OPNS-450
Spreadsheet Modeling for Managerial Decisions

Professor: Russell Walker
Office: 4223
Telephone: (847) 467-2148
E-mail: russell-walker@kellogg.northwestern.edu
Web Page: TBD

Course Overview

In this course we will learn how to structure, analyze, and solve business decision problems on Excel spreadsheets. We will focus on problems involving optimal resource allocation and risk analysis for decisions involving uncertainty; some data analysis and forecasting methods also will be covered. While the underlying concepts, models, and methods of this course are mathematical in nature, we will develop them on a more intuitive and user-friendly platform of spreadsheets, analyze them using the available Excel commands, tools, and add-ins, perform sensitivity analyses of the solutions, and study their economic interpretations.

The spreadsheet approach to problem solving is more accessible to managers, as they usually find spreadsheets a natural medium for organizing information and performing “what if” analyses. Consequently, spreadsheets have become indispensable tools of modern business analysis. The emphasis of the course will be on systematic, logical thinking, and problem solving on spreadsheets, illustrated by building and analyzing models of a variety of problems in operations, finance, and marketing. In this sense, this course also will serve to integrate various functional areas of management on a common spreadsheet platform.

It is important to note that the course is not about learning basic spreadsheet skills; it is about developing spreadsheets to set up, analyze and solve business decision problems. Good working knowledge of basic Excel will be assumed so that we can focus on the problem solving aspects of the course. Thus, knowing how to enter and copy formulas involving relative and absolute cell references, and how to draw charts in Excel will be essential. However, a typical Excel user may not be familiar with more advanced tools, techniques and add-ins that have increased the power of spreadsheet analysis significantly. This course will introduce and apply these advanced Excel skills, thereby furthering the spreadsheet knowledge base even of an expert Excel user. In particular, we will use Excel’s Solver tool for decision optimization, Simtools and @Risk add-ins for Monte Carlo simulation, and Precision Tree add-in for decision analysis.

We will also apply Excel’s data analysis tools such as Pivot tables and Filters to synthesize the available data, and introduce time series analysis for forecasting. Thus the
spreadsheet modeling and analysis experience in this course should enhance one’s analytical problem solving capabilities as well as Excel spreadsheet skills. And, hopefully, we will have fun doing so!

The course involves a hands-on, in-class learning, so **attending each class, on time, and actively solving problems on laptop in class are absolutely essential.** Course requirements consist of creating, analyzing, and solving spreadsheet models of assigned problems and cases and a term project illustrating a new application of the course material to a business decision problem of your choice. All work may be completed in groups of four; there will be no exams.

**Required Text:**
*Spreadsheet Modeling and Applications: Essentials of Practical Management Science (with CD-ROM and InfoTrac®) (Hardcover)*
by S. Christian Albright (Author), Wayne Winston (Author)

* Hardcover: 688 pages
* Publisher: South-Western College Pub; 1 edition (April 21, 2004)
* Language: English
* ISBN-10: 0534380328

A 2008 version of the text may be available by the time of class. Chapter references are written for the 2004 version and should be similar.

**Required Case Packet:** Supplementary readings, examples, and exercises.

**Course Summary**

**Objective:** How to model, analyze, solve, and interpret solutions to business decision problems on spreadsheets

**Applications:** Operations, Finance, and Marketing

This course will provide participant the skills and tools to address major business questions that can be answered with an analytical approach. The focus on spreadsheets as a platform id due to their ubiquitous presence, the availability of add-ins that allow for sophisticated analysis, and the responsibility that MBA grads often assume as consultants and business analysts, where Excel is the defacto platform for analysis.

“What’s Modeling ?” – Class introduction
“What’s Best ?” – Optimization using Solver and other tools
“What If ?” – Simulation and @Risk, sensitivity analysis
“What Now ? ” – Decision trees, decision analysis
“What’s Next ?” - Time Series Analysis and Forecasting
Course Outline

Module I: Basic Excel In Modeling

Class 1
Monday, September 22
This class is introduction to spreadsheet modeling of managerial decision problems involving optimization, simulation, decision analysis, and forecasting. We will review basic Excel functions. In addition, we will see how to use Goal Seek and Data Tables. There will also be a brief introduction to Solver.

Readings:
- Chapters 1 and 2.1-2.4 and Appendix of Chapter 2
- “Essential Excel”
- “Principles of Spreadsheet Modeling”
- “Introduction to Spreadsheets Modeling”

Topics:
- Review of basic Excel
- New Product Introduction: Goal Seek
- Sensitivity Analysis: Data Tables

In Class Case Assignments:
- Breakeven Analysis
- Monopoly Pricing

Group Case Assignments:
- Savings for the Future (Due on following Monday, September 29)

Module II: Optimization and Resource Allocation

We will learn optimization on spreadsheets by Solver. The general theme will be the problems of allocating limited resources "equipment, personnel, materials, time, space, capital" to optimize some performance measure such as profit, cost, sales, or return on investment. More specific applications will be on product mix, blending, portfolio planning, project selection, cash flow matching, budget allocation, workforce scheduling, production planning, distribution network design, and portfolio optimization.

Class 2
Thursday, September 25
In this class, we will see how to structure a managerial decision problem on excel as an optimization model. More specifically we will discuss linear decision models subject to linear constraints. Furthermore, we will discuss the significance and the information content of the sensitivity report provided by Solver. Here the concept of shadow price will be introduced.

Readings:
Chapters 3 Section 3.1-3.7  
“Spreadsheet Power”  
Interpreting the Solver Report  
Math That Helps Make Decisions  

Topics:  
Introduction to Solver  
Shadow Prices and Sensitivity Analysis  

In Class Case Assignments:  
Astros and Cosmos: Optimal Resource Allocation  

Group Case Assignments:  
Shelby Shelving (Due on Monday, September 29)  

Class 3  
Monday, September 29  
In this class, we will start by discussing blending problems in managerial decision making. We will discuss how to translate non-linear constraints into linear constraints for Solver use. A review of the sensitivity analysis will be given.  

Readings:  
Chapter 5, section 5.2  
Chapter 4, section 4.5  

Topics:  
Blending  
Best mixes  
Sensitivity Analysis  

In Class Case Assignments:  
Wine Blending: Optimal Blending  
Portfolio Planning  
Transportation Problem  

Group Case Assignments:  
Red Brand Canners (Due Monday, October 6)  

Class 4  
Thursday, October 2  
Additional examples having similar problem structure such as distribution network design models will be introduced. Next, we will see how to model managerial problems with binary (0,1) decision variables on Excel. Examples to problems with binary decision variables are plant location, project selection, budget allocation, project scheduling and fixed cost models.  

Readings:  
Chapter 5, section 5.3  
Chapter 6, section 6.3  

In Class Case Assignments:  
Budget Allocation  
Project Selection
Happy Hikers Dilemma: Optimal Selection

**Group Case Assignments:**
USA Financial One Bank Parts I, II, & III (Due Monday October 6)

**Class 5**
**Monday, October 6**
This class will discuss modeling **decision problems with integer variables** on Excel. More specifically we will focus on models for **Work Force Planning**, **Production Planning**, and **Cash Flow Models**. How to perform sensitivity analysis with integer decision variables on Excel will be discussed. In the second half of the class, we will see **non-linear decision models**.

**Readings:**
- Chapter 3 Section 3.8
- Chapter 4 Section 4.3 and 4.4

**In Class Case Assignments:**
- Cash-flow Matching
- Workforce Planning
- Production Planning

**Group Case Assignments:**
- MacPherson Refrigeration (Due Monday, October 13)

**Module III: Risk Analysis and Simulation**

We will learn how to perform Monte Carlo simulation on Excel using four different methods: `Rand()` function, data tables, `Simtools`, and `@Risk`. Applications to performance evaluation, inventory planning, revenue management, competitive advertising, optimal bidding, project valuation, cash flow analysis, income statement, stock prices and option pricing will be discussed.

**Class 6**
**Thursday, October 9**
This class will be an introduction to simulating random variables using the `rand()` function of Excel.

**Reading:**
- Chapter 7, section 7.7 Portfolio Optimization: Solver Table

**In Class Case Assignments:**
- Incentive Contract Design
- Portfolio Optimization: Solver Table

**Group Case Assignment:**
- Portfolio Optimization (Due Monday, October 13)

**Class 7**
**Monday, October 13**
**Reading:**
“Probability Management: Parts 1 and 2”
“What Puzzling Problems Teach About Simulation”

**In Class Case Assignments:**
- Introducing Uncertainty: The Rand() function
- Performance Evaluation

**Group Case Assignment:**
The Battle of the Sexes and Let’s Make a Deal (Due Monday, October 20)

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**Class 8**
**Thursday, October 16**
**Reading:**
- “Simulating the Birthday Problem”
- Simulation by *Data Table and Simtable*

**In Class Case Assignments:**
- Birthday Matching

**Group Case Assignment:**
- Dedicated to project

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**Class 9**
**Monday, October 20**
**Reading:**
- Chapter 9

**In Class Case Assignments:**
- Discrete Probability Models
- Inventory Planning

**Group Case Assignment:**
- Confederated Pulp Paper (Due Monday, October 27)

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**Class 10**
**Thursday, October 23**
**Reading:**
- Introduction to Probability and Simulation on Spreadsheets

**In Class Case Assignments:**
- The Binomial Model: Revenue Management
- Competitive Marketing

**Group Case Assignment:**
- Marsh and McLennan (Due Monday, November 3)

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**Class 11**
**Monday, October 27**
**Reading:**
- Chapter 10

**In Class Case Assignments:**
Poisson and Normal Models
Competitive Bidding
**Group Case Assignment:**
Install Palisade Tools, Practice using @Risk, review @Risk starter

**Class 12**
**Thursday, October 30**
**Reading:**
“Guidelines for Simulation with Add-ins”
**In Class Case Assignments:**
Simulation with @Risk
Project Valuation
**Group Case Assignment:**
Project Proposals (Due November 6)

**Class 13**
**Monday, November 3**
**Reading:**
“Is There Only One Value?”
“Monte Carlo Simulator for Financial Planning”
**In Class Case Assignments:**
Cash Flow Analysis
Simulating and Income Statement
**Group Case Assignment:**
Mergers and Acquisitions (Due November 13)

**Class 14**
**Thursday, November 6**
**Reading:**
Dedicated to project
**In Class Case Assignments:**
Role of Time: Stock Prices and Option Prices
Optimal Stopping: Job search
**Group Case Assignment:**
Dedicated to Project
Module IV Decision Tree Analysis

This module will discuss modeling and analysis of multiple stage decision problems under uncertainty using Precision Tree. Applications will be on valuing real options, oil drilling, process selection, capacity planning, and strategy selection.

Class 15
Monday, November 10
Reading:
“Decision Analysis”
Chapter 8
In Class Case Assignments:
Analysis of sequential decisions involving uncertainty: Precision Tree
Group Case Assignment:
Edgerton Fisheries (Due November 17)

Module V Data Analysis

Class 16
Thursday, November 13
Reading:
Dedicated to Project
In Class Case Assignments:
Data Analysis: Pivot Table and Filters
Actors’ Income
Group Case Assignment:
Internet Users (Due November 17)

Module VI Forecasting

Class 17
Monday, November 17
Reading:
Merriwell Bag Co.
Chapter 12
In Class Case Assignments:
Forecasting: Time Series Analysis
Static Models with trend and seasonality
Group Case Assignment:
Dedicated to Project

Class 18
Thursday, November 20
Reading:
  Dedicated to Project

In Class Case Assignments:
  Moving Average and Exponential Smoothing

Group Case Assignment:
  Perrin Freres (Due December 1)

Class 19 and 20
December 1 and December 4
PROJECT PRESENTATIONS

Course Requirements and Guidelines

Prerequisites: Everyone is expected to know the basics of working with Excel spreadsheets. These include developing and copying formulas with relative and absolute cell addresses, and using simple functions and drawing charts in Excel. Everyone is also expected to know the basics of functional areas of management including operations, finance, and marketing. Finally, everyone should have interest and aptitude for analytical thinking in general.

Class Work: A detailed class schedule including topics, readings, examples and assignments is attached. Excel files of the problems modeled, analyzed and solved in class should be downloaded from the course web page before (not during) the class. Preparation for each class involves reading and thinking about the problems that will be covered in that class.

The process of modeling and problem solving is a most important and difficult skill. It involves developing a structure to conceptualize, formalize and analyze a given problem. It seems deceptively simple to just watch someone else do it, while the only way to learn this skill is by practicing it yourself. Given the hands on nature of this course, you should make your own notes on how to build and analyze spreadsheet models developed in class.

Everyone is expected to attend all classes, and actively contribute to the class discussion, sharing ideas, experiences and insights into thinking about problems, organizing them on spreadsheets, and analyzing and solving them using appropriate Excel functions, tools and techniques.

Grading
The course grade will be based on the group homework assignments (50%), and the final project and its presentation (35%), and class participation and peer evaluations (15%), which includes class attendance as an essential component. All work may be completed and submitted as a group, but everyone is expected to work on each assignment. Each group will submit one copy of the report per assignment, and it should be a hard (not an
electronic) copy of their model, analysis and solution.

Each group member must fill out the attached peer evaluation form reflecting each individual’s contribution to the group output. Missing evaluations result in Incomplete grades the whole group. Groups should be a maximum of 4 people.

Re-grading
If you believe that your assignment needs to be re-graded, you must follow the Kellogg re-grading policy. This means you must provide a written request for the re-grading, justification for the re-grading, and the original work material for review. All materials must be submitted within 10 days of the handout of the graded material.

Note that re-grading of any assignment automatically subjects the entire assignment to re-grading. Grade adjustments can also include deductions during the re-grading.

Re-grading is conducted with the mindset of remaining fair and consistent across the entire class. A re-grade request does not guarantee a grade increase and may even result in a grade decrease. To fairly accomplish the re-grading, all re-grading requests are considered at a single re-grading session. Submitting an assignment for re-grading may require waiting multiple weeks for the re-grading session to be scheduled and for written requests to be reviewed in detail. The general goal is to return re-graded materials within 20 days.

Group Homework Assignments
The homework problems and cases are designed to enhance your understanding of the process of modeling and analysis on spreadsheets learned in class. Sufficient guidelines and numerical answers will be provided for each assignment, so grading will not be based on correctness of the answers per se, but on the demonstrated comprehension of the problem, the logic of your model, and application of the spreadsheet skills learned in class. The credit will be distributed approximately as follows:

- 25% for the write-up explaining the problem, model, analysis and results
- 25% for the spreadsheet organization, clarity and documentation, using Formula List, gridlines, row and column headings, color coding, shading, etc.
- The remainder will be equally distributed among the specific questions asked

Assignment solutions will be distributed and discussed in class when they are due, so late submissions will not be accepted and will be treated as zero scores.

Assignment Guidelines
Each submission should include a write-up along with your spreadsheet model. Think of your submission as a business report that you will present to your client or superior. They do not have time or patience to try to understand your work, so it is in your best interest to make your thought process, model, analysis, and results absolutely and instantly clear to the reader. A concise, logically organized, well documented and aesthetically pleasing report that is easy to follow will improve your chances of getting your client’s business,
next promotion, or a higher grade. Here are some guidelines:

**Format**
Each submission should be a typewritten and stapled hard-copy with
- The assignment title, your group number and the names of the participating members
- Font size of at least 12 points, and page margins of at least 1/2” for readability
- It should include:
  - A brief write-up explaining your model, analysis and conclusions, and
  - Supporting exhibits such as spreadsheets, charts, formulas, probability trees, etc.

**Write-up**
This should be a clear and concise explanation of your spreadsheet model, analysis, and conclusions. Use a presentation format with outlines, bullets and tables, rather than long essays.

The write-up should include:

**I. Executive Summary:**
Overview of the problem addressed, key issues involved, and your solution, which demonstrates your understanding of the assignment. Provide a clear description of recommendations, decisions to be made, and other concerns that you may wish to raise.

**II. Model:**
Present an explanation of the logical structure of your model by outlining its step-by-step development, which summarizes your thought process in setting up the problem. State the decisions and the objective of the problem, as well as the key assumptions you made to simplify its analysis. (Do not simply restate the problem data). Explain key formulas in words, such as: Cash Receipts this month = 0.2*Sales 2 months ago + 0.8*Last Month’s Sales + 0.2*This month’s sales (for example).

**III. Analysis:**
How key spreadsheet functions, commands and tools were used to analyze your model (Do not simply list them.) Conclusions: Concrete answers to the specific questions asked. Highlight the key results, and provide their intuitive interpretation. Make references to the exhibits attached, but do not simply state “See Exhibit 1 for answer to part a”.

**IV. Spreadsheets:**
Spreadsheets are notoriously difficult to read, trace the logic of, and debug, even for the person who creates them, let alone for an unfamiliar reader. It is your responsibility to make your spreadsheet clear and easy to read. Try to
organize your model and results on one page. If it does not fit on one page, determine logical break point(s) and provide sufficient documentation to guide the reader from one page to the next. The goal is to help the reader follow your work effortlessly. Each spreadsheet exhibit should be self-contained and well documented to show:

- The title of the exhibit
- Careful, logical organization with data separated from the model and its analysis
- Key cell formulas displayed using the ‘Formlist.xla’ add-in. Try to place the formula text close to the cells containing the formula. For conciseness, do not repeat similar formulas, manually typing instead “copied to...”.
- Make sure to print the gridlines, and row and column headings otherwise formula lists are useless.
- Add explanations and comments to help the reader understand your spreadsheet.
- Color coding and shading to highlight key cells and results, with a legend.

Project
This involves creating, modeling, and analyzing a business case of your choice. It may be based on your work experience, a case from another course, a magazine article, or even your own imagination! You should then develop a spreadsheet model of this case to illustrate a new application of the modeling concepts and methods learned in this course. The case should be an internally consistent business story, and the model its concise, stylized representation that captures its essence. The case need not have real data, and the model need not address all aspects of the problem or employ all of the tools learned in this course. The key will be to identify and focus on a central nugget of the problem, write a convincing case around it, and keep the model manageable by suppressing unimportant details and by making simplifying assumptions. You should submit a typewritten report with exhibits that describes your problem, model, and solution. You will also make a fifteen-minute presentation of your project to the class. The project report is due at the time of your presentation. You should prepare a presentation suitable to communicate the entire body of your work, as if you were presenting to a client or board of directors.

Please continue to pay attention to the logical organization, sufficient documentation (including comments, formulas with row-column headings printed), and appearance (with

Honor Code: The Kellogg honor code requires that you must not obtain solutions to the assignments, cases or projects from other students in the past or present classes of this course. It also stipulates that you must not include your name on a group report if you have not contributed substantially to the group work.
Class Room: To minimize delays and disruptions, please come to the class early and set up your laptop, so that the class can start on time, and then stay in your seats until the end of the class. In the interest of minimizing distraction to your fellow students, please do not use the Internet or e-mail during class. Finally, given the limited space and fragile laptops, please do not bring food or drinks to class. Thank you for your consideration and cooperation!

The Kellogg Code of Classroom Etiquette (From Office of Student Affairs)
It has been established to assist student and faculty alike to foster appreciation for a classroom environment that enhances the learning experience for all students. Attention to the code will add value to the course by creating a more meaningful and constructive discussion. Students, therefore, are expected to demonstrate classroom etiquette based on the following principles:

I. Attendance:
Students are expected to attend every class throughout the term. When unable to attend, the student should notify the professor in advance. Attendance is compulsory at the first class session. Failure to attend will result in your exclusion from the class if a waiting list exists. Wait listed students are eligible only if they attend the first class session.

II. Punctuality
Students are expected to arrive for class on time so that the professor may start and end the class according to schedule. Students more than five minutes late are subject to guidelines established by a class vote during the first session.

III. Exiting and Entering
Students are expected to remain in the classroom for the duration of the class. If a student must depart early due to unavoidable circumstances, the student should inform the instructor before class. Leaving and re-entering the class is not permitted except in the event of an emergency.

IV. Disruptive Behavior
Students should demonstrate respect for the professor and fellow students during the class, period. Students, therefore, should refrain from distracting behavior such as disruptive eating, using laptops to surf the Web or check e-mail and holding side conversations.

V. Respect the Facilities
Students are expected to help maintain the appearance of the classroom. After class students should discard all trash.

In essence, the Code emphasizes respectful behavior in the classroom that contributes to the enhancement of the learning experience at Kellogg.

Peer Evaluation
Please evaluate all members of your group (including yourself) in terms of their contribution to the group assignments and the final project, and record the scores on the spreadsheet on the back page. Highlight your own name and grade each member of your
group on each assignment on a scale of 1 (least) to 10 (most), on each assignment and the term project. At the end of the quarter, compute the average scores for all of your group members in the last column and return this evaluation form with your final project report. Please fill these forms this carefully, as it will be one of the inputs used in deciding the individual course grades. **Submission of the peer evaluation forms is mandatory.**

Your grade and the grade of others on your team will be withheld for failure to submit it. These evaluations will be guarded with utmost confidentiality, and will be used only by me, and only for grading purposes.

During this peer evaluation process, please keep in mind the following criteria in terms of each individual group member’s contribution.

**Communication:** Does the member listen to and consider others’ points of view? Communicate ideas well? Adhere to the group meeting schedule? Is the person open to feedback?

**Innovation:** Does he/she generate ideas on how to achieve group goals? Apply past knowledge and experience to the current project? Offer alternative approaches to current ways of thinking? Challenge the status quo when necessary? Encourage innovative thinking among the group members?

**Initiative:** Does the member help move ahead efficiently? Go beyond the requirements of the task? Look for opportunities to improve? Help others in the group’s understand the background material?

**Team Orientation:** Does the member work well with the group? Acknowledge and pay attention to the group and individual activities? Treat all members as colleagues? Complete individual task requirements to achieve group goals? Give other members credit for their ideas? Consider the group goals as the top priority? Attend all group meetings or provide advance notice when absent? Informs the group of his/her task so that it can be completed when absent?