FOSTER SCHOOL OF BUSINESS
UNIVERSITY OF WASHINGTON

Modeling with Spreadsheets

QMETH 551

Winter 2020

Instructor

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Course Description

This course covers modeling with spreadsheets for analyzing quantitative aspects of business problems. Spreadsheets now have features that allow managers to perform sophisticated quantitative analysis in the comfortable and intuitive environment of the spreadsheet. This gives managers the power of quantitative analysis tools without forcing them to use unfamiliar mathematical notation. Applications from a variety of business areas will be discussed, including finance, marketing, and operations. Sample applications include cash flow problems, portfolio optimization, pricing models and revenue management, municipal bond underwriting, project management, supply chain management, facility location, shortest path and routing, equipment replacement, advertising media selection, and budget-constrained project selection.

Required Materials

Hillier and Hillier, *Introduction to Management Science*, 5th Edition, McGraw-Hill/Irwin.
Course Packet includes copies of class slides, problem sets, and case studies. Available at RAMS Copy Center (4144 University Way).

Course Packet

I have prepared extensive course notes that I use as overheads during lecture. These course notes include examples that we will work together in class and other lecture material. The course notes are not intended as material that you use to prepare for class; my intent is for them to make it easier for you to listen, ask questions, and participate in class, rather than take lots of your own notes during the lectures.

Software

Microsoft Excel (including Solver), Solver Table (available on Canvas), and Crystal Ball (see instructions on Canvas). For Windows, Excel 2010 and later will work for this course. For the Mac, Excel 2016's Solver is somewhat unreliable so a Windows version of Excel should ideally be used—please read the page on Canvas for Mac Users (Modules>Software). Excel for Windows and Crystal Ball are also available through computers in the Paccar Computer Lab (Paccar 191), including virtually through a browser (Mac or Windows).

Laptop Policy

You are welcome to bring a laptop to class to work the models we build in class. Completed spreadsheets as well as spreadsheets with just the data are available for download on Canvas. You are also welcome to just watch, take notes, and participate in discussion. I want to encourage your active involvement in this course. Thus, I subscribe to the School's policy that expects you will *not* access email, surf the internet, or instant message others during class.

Academic Integrity

By being a student in this course you acknowledge that you are a part of a learning community at the Foster School of Business that is committed to the highest academic standards. As a part of this community, you pledge to uphold the fundamental standards of honesty, respect, and integrity, and accept the responsibility to encourage others to adhere to these standards. Furthermore, as part of the Foster MBA program, we have jointly agreed to conform to and uphold the MBA Honor Code.

Grading Policy

The course grade will be based on class participation, problem sets, two exams, and a student presentation, with the following weights:

- Class Participation 5%
- Problem Sets 30%
- Midterm 25%
- Final Exam 25%
- Student Project and Presentation 15%

Study Teams

The problem sets and student projects will be done in teams of three to five. The problem set teams will be self-selected on the first day of class. The teams for the presentation can be chosen later. It is acceptable (and typical) that the student project teams be the same as the problem set teams, but this is not required. At the end of the quarter, each member of the team will also evaluate each of the other members of the team in terms of their percentage contribution to the team's problem sets and/or student project and presentation. The individual evaluations will be confidential, made directly to me through Canvas. Your evaluations from others in your team will be combined and evaluated and individuals that did not make a fair contribution (or made extraordinary contributions) to the team will have their overall problem set or project scores adjusted accordingly.

Problem Sets

There will be five graded problem sets. These are to be done in teams of three to five. It is expected that the team will either work together on all problems, or each member will do all the problems individually, and then the team will compare and compile a single version from the individual versions. Groups should *not* split up the problems, work on separate problems individually, and combine. Discussing problems with others in the class (outside your team) is also acceptable, but information sharing should be in the form of discussion and explanation, and should not include copying of computer files (beyond your team). One member of each team should turn in the solution to each assignment via Canvas no later than the due date and time indicated. If possible, include all spreadsheets in a single workbook on separate tabs.

Exams

The midterm exam and final exam will both be take-home exams. You will be given nearly one week for each. These exams are open book and open notes with no time limit (other than the due date), but must be completed individually, without assistance from any other person. Use of the internet (beyond the class Canvas site) is not allowed.

Student Projects & Presentations

Student projects and presentations will be done in teams of three to five students. You may stay in the same teams as for the problem sets, but this is not required. Presentations will be given at the end of the quarter on two dates. If you have a preference for presentation day, please let me know ASAP. I will accommodate as best as possible on a first-come-first-served basis.

You may choose either of the following for the topic of your presentation:

1. Develop a spreadsheet model that addresses a decision that needs to be made. Present the decision to be made, the spreadsheet model developed to address it, and the results of the model.

2. Research a model that was developed by a business to address a decision that needed to be made. There are many references to "real-world" applications in the textbook. Most make reference to the journal *Interfaces* (available in the Foster library), which is a good resource for management science models that have been developed and used in business. Present a "case study" of the model, including discussion of the decision to be made, demonstrating a spreadsheet version of the model that was developed, and discussing the results obtained with the model. The model need not have originally been a spreadsheet model (e.g., it may have been an LP solved using an algebraic solver); if it is not, you will need to create a spreadsheet based upon the ideas of their model to show the class how the model works in spreadsheet form.

In either case, the spreadsheet model should build upon or be related to one of the techniques covered in this class. The presentations should be approximately 10 minutes after which there will be a short question-and-answer period. The presentation (and spreadsheet submission) will be graded for both content (two-thirds weight) and quality of presentation (one-third weight). Qualities I will be looking for include: (1) does the model build effectively on the modeling techniques discussed in class, (2) how well does the model address the decision being made, (3) is the presentation clear and easy to understand, (4) can you convince the audience that the model is effective and the solution a good one. More successful presentations typically discuss the model at a relatively high level, without digging into the model at the formula level.

Deliverables:

- Thursday, February 20 (by 9pm), please email me (mhillier@uw.edu) a list of your team members, a brief description of your topic, a brief description of the model you intend to build or discuss, and a date preference (if you have one) for the presentation.

- At least one hour before class on your presentation day, please have one member of your team submit to Canvas the spreadsheet model that your team has built and any other electronic items used in your presentation (e.g., Powerpoint slides).

Religious Observance Accommodation

Washington state law requires that UW develop a policy for accommodation of student absences or significant hardship due to reasons of faith or conscience, or for organized religious activities. The UW's policy, including more information about how to request an accommodation, is available at Religious Accommodations Policy (https://registrar.washington.edu/staffandfaculty/religious-accommodations-policy/). Accommodations must be requested within the first two weeks of this course using the Religious Accommodations Request form (https://registrar.washington.edu/students/religious-accommodations-request/).

QMETH 551 Schedule

	Section A&B	Section C&D
Session #1: Modeling with Spreadsheets **Review:** Text, Chapter 1	Mon, January 6	Mon, January 6
Session #2: Applications of Linear Programming **Review:** Core Sessions #2-4; Text, Chapters 2-4	Wed, January 8	
Due: Problem Set #1 (Linear Programming)	**Monday, January 13, 10am**	
Session #3: Network Models **Read:** Text, Chapter 6	Mon, January 13	Mon, January 13
Session #4 Nonlinear & Separable Programming **Read:** Text, Sections 8.1–8.3	Wed, January 15	
Session #5 Applications of Optimization	Wed, January 22	available on video
Due: Problem Set #2 (Network & Nonlinear)	**Monday, January 27, 10am**	
Session #6: Applications of Integer Models **Review:** Core Session #6; Text, Chapter 7	Mon, January 27	Mon, January 27
Session #7: Municipal Bond Underwriting Case Study **Prepare:** Municipal Bond Case Study (back of packet)	Wed, January 29	
Due: Problem Set #3 (Integer)	**Monday, February 3, 10am**	
Session #8: Multiple Objectives and Goal Programming **Read:** Text, Chapter 17	Mon, February 3	Mon, February 3
Session #9: Evolutionary Solver **Read:** Text, Sections 8.4–8.5	Mon, February 10	
Due: Midterm Exam (Available Monday, February 3, 10pm)	**Monday, February 10, 10am**	
Session #10: Macros, VBA, Analytic Solver, and alldifferent Constraint	Wed, February 12	Mon, February 10
Session #11: Simulation and Crystal Ball **Review:** Core Sessions #9-10; Text, Sections 20.1–20.8	Wed, February 19	
Due: Problem Set #4 (Goal, Evolutionary)	**Wednesday, February 19, 10am**	
Due: Student Project Proposals	**Thursday, February 20, 9pm**	
Session #12: Mountain Realty Case Study **Prepare:** Mountain Realty Case Study (back of packet)	Mon, February 24	Mon, February 24
Session #13: Optimizing with Simulation **Read:** Text, Section 20.9	Wed, February 26	
Due: Problem Set #5 (Simulation)	**Monday, March 2 or 9*, 10am (*if team presenting March 2 or 4)**	
Session #14: Models for Analyzing Waiting Lines **Read:** Text, Sections 11.1–11.7	Mon, March 2	Mon, March 2
Session #15: Student Project Presentations	Wed, March 4	
Session #16: Analysis of Waiting Lines **Read:** Text, Sections 11.8–11.9	Mon, March 9	Mon, March 9
Session #17: Student Project Presentations	Wed, March 11	
Due: Peer Evaluations	**Thursday, March 12, 9pm**	
Due: Final Exam Early Option (Available Friday, March 6, 6pm)	**Friday, March 13, 6am**	
Due: Final Exam (Available Monday, March 9, 10pm)	**Monday, March 16, 10am**	

Session Summaries

Session #1: Modeling with Spreadsheets

In this session we will discuss the role of models in managerial decision making, including the use of spreadsheets, and provide an overview of the models and techniques to be covered in this quarter. We discuss good and poor spreadsheet modeling, and how proper layout and formatting can produce models that are easier to build, debug, read, and modify.

Session #2: Applications of Linear Programming with Spreadsheets

We discuss applications of linear programming with spreadsheets to problems in finance, marketing, and operations.

Session #3: Network Models

Transportation and communication networks pervade our daily lives. In this session, we discuss applications of network optimization. We then discover that most network optimization problems are really linear programming problems. We discuss minimum-cost flow, maximum flow, shortest path, and equipment replacement problems.

Session #4: Nonlinear and Separable Programming

Here we discuss spreadsheet models with a nonlinear objective function and/or nonlinear constraints. What are the ramifications on solvability? We also will discuss the use of separable programming to approximate a nonlinear model with a linear one.

Session #5: Applications of Optimization

In this session we combine various optimization techniques to develop advanced optimization models addressing problems in project management and pricing and revenue management.

Session #6: Applications of Integer Models

In this session we address problems where some or all of the decision variables are required to assume integer values and discuss the application of binary variables. We discuss applications in finance, marketing, and operations.

Session #7: Municipal Bond Underwriting Case Study

In this session we discuss the application of binary integer models to a municipal bond underwriting case. We also discuss other advanced applications of integer programming.

Session #8: Multiple Objectives and Goal Programming

In this session we look at problems that have more than one objective. Techniques for addressing all of the objectives are discussed.

Session #9: Evolutionary Solver

We introduce genetic algorithms and the Evolutionary Solver to address problems that can not be solved using the standard Solver.

Session #10: Macros, VBA, Analytic Solver, and the AllDifferent Constraint

In this session we will discuss the use of macros and VBA, how they can aid in modeling, and how they can be used to create a decision support system. Next, the Analytic Solver Platform will be demonstrated. Finally, we discuss the alldifferent constraint and its applications.

Session #11: Simulation and Crystal Ball

In this session we discuss the use of the Crystal Ball Excel add-in for performing Monte-Carlo simulation, and applications in finance, marketing, and operations.

Session #12: Mountain Realty Case Study

In this session we will use Crystal Ball to explore a business decision faced by Mountain Realty.

Session #13: Optimizing with Simulation

In this session we discuss how optimization can be performed with a simulation spreadsheet model. The OptQuest add-in for Crystal Ball will be demonstrated.

Session #14: Models for Analyzing Waiting Lines

In this session we introduce analytical models and corresponding spreadsheet templates for predicting the effects of congestion in waiting line systems. Single and multiple-server queues, priority queues, and systems with finite queue capacity will all be discussed.

Session #15: Student Presentations

Groups of three to five students will give a 10 minute presentation about a model that they have developed or that a business has used to analyze a problem.

Session #16: Analysis of Waiting Lines

In this session, we utilize the queueing templates to make the following kinds of decisions: How many servers should we use? How much space needs to be made available for the waiting line? How many phone lines and representatives should a call center utilize? When should a priority scheme be utilized?

Session #17: Student Presentations

Groups of three to five students will give a 10 minute presentation about a model that they have developed or that a business has used to analyze a problem.