THE UNIVERSITY OF ALABAMA

OM500: Management Science & Spreadsheet Modeling

Developed by Dr. Chuck Sox
Professor & Director of Operations Management
The University of Alabama
Tuscaloosa, Alabama

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Syllabus

- Objectives
  - Develop quantitative, analytical skills for effective business decision-making
  - Spreadsheet skills
  - Modeling decision problems
  - Optimization, Simulation, Data Mining
- Course website
  - » http://elearning.ua.edu
  - » Select "OM500"
  - » VERY IMPORTANT!! Check it regularly

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Syllabus

- Textbooks

  Powell and Baker, *Management Science: The Art of Modeling with Spreadsheets, 2nd edition.* Wiley, 2007.

  » How to "read" the textbook . . .

- Computer Usage
  - » Naturally computer intensive
  - » Install course software
    - See orientation and installation videos
  - » All assignments and exams will require a computer

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Grading

Assignments	25%		
Exam 1	25%		
Exam 2	25%		
Exam 3	25%		
		A	≥ 90.0
		B	80.0-89.9
		C	70.0-79.9
		D	60.0-69.9
		F	< 60.0

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Syllabus

- Academic Conduct
  - » Graduate Catalog
  - » University of Alabama *Student Handbook*
  - » Cheating
    - – Using or attempting to use unauthorized materials, information, study aids, or computer-related information.
  - » Plagiarism
    - – Representing the words, data, works, ideas, computer programs or output, or anything not generated in an authorized fashion, as one's own work.
  - » Fabrication
    - – Presenting as genuine any invented or falsified citation or material.
  - » Misrepresentation
    - – Falsifying, altering, or misstating the contents of documents or other materials related to academic matters, including schedules, prerequisites, and transcripts

Other Stuff

- Students with disabilities
- Importance of active learning
  - » Homework and in-class assignments
- Make-up policy
  - » Assignments
    - – Deduct 5 pts. for every 10 minutes late
  - » Exams
    - – Must provide valid documented excuse within 24 hours of the exam

Expectations

- Keep up with lecture schedule and assignment deadlines
- Read the assigned material BEFORE viewing lecture material
- Keep thorough, organized class notes
- Do the homework assignments and learn from them

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Course Outline

- Spreadsheet modeling
  - » Spreadsheet engineering & analysis
  - » Working with data
  - » Advanced excel functions
- Optimization
  - » Premium solver
  - » Nonlinear, Linear, Network Optimization
- Simulation
  - » Crystal Ball
  - » Simulation modeling and analysis

Decision Modeling

- What is "Decision Modeling?" (AL)
  - » *The art and science of analyzing business problems with mathematical models.*
  - » Science: analytical tools, experiments, trial and error
  - » Art: design, communication, ease of use
- aka:
  - » Operations Research (OR)
  - » Management Science (MS)
  - » Decision Science (DS)
- Set of generic tools
  - » *Spreadsheets, Optimization, Simulation*

Decision Modeling

- Potential applications in other courses
  - » *Finance and valuation*
  - » *Statistics*
  - » *Accounting*
  - » *Marketing*
  - » *Operations*

Decision Modeling

- Some large-scale applications
  - » *Airline flight and crew scheduling*
  - » *Supply chain network design*
  - » *Financial engineering*

- End-user applications
  - » *Staff scheduling*
  - » *R&D portfolio management*
  - » *Valuation models for M&A*

Corporate Success Stories

- American Airlines: Robert Crandall (CEO)

  "Yield management is the single most important technical development in transportation since deregulation."

- San Miguel: Francisco Eizmendi (CEO)

  "We would not have dared to undertake our 5-year, $1B expansion without OR/MS."

- FedEx: Fred Smith (CEO)

  "The OR department has played a role in the development of long-range plans for the past 17 years. … Computer modeling works …"

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Corporate Success Stories

- National Car Rental

  "OR basically saved National. … Just applying these MS models made the life or death difference for this company."

- Harris Corporation- semiconductor division: Phil Farmer (CEO)

  "A $3.8M OR/MS project raised our on-time delivery from 75% to 95%, from worst to best performance in the industry. The financial consequences were that a loss of $100M was turned into steadily increasing profits."

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MBA Success Stories

- "At first I didn't understand why we were required to take this course, but now I really see how I will be able to use this in my MBA classes and in my career."
- Spreadsheet tool for balanced scorecard analysis of suppliers for a major U.S. retailer
- Demand planning and market data analysis for a global consumer products company
- Pricing health care services at a local hospital
- Spreadsheet tool for break-even analysis for a summer basketball camp

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Executive MBA Students

- 58% use spreadsheets every DAY
- 100% use spreadsheets every WEEK
- 42% create a NEW spreadsheet every WEEK
- Some Quotes:

. . . the course could have run the whole term and been even more helpful. I enjoyed it and am sure I will be building on what I have learned so far.

I think this course should be an entire semester so that we can get into even more detail. Most companies use excel in a lot of different applications and the employees end up just teaching themselves. There are a lot tools I had no idea existed.

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What is a Model?

- A model is a purposeful representation of the key elements of an object or system and the relationships among those elements.
  - » Abstract representation of something real
  - » Enough detail so that key elements and relationships are accurately represented
  - » Omit unnecessary details
- "Everything should be made as simple as possible, but not simpler." (Albert Einstein)

Types of Models

- Mental Models
- Visual Models
- Physical Models
- Mathematical Models
  - » Spreadsheet Models

- (AL) Work with someone near you to come up with one or two examples of each type of model and write them down.
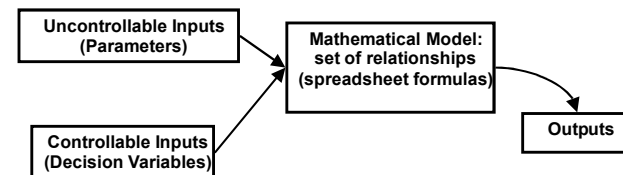
Key Elements of a Mathematical Model

- Inputs
  - » Quantities or factors that affect a decision
  - » Controllable Inputs (<u>Decision Variables</u>)
  - » Uncontrollable Inputs (<u>Parameters</u>)
- Outputs
  - » Primary
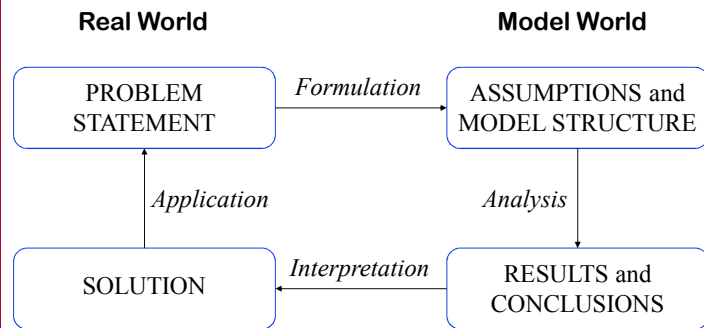 - » Secondary
- Mathematical relationships/structure

A Mathematical Model

Uncontrollable Inputs (Parameters) → Mathematical Model: set of relationships (spreadsheet formulas) → Outputs

Controllable Inputs (Decision Variables) → Mathematical Model: set of relationships (spreadsheet formulas)

Decision Modeling

Real World **Model World**

PROBLEM STATEMENT	*Formulation* →	ASSUMPTIONS and MODEL STRUCTURE

Application ↑ *Analysis* ↓

SOLUTION	← *Interpretation*	RESULTS and CONCLUSIONS

The Spreadsheet Modeling Process

1. Turn off the computer. Draw a picture/diagram, identify controllable & uncontrollable inputs, outputs. (Influence Chart)
2. Sketch out overall plan for spreadsheet model. Determine where inputs, intermediate calculations, and outputs will go.
3. Develop the base case spreadsheet model.
4. Test the model using trial values.
5. Use the model to perform the needed analysis.
6. Document the model so others can understand it.

Influence Chart

- You should start the spreadsheet modeling process by drawing an Influence Chart
- It is a simple diagram to show the relationships between inputs and outputs in a spreadsheet model
- The goal is to define problem structure
- The chart ignores all available numerical data
- It identifies the main elements of a model
- The chart helps to define the assumptions of the model

Building an Influence Chart

- Built from right to left
- Conventions for different types of variables

Outputs

Decisions

Inputs

Other variables

Random variables

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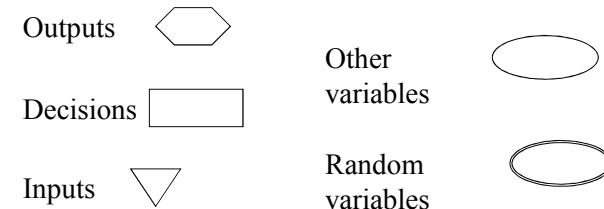
Influence Chart Principles

- Start with outcome measure
- Decompose outcome measure into independent variables that *directly* determine it
- Repeat decomposition for each variable in turn
- Identify input data and decisions as they arise
- A variable should appear only once

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Example: Sports Feet Mfg.

Sports Feet Manufacturing is considering whether to produce a new line of footwear. The company estimates that the variable cost for each pair of shoes manufactured and sold is $9 and the fixed cost per year is $52,000. The selling price is $25 per pair. How many shoes must Sports Feet make and sells in order to break-even (zero profit)?

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Influence Chart for Sports Feet Mfg.

- Take out a sheet of paper and work with someone next to you to answer the following questions.
  - » What is the decision variable?
  - » What are the input parameters?
  - » What is the spreadsheet output?

- Now let's draw the influence chart
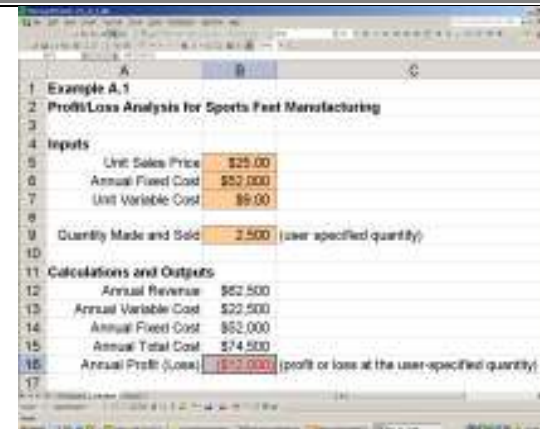
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Influence Chart for Sports Feet Mfg.

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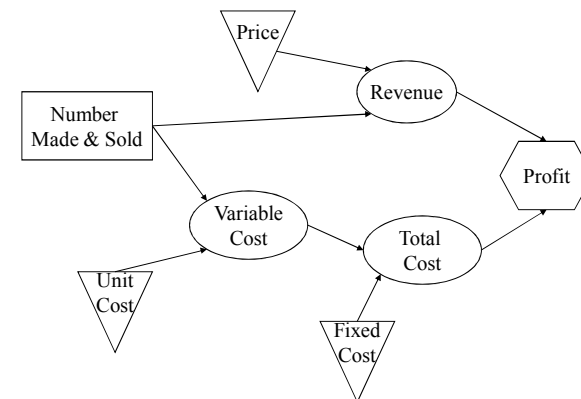
Mathematical Relationships

- Profit = Revenue – Total Cost
- Revenue = Unit Price x Quantity Made & Sold
- Total Cost = Fixed Cost + Variable Cost
- Variable Cost = Unit Cost x Quantity Made & Sold

A Spreadsheet Model