Course Syllabi

At the Tuck School, we teach several courses in modeling: *Decision Science, Applications of Optimization, Applications of Simulation, Advanced Business Analytics,* and the *Art of Modeling*. Decision Science is a requireds first-year course devoted to spreadsheet engineering, optimization and simulation. Lately, this has been an 18-session course, split roughly in thirds among the three topics. This is followed by the elective courses. Applications of Optimization and Applications of Simulation and Advanced Business Analytics are nine-week, 18-session courses taken either by first-year students at the end of their first year or by second-year students during their second year. These courses extend and deepen the treatment of topics introduced in Decision Science. The final elective is the Art of Modeling, which is taken primarily by second-year students. This is a studio course which focuses on problem solving and modeling craft.

Syllabi for these courses are available on this website. We will not repeat here the information contained in these syllabi; instead, we give an overview of our philosophy of teaching modeling to MBAs and how we have adapted to the environment at Tuck.

# Decision Science

Decision Science is currently one of two required quantitative courses in the MBA Program; the second is Statistics for Managers. Because the two courses are taught independently and the Statistics course is compressed, Decision Science takes on the role of providing the essential Excel toolkit for Tuck MBAs. We have also found that students need to understand the essentials of modeling (abstraction, sensitivity analysis, and so on) before they can successfully appreciate the more advanced tools of management science. Therefore, we devote the first five or six class days to Excel modeling. This includes Chapter 3 (Spreadsheet Engineering) and Chapter 4 (Spreadsheet Analysis). It also includes the parts of Chapter 5, on data analysis because these tools are not covered in the statistics course. We also devote a day to advanced features of Excel, some of which is covered in Appendices 1 and 2.

The middle third of this course covers optimization. This portion of the course is designed to provide the students with a basic understanding of how to build and analyze nonlinear and linear models. We cover much of Chapters 8 and 9, excluding a full treatment of patterns and network models. Because there is a full elective in optimization, we can focus on basic modeling in this module and also have one or two full-scale cases to allow students to grapple with issues beyond the merely technical.

The final third of the course is devoted to simulation. Drawing on Chapter 14, we cover the basics using examples from a range of topics relevant to MBAs, such as valuation, option pricing, cash management, and market share modeling. Because there is an elective in simulation, we cover only grid search under optimization in simulation, leaving the more advanced optimization approaches (covered in Chapter 15) to the elective.

# Applications of Optimization

This course has been offered as an elective for several years. The course builds on the coverage of optimization from the Decision Science course. It begins with a more in-depth treatment of a variety of linear programming models, and moves on to cover data envelopment analysis, nonlinear programming, integer programming, and the genetic approach in the Evolutionary Solver. Ken Baker has written a specialized textbook for this course entitled,*Optimization Modeling with Spreadsheets* (Second Edition, John Wiley & Sons, 2011). It is largely an elaboration of the material in Chapters 8-12.

# Advanced Business Analytics

This course is relatively new, capturing the increased interest in analytics, and it follows the traditional descriptive/predictive/prescriptive framework that is commonly imposed on topics in analytics. The course builds on both the Decision Science and Statistics core courses, aiming mainly to fill in gaps in their coverage where analytics is concerned. It draws on both Excel and XLMiner for software coverage to implement a variety of techniques.

# Applications of Simulation

Steve offered an elective in simulation for several years. This course covered three types of simulation: Monte Carlo simulation using *Crystal Ball*, discrete event simulation using *Extend+*, and dynamic system simulation also using *IThink*. *Risk Solver* would be the current substitute for *Crystal Ball*.

The first portion of the course builds on the coverage of simulation in the Decision Science course. We review the simulation modeling cycle and model some more complex situations than could be covered in the earlier course. We also cover statistical analysis of results in more detail, and optimization using the evolutionary solver (Chapter 17).

The middle third of the course introduces the student to discrete event simulation using *Extend+*. We build models for a variety of situations, including manufacturing and service sector processes. This module also reinforces some of the lessons of factory physics (for example, the nonlinear relationship between utilization and cycle time) that Tuck students acquire in the required Operations course.

The final portion of this course is devoted to dynamic systems simulation, which is an approach to simulation that uses continuous relationships to model the dynamics of a process. This is the same technical approach as used in System Dynamics, the modeling school associated with Jay Forrester. However, we do not teach the philosophy of System Dynamics.

# Art of Modeling

The fourth elective in modeling at Tuck is the Art of Modeling. This is a studio course in the sense that the emphasis is on learning the craft skills of modeling rather than on learning more technique. The portion of *The Art Of Modeling with Spreadsheets* that is most relevant to this course is Chapter 2 on modeling heuristics and influence diagrams. Steve Powell and Bob Batt wrote another book that relates more directly to this course, titled *Modeling for Insight* (John Wiley & Sons, 2008).

The first six classes in this eighteen-class course are devoted to learning to model unstructured problems. We teach students to develop influence diagrams to provide an initial, high-level understanding of the situation. We also teach prototyping as a strategy for developing a model in a controlled, iterative fashion. Finally, we teach methods for identifying insights within the analysis portion of modeling.

The remaining six weeks of this class are devoted to challenging week-long cases that students tackle in teams of two. The Retirement Planning, Draft TV Commercials, and Racquetball Racket cases have all been used for this purpose. Other cases are available from Steve on request. During this portion of the course, student teams are required to come in for office hours with the instructor. This provides us an opportunity to coach students in developing the craft skills.