Sixth Edition

APPLIED BUSINESS STATISTICS

Making Better Business Decisions

KEN BLACK

International Student Version

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Making Better Business Decisions

International Student Version

Ken Black

University of Houston—Clear Lake

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藏书章

WILEY

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For Carolyn, Caycee, and Wendi

The sixth edition of *Applied Business Statistics* continues the rich tradition of using clear and complete, student-friendly pedagogy to present and explain business statistics topics. With the sixth edition, the author and Wiley continue to expand the vast ancillary resources available through WileyPLUS with which to complement the text in helping instructors effectively deliver this subject matter and assisting students in their learning. The resources available to both the instructor and the student through WileyPLUS have greatly expanded since the fifth edition was launched; and because of this, an effort has been made in the sixth edition to more fully integrate the text with WileyPLUS.

In the spirit of continuous quality improvement, several changes have been made in the text to help students construct their knowledge of the big picture of statistics, provide assistance as needed, and afford more opportunities to practice statistical skills. In the fifth edition, the 19 chapters were organized into four units to facilitate student understanding of the bigger view of statistics. In the sixth edition, these same 19 chapters have been organized into five units so that chapters could be grouped into smaller clusters. The nonparametric and the analysis of categorical data chapters have been moved further toward the back of the text so that the regression chapters can be presented earlier. The decision trees that were introduced in the fifth edition to provide the student with a taxonomy of inferential techniques have been improved and expanded in the sixth edition. Nonparametric inferential techniques have been separated from other inferential techniques and given their own decision tree. This has simplified the decision trees for parametric techniques and made the decision trees easier for students to decipher. Further integration of the text with WileyPLUS is addressed through icons that are used throughout the text to designate to the reader that a WileyPLUS feature is available for assistance on a particular topic. The number of databases associated with the text has been expanded from seven to nine, and one of the fifth edition databases has been replaced, thereby bringing the total of new databases in the sixth edition to three.

All of the features of the fifth edition have been retained, updated, and changed as needed to reflect today's business world in the sixth edition. One Decision Dilemma has been replaced, and nine new Statistics in Business Today features have been added. In the sixth edition, as with the fifth edition, there are 17 high-quality video tutorials with the author explaining key difficult topics and demonstrating how to work problems from challenging sections of the text.

This edition is written and designed for a two-semester introductory undergraduate business statistics course or an MBA-level introductory course. In addition, with 19 chapters, the sixth edition lends itself nicely to adaptation for a one-semester introductory business statistics course. The text is written with the assumption that the student has a college algebra mathematical background. No calculus is used in the presentation of material in the text.

An underlying philosophical approach to the text is that every statistical tool presented in the book has some business application. While the text contains statistical rigor, it is written so that the student can readily see that the proper application of statistics in the business world goes hand-in-hand with good decision making. In this edition, statistics are presented as a means for converting data into useful information that can be used to assist the business decision maker in making more thoughtful, information-based decisions. Thus, the text presents business statistics as "value added" tools in the process of converting data into useful information.

CHANGES FOR THE SIXTH EDITION

Units and Chapters

The fifth edition presented 19 chapters organized into four units. The purpose of the unit organization was to locate chapters with similar topics together, thereby increasing the likelihood that students are better able to grasp the bigger picture of statistics. As an

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example, in the fifth edition, Unit II was about distributions and sampling. In this unit of four chapters, the students were introduced to eight probability distributions and to methods of sampling that are used as the basis for techniques presented later in the text.

In the sixth edition, the 18 chapters are organized into five units. The first two units of the sixth edition are the same as those used in the fifth edition. For several reasons, Unit III, Making Inferences About Population Parameters, which contained six chapters of statistical techniques for estimating population parameters and testing population parameters in the fifth edition, has been reduced from six to four chapters in the sixth edition. This makes Unit III less formidable for students to digest, simplifies tree diagrams, and moves two chapters that are less likely to be covered in many courses to later in the text. In the sixth edition, Unit IV, now named Regression Analysis and Forecasting, consists of the same four chapters as it did in the fifth edition. In addition, these four chapters have been moved up two chapters in the sixth edition. Thus, the chapter on simple regression analysis, a chapter that is covered in most courses, is now Chapter 12 instead of Chapter 14. This organization will make it easier for instructors to get to simple regression material without having to skip many chapters.

Topical Changes

Sections and topics from the fifth edition remain virtually unchanged in the sixth edition, with a few exceptions. Correlation analysis has been moved from Section 3.5 in the fifth edition to Section 12.1 in the sixth edition. With this organization, the student begins the chapter (12) on simple regression analysis by studying scatter plots and correlation. Thus, the student is able to see visually what it means for variables to be related and to begin to imagine what it would be like to fit a line through the data. In addition, students are introduced to the r statistic as a forerunner of r^2, and they can see how the five-column analysis used to mechanically solve for r is similar to that used in solving for the equation of the regression line.

In Chapter 2, Charts and Graphs, Section 2.2 of the fifth edition, has been expanded and reorganized into two sections, Quantitative Data Graphs and Qualitative Data Graphs. In addition, a treatment of dot plots has been added to Chapter 2 as an additional quantitative data graph. Dot plots are simple to construct and easy to understand and are especially useful when analyzing small- and medium-size databases. Their importance in visually depicting business data is growing.

Upon request by text users, presentation of the median of grouped data has been added to Chapter 3, Descriptive Statistics.

Acceptance sampling, the last section of Chapter 18 of the fifth edition, has been deleted in the sixth edition. Because acceptance sampling is based on inspection and is generally only used to accept or reject a batch, it has limited usefulness in the present world of Six Sigma, lean manufacturing, and quality improvement. In place of acceptance sampling in the sixth edition, Chapter 18, Statistical Quality Control, additional information on quality gurus, quality movements, and quality concepts, has been added.

Integration of Text and WileyPLUS

WileyPLUS, with its rich resources, has been a powerful partner to this text in delivering and facilitating business statistics education for several years. Many instructors have discovered that WileyPLUS can greatly enhance the effectiveness of their business statistics course, and they use WileyPLUS hand-in-hand with the text. With this in mind, the sixth edition further integrates the text and WileyPLUS by using icons to represent such WileyPLUS features as interactive applets, videos by the author, demonstration problems, Decision Dilemma, Decision Dilemma Solved, flash cards, and databases showing exactly where each one corresponds to text topics. In this way, students are reminded in the text when there is a WileyPLUS feature available to augment their learning.

Tree Diagram of Inferential Techniques

To assist the student in sorting out the plethora of confidence intervals and hypothesis testing techniques presented in the text, tree diagrams are presented at the beginning of Unit III and Chapters 8, 9, 10, and 17. The tree diagram at the beginning of Unit III displays virtually

all of the inferential techniques presented in Chapters 8–10 so that the student can construct a view of the "forest for the trees" and determine how each technique plugs into the whole. Then at the beginning of each of these three chapters, an additional tree diagram is presented to display the branch of the tree that applies to techniques in that particular chapter. Chapter 17 includes a tree diagram for just the nonparametric statistics presented in that chapter. In the fifth edition, all of these techniques were shown on one tree diagram; and because it was determined that this made the diagram less useful and perhaps overwhelming, in the sixth edition, the nonparametric branches are placed in a separate diagram.

In determining which technique to use, there are several key questions that a student should consider. Listed here are some of the key questions (displayed in a box in the Unit III introduction) that delineate what students should ask themselves in determining the appropriate inferential technique for a particular analysis: Does the problem call for estimation (using a confidence interval) or testing (using a hypothesis test)? How many samples are being analyzed? Are you analyzing means, proportions, or variances? If means are being analyzed, is (are) the variance(s) known or not? If means from two samples are being analyzed, are the samples independent or related? If three or more samples are being analyzed, are there one or two independent variables and is there a blocking variable?

Decision Dilemma and the Decision Dilemma Solved

The popular Decision Dilemma feature included in previous editions of the text has been retained in the sixth edition along with the In Response feature, which has been renamed as Decision Dilemma Solved. The Decision Dilemmas are real business vignettes that open each chapter and set the tone for the chapter by presenting a business dilemma and asking a number of managerial or statistical questions, the solutions to which require the use of techniques presented in the chapter. The Decision Dilemma Solved feature discusses and answers the managerial and statistical questions posed in the Decision Dilemma using techniques from the chapter, thus bringing closure to the chapter. In the sixth edition, all decision dilemmas have been updated and revised. Solutions given in the Decision Dilemma Solved features have been revised for new data and for new versions of computer output. In addition, one new Decision Dilemma has been added in the sixth edition in Chapter 10. The title of this Decision Dilemma is "Online Shopping," a current and timely topic in the business world. In this Decision Dilemma, the results of surveys by the Pew Internet/American Life Project of 2400 American adults and a Nielsen survey of over 26,000 Internet users across the globe are presented in addition to a Gallup household survey of 1043 adults and a survey of 7000 people in Europe conducted by the European Interactive Advertising Association. Some of the findings of these studies include 875 million consumers around the world have shopped online, the market for online shopping has increased by 40% in the past 2 years, and European shoppers spend an average of €750 shopping online over a 6-month period. In the Decision Dilemma, presented at the opening of the chapter, students are asked to consider some managerial and statistical questions that are later answered in the Decision Dilemma Solved feature at the end of the chapter. An example of such as question, associated with this new Decision Dilemma is this:

One study reported that the average amount spent by online American shoppers in the past 30 days is $123 at specialty stores and $121 at department stores. These figures are relatively close to each other and were derived from sample information. Suppose a researcher wants to test to determine if there is actually any significant difference in the average amount spent by online American shoppers in the past 30 days at specialty stores vs. department stores. How does she go about conducting such a test?

Statistics in Business Today

The sixth edition includes one or two Statistics in Business Today features in every chapter. This feature presents a real-life example of how the statistics presented in that chapter apply in the business world today. There are nine new Statistics in Business Today features in the sixth edition, which have been added for timeliness and relevance to today's students,

and others have been revised and updated. The nine new Statistics in Business Today features are "Cellular Phone Use in Japan," "Recycling Statistics," "Business Travel," "Newspaper Advertising Reading Habits of Canadians," "Plastic Bags vs. Bringing Your Own in Japan," "Teleworking Facts," "Sampling Canadian Manufacturers," "Canadian Grocery Shopping Statistics," and "Rising Cost of Healthcare in the U.S." As an example, from "Canadian Grocery Shopping Statistics," Canadians take a mean of 37 stock-up trips per year, spending an average of 44 minutes in the store. They take a mean of 76 quick trips per year and average of 18 minutes in the store. On average, Canadians spend four times more money on a stock-up trip than on a quick trip. Twenty-three percent often buy items that are not on their list but catch their eye, 28% often go to a store to buy an item that is on sale, 24% often switch to another check out lane to get out faster, and 45% often bring their own bag.

New Problems

Every problem in the fifth edition has been examined for timeliness, appropriateness, and logic before inclusion in the sixth edition. Those that fell short were replaced or rewritten. While the total number of problems in the text is 950, a concerted effort has been made to include only problems that make a significant contribution to the learning process. Thirty new problems have been added to the sixth edition, replacing problems that have become less effective or relevant. Over one-third of the new problems are in Chapter 3, Descriptive Statistics, where it is especially important for the student to analyze up-to-date business situations and data. All other problems in text have been examined for currency, and many problems have revised with updated data.

All demonstration problems and example problems were thoroughly reviewed and edited for effectiveness. A demonstration problem is an extra example containing both a problem and its solution and is used as an additional pedagogical tool to supplement explanations and examples in the chapters. Virtually all example and demonstration problems in the sixth edition are business oriented and contain the most current data available.

As with the previous edition, problems are located at the end of most sections in the chapters. A significant number of additional problems are provided at the end of each chapter in the Supplementary Problems. The Supplementary Problems are "scrambled"—problems using the various techniques in the chapter are mixed—so that students can test themselves on their ability to discriminate and differentiate ideas and concepts.

New Databases

Associated with the sixth edition are nine databases, three of which are new to this edition. One new database is the 12-year Gasoline database, which includes monthly gasoline prices, the OPEC spot price each month, monthly U.S. finished motor gasoline production, and monthly U.S. natural gas well head prices over 12 years. A second new database is the Consumer Food database, which contains data on annual household income, non-mortgage household debt, geographic region, and location for 200 households. The third new database is a U.S. and International Stock Market database with 60 months of actual stock market data from the Dow Jones Industrial Average, the NASDAQ, Standard and Poor's, Japan NIKKEI 225, Hong Kong Hang Seng, United Kingdom FTSE 100, and Mexico's IPC. This new International Stock Market database replaced the old Stock Market database that was in the fifth edition.

VIDEOTAPE TUTORIALS BY KEN BLACK

An exciting feature of the sixth edition package that will impact the effectiveness of student learning in business statistics and significantly enhance the presentation of course material is the series of videotape tutorials by Ken Black. With the advent of online business statistics courses, increasingly large class sizes, and the number of commuter students who have

very limited access to educational resources on business statistics, it is often difficult for students to get the learning assistance that they need to bridge the gap between theory and application on their own. There are now 17 videotaped tutorial sessions on key difficult topics in business statistics delivered by Ken Black and available for all adopters on WileyPLUS. In addition, these tutorials can easily be uploaded for classroom usage to augment lectures and enrich classroom presentations. Each session is around 9 minutes in length. The 17 tutorials are:

1. Chapter 3: Computing Variance and Standard Deviation
2. Chapter 3: Understanding and Using the Empirical Rule
3. Chapter 4: Constructing and Solving Probability Matrices
4. Chapter 4: Solving Probability Word Problems
5. Chapter 5: Solving Binomial Distribution Problems, Part I
6. Chapter 5: Solving Binomial Distribution Problems, Part II
7. Chapter 6: Solving Problems Using the Normal Curve
8. Chapter 8: Confidence Intervals
9. Chapter 8: Determining Which Inferential Technique to Use, Part I, Confidence Intervals
10. Chapter 9: Hypothesis Testing Using the z Statistic
11. Chapter 9: Establishing Hypotheses
12. Chapter 9: Understanding p-Values
13. Chapter 9: Type I and Type II Errors
14. Chapter 9: Two-Tailed Tests
15. Chapter 9: Determining Which Inferential Technique to Use, Part II, Hypothesis Tests
16. Chapter 12: Testing the Regression Model I—Predicted Values, Residuals, and Sum of Squares of Error
17. Chapter 12: Testing the Regression Model II—Standard Error of the Estimate and r^2

FEATURES AND BENEFITS

Each chapter of the sixth edition contains sections called Learning Objectives, a Decision Dilemma, Demonstration Problems, Section Problems, Statistics in Business Today, Decision Dilemma Solved, Chapter Summary, Key Terms, Formulas, Ethical Considerations, Supplementary Problems, Analyzing the Databases, Case, Using the Computer, and Computer Output from both Excel 2007 and Minitab Release 15.

- **Learning Objectives.** Each chapter begins with a statement of the chapter's main learning objectives. This statement gives the reader a list of key topics that will be discussed and the goals to be achieved from studying the chapter.
- **Decision Dilemma.** At the beginning of each chapter, a short case describes a real company or business situation in which managerial and statistical questions are raised. In most Decision Dilemmas, actual data are given and the student is asked to consider how the data can be analyzed to answer the questions.
- **Demonstration Problems.** Virtually every section of every chapter in the sixth edition contains demonstration problems. A demonstration problem contains both an example problem and its solution, and is used as an additional pedagogical tool to supplement explanations and examples.
- **Section Problems.** There are over 950 problems in the text. Problems for practice are found at the end of almost every section of the text. Most problems utilize real data gathered from a plethora of sources. Included here are a few brief excerpts from some of the real-life problems in the text: "*The Wall Street Journal* reported that 40% of all workers say they would change jobs for 'slightly higher pay.' In

addition, 88% of companies say that there is a shortage of qualified job candidates." "In a study by Peter D. Hart Research Associates for the Nasdaq Stock Market, it was determined that 20% of all stock investors are retired people. In addition, 40% of all U.S. adults have invested in mutual funds." "A survey conducted for the Northwestern National Life Insurance Company revealed that 70% of American workers say job stress caused frequent health problems." "According to Padgett Business Services, 20% of all small-business owners say the most important advice for starting a business is to prepare for long hours and hard work. Twenty-five percent say the most important advice is to have good financing ready."

- **Statistics in Business Today.** Every chapter in the sixth edition contains at least one Statistics in Business Today feature. These focus boxes contain an interesting application of how techniques of that particular chapter are used in the business world today. They are usually based on real companies, surveys, or published research.
- **Decision Dilemma Solved.** Situated at the end of the chapter, the Decision Dilemma Solved feature addresses the managerial and statistical questions raised in the Decision Dilemma. Data given in the Decision Dilemma are analyzed computationally and by computer using techniques presented in the chapter. Answers to the managerial and statistical questions raised in the Decision Dilemma are arrived at by applying chapter concepts, thus bringing closure to the chapter.
- **Chapter Summary.** Each chapter concludes with a summary of the important concepts, ideas, and techniques of the chapter. This feature can serve as a preview of the chapter as well as a chapter review.
- **Key Terms.** Important terms are bolded and their definitions italicized throughout the text as they are discussed. At the end of the chapter, a list of the key terms from the chapter is presented. In addition, these terms appear with their definitions in an end-of-book glossary.
- **Formulas.** Important formulas in the text are highlighted to make it easy for a reader to locate them. At the end of the chapter, most of the chapter's formulas are listed together as a handy reference.
- **Ethical Considerations.** Each chapter contains an Ethical Considerations feature that is very timely, given the serious breach of ethics and lack of moral leadership of some business executives in recent years. With the abundance of statistical data and analysis, there is considerable potential for the misuse of statistics in business dealings. The important Ethical Considerations feature underscores this potential misuse by discussing such topics as lying with statistics, failing to meet statistical assumptions, and failing to include pertinent information for decision makers. Through this feature, instructors can begin to integrate the topic of ethics with applications of business statistics. Here are a few excerpts from Ethical Considerations features: "It is unprofessional and unethical to draw cause-and-effect conclusions just because two variables are correlated." "The business researcher needs to conduct the experiment in an environment such that as many concomitant variables are controlled as possible. To the extent that this is not done, the researcher has an ethical responsibility to report that fact in the findings." "The reader is warned that the value lambda is assumed to be constant in a Poisson distribution experiment. Business researchers may produce spurious results if the value of lambda is used throughout a study; but because the study is conducted during different time periods, the value of lambda is actually changing." "In describing a body of data to an audience, it is best to use whatever statistical measures it takes to present a 'full' picture of the data. By limiting the descriptive measures used, the business researcher may give the audience only part of the picture and skew the way the receiver understands the data."
- **Supplementary Problems.** At the end of each chapter is an extensive set of additional problems. The Supplementary Problems are divided into three groups: Calculating the Statistics, which are strictly computational problems; Testing Your Understanding, which are problems for application and understanding; and

Interpreting the Output, which are problems that require the interpretation and analysis of software output.

- **Analyzing the Databases.** There are nine major databases located on the student companion Web site that accompanies the sixth edition. The end-of-chapter Analyzing the Databases section contains several questions/problems that require the application of techniques from the chapter to data in the variables of the databases. It is assumed that most of these questions/problems will be solved using a computer.
- **Case.** Each end-of-chapter case is based on a real company. These cases give the student an opportunity to use statistical concepts and techniques presented in the chapter to solve a business dilemma. Some cases feature very large companies—such as Shell Oil, Coca-Cola, or Virgin Blue. Others pertain to small businesses—such as Thermatrix, New Zealand wine industry, or DeBourgh—that have overcome obstacles to survive and thrive. Most cases include raw data for analysis and questions that encourage the student to use several of the techniques presented in the chapter. In many cases, the student must analyze software output in order to reach conclusions or make decisions.
- **Using the Computer.** The Using the Computer section contains directions for producing the Excel 2007 and Minitab Release 15 software output presented in the chapter. It is assumed that students have a general understanding of a Microsoft Windows environment. Directions include specifics about menu bars, drop-down menus, and dialog boxes. Not every detail of every dialog box is discussed; the intent is to provide enough information for students to produce the same statistical output analyzed and discussed in the chapter. The sixth edition has a strong focus on both Excel and Minitab software packages. More than 250 Excel 2007 or Minitab Release 15 computer-generated outputs are displayed.

WILEYPLUS

WileyPLUS is a powerful online tool that provides instructors and students with an integrated suite of teaching and learning resources, including an online version of the text, in one easy-to-use Web site. To learn more about WileyPLUS, and view a demo, please visit www.wiley.com/college/WileyPLUS.

WileyPLUS Tools for Instructors

WileyPLUS enables you to:

- Assign automatically graded homework, practice, and quizzes from the end of chapter and test bank.
- Track your students' progress in an instructor's grade book.
- Access all teaching and learning resources, including an online version of the text, and student and instructor supplements, in one easy-to-use Web site. These include full color PowerPoint slides, teaching videos, case files, and answers and animations.
- Create class presentations using Wiley-provided resources, with the ability to customize and add your own materials.

WileyPLUS Resources for Students Within WileyPLUS

In WileyPLUS, students will find various helpful tools, such as an ebook, the student study manual, videos with tutorials by the author, applets, Decision Dilemma and Decision Dilemma Solved animations, learning activities, flash cards for key terms, demonstration problems, databases in both Excel and Minitab, case data in both Excel and Minitab, and problem data in both Excel and Minitab.

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- **Ebook.** The complete text is available on WileyPLUS with learning links to various features and tools to assist students in their learning.
- **Videos.** There are 17 videos of the author explaining concepts and demonstrating how to work problems for some of the more difficult topics.
- **Applets.** Statistical applets are available, affording students the opportunity to learn concepts by iteratively experimenting with various values of statistics and parameters and observing the outcomes.
- **Learning Activities.** There are numerous learning activities to help the student better understand concepts and key terms. These activities have been developed to make learning fun, enjoyable, and challenging.
- **Data Sets.** Virtually all problems in the text along with the case problems and the databases are available to students in both Excel and Minitab format.
- **Animations.** To aid students in understanding complex interactions, selected figures from the text that involve dynamic activity have been animated using Flash technology. Students can download these animated figures and run them to improve their understanding of dynamic processes.
- **Flash Cards.** Key terms will be available to students in a flash card format along with their definition.
- **Student Study Guide.** Complete answers to all odd-numbered questions.
- **Demo Problems.** Step-by-step solved problems for each chapter.

ANCILLARY TEACHING AND LEARNING MATERIALS

www.wiley.com/go/global/black

Students' Companion Site

The student companion Web site contains:

- All databases in both Excel and Minitab formats for easy access and use.
- Excel and Minitab files of data from all text problems and all cases. Instructors and students now have the option of analyzing any of the data sets using the computer.
- Full and complete version of Chapter 19, Decision Analysis, in PDF format. This allows an instructor the option of covering the material in this chapter in the normal manner, while keeping the text manageable in size and length.
- A section on Advanced Exponential Smoothing Techniques (from Chapter 17), which offers the instructor an opportunity to delve deeper into exponential smoothing if so desired, and derivation of the slope and intercept formulas from Chapter 12.
- A tutorial on summation theory.

Instructor's Resource Kit

All instructor ancillaries are provided on the Instructor Resource Site. Included in this convenient format are:

- **Instructor's Manual.** Prepared by Ken Black, this manual contains the worked out solutions to virtually all problems in the text. In addition, this manual contains chapter objectives, chapter outlines, chapter teaching strategies, and solutions to the cases.
- **PowerPoint Presentation Slides.** The presentation slides, prepared by Lloyd Jaisingh of Morehead State University, contain graphics to help instructors create stimulating lectures. The PowerPoint slides may be adapted using PowerPoint software to facilitate classroom use.
- **Test Bank.** Prepared by Ranga Ramasesh of Texas Christian University, the Test Bank includes multiple-choice questions for each chapter. The Test Bank is provided in Microsoft Word format.

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—Ken Black

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Since joining the faculty of UHCL in 1979, Professor Black has taught all levels of statistics courses, forecasting, management science, market research, and production/operations management. In 2005, he was awarded the President's Distinguished Teaching Award for the university. He has published over 20 journal articles and 20 professional papers, as well as two textbooks: *Business Statistics: An Introductory Course* and *Business Statistics for Contemporary Decision Making.* Black has consulted for many different companies, including Aetna, the city of Houston, NYLCare, AT&T, Johnson Space Center, Southwest Information Resources, Connect Corporation, and Eagle Engineering.

Ken Black and his wife, Carolyn, have two daughters, Caycee and Wendi. His hobbies include playing the guitar, reading, traveling, and running.

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