

## MANAGEMENT DECISION MAKING

### Spreadsheet modeling, analysis, and application

*Management Decision Making* is a spreadsheet-based introduction to the tools and techniques of modern managerial decision making. The author shows how to formulate models in Microsoft Excel that can be used to analyze complex problems taken from all the functional areas of management, including finance, marketing, operations, and human resources. Throughout the book, the goal is to understand how business decisions are reached, what trade-offs are made, and how outcomes depend on the underlying data.

A broad range of analytical methods is discussed, including linear programming (with an emphasis on post-optimality analysis), integer linear programming, decision analysis, decision trees, queues (including optimization of queues), and Monte Carlo simulation. Included is a CD-ROM that contains Excel files for all examples in the book plus the widely-used decision analysis software applications, TreePlan and Crystal Ball.

The book is aimed at undergraduate and graduate students of business, economics and engineering, including those taking MBA courses. It will also be of great interest to business managers who want to learn more about practical spreadsheet modeling.

**George E. Monahan** received his PhD from the Kellogg Graduate School of Management at Northwestern University and is Professor of Business Administration at the University of Illinois, Urbana-Champaign. He has been a visiting scholar at the London School of Economics and is an Area Editor for the journal *Production and Operations Management*.

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George E. Monahan

University of Illinois at Urbana-Champaign



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To the people who are the center of my universe—  
my wife Susan and my children Aili and David

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## Preface

*Management Decision Making: Spreadsheet Modeling, Analysis, and Application* is an introduction to the tools, techniques, language, and methods of analysis of modern managerial decision making for students in business, economics, and engineering. The focus is on *translation*, *construction*, and *interpretation*:

- Complex problems in all of the functional areas of management, including finance, marketing, operations, and human resources, are *translated* into decision models. Emphasis is on the art of analytical model building.
- *Construction* is the process of building *spreadsheet models* in Microsoft® EXCEL from the decision models. Skills developed here center on the effective use of the many powerful features of EXCEL. Built-in functions in EXCEL, as well as add-in software that comes bundled with this book, are used to generate “solutions” to spreadsheet models.
- *Interpretation* is the conversion of solutions generated in EXCEL into managerially-relevant terms that are understandable to those familiar with neither analytical tools nor spreadsheet models.

Little attention in this book is devoted to underlying details regarding the computational procedures used by EXCEL. At times, however, some computational details are needed to motivate managerial insight.

### Key emphases and features

1. *A management orientation*

Each of the decision problems presented in the book is motivated from a managerial perspective. The purpose is to glean significant insights into complex managerial problems found in all of the functional areas of the firm.

2. *Development of decision modeling skills*

Detailed, step-by-step approaches are provided for converting complex problem statements into effective decision models, which enhance the

student's ability to fully appreciate the nuances of the analysis of the decision problem.

3. *Model analysis*

A key emphasis of this book is the analysis of the output generated by the computer and, more specifically, by EXCEL. Students learn to translate the computer output back into managerially-relevant terms. Questions such as “Why?” and “What if...?” are prevalent. *Sensitivity analysis*, which examines how a solution depends on specifications of the model, is emphasized. Indeed, one of the benefits of confining the analysis to spreadsheets is the ease with which sensitivity analysis can be done.

4. *Development of spreadsheet skills*

Students using this book will, as a natural byproduct, polish their spreadsheet modeling skills. Advanced features of EXCEL are routinely used in examples and end-of-chapter problems. Detailed descriptions and illustrative examples are used to describe many of these advanced functions of EXCEL, such as data tables, VLOOKUP, and GOAL SEEK. In addition, many of the statistical and financial functions of EXCEL are used. An extensive appendix to the book is an EXCEL primer that reviews much of the functionality of EXCEL.

5. *EXCEL 2000*

Extensive use of screen captures and printouts of EXCEL 2000 worksheets are used to illustrate at a detailed level the development and analysis of spreadsheet models.

6. *Bundled software*

Several EXCEL add-in programs come on a CD-ROM disk that accompanies the book:

- (a) **CRYSTAL BALL**: a student version of this new powerful commercial software package simplifies Monte Carlo simulation in spreadsheets and combines optimization with Monte Carlo simulation.
- (b) **TreePlan**: a shareware add-in for constructing and analyzing decision trees.
- (c) **Queue.xls**: an EXCEL workbook, written by the author, that contains templates for computing steady-state quantities for several common types of queues.



7. *Hands-on exercises*

The reader is frequently asked to do tasks throughout each chapter. These exercises are marked with the computer icon shown here in the margin. The objective is to have the reader do something on the computer that illustrates and/or expands the concept currently being discussed.

8. *Decision Models in Practice*

These are detailed descriptions of real-world applications of techniques

discussed in the book. The novelty is that in addition to a description of the application, a detailed prototype of the model is developed, the analysis of that model is discussed, and the recommendations resulting from that analysis are made.

The following applications are discussed:

- Disentangling bankruptcies resulting from the crash of the al-Manakh stock market in Kuwait. (This is a linear programming application.)
- Bidding for the salvage rights to the SS *Kuniang*, a ship that sunk off the coast of Florida. (This is a decision tree example.)
- Determining a portfolio of treasury bonds that generate cash flows mandated by a judgment in a law suit. (This is an application in integer linear programming.)
- Scheduling police patrol cars in New York City in an environment characterized by high levels of uncertainty. (This is an application in both queueing and integer linear programming.)

#### 9. *Auxiliary applications on the CD-ROM*

There are a number of small HTML files that can be uploaded to a web server which illustrate real applications of the tools that are discussed in the book. Many of these files contain links to the home pages of the companies and organizations that are using the tools. The current list of applications is given in Table 0.1.

#### 10. *EXCEL workbooks on the CD-ROM*

All of the EXCEL workbooks discussed in the text are on the accompanying CD-ROM. A CD icon, like the one in the margin, highlights the name of the relevant EXCEL workbook.



xxx.xls

## Prerequisites

This book is designed for the following:

- undergraduate business and economics students;
- MBA students;
- Executive MBA students;
- undergraduate engineering students who seek a business and/or economics orientation to mathematical model building.

The analytical prerequisites are the minimal requirements of most AACSB Schools of Business: high school algebra and at least one semester of a combined probability and statistics course.

In my experience, undergraduate students who have had only one course in probability and statistics take very little away from such a course. Chapter 8 of this book is an extensive “review” of the elements of probability, especially

**Table 0.1:** Applications in management science.

United Airlines	Forecasting personnel requirements using LP
GE Capital	Using LP's to improve collections
Ministry of Finance, Kuwait	Disentangling bankruptcies using LP
Hanshin Expressway, Osaka, Japan	Managing a major toll road in Japan using LP
Citco	Managing refinery costs using LP
Wellborn Cabinet, Inc.	Determining best use of raw materials using LP
US Department of Energy	Phasing out operations at a high-tech company using LP
Canadian National Railway	Capacity expansion using simulation
US Postal Service	Evaluating mail processing strategies using simulation
National Forest Service	Controlled burns at national forests
American Airlines	Yield management: managing discount fares using decision trees
L.L. Bean	Managing telecommunication functions using queueing theory
New Haven, CT Fire Department	Closing fire stations using queueing theory

conditional probability, as a prelude to decision analysis, the study of queues, and Monte Carlo simulation. This chapter also contains a discussion of the common discrete and continuous probability distributions. Elementary ideas from statistics are used in the analysis of simulation output.

One of my primary objectives is to make the material in this book accessible to students who are not “quant jocks” but to do this in a way that does not treat every analytical idea as a “black box”. Care is taken in the presentation of analytical concepts. Fundamental notions in mathematics (many of which are now routinely taught in high school), such as functions, variables, slopes of functions, graphs of functions, and the like are utilized. The underlying goal, however, is to develop a deeper understanding of managerial decision problems.

I thoroughly enjoy teaching quantitative material to management students and have tried to convey that enthusiasm in the pages that follow. The “one-on-one” style of the exposition is somewhat informal. As I wrote this material, I imagined that I was tutoring a bright student in my office. I hope that not too many readers are disturbed by the casual tone.

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Preface

Keyword. Ms Susan Worrall did a masterful job as copy editor, strengthening weak points in the exposition and introducing uniformity in the presentation. Her wit, sense of humor, and sunny disposition made the arduous task of editing the final manuscript as pleasant as possible. Ms Maureen Allen, Senior Production Editor, and her colleagues at Keyword, did an excellent job dealing with the technical complexities of this project.

Not all of the advice I received from knowledgeable and thoughtful people was incorporated. I take full responsibility for any remaining deficiencies or obfuscations.

**George E. Monahan**

*Champaign, IL*

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