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STATISTICS FOR BUSINESS PROBLEM SOLVING

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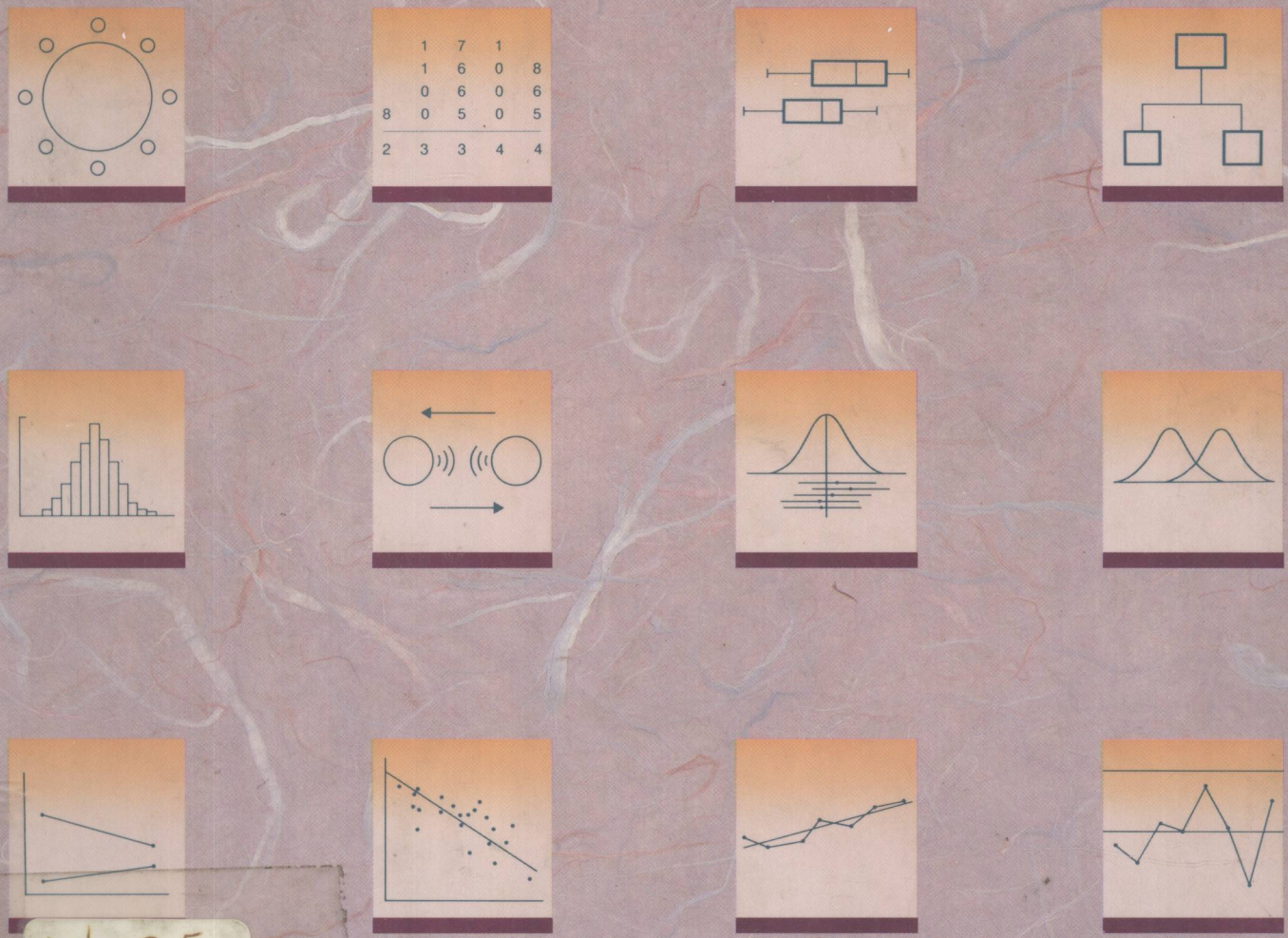

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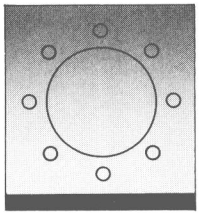

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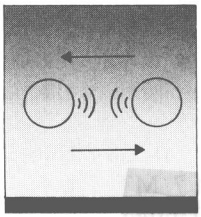

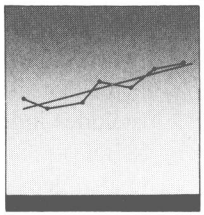

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STATISTICS FOR BUSINESS PROBLEM SOLVING

PREFACE

The study of statistics can be a rewarding experience. Over the years, statisticians have developed a powerful set of tools that have resulted in major contributions to human welfare. Statistical forecasting tools, for example, are in everyday use throughout the world. The quality control techniques pioneered by W. Edwards Deming are applied widely in Japan and are helping to revitalize the U.S. economy. Marketing research and opinion polling depend heavily on statistical sampling techniques. In fact, statistical methods have made major contributions to *all* areas of business.

But let's be frank. The first course in business statistics is often frustrating for both student and instructor. Students tend to view the course as an arbitrarily imposed hurdle that they must jump (or find a way around). They see no reason to study the subject, are often intimidated by it, and tend not to retain the material after the final exam. And teachers, who have felt the excitement of statistics, can be intimidated themselves by the prospect of conveying that excitement to students who would rather be elsewhere.

In this book, we propose to take a necessary and energetic step toward making the study of business statistics more rewarding for both students and their instructors. Above all, we aim to demonstrate that statistics is useful, not sterile; practical, not esoteric; and challenging, but rewarding.

We wrote this book for two reasons. In our own teaching, we have faced some of the problems just mentioned and believe we have overcome them. We hope we can translate some of our successes to a wider audience.

More recently, we have been heartened by the emergence of what might be called a statistics reform movement. A growing number of statistics instructors and business executives have been meeting in a series of conferences on Making Statistics More Effective in Schools of Business. The participants believe that statistics instruction can be made more vital and more relevant. Out of these meetings has emerged a new consensus. We have incorporated many elements of the consensus view in writing this book.

About This Book

This text is designed for a first course in statistics for students of business or public administration. It may be used for a one-quarter, one-semester, or two-quarter course aimed at students who will become business professionals. Its novel elements are:

1. A focus on using statistical methods to solve business problems
2. An early introduction to, and use of, time series data
3. An emphasis on graphics and descriptive statistics
4. Inclusion of nonparametric methods where appropriate (rather than in a separate chapter)

5. A chapter on data collection methods
6. Use of integrating frameworks to provide context and anchor the material
7. A stress on communicating statistical results to management
8. An extensive set of interesting, real-world problems
9. A readable and discovery-based presentation style

FOCUS ON PROBLEM SOLVING Business professionals must be effective problem solvers and they must be able to find and exploit opportunities. The text demonstrates how probability and statistics can improve all phases of problem solving—sensing, diagnosis, and choice. Problem sensing, for example, involves detecting outliers that may signal an emerging problem or opportunity. The key statistical tools are histograms, box plots, line graphs, and residual plots. Diagnosis involves finding relationships among two or more variables. Here the relevant tools include cross-tabs, scatter plots, and correlation. Finally, the techniques of statistical inference are relevant in making choices.

To provide context, each chapter is problem-driven. It begins with a memo from a manager of a hypothetical firm, COMCEL. In it, the manager asks someone to identify an emerging problem, diagnose its root causes, take corrective action, or exploit an opportunity. The memo provides motivation for the chapter's material. The chapter concludes with a response memo outlining the findings and the statistical tools used.

TIME-ORDERED DATA This text departs from the usual emphasis on cross-sectional data. The simple reason is that most data that cross a manager's desk are time-ordered (time series). It just makes sense to emphasize the situations and problems that managers most frequently face.

EMPHASIS ON GRAPHICS We believe that graphical analysis is as important as more formal statistical methods. Throughout the book, we show how graphics and simple descriptive statistics can help summarize data quickly, identify emerging problems, or generate forecasts. Above all, we stress the need to examine the data *before* applying formal statistical methods.

TREATMENT OF NONPARAMETRICS Where appropriate, we present both parametric and nonparametric methods in the same chapter. For example, in Chapter 7, we present confidence intervals on the mean followed by confidence intervals on the median. In Chapter 9, the usual one-way analysis of variance is followed by a discussion of the Kruskal–Wallis test and Dunn's multiple comparison method. This approach, we think, is far superior to the alternative of segregating nonparametrics in a single chapter that may not be covered.

DATA COLLECTION METHODS Regardless of what textbooks may suggest, data do not just appear out of the void; they must be gathered. Consequently, we devote Chapter 6 to methods of data collection. We show how to plan a survey, write survey questions, and select the appropriate survey method and sampling design. We also discuss how to design planned change studies in order to minimize the most common validity-destroying errors.

COMMUNICATING RESULTS Very little statistical analysis is useful unless the conclusions are communicated effectively to decision makers. As men-

tioned above, each chapter begins with a memo in which a manager describes a problem to be analyzed. The chapter ends with another memo, in which a subordinate reports the results of a statistical analysis. In that reply memo, the emphasis is on translating statistical results into managerial terms.

INTEGRATING FRAMEWORKS To retain the material, readers must understand how the various subjects covered in the text are related. To help with retention, we have incorporated a variety of integrating frameworks. For example, hierarchical charts illustrate the organization of a particular subject and aid retention. Compare-and-contrast tables distinguish between two or more similar topics and aid comprehension.

INTERESTING PROBLEMS Our book contains over 1,000 business-related problems and questions. Wherever possible, we have used real-world data. The end-of-section exercises stress the mechanics. The end-of-chapter problems require the student to (1) answer an important question, (2) investigate a statistical method, (3) draw inferences from samples to populations, or (4) verify a hunch or theory. Those problems were drawn from six broad subject areas: accounting and finance, marketing, general management, operations management, economics and public policy, and nonbusiness. To aid in comprehension, we define unfamiliar terms and describe how the data were collected.

PRESENTATION STYLE Our style is business-oriented and not heavily mathematical. We have kept mathematical notation to a minimum because formulas can be a barrier to understanding. We often discuss a formula's underlying logic before presenting the mathematical notation. This book also avoids a lot of data-crunching that is best left to statistical software packages. The text's goals are to improve statistical reasoning and problem solving, skills that are essential to business success.

We have employed a writing style that reflects how business students learn best. Chapters are problem-driven, sections are highly structured with clear objectives, and the writing style is friendly and readable. We occasionally use discovery learning where we ask students to discover the key idea before we make the formal presentation. We have used this procedure in class with great success.

Each section includes a list of cognitive objectives that we believe are essential for mastery of statistics. Many of the objectives require that students translate statistical ideas among the three business languages—words, pictures, and mathematics.

Ancillaries

The text package contains a complete set of supplementary items. For the student, the Study Guide provides an additional set of explanations and problems. Each copy of the text comes with a copy of COM-STAT, a software package for IBM-compatible microcomputers. It can be used to solve many of the problems in the book.

The Instructor's Manual, prepared by the authors, contains suggested syllabi, chapter outlines, section summaries, additional problems, and a set of

suggested readings. It also includes answers to all of the problems and exercises that appear in the text. A set of transparency masters is available to qualified adopters of the textbook. The Test Bank, prepared by Michael Broida, is also available in printed, MS-DOS, and Macintosh formats.

Finally, videotapes from the PBS series *Against All Odds: Inside Statistics* are available to qualified adopters of the textbook.

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About the Authors

Harvey Brightman is Regents' Professor of Decision Sciences at Georgia State University. He is Past President and a Fellow of the Decision Sciences Institute. His work has appeared in *Decision Sciences, The American Statistician, Interfaces, Journal of the Academy of Management*, and many other journals. A renowned educator, Professor Brightman has won numerous teaching excellence awards at Miami University and at Georgia State. He has consulted with major corporations such as IBM, Armco Steel, ARCO Oil and Gas, and Georgia Power. His *Problem Solving: A Logical and Creative Approach* was a selection of the Executive Book of the Month Club and has been translated into Japanese.

Howard Schneider is Associate Professor of Decision Sciences at Georgia State University. Professor Schneider received his Ph.D. from the University of Virginia and is a specialist in multivariate statistics, forecasting, and survey design. He has served as a consultant to the U.S. Office of Personnel Management, Wachovia Bank, The Southern Company, Deloitte & Touche, General Electric, the U.S. Department of Transportation, and the Georgia Department of Offender Rehabilitation. He has developed and taught more than 100 seminars and short courses in statistical methods.

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IMPROVING BUSINESS PROBLEM SOLVING THROUGH STATISTICS

CHAPTER OUTLINE

1.1 Introduction

Statistics. We know what you're thinking—plugging numbers into unreadable formulas; sadistics; irrelevant. You are mistaken. Statistics can improve the problem solving performance of salaried and professional workers, supervisors, and managers in every business field.

Solving problems quickly is essential to business and personal success. Business professionals face two major types of problems. A *disturbance*, or *crisis*, problem is a gap between a previous or budgeted level of performance and the present performance. For example, when a retail department's sales show a sudden and dramatic decline from the previous quarter, we must diagnose the problem's causes and take corrective action to solve the problem permanently. A *managerial* problem, on the other hand, is a gap between the present level of performance and a desired higher level of performance. For example, a support staff takes 3 hours to type and mail a letter, a task that the supervisor believes should take only 1 hour. This is a managerial problem and we must seek ways to improve performance. In summary, solving a disturbance problem means asking, "How can we *restore* performance to previous levels?" Solving a managerial problem means asking, "How can we *improve* performance to the desired level?"

American managers and business professionals are often not effective problem solvers. One reason is that the mass of data that daily crosses their desks overwhelms them. But it need not! We can learn how to organize and analyze the data to develop *mental models* of the state of the department or firm. A mental model describes how an area is doing, where the opportunities lie, and what the emerging problems are. Mental models need not be complex or mathematical. Rather, they should be simple, verbal, or visual. In short, mental models describe how an area is operating, how it used to operate, and how it should operate. **Statistics** can play an essential role in building mental models.

Statistics is a way of thinking that helps collect or create, organize, analyze, summarize, and interpret data to improve problem solving.

Whether solving disturbance problems or managerial problems, we must follow a plan of attack. Consider the approach outlined in Figure 1.1. The three phases incorporated in this problem solving model are explained in this chapter.

FIGURE 1.1 A Problem Solving Model