

Tools for Analysis: Design for Real Estate and Infrastructure Development

11.434, 15.428J and ESD.712J
G Level subject, 2-0-4 units
No formal prerequisites

Professors David Geltner and Richard de Neufville

Meets Tuesdays and Thursdays, Second Half of Spring Semester (April to Mid May)

Lectures 2.30 to 4 **Room E52-175**

Recitation 4 to 5 on Thursdays **Room E51-085**

Texts: D Geltner, N Miller, J Clayton & P Eichholz, "Commercial Real Estate Analysis & Investments"
2nd Ed., Cengage South-Western (2007).

Richard de Neufville and Stefan Scholtes, "Flexibility in Design", MIT Press, Draft Manuscript ©

Part 1 : http://ardent.mit.edu/real_options/Draft%20Textbook/de%20N%20SS%20Part%201%20--%20with%20Preface%20Oct%2010.pdf

Part 2: http://ardent.mit.edu/real_options/Draft%20Textbook/de%20N%20SS%20Part%202%20%20--%20October%2010.pdf

Appendices:

http://ardent.mit.edu/real_options/Draft%20Textbook/de%20N%20SS%20Appendix%20entire%20Oct%2010.pdf

Richard de Neufville, "Thesis Manual" © http://ardent.mit.edu/thesis_manual.pdf

Course Description

Starting Point: The course builds upon the reality that "the forecast is always wrong", that is, that the future cannot be known accurately. This fact is especially true for real estate and infrastructure projects, whose up-front costs are huge and whose benefits extend far into the future. The fundamental question, for both designers and developers, is: "How do we most effectively manage our inability to forecast the future accurately?"

Basic Concept: We argue that it is best to deal with project uncertainty proactively, that is, by deliberately building flexibility into the project, to enable the owners or operators to take advantage of new opportunities, while protecting the project from bad outcomes. From the perspective of finance, this consists of creating "real options" that provide "calls" on favorable developments and "puts" on failures. From the perspective of design, the flexibility consists of features that, like options, enable the project owners to reconfigure the project in useful ways – to expand it, to change its function, to alter its operating characteristics.

Intended Audience: The course is intended for all those with a serious interest in the design, development and management of real estate or infrastructure projects. In addition to real estate professionals, the instructors expect to serve architects and urban planners, business managers, civil and other engineers concerned with construction.

Background Assumed: The course will cover all the mathematics and technical aspects required. It assumes that participants are familiar with and comfortable with:

- quantitative analysis, such as used in spreadsheets;
- discounted cash flow concepts; and
- basic elements of probability and statistics

Background in real estate is a plus, but is not essential to benefitting from the course.

* We are sympathetic that students who don't already have this textbook may not want to purchase it just for this course. MIT Libraries won't let us put more than one copy on reserve (at Rotch Library). However, there are two other copies that can be checked out for intraday or overnight (or over-weekend) use from the CRE office in W31-310 (see Jennifer Boyles). If you have a deep interest in real estate, however, this is the most-cited real estate textbook in the world (on Google Scholar and the SSCI), so you may find it worth it to purchase a copy.

Learning Objectives: The course intends to develop the understanding and skills useful in developing flexible designs. Specifically, it presents methods for valuing this flexibility, so that developers and others can determine what level and kinds of flexibility are desirable in specific circumstances. These include:

(a) Concepts:

- The understanding of uncertainty in practice;
- Jensen's inequality; valuation or design around average values leads to erroneous results;
- The intuition of why flexibility is valuable in the context of uncertainty, and why the greater the uncertainty, the greater the value of flexibility;
- "Calls" to take advantage of opportunities, and "puts" to exit unfavorable circumstances;
- The assumptions underlying the financial valuation of options;
- Insights and lessons from the economic analysis of options: effect of payout yield and volatility (uncertainty) on the value and exercise decision for real options;
- The reality of real estate markets, and the consequent desirability of alternative methods of valuation; and (GIGO and other problems with using the economic model).

(b) Techniques:

- The practical characterization of uncertainties;
- Certainty Equivalence Valuation;
- DSM – Design Structure Matrix as a means to understand system and thus to identify opportunities for flexibility; and
- Valuation of options via Monte Carlo simulation.

The class can also provide the basis for a thesis or similar project. The research and analysis done for the class project may provide students, singly or in teams, with the basis for a thesis topic. The instructors are certainly open to discussions along these lines and will assist students trying to develop thesis proposals.

Approach to Learning: We base the course on:

- "Learning by doing". Specifically, we expect students to engage with practical projects, to explore how the concepts and techniques apply to individual situations.
- Multidisciplinary, team learning – students will work in groups combining colleagues from different backgrounds and skills.

Student Participation: Students will work on actual projects of their choosing, subject to approval by the instructors. They will develop an in-depth understanding of their case by applying the concepts and techniques to it. This engagement will give them a basis for appreciating the relative merits and applicability of the concepts and techniques presented in class.

Organization of the Class Project Groups: To make the best use of the limited time available to us, the instructors have organized the class in advance of the first meeting:

- We have divided the class into interdisciplinary teams of students from the pre-registered class list.
- Each group will select a real estate or infrastructure development projects that they wish to examine in detail over the balance of the semester. They will then investigate and analyze it, write up the case for archival use, and will present it to the class for discussion.

Grading: The instructors will grade based on both individual participation and the group write-up and presentation. A component of the class participation grade will be based on Stellar forum participation.

Interaction with Faculty and fellow students: The course will rely heavily on the MIT Course Management System, Stellar, for the distribution of materials and announcements. Students are expected to post questions on the Stellar "Forum" so that all students can benefit from comments from faculty or fellow students.

- A component of the class participation grade will be based on Stellar forum participation (details TBA).

Class Schedule – subject to adjustment over semester

Last Update: 1 April 2010

Month	Day	Instructor	Topic	Reading	Assignment
Mar	30	RdeN DG	Introduction: Course Organization and Learning Objectives. Uncertainty Exercise Garage Case Concepts	Na Report: Real Estate Uncertainty and variability deN/SS: Chapter 1 deN: Thesis Manual	
Apr	1	DG	Discounting: Standard and Certainty-Equivalence	Geltner: Chap 10 (including Appendix C)	Project Selection specification
	1	REC – RdeN DG	Review of Groups and Projects		
	6	DG	Economic Model of Options Applied to Real Estate: Intro	Geltner: Chap 27	
	8	DG	Economic Model of Options (cont.): Underlying asset dynamics & GIGO issues	Geltner: Chap 27 & 29 (Appendix)	Report on your project's Uncertainties
	8	REC RdeN	Discussion of Uncertainties in your projects		
	13	Eppinger	Design Structure Matrix Identification of points of flexibility	Bulloch + Sullivan thesis	
	15	DG	DSM follow-up Discussion of Development Process	Bartolomei dissertation extract	
	15	REC	Q and A DSM		
	20		NO CLASS – PATRIOT'S DAY		
	22	RdeN Cardin	"Engineering' Analysis of Options; Garage Case: Detailed Analysis and Lessons	Parking Garage Case	DSM Report: Your project's "road map"
	22	REC Cardin	Practical Workshop on Mechanics How pdfs work in Excel	ESD 70 handouts	
	27	RdeN	Monte Carlo Simulation in Practice: Case Examples	Hassan et al. Wang et al. Ohama thesis	
	29	RdeN Angela Watson	Flexibility in Real Estate Development – case examples of vertical and horizontal expansion	Guma et al Pierson-Wittels theses; Dartmouth Hitchcock Med Ctr deN/SS Appendix D	Monte Carlo Analysis
	29	REC RdeN	Discussion of Monte Carlo Analyses		
May	4	RdeN	Multi-objective evaluation	deN/SS Chapter 6	Draft Reports with MonteCarlo models
	6	DG	Scheduled Reviews with Teams: What does your model teach us?		
	6	RdeN			
	11	DG	Team Presentations		Team Report
	13	RdeN	Team Presentations		
	13	All	END OF COURSE PARTY		