INTRODUCTION TO DECISION ANALYSIS

CEE 598
Fall 3 Credits
Instructor: Dr. Rachel Davidson (rad24@cornell.edu)
Prerequisite--Course in probability and statistics

Which Superfund hazardous waste sites should be cleaned up and in what order?

Should a building owner seismically upgrade his building, buy earthquake insurance, or do nothing?

Should a company introduce a new product? Build a new production facility? Enter a new market?

Should the government use controlled burning in forest management?

Should a structural engineering firm bid on a project?

Should a patient with cancer have experimental surgery?

Should an oil company dig an exploratory well? How many? Where?

Which job should you take after graduation?

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Decisions are everywhere—in engineering and in life. Uncertainty, competing objectives, and complexity make many decisions difficult. Decision analysis offers a framework for analyzing decision problems systematically, and a set of analysis tools to help model decisions and determine the best course of action.

This course will cover three main areas:

1. **The framework**. We will learn how to structure the way we think about decision situations that are complicated by uncertainty, complexity, and competing objectives.
2. **Analysis tools**. We will learn a suite of concepts and tools used in decision analysis, including, for example, decision frames, influence diagrams, decision trees, Monte Carlo simulation, sensitivity analysis, utility functions, and value of information analyses.
3. **Case studies**. We will examine many case studies and examples that relate to the planning, designing, operating, and maintaining engineering structures and facilities, as well as to areas outside of engineering. Examples, like those mentioned above, will illustrate the decision analysis process and concepts, and the application of the specific analysis techniques.

CEE 598 will provide a set of tools and a way of thinking that can help in almost every area of engineering. All graduate and upper-level undergraduate students are welcome.

COURSE INFORMATION (Fall 2000)

Classes

MWF 11:15am-12:05pm
Hollister 366

Course objectives

At the end of the course, students will be able to:

1. use a new approach and framework to structure the way they think about decision situations that are complicated by uncertainty, complexity, and competing objectives
2. apply specific decision analysis concepts and tools to help them make those decisions

The course will be primarily a prescriptive discussion of the way that decisions *should be* made; rather than a descriptive explanation of the way that decisions generally *are* made.

Instruction

Dr. Rachel Davidson
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Office hours

Hollister Building, Room 373
Wednesday After class–1:30pm
Friday 9:30am–11am
or by appointment

Prerequisite

There is no prerequisite, although some background in basic probability and statistics will be helpful.

Required text

Clemen, Robert T. 1996. *Making Hard Decisions: An Introduction to Decision Analysis*, 2nd ed. Belmont, CA: Duxbury Press.

Software

It is suggested that each student purchase a student version of the decision analysis software entitled *DATA 3.5* by TreeAge Software, Inc. There will be a signup in the second week so that all students can order copies together. The price is $40/copy if there are at least 10 orders, or $30/copy if there are at least 25 orders. There will also be a few copies available on the computers in Carpenter for those students who do not wish to purchase their own.

Course format The course will follow the text fairly closely. I will assume that students have read and understood the assigned chapters. During class meetings, I will use discussions, in-class exercises, and supplementary material to highlight the most important issues and help students gain a deeper understanding of them. The aim is to make classes worthwhile in themselves, rather than just a repetition of the reading.

The course will include many case studies that illustrate the application of decision analysis in a variety of contexts.

Homeworks Several homework assignments will be distributed during the course. Homeworks are due *at the beginning of class* on the assigned date. Each graded homework will be returned with an accompanying solution set in class the following week.

Late homeworks (that means any homeworks handed in after the beginning of class) will be reduced by 25%. Homeworks will not be accepted for credit after the solution set is distributed.

Homework grades will be based on: (1) thought process and procedure, (2) clarity, and (3) final answer.

Group project A small group project will be assigned midway through the semester. The project essentially will involve analysis of a real-world decision situation of the group's choosing. The project typically will include structuring values, identifying alternatives, collecting and modeling information about these alternatives, and doing appropriate analyses to help make the choice. The project will incorporate topics from the entire semester to provide both a review of the methods studied, and an improved understanding of how they can be applied to a real-world situation. Students will be required to submit a written project proposal, draft report, and final report, and to make a project presentation.

Grading

Homeworks	30%
Midterm	20%
Project	20%
Final exam	30%

Class participation will determine borderline grades.
The lowest homework grade may be dropped.

Course materials Unclaimed graded homeworks, homework solutions, and extra copies of any course materials will be available in a box outside Dr. Davidson's office, Hollister 373.

[1] Readings from required text: Clemen, Robert T. 1996. *Making Hard Decisions: An Introduction to Decision Analysis*, 2nd ed. Belmont, CA: Duxbury Press.
[2] Homework is due on this date at the beginning of class.

SYLLABUS

Week	Date		Topic	Reading due[1]	Homework due[2]
	Aug. 25	F	Course introduction.		
1	Aug. 28	M	Introduction. What is decision analysis? Why do it? Elements of decisions.	Ch. 1, 2	
	Aug. 30	W	Structuring decisions. Value-focused thinking. Structuring values.		
	Sept. 1	F	Structuring decisions. Framing decisions.	Ch. 3	
2	Sept. 4	M	Structuring decisions. Influence diagrams.		HW 1
	Sept. 6	W	Uncertainty. Probability basics.	Ch. 7	
	Sept. 8	F	Uncertainty. Probability basics.		
3	Sept. 11	M	Structuring decisions. Decision trees.		HW 2
	Sept. 13	W	Structuring decisions. Decision trees.		
	Sept. 15	F	Making choices. Solving trees.	Ch. 4*	
4	Sept. 18	M	Making choices. Dominance. Multiobjective decisions.		HW 3
	Sept. 20	W	Sensitivity. One-way, two-way sensitivity.	Ch. 5	
	Sept. 22	F	Sensitivity. Tornado diagrams. Sensitivity to probabilities.		
5	Sept. 25	M	Decision analysis software. Meet in ***Room??***		HW 4
	Sept. 27	W	Decision analysis software. Meet in ***Room??***		

* Skip optional sections.

Week	Date		Topic	Reading due[1]	Homework due[2]
5	Sept. 29	F	Generating alternatives. Blocks to creativity.	Ch. 6	
6	Oct. 2	M	Generating alternatives. Techniques to enhance creativity.		HW 5
	Oct. 4	W	Generating alternatives. Techniques to enhance creativity. Assign project.		
	Oct. 6	F	**Midterm**.		
7	Oct. 9	M	**Fall break**. No class.		
	Oct. 11	W	Uncertainty. Subjective probability assessment.	Ch. 8	
	Oct. 13	F	Uncertainty. Subjective probability assessment.		
8	Oct. 16	M	Uncertainty. Theoretical probability models.	Ch. 9, 10	HW 6 Project proposal
	Oct. 18	W	Uncertainty. Theoretical probability models. Using data.		
	Oct. 20	F	Uncertainty. Value of perfect information.	Ch. 12	
9	Oct. 23	M	Uncertainty. Value of imperfect information (experimentation).		HW 7
	Oct. 25	W	Preferences. Risk attitudes.	Ch. 13	
	Oct. 27	F	Preferences. Certain equivalent. Expected utility.		
10	Oct. 30	M	Preferences. Utility functions.		HW 8
	Nov. 1	W	Preferences. Utility axioms.	Ch. 14	

Week	Date		Topic	Reading due[1]	Homework due[2]
10	Nov. 3	F	Multiple objective decisions. Additive utility functions.	Ch. 15	
11	Nov. 6	M	Multiple objective decisions. Additive utility functions.		HW 9
	Nov. 8	W	Multiple objective decisions. Analytic hierarchy process.	Handout	
	Nov. 10	F	Multiple objective decisions. Multiattribute utility functions.	Ch. 16	
12	Nov. 13	M	Multiple objective decisions. Multiattribute utility functions.		Draft project report
	Nov. 15	W	Multiple decision makers.	Handout	
	Nov. 17	F	Multiple decision makers.		
13	Nov. 20	M	Uncertainty revisited. Monte Carlo simulation.	Ch. 11	Final project report
	Nov. 22	W	Uncertainty revisited. Monte Carlo simulation.		
	Nov. 24	F	**Thanksgiving break**. No class.		
14	Nov. 27	M	Project presentations.		
	Nov. 29	W	Project presentations.		
	Dec. 1	F	Review for final.		HW 10
	Dec. 14	Th	**Final exam**. 12:00noon - 2:30 pm.		