Risk and Decision Analysis & Engineering Systems Analysis for Design

Course Introduction

IDS.332J and IDS.333
Welcome!

- It’s a pleasure to be with you – in person
- We will be covering much new material
- I look forward to learning with you
- Hope to make some long-term friends
GOOD MORNING!

BONJOUR!
¡BUENOS DIAS!
GUTEN MORGEN!
SALAAM ALEIKUM!
O HAYO GOZAIMASU!
SELAMAT DATANG!
КАΛΗ ΜΕΡΑ!
NI HAO MA!
NAMASTE!
SHALOM!
BOM DIA!
Today’s class has 4 parts

1. Brief Course Introduction
2. Review of Pre-Read Responses
3. Discussion of Paradigm Shift
4. Example Project
IDS.333J / IDS.332

- You are at opening of 2 subjects!
- IDS.332J (also 1.146, 16.861): *Engineering Systems Analysis for Design* 12 units
- IDS.333: *Risk and Decision Analysis* 6 units
  (at pace or 12 hours/week or ½ semester)
  - Methods, followed by applications in either
  - IDS.332 for those that continue in fall
  - IDS.330 6 unit Spring course *Real Options for Product and System Design*
- Which should you choose (if any)?
Many students choose either
- Combination of 6 unit Fall and Spring courses
- Or 6 unit Fall course alone

Because
- Possibly not yet ready for a deep dive into an application project
- They’ll appreciate that course ends in October and lightens end of semester heavier loads
- In Spring they will be ready for deep dive application, to either thesis or other project

See Canvas sites for full details for each
IDS.333 / IDS.332 / IDS.330 Choice

- **IDS.332**: Engineering Systems Analysis for Design, 12 unit, Full semester course
- The second half of the semester will be project oriented. It will combine lectures, seminar discussions, and personal coaching on project
- Restricted to students who
  - Can develop or have a suitable personal project
  - We explore this with discussion of “Initial Project Status” form
Main Objectives:

1. To increase your awareness and appreciation for **WHY uncertainty matters** in engineering design, **Being Proactive better than being Passive**

2. To give you tools to **analyze effect of uncertainty on performance of design**, 

3. To help you appreciate **how to choose best tool for your problem**, and 

4. To use the tools to **design flexible strategies** that will maximize overall expected performance.
Overall objective:
• To give you confidence in practical application of course material to engineering design

Topics
• Drivers for Flexibility
• Decision Rules
• Real Options Theory
• Multidimensional Choice
• Case Examples
• Creating a Strategy: Choice and Plan

Project: Preparation of a Design or a Plan with Flexibility based on analysis of alternative options
Introduction of Teachers

- Richard de Neufville
  - Prof. of Engineering Systems, MIT Institute for Data, Systems, and Society (IDSS)
  - Civil Engineer by training, specialty in “airports”
  - International practice “every inhabited continent”
  - Sabbaticals: England, France, Portugal, Japan, Australia… and California
  - Rows and will participate in Head of Charles

Website: ardent.mit.edu
Aparna Kulkarni, Teaching Assistant

- Fellow, MIT System Design & Management
- Was Systems Engineer at Honeywell
- Worked 8+ years in Industrial, particularly Building, Automation
- Current interests: Innovations in energy industry, exploring System of Systems with emphasis on Smart Cities using platform solutions
- Academic background: Instrumentation and Controls Engineering
Logic of the Course

- Engineering Systems exist in Uncertainty
  - Technical – New Developments
  - Economy – Boom, Crisis, Prices, Competition
  - Social – New Regulations, Political Changes

- Engineering Systems Need to Adapt
  - Take advantage of Opportunities
  - Avoid Hazards, Risks

- Flexibility is an Essential Part of Design
  - How do we identify, choose, and implement flexibility?

- Course shows how to Determine Answers
New Material

- New Approach to Engineering Design
  - Recognizes Uncertainty and Use of Flexibility, thus Changes Engineering Design Process
- Revolutionary possibilities
  - Explicit consideration of flexibility easily increases expected performance 30%!
- Related to “Real Options”, but different
- Procedures developed to fit engineering realities
  - Little historical data; Rapid Procedures needed
- Develops coherent road-map for strategic design
Objectives of First half of Semester

1. Conceptual framework for thinking about designing/decision-making under uncertainty.

2. Introduce useful tools for helping you think and do analysis in these situations.

Course will present 4 elements:

- Uncertainty
- Value over Time
- Simulation over Spreadsheet
- Decision Analysis, Value of Information
Prerequisites

Syllabus assumes:

- comfort with basic calculus, probability, statistics
- familiarity with some advanced concepts of Excel used in course
- Presentation of necessary Excel material built into course
Courses “Flipped”; on Canvas

- In general “lecture material” distributed on web in advance, and discussed in-person classes
- Students review “lecture material” before class, and respond to it via “Pre-Read” forms
- Pre-Read responses form basis for in-person discussion of questions, and lead to further clarifications and extensions
- Pre-Read assignments are not graded but each earns full points for participation
- Canvas is course management system
Questions?

THANK YOU FOR YOUR ATTENTION

NOW AVAILABLE FOR DISCUSSION