alternating Wed 1:00-4:00

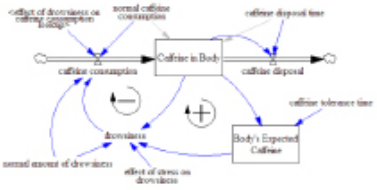
## Description



This is a hands-on class designed to introduce students to the exciting world of computer modeling and simulation. Course begins with concept of modeling in general and then visits several standard approaches to modeling and simulation such as queuing, intelligent agents, Monte Carlo, Markov, cost-benefit, system dynamics, linear programming, decision analysis. Data and examples are drawn from economics, history, political science, public policy, anthropology, and sociology. Lectures will cover theory, demonstration, and problem solving. The course necessarily includes "knowledge about," but goal is "knowledge how to" – that is, becoming adept at "flying" computer applications. Graded work will include regular problem sets and two individual projects. Class will meet for workshops/lab every other Wednesday, but students should also expect to spend time on computer outside of class. Participants *will* increase their facility in the use of standard desktop software, but this is NOT a course in Excel, Word, or Access.

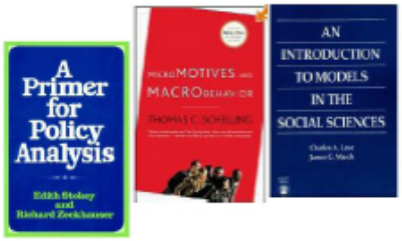


## Prerequisites



Minimal: (1) computer skills equivalent to an excellent completion of COLL005, (2) solid college level algebra and a general openness to things mathematical, and (3) previous course work in social sciences beyond the introductory level. Ideal: calculus, some computer programming, introduction to economics, advanced courses in social/policy sciences.

## Books (tentative)




James G. March and Charles A. Lave. *An Introduction to Models in the Social Sciences*

Thomas Schelling. *Micromotives and Macrobehavior.*

Edith Stokey and Richard Zeckhauser. *A Primer for Policy Analysis*

**Course Policies**

Students are expected to attend all class meetings, arriving early and having completed all readings and other assignments due on that date. Students are responsible for keeping track of the syllabus and where we are on it.

Written assignments should be submitted at the start of class on the day on which they are due. Unannounced late work will not be accepted. If one expects to be unable to complete something on time, one must give prior notice (the night before is not considered "prior") with an indication of the date on which a finished product can be expected AND submit on-time a presentable version of that which could be completed as a down payment. A letter grade penalty should be expected per week of tardiness.

Every effort will be made to make this class accessible for students regardless of disability. Students with needs for accomodation should contact for Students with Disabilities (Cowell Building, x2130) and inform the instructor in order for access to be arranged adequately and promptly.

Customary academic standards academic integrity (including proper bibliographic citation) apply. It is your responsibility to know what these are and to follow them. Collaborative learning is encouraged, but work that is submitted under your name as a demonstration of your skills and competence must represent YOUR work. Plagiarism, as defined under the Mills College Honor Code, will be cause for, at a minimum, a failing grade in this course. Please consult with instructor if you have any questions, or even the slightest doubt, about how to follow these requirements.

## Assignment #1: Logic, Process, Cost, Decisions

This assignment assumes that you have a nascent project for your masters paper. All the questions here refer to that project. If you are an undergraduate, you can use a project of your own devising (probably good to consult with instructor) or take the presented issue of undergraduate persistence in liberal arts colleges.

NOTE: you probably don't know most of the techniques described below. That's OK; this is not an entrance exam! Just make whatever sense you can based on everyday language and the examples given and produce a two page or so document with your best-shot-at-this-point-in-time.

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Most policy projects can — with a certain amount of "analytical license" — be morphed into a form that looks something like this:

1. There is an issue/problem that my client cares about. We'll call it the *status quo.* The client wants to change the *status quo* or keep the *status quo* from changing.

2. There is a process or system — perhaps my job is to figure out what it is — that produces the *status quo.*
3. We believe that there exists some intervention into this process — perhaps it is my job to design one — that can move matters toward a more desirable (an admittedly problematic concept) state.
4. Implementing an intervention will require decisions — perhaps about which alternative to choose or about whether or not intervene at all.
5. Actions require resources (either new or redirected) and hopefully produce results. Decisions are usually based on which actions will yield the most results we care about for the least expenditure of things we care about (time, money, good will, forests, whatever).

Your Assignment: Translate your project — in whatever state of preliminary-ness it may be in — into the above form (either in your head or on paper) and produce a four page document that includes the following.

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## Logic Model

A logic model represents how we think an intervention will give rise to desirable results. A logic model diagram typically shows what "inputs" an intervention involves (resources, information, people), outputs (what the intervention will deliver in terms of activities, services, products), outcomes (results or changes for persons, organizations, or communities), assumptions, and environment (external factors that will affect the intervention).

Based on whatever you already know about your case, sketch a logic model that describes how a possible intervention (perhaps one your client has in mind, perhaps a generic intervention you have general knowledge of, or perhaps just something you make up).

**Examples**


☞"source"


☞source


☞source

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## Flow Chart

A flow chart is a picture of a process or system that shows the how activity proceeds or how a case moves through the system or the protocol that is followed to figure out which of the things that an organization can do should be done in what order. Draw a flow chart for the process that is most "at the heart of" the thing your project is on. Some examples (not all exemplary) are shown below.

**Examples**

http://aspe.hhs.gov/HSP/cps-status03/site-visits/ch7.htm
http://www.mncasa.org/svji_legal_flow2.html
http://www.cafamerica.org/dnn/AboutUs/HowWeWork/tabid/117/Default.aspx

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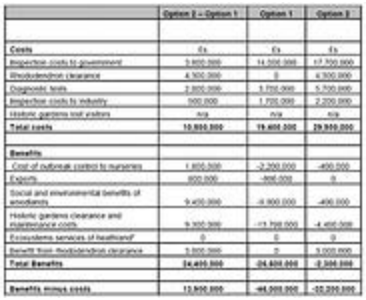
## Benefits and Costs

Benefit cost analysis is basically the process of tallying up all costs and all benefits of different alternatives and then following a procedure for selecting among the alternatives. The analysis itself can come in many forms — narrative, tabular, graphic. Some examples below.

Considering what you know or can surmise about your project, what are some likely costs and benefits associated with possible interventions? Write a paragraph (no more than 250 words!) about how you think these stack up. If you want to include a table or chart, that's fine, but it has to be included in the word count and it all has to fit on one page.

**Examples**

☞http://it.toolbox.com/blogs/irm-blog/the-elements-of-costbenefit-analysis-3724
☞http://www.bbc.co.uk/blogs/thereporters/markeaston/2009/03/the_cost_of_fungus.html

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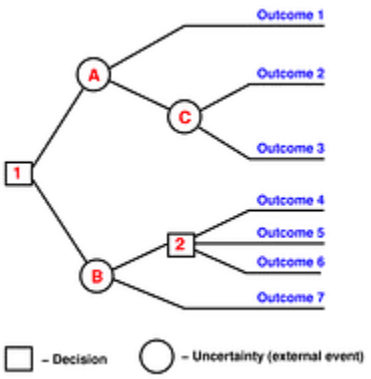
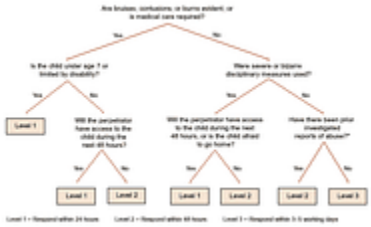
## Decisions

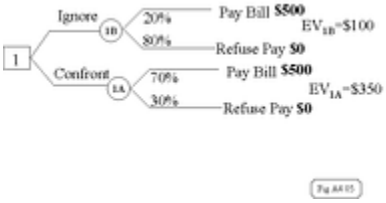
In the end, our work comes down to decisions. Typically, decisions are spread out in time and early decisions close off or open up opportunities for later decisions (for example: a mountain vacation or a seaside vacation? Once I've chosen mountains or beach, then I get to choose specific locations and then after that, perhaps, I get to choose specific activities.).

Again, consider what you know or can surmise about your project and sketch out the sequence of decisions that your client will likely face in response to any suggestions or alternatives you may present. There are many ways to do this, but a typical one is a decision tree as shown below. Time proceeds left to right and at each branching we face a decision.

**Examples**






source
☞http://www.ncjrs.gov/html/ojjdp/jjbul2001_7_1/page4.html
☞http://www.keysdreams.com/conf-res/decision_making_chapter.htm

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Tues | **JAN** | 19 | 26 | **FEB** | 2 | 9 | 16 | 23 | **MAR** | 2 | 9 | 16 | SB | 30 | **APR** | | 6 | 13 | 20 | 27 | **MAY** | 4 |
| Wed | | 20 | 27 | | 3 | 10 | 17 | 24 | | 3 | 10 | 17 | | 31 | | | 7 | 14 | 21 | 28 | | 5 |
| Thur | | 21 | 28 | | 4 | 11 | 18 | 25 | | 4 | 11 | 18 | | | | 1 | 8 | 15 | 20 | 29 | | |

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## Detailed Schedule

### Week 1

**1.20**

**LAB: Preliminaries**

Getting started.

**1.21**

**Course Introduction**

What is the course about? Short answer: the world demands of us not answers rooted in ideology and conviction, but analysis. Our recommendations and conclusions are believable because we apply tried and true techniques. These techniques help us to understand how systems work, to predict what will happen under various conditions, and to make decisions among alternative courses of action to achieve goals.

#### Readings

Stokey & Zeckhauser, ch. 1, "Thinking About Policy Choices," pp. 3-7. (see leading questions here)
Stokey & Zeckhauser, ch. 2, "Models" A General Discussion," pp. 8-21.(see leading questions here)

#### Optional

Schelling, Ch. 1, *Micromotives and Macrobehavior*, pp. 9-44.

#### Handouts

Main Points and In Class Exercise

### Week 2

**1.26**

## Flow Charts and Logic Models

*Probably the two most common diagrammatic models. A flow chart is a graphical representation of a process. It shows a time sequence of steps and changes in sequence based on information. A logic model is a visual representation of the inputs, actions, and outputs of a system or program. It shows how the system or program produces desired results.*

**Readings**

1. Wikipedia articles on Flow Charts
2. Flow Charts for Simple Tasks: Tutorial with exercises at Univ Plymouth, UK
3. Flow Charts for Classification: Tutorial with exercises at Univ Plymouth, UK
4. An overview by HCI consulting in Australia
5. Human Subject Regulations Decision Charts at U.S. Department of Health and Human Services (HHS)

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1. http://en.wikipedia.org/wiki/Logic_model
2. http://www.cdc.gov/DHDSP/state_program/evaluation_guides/pdfs/logic_model.pdf
3. http://www.innonet.org/client_docs/File/logic_model_workbook.pdf
4. W.K. Kellogg Foundation Logic Model Development Guide
5. http://uidaho.edu/extension/LogicModel.pdf
6. http://en.wikipedia.org/wiki/Logic_model
7. How to Develop a Logic Model for Districtwide Family Engagement Strategies
8. Download a Worksheet from http://www.shapingoutcomes.org/course/model/index.htm

**1.27 LAB**

## LAB: Drawing Flow Charts and Logic Models

*Microsoft Office offers a number of tools for drawing "eye candy" diagrams, but we'll focus on some basic drawing skills rather than those deskilling tools.*

**Readings**

PREP

MS Word Help: Drawing Flowcharts

See also

MS Excel Help: Create or change a cell reference

MS Excel Help: Overview of formulas

MS Excel Help: Understanding Array Formulas

MS Excel Help: FREQUENCY function

MS Excel Help: Under "absolute cell reference" view the video: Understanding relative and absolute in Excel (Brainstorm Inc.)

**1.28**

## Flow Charts and Logic Models

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1. Wikipedia articles on Flow Charts
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4. An overview by HCI consulting in Australia
5. Human Subject Regulations Decision Charts at U.S. Department of Health and Human Services (HHS)

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1. http://en.wikipedia.org/wiki/Logic_model
2. http://www.cdc.gov/DHDSP/state_program/evaluation_guides/pdfs/logic_model.pdf
3. http://www.innonet.org/client_docs/File/logic_model_workbook.pdf
4. W.K. Kellogg Foundation Logic Model Development Guide
5. http://uidaho.edu/extension/LogicModel.pdf
6. http://en.wikipedia.org/wiki/Logic_model
7. How to Develop a Logic Model for Districtwide Family Engagement Strategies
8. Download a Worksheet from http://www.shapingoutcomes.org/course/model/index.htm

**Week 3**

**2.2**

## Benefit Cost Analysis I

*Benefit cost- analysis has, perhaps more than any other analytical technique covered in this course, become an everyday concept. And, fortunately, the real thing is, more or less, the same as its popularization. But even if the concept is well known, how to carry out a cost-benefit*

*analysis well requires a little training.*
*This approach is generally intended to be ex-ante – that is, we will attempt to evaluate projects before they are implemented. We lay out how to deal with multi-attributed outcomes, set up and carry out benefit/cost and cost effectiveness analysis and zero in on when they are appropriate and what limitations they are subject to.*

**Readings**

Read SZ 134-153

**2.3**

## CBA with Excel

We'll use Excel to apply 5 CBA scenarios to a fictional case of downtown revitalization.

**2.4**

**Benefit Cost Analysis II**

*Different types of CBA problems*

**Readings**

continue S&Z on CBA

Sunday February 7 Problem Set One due 5 p.m.

**Week 4**

**2.9**

**Benefit Cost Analysis II**

*Different types of CBA problems*

**Readings**

continue S&Z on CBA

**2.10 LAB**

**2.11** More CBA

**Week 5**

**2.16** More CBA

**2.17**More CBA

**2.18** More CBA

Friday February 19 Problem Set Two due before midnight

**Week 6**

**2.23**

**Difference Equations I**

*Abstract*

**Readings**

Stokey & Zeckhauser, ch. 4, "Difference Equations," pp.47-58.

**2.24**

**2.25**

**Difference Equations Equilibrium and Stability**

*Abstract*

**Readings**

Stokey & Zeckhauser, ch. 4, "Difference Equations," pp.58-68.

**Week 7**

**3.2** More Difference Equations

**3.3** More Difference Equations

## Lab: Difference Equations Simulator

Upload new file "practice.xlsx"

**3.4** More Difference Equations

Friday March 5 Problem Set Three due before midnight

**Week 8**

**3.9** Difference Equations: Stocks and Flows

**Stock and Flow Models I**

*Lots of important processes can be modeled as "stocks" (anything we can count or measure and care about the amount of) and "flows" changes in stocks — flows in and flows out. This is the "bathtub" model of reality with the added feature that a system can consist of multiple bathtubs linked together in interesting ways.*

**Readings**

SZ, ch. 4, pp. 68-73

**Suggested/Optional**

Kirkwood, Craig W. *System Dynamics Methods: A Quick Introduction*
Ch 1. " System Behavior and Causal Loop Diagrams" (PDF)

Ch 2. " A Modeling Approach" (PDF)

**3.10** Difference Equations Lab and Problems

**LAB: Building a Simple Stock and Flow Simulation**

*In this lab we'll build a very simple stock and flow simulation with Excel*

**Readings**

TBA

**3.11** A Difference Equation Approach to Queues

**Queues I**

*Abstract*

**Readings**

Stokey & Zeckhauser, ch. 5, "Queues," pp.74-83
Probability Refresher

**Week 9**

**3.16** Monte Carlo Models of Queues

**Queues II**

*More on queues and waiting.*

**Readings**

Finish S&Z on queues.

**3.17** A Simple Queuing Model With Excel

**Lab: Simulating Queues with Excel**

*Abstract*

**Readings**

Stokey & Zeckhauser, ch. 6, "Simulation," pp.89-97.
Queuing Model in Wikipedia http://en.wikipedia.org/wiki/Queueing_model
Wikipedia on Poisson distribution and Poisson Process

**Optional**

Schwartz, Barry. Queuing and Waiting : Studies in the Social Organization of Access and Delay. Chicago, Ill.: The University of Chicago Press, 1975.

"Queuing Theory in Operations Management" @ St. Norbert College ⇨ http://www.snc.edu/socsci/chair/333/quethry.htm

**3.18** Waiting as Deadweight Loss

**Waiting Time as Deadweight Loss**

*Abstract*

**Readings**

Stokey & Zeckhauser, ch. 5 "Queuing," pp. 83-88.

Friday March 19 Problem Set Four (Using a Queuing Model) due before midnight

**Week 10**

**3.30**

**Markov Models I**

*Abstract*

**Readings**

Stokey & Zeckhauser, ch. 7, "Markov Models," pp. 98-107.
Stokey & Zeckhauser, ch. 7, "Markov Models," pp.104-114.
⇨MS Excel Help: "Introduction to Monte Carlo simulation"

**3.31**

**TBA**

*Abstract*

**Readings**

*TBA*

**4.1**

**TBA**

*Abstract*

**Readings**

*TBA*

**Week 11**

**4.6**

**Decision Analysis I**

*Abstract*

**Readings**

Stokey & Zeckhauser, ch. 12, "Decision Analysis," pp.201-208.

**4.7** Lab Decision Analysis

**4.8**

**Decision Analysis II**

*Abstract*

**Readings**

x

Friday April 9 Problem Set Five due before midnight

**Week 12**

**4.13**

**4.14**

**LAB: Discounting**

**Readings**

Excel help for functions ⇨FV, ⇨NPV, ⇨PV, ⇨POWER.

**4.15**

**Week 13**

**4.20**

**Decisions with Uncertainty**

*Abstract*

**Readings**

Stokey & Zeckhauser, ch. 12, "Decision Analysis," pp.208-219.

**4.21**

**TBA**

*Abstract*

**Readings**

*TBA*

**4.22**

**Decisions: The Value of Information**

*Abstract*

**Readings**

Stokey & Zeckhauser, ch. 12, "Decision Analysis," pp.219-236.

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Friday April 22 Problem Set Six due before midnight

**Week 14**

**4.26**

**TBA**

*Abstract*

**Readings**

*TBA*

**4.27**

**Communicating Results I**

*Abstract*

**Readings**

x

**4.28**

**Communicating Results I**

*Abstract*

**Readings**

x

**Week 15**

**5.4**

**Cautions, Caveats, and Marching Orders**

*Abstract*

**Readings**

Stokey & Zeckhauser, ch. 15, "Putting Analysis to Work," pp.320-329

**5.5** PARTY???

## Goals and Criteria

| Mission Goals | | |
|---|---|---|
| | Goal Desc | Criteria |
| | Students will learn to think critically. (Practice) Every technique learned in this course involves critical thinking. If students master the techniques, they've demonstrated critical thinking. See syllabus for details. | |
| **Program Goals** | | |
| | Goal Desc | Criteria |
| Public Policy | Analytic skills relevant to problem-identification, problem-solving, and decision-making (Practice, Master) | Correct solution of problems in problem sets and labs. |
| | Analytic applications aross policy areas and in-depth (Practice) | Correct solutions to problems in problem sets and labs. |
| | Professional communication skills (Practice, Master) | Presentation of problem solutions in memo and verbal presentation form. |

## Assignments

Approximately 7-10 problem sets/labs constitute the work of the course. Each has approximately 5 components, usually ranging from straightforward to challenging in terms of level of competence required for correct completion.

## Assessment Plan

Keep track of overall pattern of relative success in problem solutions.