Data Analysis Through Modeling: Thinking and Writing in Context

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About this text

Data Analysis Through Modeling is a one-semester data analysis and calculus text that can be used as part of a one-, two- or three semester sequence of mathematics courses usually required of business and management undergraduate majors. We believe the following features distinguish this text from other texts in the curriculum:

⇒ Data-driven, open-ended problems
⇒ Extensive use of spreadsheets throughout the text as more than just a calculator
⇒ Key problems framed as realistic business memos
⇒ Follows recommendations of MAA's Curriculum Foundations Project CRAFTY report for business and management

The increasingly information-driven demands of business in the 21st century require a different emphasis in the quantitative skills and ways of thinking than traditional mathematics courses have provided in the education of managers. This emphasis has to do with becoming comfortable in the world of data and mathematical models, being able to use technology as a tool through which to think, and expressing one's thinking effectively in writing.

The key, we believe, is data analysis through modeling. Data analysis for us means "What can we find out about this data set relevant to our problem?" Models for us are such things as: averages, boxplots, histograms, single- and multivariable regression equations, both linear and nonlinear. These models are proxies for data that are too complex to understand any other way. We think of calculus as a way of analyzing certain kinds of models, which in turn, reveals something about underlying data structures. Our treatment of calculus emphasizes basic concepts, such as rates of change, constrained optimization, and interpretations of area under a graph, and their applications to business problems. We use spreadsheets to develop numerical methods for both differentiation and integration while deemphasizing symbolic manipulation. We use Excel's Solver routine instead of the simplex method to solve linear programming problems. Using Solver has the advantage that we can also solve nonlinear programs.

As we developed this text, we found the introduction of spreadsheet technology for analysis of data not only changed our teaching approach and the content of the course, but it caused us to modify our assignments as well. We found that we simply could not get the quality and depth of understanding we desired from our students by using conventional exercises. We found that students have to explain their thinking and make explicit their assumptions and inferences. In short, we had to supplement our more conventional exercises with memoranda problems with accompanying data files that students respond to in an appropriate business format that are, in turn, read by their supervisor. Further, we find that students learn more by having a chance to revise their work based on instructor/supervisor feedback. All of which should give an indication as to why the book is subtitled "Thinking and Writing in Context."

Although the text has a unit of descriptive statistics and develops regression all the way through multivariable regression with interaction terms, Data Analysis Through Modeling is not a statistics text. Most one-semester introductory statistics courses do not treat regression at the level presented in this text. Moreover, most introductory statistics texts do not give

the same emphasis to descriptive statistics that this text does, which is to use these relatively simple concepts for rather deep analysis. *Data Analysis Through Modeling* fits well with an introductory statistics course that primarily deals with probability and hypothesis testing.

How this text fits into the curriculum

We recommend the following tracks for a three-credit-hour, semester-long course using *Data Analysis Through Modeling*:

- For students not having a prior statistics course: Chapters 1-9, 11-12 [11 chapters]. This course would not contain calculus and would be the first in either a two- or three semester sequence: 1) data analysis and statistics or 2) data analysis, statistics, and calculus. In our experience, students then do quite well in the follow-up statistics course after their experience with our approach to data analysis.

- With a statistics prerequisite: Chapters 1-3, 7-9, 11-17 [12 chapters]. This course would contain calculus and constitute the second course in a two-semester sequence containing probability and hypothesis testing, data analysis, and calculus.

The basic concepts of calculus are emphasized and applied to business problems involving marginal analysis, optimization and area under a curve. As recommended by CRAFTY, formal techniques of symbolic manipulation are kept to a minimum, whereas spreadsheets are used extensively not only for finding numerical solutions but, equally important, for the development of the basic concepts of calculus themselves.

The Technology Used in this Text

In addition to problem solving in the dynamic environment of spreadsheets, students will have the opportunity to learn about and use the following Excel tools: pivot tables, sorting, stacking and unstacking data, basic statistical functions, frequency tables, sumproduct, building boxplots and histograms, correlation tables, simple regression, multivariable regression (quantitative and qualitative), scatterplots, trendlines, Goal Seek, SOLVER table and graphing in three dimensions. In addition, students will develop many basic computer literacy abilities, such as copying and pasting and integrating numerical, textual and graphical analyses into a single Word document. But what is most important about the way students learn these tools is that they are all taught in the context of solving business-type problems; this context, we believe, is critical for students learning how to transform these tools from a set of instructions to follow into a method of thinking and analyzing data.

The Structure of the Book

This text is organized into five units, not all of which can be covered in one semester, as mentioned above. The chapters in each unit are all connected through a common "thinking

Unit	Thinking Strategy
Quantifying the World	Students learn the importance of data and how to locate data in real world situations.
Analyzing Data Through Spatial Models	Students learn how to use basic charts and graphs to deeply understand a problem situation.
Analyzing Data Through Linear Models	Students learn how to apply proportional reasoning to understand data with one or more independent variables.
Analyzing Data Through Nonlinear Models	Students learn to build models by linearizing non-proportional data and learn how to interpret these in realistic situations.
Analyzing Data Through Calculus Models	Now that students understand how to build models from data, they learn how to use concepts from calculus to understand the problem from which the data and the model were derived.

Table 1: Units and thinking strategies covered in the text.

strategy". The thinking strategies are described in the table 1. The breakdown of topics in each chapter within the units is described later.

Each chapter is designed to be covered in one week of a typical semester course. Since the homework problems (see below) come at the end of a chapter, the homework schedule should, ideally, consist of one assignment per week. Each chapter's introduction provides a brief overview. It also includes a list of goals and objectives that the student should have after completing the chapter. After the introduction and overview, the main content of each chapter is separated into two major sections, each of which consists of the following:

Discussion. This presents a short overview of the chapter or discusses a short motivational example illustrating the use of the chapter material. The material in this section is conceptual in nature.

Definitions and Formulas. This lists the factual information of the chapter in the form of definitions, formulas, graphs, and methods of computing. It is intended as a reference guide.

Worked Examples. These offer worked examples of using the formulas and techniques of the chapter. This material is more often procedural in nature, but uses concepts to unpack and apply the material to realistic situations from the business world.

Explorations. These involve small scenarios, often supplemented with data in Excel. They are open-ended and require discussion and scaffolding. These are basically guided-discovery type activities and are ready-made in-class activities, but can also cbe completed by students outside of class in order to enhance their understanding of the chapter material.

How to Guides. These offer the details for getting Word, Excel and StatPro (an Excel add-in) to handle the computations and graphing needed to complete the exercises.

Homework Problems

Each chapter within a unit is designed to provide the material for a weekly homework assignment at the end of the second section of the chapter. The problems at a chapter's end come in three types: Mechanics and Technique Problems, Application and Reasoning Problems, and Memo Problems (which include Communication and Professionalism skills). Although we consider the memos to be the heart of any course using this book, the number of memos instructors choose to assign on a weekly basis will vary and the two other types of problems work very well to provide a balanced weekly assignment load.

Mechanics and Technique Problems. These problems involve straightforward calculations by hand or, more often, with the computer, and use the basic definitions, formulas, and computer techniques from the chapter.

Application and Reasoning Problems. These problems require students to analyze data or apply the concepts of the chapter to small decision-making scenarios. Many of these require students to explain their thinking in a few short sentences so that the inferences they have drawn from the data and other information are made explicit.

Memo Problems. Each chapter concludes with a memo problem from a supervisor at Oracular Consulting. The memos are written in the style of a management memo, often having a rather open-ended feel, and will most often direct the analysis staff (the students) to analyze some data for a client, using the tools of that chapter (and possibly previous chapters). Students are expected to reply to these memos with their own professionally written memos or reports. Most memo problems usually permit more than one "correct" response. We have developed detailed "rubrics" for assessing each memo which are invaluable should the instructor choose to have students revise and resubmit their memos. These can be found in the *Instructor's Guide*. These rubrics do not contain "answers" per se, but rather statements to be checked off by the instructor that note lapses in analysis, missing pieces, incorrect or misapplied mathematical/computer procedures, or point out structural writing difficulties. These statements are divided into three discrete areas: Mechanics and Technique, Applications and Reasoning, and Communication and Professionalism, and each of these three is divided into two levels of competence, Expected and Impressive (see the appendices for an example). In the *Instructor's Guide* we describe in detail how we arrive at grades.

Entering Student Profile

As a student entering a course using this book, or as someone using this book on their own to gain new skills, techniques, and concepts about quantitative analysis in the business world, you shold have some skills in the areas of mathematics, the use of technology, and writing.

Mathematics background: Basic algebra skills are essential, but the text does not require well-honed algebraic skills as a pre-requisite. What is most essential is the abstraction that algebra supports in moving from concrete objects to expressions and functions

with parameters and variables. Students should have had a mathematics background up to, but not necessarily including, precalculus.

Technology background: The text does not assume that the students have any knowledge of spreadsheets, though in our experience most have some familiarity with computers and spreadsheets, Excel in particular.

Writing Background: In our experience, students gain the most from this text when it is taught in a writing-intensive format, using a selection of the chapter memo problems (including revisions). Most first-year college writing course requirements will have prepared students sufficiently to write at the level the memos demand.

Exiting Student Profile

By the end of a course based on this text, we expect students to have developed capabilities in three areas. The first area (mentioned above) is "Mechanics and Techniques," which includes knowledge of basic mathematical notation and symbol manipulation as well as basic technological (especially spreadsheet) skills for structuring problems for solutions. The second area is "Application and Reasoning," which covers the ability to contextualize the mathematical ideas, to extract quantitative information from a context, and to make logical inferences from quantitative analyses. The final area is "Communication and Professionalism," which covers the ability to write coherently about a problem and its proposed solution and to communicate this analysis in a professionally appropriate manner.

Specifically, a student earning an average grade in a course based on this text would have the capabilities in each of the three areas shown in the outline below.

Mechanics and Techniques

- Has had experience formulating and interpreting algebraic, graphical and numerical mathematical models
- Has used spreadsheets to apply various mathematical, statistical, and graphical tools to business situations
- Understands enough about data analytic techniques to effectively communicate with statisticians and other types of expert analysts
- Is competent and comfortable with spreadsheets
- Has learned to use technology as a tool with which to think

Application and Reasoning

- Understands how to define a problem situation in terms of data
- Understands the basic design of data collection forms and how to employ them
- Has experience in working in open-ended, ambiguous problem situations
- Understands the interpretive power of graphical displays of data
- Understands the power and limitations of mathematical models
- Has experience in interpreting the parameters and coefficients of mathematical models

- Is capable of drawing contextual inferences from statistical and graphical analysis

Communication and Professionalism

- Knows the importance of writing in the workplace
- Can write competent memos and reports as part and parcel of one's job
- Knows how to integrate and arrange statistical and graphical elements in a word processing document to produce a convincing argument
- Has learned to consider the reader's response to a memo
- Has learned to plan ahead to meet the demands of the course
- Persists when the path is not clear
- Has learned self discipline in accomplishing long and complex tasks

Some Words About Level of Difficulty

Viewed apart from a context of a memo, the mathematics, technology, and writing demands of certain chapters may not seem very difficult when taken separately. But when students analyze a data set using Excel, interpret and draw inferences from mathematical formulations within specific problem contexts and then organize the various charts, computer output, and text into a coherent and readily understood memo, they find the work to be anything but easy. Indeed, instructors of this text invariably comment on how they themselves have been challenged by the problems. The open-ended nature of the problems (e.g. see the Chapter 1 memo) contributes to this challenge, as well as the sheer amount of time it takes to complete the whole process. This is one of the reasons that instructors may not wish to assign a memo problem every week, especially when requiring revisions, which students mightily appreciate and benefit from.

Some Words About Plagiarism and Working Together

We require all memos to be submitted electronically through a course website (Blackboard) in Word. This enables us to issue the following policy that eliminates concerns about plagiarism:

"We encourage you to work together and to seek help when you need it. Our only requirement is that you write your own memo in your own words."

Invariably, two or three students will copy each other's work sometime in the beginning of the semester. Because each writer's voice comes through so strongly even in the memo genre, duplication is easy to detect. Furthermore, technology is an aid in identifying copying. For example, Microsoft Word has a feature called *compare and merge documents* (under tools) that superimposes one document upon another showing all differences in red (every space, every comma, whole chunks of text, etc.) or, more importantly, no differences. Tips on using this tool are available in the *Instructor's Guide*. Once identified, instructors can respond with the following notification: "Computer analysis shows that significant portions of your memo and Mike's memo are identical. While we encourage you to work together, we do require that you do your own write up. Friendly warning." There are no copying problems from this point on. Maybe word gets around the class about the "computer analysis."

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Chapter Details

Unit 1. Quantifying the World. Students learn the importance of data and how to locate data in real world situations.		
Chapter	Content	Memo Regarding
1. Problem Solving	Framing a problem in terms of data	Performing the up-front analysis in response to a RFP from Carnivorous Cruise Lines concerning lack of attendance at its entertainment venues (No data file)
2. Understanding the Role of Data	Collecting and organizing data to support problem solving	Creating data collection forms and displaying sample test data in spreadsheets for the Carnivorous Cruise Lines RFP (Create your own data file)
3. Using Models to Interpret Data	Building simple models to analyze data using the mean, standard deviation and pivot tables	Analyzing sample data from Carnivorous Cruise Lines to make changes in the entertainment schedule (Data file)

Unit 2. Analyzing Data Through Spatial Models. Students learn how to use basic charts and graphs to deeply understand a problem situation.		
Chapter	Content	Memo Regarding
4. Box-and-Whisker Plots	Using boxplots and associated measures to build and analyze spatial models of data	Using boxplots to explore the salary structures of four different companies for two quite different managers in need of a job (Data file)
5. Histograms	Using z-scores and histograms for understanding different distributions of data	Analyzing customer wait times at a fast food restaurant in response to customer complaints of poor service (Data file)
6. Interpreting Spatial Models	Estimating statistics from summary data and connect the different spatial models (boxplots and histograms) to build a more complete understanding of a set of data	Analyzing ten different stocks in order to build financial portfolios for two quite different clients. (Data file)

Unit 3. Analyzing Data Through Linear Models. Students learn how to apply proportional reasoning to understand data with one or more independent variables.		
Chapter	Content	Memo Regarding
7. Correlation	Picturing and quantifying the relationship between two variables using correlation and trendlines	Using and interpreting trendlines to determine how in-city and out-of-city driving conditions effect maintenance costs for a trucking fleet (Data file)
8. Simple Regression	Using simple linear regression to measure the effect of one variable upon another and to interpret how well our models fit the data	Building and interpreting simple regression models regarding the how various variables affect ridership on a commuter rail system (Data file)
9. Multiple and Categorical Regression	Extending regression modeling into many dimensions and using qualitative variables	Building successive multivariable models using quantitative and qualitative variables to analyze how gender might be implicated in the salary structure at a company (Data file)
10. Is the Model Any Good?	Exploring the reliability of linear models and introducing interaction terms into the models	Developing more realistic models of the truck fleet maintenance costs using interaction terms and stepwise regression analysis (Data file)

Unit 4. Analyzing Data with Nonlinear Models. Students learn to build models by linearizing non-proportional data and learn how to interpret these in realistic situations.		
Chapter	Content	Memo Regarding
11. Graphical Approaches to Nonlinear Data	Examining a variety of nonlinear graphical models with one independent variable (logarithmic, exponential, square, square root and reciprocal) and their transformations	Analyzing various data sets from a customer who wants better models for each set than those created by Excel's trendlines; this is accomplished by shifting and scaling the basic models and computing the goodness of fit for each (Data file)
12. Modeling with Nonlinear Data	Building and interpreting nonlinear regression models, including general power models and multiplicative models in several variables	Creating and comparing multivariable models (one linear and one multiplicative) to help analyze operating costs at an insurance company (Data file)
13. Nonlinear Multivariable Models	Extending the variety of nonlinear multivariable models to include quadratic models developed from interaction terms	Developing more accurate models of the commuter rail system data by using quadratic interaction terms (Data file)

Unit 5. Analyzing Data Using Calculus Models. Now that students understand how to build models from data, they learn how to use concepts from calculus to understand the problem from which the data and the model were derived.		
Chapter	Content	Memo Regarding
14. Optimization and Analysis of Models	Using calculus (derivatives) to interpret and optimize polynomial and power models	Developing and optimizing a mathematical model to challenge an interpretation of a data set (Create your own data file)
15. Deeper Exploration of Logs and Exponentials	Applying calculus to the analysis and optimization of logarithmic and exponential models	Applying calculus skills to exponential functions in order to help a wine collector plan her wine storage for the future (Create your own data file)
16. Optimization in Several Variables	Defining constraints and performing constrained optimization using Excel's SOLVER routine	Determining optimal mix of advertising budget under uncertain conditions, using Solver (Data file)
17. Area Under the Curve	Evaluating definite integrals using both the Fundamental Theorem of Calculus and numerical methods to find the area under a curve.	Finding the area between curves to resolve a pricing dispute for a doll at Cool Toys for Tots (consumers' and producers' surplus). (Data file)

Contents

Part I

Quantifying the World

Thinking of the world as data

In today's world, everyone is collecting data. It's everywhere. Some even say we are innundated with data, so much so that we cannot keep up with the amount of data we can generate and collect. With this in mind, consider the following definition of **data**:

Data: Information extracted from real-world contexts that has been organized for analysis in forms that can be used for making decisions.

Given this definition, who among the following are more likely to think of the world as data in their professional work?

- Mathematicians?
- Scientists?
- Reporters?
- Detectives?
- Business managers?

We can be fairly safe in saying that mathematicians do not see the world as data in their day-to-day work. Only a relatively few mathematicians deal with the real world at all in their professional work. While they may construct mathematical models that others (such as scientists or business managers) may find very useful in making sense of real-world data, mathematicians themselves are often quite unconcerned about the real-world usefulness of their work.

Scientists, on the other hand, use data extensively in their everyday work, but they use it under carefully controlled circumstances. They are interested in data in terms of its experimental reproducibility. They tend to think of the world in terms of patterns of data that occur and reoccur under certain specified conditions. They tend to think of real-world data in terms of how it conforms to predictable scientific laws.

Reporters think of the world as stories. Not rambling stories, but stories told in a certain way so as to communicate a lot of information in a short space. They efficiently extract information from the cacophony of life's events by using the five W's (though not necessarily in this order:

- Who,
- What,
- Where,
- When, and
- Why).

Depending on the nature of the story, experienced reporters usually try to work the answers to the 5-W's into the first paragraph or so of the story. This enables them to accurately convey the context and gist of the story as soon as possible, so that anything else further down the column is merely an elaboration of what is already known. The point is that without the 5-W's approach news reporting becomes less focused, more meandering, and results in less accurate information transmitted for the amount of print expended. But do reporters see the world as data in the sense we have defined it above? They certainly see the world as story based on information, but as data?–probably not. Even if a reporter were writing a financial story, for example, and even if that story contained numerical information that was organized in a form that could be analyzed in some way (for example, graphs or charts), that data would not be specific enough or numerous enough to be of much use to a bank or stock brokerage firm for decision making. Indeed, such businesses would probably have their own data analysis staff anyway or would contract out such services. Nevertheless, the 5-W tool for extracting and organizing information from the world is a useful one from which managers can profit. You will get the opportunity to try it out for yourself in this first unit.

Do detectives see the world as data? "Nothing but the facts, ma'am," says Joe Friday, the laconic police investigator of that ancient TV show Dragnet. Clearly, detectives think of the world as data. Not management-type data, but certainly as information that is organized for analysis in forms that can be used for making that one bottom-line decision - whodunnit? Of course, there are a host of decisions that precede this big one. The detective makes these decisions by drawing inferences from evidence, which is another way of saying "by analyzing the data." So while the data that detectives work with is quite different from the data that managers compile, there is a similarity in what the two do with the data, the way they marshal compelling evidence and draw inferences from that evidence as they argue their case. Everyone knows that detectives cannot make judgments or decisions that will hold up in court without the proper supporting evidence. So it is with business managers. They likewise must present their arguments based on proper supporting evidence. We will be concerned with what constitutes proper evidence and how to present it in almost all of the homework problems.

Because business managers have to constantly make decisions in less-than-certain circumstances, it is to their advantage to think of the world as data, almost to the extent that it becomes second nature to them, a way of seeing. While it is true that certain aspects of business occur with regularity, such as manufacturing processes or financial dealings, it is also true that many important aspects of business, such as sales trends or employee equity issues, are not reducible to known scientific laws. Then too, all aspects of business eventually come down to that one irreducible basic fact, the bottom line. For example, here is a list of bottom-line questions that a manager has to answer on a day-to-day basis that should make clear the case for thinking of the world as data:

- How are we performing?
- Do we have a problem? If so, what is it?
- What can we expect will happen in the future if we continue doing what we're doing now?

- What will happen in the future if we make some key changes?

Putting the case plainly: Would you place a person in a management position requiring answers to these kinds of bottom-line questionsif they could not see the world as data? This raises another question: Does this mean that managers have to be statisticians?

You may have noticed that the list of professions above does not include statisticians. To be sure, they are the real data professionals and data is their bread and butter. But statisticians are, in a sense, generalists. While they probably do see the world as data in a way that few others do, chances are that they do not see your particular business world as you do. As a business manager, you are in a position of responsibility and you are the one who has to make those bottom-line decisions that often have far-reaching consequences. Nevertheless, you do need to think of the world as data.

Which brings us to this point: is this then a statistics text for business managers? The answer is "no, not really." While you will gain experience in dealing with those all-important bottom-line questions listed above by using some rather basic techniques, it would indeed take a lot of statistical background to be able to answer them the way a statistician would. But companies do not, as a rule, hire statisticians as their managers. Similarly, this book is not written for prospective statisticians, but rather prospective managers who will have learned enough from the text to not only appreciate the value of data but also to be able to manage its collection and analysis. This means that they will be expected to understand the technical language of professional data analysts, at least enough to effectively communicate with them, and then to make sense of it all for both their employees and their supervisors. This book takes seriously the assumption that you will be involved either as managers or as team members of a group of professional data analysts in projects similar to those presented in the memo homework problems. This is why the book begins with a unit on thinking of the world as data.

Key Thinking Strategy: Thinking of the world as data.

How does one even begin to recognize and then collect the necessary data that will enable us to first define the problem and then to analyze it? Restated: How does one go about isolating what is relevant to the problem and what is not relevant from the undifferentiated flow of activities or actions or states of existence that we confront in a real-life situation?

One of the easiest and most effective ways to think of the world as data is from the reporter's point of view. The job of a reporter is to tell a story, a story based on facts. The reporter collects facts mostly by asking questions. This an excellent starting point for the business manager as well. In this unit we will use the 5 W's-plus one extra - as a strategy to help us see the world as data: Who, what, when, where, why and how. Although we will be using the 5W's+H, or a selected subsets of them, as a thinking strategy throughout the book, they may take on different meanings and emphases in different sections of the book, depending on whether we are doing the initial work of defining the problem, or creating a plan and timeline to carry out the project or using a particular mathematical technique to analyze the data or writing a memo to convey the results of our analysis. The point is that while it is important to be able to roll the 5W's+H off the tongue, it is also important to be

aware that not only will we not always talk about all of them all the time but that even when we do we may not be thinking of them in quite the same way from situation to situation. Then too, the W's are not necessarily mutually exclusive, meaning that, for example, there may be situations in which it does not make sense to ask What? without asking Where? in the same breath or How? without asking When?

Chapter 1

Problem Solving By Asking Questions[1]

Sometimes the data that is needed to solve a problem has already been gathered and is sitting in a data bank just waiting to be analyzed. Sometimes it is not. If this is the case, one of the first steps in solving the problem is to gather the necessary data. But exactly what data does one need? Clearly, that depends on the problem and that, in turn, assumes we know what the problem really is. This chapter is about letting go of our preconceived notions of what the problem is and then developing ways of getting at the data that will not only define the problem situation but also point to a solution.

- *As a result of this chapter, students will learn*
  - √ The importance of not making assumptions about a problem
  - √ To understand a problem within its context
  - √ The importance of data
  - √ What is involved in gathering data
- *As a result of this chapter, students will be able to*
  - √ Better understand how to read complex interrelated texts
  - √ Develop a plan for gathering data
  - √ Develop a rough timeline for a project
  - √ Write a memo in response to a problem

[1]

1.1 Why Data?

One of the first things that an aspiring manager or consultant has to learn about solving a problem is that he or she is not being paid to provide unsubstantiated beliefs about what might or might not be a good solution. Rather, the successful manager or consultant is paid to propose solutions based upon pertinent data and a well-reasoned analysis of that data. The manager's feelings or guesswork or intuitions can be helpful in exploring a problem situation but they cannot by themselves be the basis for making sound and reliable decisions. Again, it is having a clear idea of how to define the problem and having a plan for collecting the relevant data that constitute the professional approach.

The first step to solving a problem is to define the problem. This is not as obvious or as simple as it sounds; there are numerous case studies showing how businesses have wasted large quantities of money trying to solve the wrong problem. Listed below are the other steps in the general problem solving process. Keep in mind that the process is usually not sequential. You will usually find yourself jumping steps and repeating steps in an attempt to refine your solution.

1. Problem formulation stage
    (a) Define the problem
    (b) Identify possible causes and their effects
    (c) Determine data to be collected
2. Data collection stage
    (a) Determine what the variables are and how they will be coded
    (b) Construct data collection forms
    (c) Construct the database for analysis
3. Solution development stage
    (a) Interrogate the data
    (b) Determine a root cause for the problem
    (c) Develop possible solutions
    (d) Use the data to select the best solution
4. Refinement stage
    (a) Test the solution with sample data
    (b) Modify the solution based on the tests
5. Implementation stage
    (a) Present your findings and your plan
    (b) Put your solution into practice

(c) Collect data as to the effectiveness of the solution

(d) Modify the solution as needed, based on data

One of the reasons that it is vitally important to define the problem you are studying is because real-world problems are often multifaceted. Their causes may be well hidden, and what you observe - the **perceived problem** - may mask the real problem's causes. Part of your job in studying a problem is to think of possible causes for the perceived problem, then determine ways to investigate the situation by collecting data that can sort through these causes. Making this even more difficult is the fact that a single cause can have multiple effects, each of which may generate more effects of its own, some of which may overlap. Identifying this **chain of cause and effect** is really what understanding the problem is all about.

1.1.1 Definitions and Formulas

Data Information extracted from real-world contexts that has been organized for analysis in forms that can be used to inform decision-making.

Consultant/Business Manager A person who is paid to propose solutions that are based upon the collection and analysis of pertinent data.

Perceived problem What the supervisor or employee or customer or client thinks is happening, which may or may not be the actual problem.

Problem situation The circumstances in which a problem takes place and that give rise to the problem

Cause The cause of a problem is often very unclear. The cause is what is really keeping your situation from being ideal. Very often, you will need to brainstorm possible causes and then collect data in order to rule out one or more of them.

Effect or symptom This is the real problem, the result of the cause of the problem. It may be something obvious like lost revenue, and there may be several effects from a single cause.

Chain of cause and effect Very often, a single root cause will "ripple" through the situation, leading to an intermediate effect, which itself becomes the cause of another problem, which has an effect, which causes another problem, and so on. Identification of the real problem and its cause then becomes more difficult because you are forced to backtrack from the obvious problem all the way to the root cause in order to most effectively solve the problem. For example, you may be experiencing the symptom of abdominal pain. In order for the doctor to help you, she must determine why you have the pain (the cause): it could be something you ate, an ulcer, a broken rib, a bruise, or something even more serious. Each possible cause has a very different solution. However, if the cause of the pain is, say, an ulcer, what is causing the ulcer? Stress? Spicy food? Poison?

1.1.2 Worked Examples

Example 1.1. A Problem at Gamma Technologies

Consider the memo below, from the CEO of Gamma Technologies, a firm that makes electronic sensors and filters for medical imaging equipment. The company is fairly large, has been around for many years, and has a varied and diverse workforce.

To: All department managers
From: CEO, Gamma Technologies
Date: May 1, 2008
Re: Working environment at Gamma

I have received a number of complaints that the working environment at Gamma is unfriendly to older workers. As a result, it is believed that older workers are leaving the company in such numbers that they are drastically underrepresented in the company. What should we do about this?

Excerpts from the responses of three managers, X, Y, and Z, are given below. These excerpts are followed by critiques in which some of these managers' unsubstantiated beliefs and assumptions are pointed out.

How Manager X Responded (an excerpt): "...Age discrimination is clearly a problem in today's workforce and it will become even more so in the immediate future as baby-boomers begin retiring later in life than previous generations of workers, either by choice or because of the increasing difficulty of accumulating a sufficient nest egg. Attitudes toward and perceptions of aging workers must be addressed head on. I recommend that a required-attendance series of sensitivity training classes be inaugurated immediately..."

How Manager Y Responded (an excerpt): "...Underrepresentation, whether regards to gender, race, or age, is a serious matter and puts Gamma at risk of a major class-action discrimination law suit. I recommend that management immediately establish 1) a secure hotline to handle complaints and 2) a review board that will investigate such complaints and 3) a set of procedures that establish clearly what actions will be taken upon the review board's conclusions..."

How Manager Z Responded (an excerpt): "..It is difficult to say with certainty how much of the underrepresentation of older workers is due to an unfriendly environment and how much to other factors, such as wanting a career change or having accumulated sufficient financial resources for early retirement.."

Example 1.2. Critique of the Beliefs and Assumptions of the Managers

- Manager X

    1. Belief: Age discrimination is clearly a problem in today's workforce. Critique: While this may be true, X has not presented any evidence (data) to support this belief.
    2. Assumption: Younger workers at Gamma have an attitude problem (unfriendliness) toward older workers. Critique: How do we know this is true? X does not present any evidence (data) to support this assumption.
    3. Assumption: Gamma's unfriendliness to older workers is due to age discrimination. Critique: If there is unfriendliness to older workers (which has yet to be established), there is no evidence (data) that this unfriendliness is due to the age

of the worker and not to some other characteristic. Moreover, if there is indeed an unfriendly environment at Gamma, perhaps it is due to the unfriendly attitude of older workers to younger workers, not the other way around.

4. Belief: Sensitivity training effectively curbs discrimination. Critique: There is no evidence presented that such is the case. Even if X had presented data supporting the effectiveness of sensitivity training based on studies conducted at other companies, X would have to demonstrate that Gamma fits the profiles of these other companies.

- Manager Y:

1. Assumption: There is an under representation of older workers at Gamma. Critique: There is no evidence (data) as to what the representation of older workers actually is at Gamma or how it compares to that of similar companies.
2. Assumption: Gamma is at imminent risk of a class-action law suit. Critique: If there is under representation of older workers at Gamma, how do we know it is of sufficient proportion to precipitate a class-action law suit?

- Manager Z:

1. Assumption: The under representation of older workers at Gamma may be attributed to reasons other than just an unfriendly environment. Critique: While not providing any supporting evidence that Gamma's older workers are indeed underrepresented, Z does properly question whether any such under representation can be attributed to age alone. This demonstrates a degree of analytic sophistication not found in the other manager' responses.

Example 1.3. The Common Assumption: There is a problem at Gamma.
Critique: All of the managers took as a given that what the CEO says is a problem is indeed a problem. A good manager or consultant understands that there is a perceived problem (what the boss or employee or customer or client perceives to be the problem) but also understands that the person being consulted should not propose solutions to bogus problems. The client's view of the problem will almost certainly be stated in terms of one or more assumptions and beliefs. This is to be expected, since if the client/customer knew what the situation really was, he or she would not need a consultant. It is the consultant's job to use the client's perceptions as a first approximation, a way of framing the problem, but to not buy into these perceptions unless analysis of the data supports them.

A Serious Misstep: Managers X and Y are recommending solutions to a perceived problem. That is, they are proposing solutions before knowing what the problem is and without gathering data to understand its dimensions.

While it is true that the manager/consultant is not paid for his or her unsubstantiated beliefs about what might or might not be a good solution (even to a genuine problem), one's beliefs or intuitions can be useful tools for figuring out what data should be gathered. It may turn out that some of the assumptions managers X, Y, and Z made are, in fact, true and can be supported by the gathering and analysis of appropriate data.

1.1.3 Exploration 1A: Assumptions get in the way

The beliefs and assumptions underlying the managers' responses to the CEO's directive at Gamma are all plausible, but they are not grounded in an analysis of data. We can use assumptions like these, however, to help us determine what kinds of data we need to gather in order to explore as many dimensions of a situation as we can without assuming we know the answers. The managers' "solutions" were likewise plausible but were proposed at the final stage of the problem-solving process instead of at the problem formulation stage where they could be most useful. In similar situations, we can use our imagined solutions as a way of testing whether we have thought of all the data we need to gather in order to adequately support them.

Briefly describe how you would gather the data needed to test the assumptions/beliefs of X, Y, and Z.

NOTE: If a particular belief or assumption does not seem to be particularly helpful for collecting the kind of data you need, explain briefly why not and move on to the next one.

Manager	Belief or Assumption	Data Needed or Explanation
X	Age discrimination is a problem	
	Young workers are unfriendly toward older workers	
	Unfriendliness is due to age discrimination	
	Sensitivity training curbs age discrimination	
Y	Older workers are underrepresented at Gamma	
	Gamma is at risk of a lawsuit	
Z	Under-representation may be due to more than just unfriendliness	

Explain below why you think that the data you listed above will help you gather enough data to assure that you have gotten beneath the perceived problem to the real problem (they may be one and the same, of course).

1.1.4 How To Guide

Writing business memos and reports

All solutions to memo problems should be written so as to "stand alone." That is, any reader should be able to pick up your solution and read it without knowing anything else about the problem (but might need to know something about the content). In other words, you must think objectively about your response to the memo. Ask yourself, "What if I got this on my desk and knew nothing about the project? Would I understand the memo?" If the answer is no, then your response needs more information.

Writing is one of the most (if not THE MOST) important aspects of a career - any career, but especially one in business. Writing is a way of seeing, understanding, explaining, and envisioning the world around you. Managers with good communication skills will never be outsourced.

In this course, you will be preparing two types of responses to memos. The first type of response you will produce is an informal, routine type of memo (see the sample in Example 1 (page 10) - problem at Gamma) . In a routine memo, you should:

- Use an informative subject line that summarizes the purpose of the memo.
- State the purpose of your memo in a direct manner in your introduction.
- Organize the body of your memo for readability, using visual cues, bulleted lists, and tables.
- Summarize your analysis, findings, or recommendations, as appropriate in your closing paragraph.
- DO NOT include a closing (like "Sincerely, John")

The second type of response you will be preparing is really what would be called a Business Report. In this type of response, you should include the following sections:

1. The Executive Summary (1 - 2 paragraphs)
   (a) Introduction. Tell the reader what the problem is about. Briefly tell the reader what data has been collected. Explain what you want to determine or find out.
   (b) Preview. Then tell the reader what you are planning to do and give him/her an idea about how the analysis of the data will flow. Explain what the structure of the memo is.
   (c) Conclusions of the Analysis. Briefly describe the conclusions, if possible.
2. Analysis (the bulk of the report)
   (a) Steps to Reach the Conclusion. Explain what you did; explain all the steps and the reasoning that led to each step.

   (b) Supporting Evidence. Provide all the supporting evidence - graphs, tables, charts, etc. Labe leach item appropriately and refer to it by name in the text of the response. Organize the evidence and the explanation so the reader can follow the argument.

3. Conclusion (1 - 2 paragraphs)

   (a) Summary of results. Provide a summary of the results of the analysis, collected into a convenient form (like a table).

   (b) Context. Put your solution into context and explain what the results actually mean for the situation you are analyzing. Interpret the results so the reader does not have to guess.

   (c) Sensitivity. How accurate are your results? How much are they likely to change as a result of changes in the underlying data? Give the reader a sense of what the limits are to your analysis, so that he/she knows how much to rely on these results.

   (d) Advice. If the original assignment/memo called for a decision, be sure you provide a clearly stated response to that requirement, and clearly connect your evidence and process to the decision you are advocating.

Another helpful hint is to use headings in the memo to improve both the visual and logical organization. These may take many different visual formats (bold type, underlining, larger font, etc.) but should match with the structure provided in the introduction of the memo, so that an interested reader can easily locate the information he or she needs. This helps with your overall goal in writing a good memo: Make your thought process transparent for both your reader and yourself. After all, you may need to come back to this project in six months or a year; a good memo now will save you a lot of time later.

Elements Of An Effective Memo

- √ Writing is competent (grammar, spelling and sentence structure are correct and clear)
- √ Directed at the right person (your audience)
- √ Fully addresses the problem
- √ Margins are clean
- √ Organized and focused so it can quickly be read and understood
- √ Sufficient analytic detail to justify all conclusions
- √ No charts or tables split across page breaks
- √ Charts and tables are labeled and referred to by these labels in the text
- √ Evidence (charts and tables) is embedded in the report, somewhat near the discussion about it (integration of text and graphics)
- √ Charts and tables are all legible
- √ Document sections are in order and not fragmented
- √ Introduction provides an overview of the memo and its structure
- √ Introduction reminds the reader (briefly) of what the problem context is and what you have been asked to do

Elements of an Exceptional Memo

√ Additional tables used to organize all conclusions and make comparisons easier
√ Features like bold text, shading, and headings used to highlight important information
√ Conclusion summarizes the analysis
√ Report includes an analysis of accuracy and possible errors

The 5W+H Strategy

√ Who writes? To whom?
√ What do they write about?
√ When should you write?
√ Where should you write?
√ Why should you write?

Email protocols for professional communication

You are probably used to sending and reading emails. You probably even have multiple email accounts to manage. Since all systems are slightly different, we want to talk about something more important to the general concept of sending emails, whether you are sending them to your course instructors, your family, your boss, or your friends.

Personal Information. It is critical that several things appear in any email message.

- Your name. It may seem redundant; after all, the recipient has your email address. But consider this. Many usernames are not clearly connected to to your name. When someone receives an email from abC1434, they don't usually have time to think about everyone they know that might have that as a username. They really don't know who sent the message. If you aren't willing to sign your actual name to the message, you should really think about whether it is a message you should be sending.

- Your job title and address

- Maybe even a phone number.

If your e-mail system allows signature files, it probably will let you create several different ones. You could have a signature file for professional communications and a separate one for personal communications, with different information in each.

Subject Line. Be sure that you put something meaningful in the subject line of your messages. With the thousands of junk email messages that most people receive each week, the subject line will often be the deciding factor in whether your email gets read or not. If your email is to a course instructor, for instance, your instructor will appreciate it if the subject line contains the course number (like MSTI 130) as the first part of the subject line. In the business world, many people will automatically delete messages with inappropriate subject lines or without a subject altogether, not to mention that many spam filters will automatically remove messages without subject lines before the intended recipient every gets an opportunity to examine them.

Be Professional. Make sure that you do a little proofreading in your emails. They may be short, but don't be sloppy. Grammar, punctuation, and spelling are all important in emails. Very often, this may be your only chance to make a first impression, so make it good.

1.2 Defining the Problem

More often than not, the most important step in solving a real-life problem is finding out exactly what the problem is. Obvious - and sometimes not so obvious. There are times when you will be called on to work with supervisors or clients who come to you for a solution but who don't really have a clear idea of what the problem is, and it will be your job to get to the bottom of the situation by gathering the data that define the problem and that provide all that will be needed to solve the problem once it is identified. Defining the problem and coming up with a plan for gathering the appropriate data to think about the problem go hand in hand.

But how, for any given problem situation, do we recognize what data will enable us to first define the problem accurately and then later to analyze it? We need to learn how to isolate what is relevant to the problem from what is not relevant to it. We will see in the Examples and Exploration how to use the 5W+H thinking strategy to recognize and isolate relevant information from a problem situation. In most cases, the strategy must be applied twice: once to the **problem context**, in order to understand what is going on and how one might resolve it, and once to the **communicative context**, in order to understand the purpose for solving the problem and how the results are to be shared.

In the problem context, we ask questions to help understand the perception of the problem, the causes of the problem, and the consequences of the problem. In other words, they help us develop an accurate picture of chain of cause and effect involved in the problem. If the perceived problem is "poor customer service" at your fast food restaurant, one needs to know a great deal more before trying to solve the problem. Who is complaining about the customer service? Is it a particular type of customer, customers placing a particular order, or something else? When are the complaints occurring? Are they around the clock, only at certain times of day/night, or are they connected to a particular staffing arrangement? Where are the complaints centered? Are they at the counter, drive-through, or both? What do the customer complaints even mean? Are they in regards to waiting too long for food, lack of friendliness, lack of cleanliness, or some other aspect of customer service? Why have these complaints just been brought up? Has something changed about the customer service? By first asking these questions, and then systematically collecting data to answer them, one can develop a better picture of the problem context. One can then attempt to resolve the problem as it actually exists. Without relevant data in the restaurant example, a manager might be tempted to push her employees to work faster, trying to minimize service times, when the real issue is that no one is keeping the dining area clean. Solving the wrong problem is often costly in time and money, and it still leaves the original problem unsolved.

Capturing the needed information in analyzable forms, however, is not always easy. Here are four ways to collect data that you might consider when defining the problem:

- Observations
- Survey Questionnaires
- Interviews
- Archives

We will use observations and survey questionnaires in later sections. You might consider, however, using any or all of these methods of data collection when doing the memo problem at the end of this chapter.

1.2.1 Definitions and Formulas

5W+H Strategy A method for making sure that you have considered as many different aspects of the problem situation as possible by asking six essential questions: Who? What? When? Where? Why? and How?

Problem Context This is the situation giving rise to the problem. It includes everything about the situation. For example, if there are complaints about a restautant's service times, then the food preparation process, the layout of the store, the menu, the customers, and everything else involved in placing and picking up an order can be considered part of the problem context.

Communicative Context This is an additional aspect of solving a problem that is often ignored. The problem context describes the situation; the communicative context helps one to understand the purpose and goals for solving the problem. Typically, this is because your boss has contacted you and given you deadlines and goals for the project.

Observation Either a person or some sort of mechanical process (or combination) records the occurrence of some pertinent event, usually recorded in a format specially prepared for this purpose, e.g. keeping tallies on a lined paper form or noting times in one-hour blocks or an electric eye keeping tallies and times of the traffic flow through a gate.

Survey Questionnaire A form (paper or electronic) filled out by customers, usually requires some sort of short answer or circle (check mark) of possible responses, e.g. Check: Male/Female; On a Likert scale of 1 (most liked) to 5 (least liked), circle one of the following, etc.

Interview Either structured (the interviewer asks all interviewees exactly the same questions) or semi-structured (the interviewer asks each interviewee the same basic questions but "goes with the flow," according to how the interviewee responds). Structured interviews lend themselves most readily to quantitative analysis and often are somewhat like a questionnaire, except they are usually longer and have certain advantages, such as the interviewer making sure that all the questions are answered and understood.

Archival Data Data that is compiled from already-existing sources, e.g. company data banks, government reports, or trade/industry tables that are available in print form, on CDs or that can be downloaded from the web.

Timeline A schedule of the events or tasks needed to complete a project along with the length of time each task will require and, usually, the personnel needed for each task.

RFP A request for a proposal. A business solicits proposals from other companies to undertake a project. The business will evaluate all submitted proposals on a competitive basis with regard to how well the proposals address the task or problem at hand and at what cost. The business will then award a contract to the company submitting the best proposal.

1.2.2 Worked Examples

These examples start with a memo from a regional manager of a fast-food chain to you, the manager of a local restaurant in the chain. This is followed by some notes on how you might respond to the memo. and a sample response memo to critique. The subsequent exploration begins with the response from the regional manager to your memo and gives you the opportunity to explore how you might address the regional manager's concerns.

Example 1.4. A Problem at Beef n' Buns

To:	Local Manager, Beef n' Buns
From:	Chad R. Chez, Regional Manager, Beef n' Buns
Date:	May 8, 2008
Re:	Customer Service

I seem to be getting a lot of complaints from across the region that our Beef n' Buns service is lousy. I want each of you to send me a detailed plan and a rough timeline for addressing this problem. I will review them and get back to you.

My Notes Toward a Reply There seems to be a lot going on with this memo, so I'm going to deal with it on two levels:

1. How should I deal with my boss in the context of the memo?
2. How can I come up with what he wants?

The Memo Context. This will help ensure that I do everything the boss wants in the way that he has asked for it to be done. While it doesn't resolve the problem itself, it will probably help me understand the boss better, and it will certainly help me keep my job.

WHO? My boss, the Regional Manager

WHAT? Wants me to devise a plan and a timeline for addressing the perceived problem. I'll send my response as a well-thought out memo

WHEN? ASAP (if I know what's good for me!), then I'll wait for his comments to see when I will actually have to do put the plan into action

WHERE? Sent to him

WHY? Perceived Problem: Lousy-service complaints. Whether I feel these complaints are justified or not, I am responsible for addressing his concern

HOW? Send him a memo with two things: A plan and a timeline. I think I'll also send along some idea of what the project will cost, just to let him know that such things don't come free.

The Problem Situation. This is where I find out about the causes of the problem and hopefully find some ways to fix it.

WHO? My customers

WHAT? Perceived problem: lousy service.

WHERE? At the drive-up window? At the walk-in service counter? In the kitchen? In the dining area?

WHEN? Does the time of day matter? Is it tied to a particular set of staff members?

WHY? To see if my restaurant has a problem with service times. Are lousy-service complaints justified at my business? Is it related to something other than service times (like cleanliness, friendliness or something else?)

HOW? How can I and my staff go about gathering data to find out about service times?

PLAN: I don't know what the problem really is. I need to find out if it's a matter of unacceptably long service times at the drive-up and/or the walk-in counter. I'll need to collect data on both. I (or my staff) will have to observe, time, and record the service-time data and do some analysis of the data.

OBSERVATIONS: Where should I position my observers? When should they be there? How will they actually do it? Over what period of time should we collect data?

TIMELINE: I don't need a definite starting date for my project at this point, but I do need some kind of estimate of how long each of the tasks in my plan will take. Trying to set up a timeline really points out the missing pieces of my plan, and that is helpful. For example, who will carry out all these tasks? Seeing the overall project laid out like this also gives me an idea of the extra personnel cost and personnel scheduling problems I will encounter in carrying out the study–I will want to at least mention these things in my memo. Part of the timeline should include the time required to analyze the data. All in all, it is important to show the Regional Manager that I have thought about some of the ins and outs and that I have a realistic picture of the whole.

Example 1.5. A Proposed Plan and Timeline for Beef n' Buns

To: Chad R. Chez, Regional Manager, Beef n' Buns
From: Local Manager, Beef n' Buns
Date: May 8, 2008
Re: Customer Service

This is in response to your request for a plan and timeline for determining if customers are receiving poor service at my location.

Plan My staff and I will collect service wait times at the two venues, the drive-up window and the walk-in counter. One of us will record the time each order has taken from the moment it is placed to when the completed order is delivered to the customer. We will gather the wait times during a continuous one-hour interval for the periods we are busiest, that is, breakfast, lunch, and at dinner. Here is my timeline for the project:

Task	Time	Personnel
1. Create detailed plan for data collection	1 week	1 me
2. Actual data collection	2 weeks	2 people for 3 hrs/day
3. Analysis of data	2 weeks	1 me + consultant
4. Writing of report	1 week	1 me

Although there may be some additional expenses, most of the cost of the project will come from filling the slots vacated by the observers during the period of data collection and the hours the consultant puts in. I have identified a reputable statistical consultant at our local university who charges $50/hr and would be interested in the project.

Cost Estimate:

2 people x 3 hrs/day x 14 days @ $10.00/hr	= $840
1 Statistical consultant x 4 hrs x $50/hr	= $200
Miscellaneous expense (forms, etc)	= $100
Total	=$1140

I await your reply as to when to begin and how I should take care of the accounting.

1.2.3 Exploration 1B: Beef N' Buns Service

Consider the following response from your boss:

To: Local Manager, Beef n' Buns
From: Chad R. Chez, Regional Manager, Beef n' Buns
Date: May 11, 2008
Re: Customer Service

You are definitely headed in the right direction. Here are some things I would like you to think about for your revision.

I'm thinking that the type of order might have something to do with the wait time. We might find that some items or combination of items take longer than others. What might make one order take a significantly longer time than another? Just the size? Is there some way of comparing all these different combinations? If so, we could pinpoint the problem items and figure out ways to cut down their prep or processing times. Also, should the drive-up data be kept separate from the walk-in data or is it sufficient just to identify which is which in the same data base?

Collecting data during certain times of the day seems reasonable. Have you thought about the day of the week as a variable as well?

Have you considered that the complaints might mean something other than too-long wait times? What about customer relations? You know–friendliness, courtesy? Is there a way of getting at this possibility?

I think your timeline ought to include something about the time it is going to take to design the data collection forms and also maybe a training period for your observers. Shouldn't there be some trial runs to catch any bugs and then some time to make any necessary modifications to the collection forms? Also, what about the time it will take to enter the data into spreadsheets? Considering the amount of data you will be collecting, entry time might be significant enough to figure in the timeline. Much of the data can be captured and stored by the computer as the orders are placed and so your observers need not write down everything at the moment.

I am pleased that you thought to include the services of a statistical consultant in this project because so many of my local managers did not. I suspect that either they didn't even think of a consultant or were afraid that they didn't know enough to deal with one. As a matter of fact, I think that you might consider bringing in the consultant at other times in the process, instead of just for the data analysis.

Anyway, give me a revision of your plan and timeline ASAP. I will let you know how we will deal with the cost and the accounting of the project later on.

Make some notes as to how you would modify your plan based on the regional manager's memo and then create an expanded timeline to include his suggestions.

Notes on how to deal with the differences in orders:

Notes on collecting data on customer relations:

Revised timeline:

1.2.4 How To Guide

Format of computer information in this text

This textbook contains three kinds of computer information to help you. Each will be formatted a little differently, so we have included a brief overview of each to help you.

Excel Information

Excel information will be presented with a brief set up of how the spreadsheet should be organized and what the new tool will do. Step-by-step instructions will follow. Any formulas in the format below show the syntax of formulas to be typed into Excel.

```
=FormulaName(argument 1, argument 2, etc.)
```

Any formulas shown in this format, with specific cells or cell ranges in the formula, should be typed exactly as shown, assuming that your spreadsheet is set up as described in the information or as shown in the accompanying screenshots and images.

```
=FormulaName(A1:A10, 3)
```

Advice on computers and doing work electronically

There is nothing so tragic as bad things happening to good students.
Unknown Instructor

If you want to avoid being one of those good students to whom bad things happen, take heed of the following advice. It should become a mantra, repeated to yourself over and over until it is a part of your psyche:

SAVE EARLY, SAVE OFTEN.

Anytime you make a substantial change to your work like pasting a graphic in, typing a whole sentence or paragraph, adding a table, or reformatting, you should save your file. Save as soon as possible after starting a file. There is also a keyboard shortcut for saving files: CTRL+S. Use this frequently to avoid losing a substantial part of your work.

Using the help system in Microsoft Office

The help system for Microsoft Office is fairly extensive. In Word or Excel (or Power Point), there is a button in the upper right corner of the screen that is labeled with a question mark. Clicking this button will activate the help system, shown in figure 1.1

The basic help dialog box has a search feature and some organized links about Excel. For starters, try searching for help on "help". Simply type the word "help" into the search box. If you are offline (not connected to the internet) you will have access to the basic help features; if you are online the help center can search a huge database of information to help you with your questions.

You should get used to using the help features. Very often, your first try will not turn up anything, but always check the "see also" line that appears with most help information. This will link you to other information that is related to the topic you originally searched for.

Within the information portion of the help window, most of the phrases and sentences are hyperlinked to allow you to navigate through the information to locate what you need.

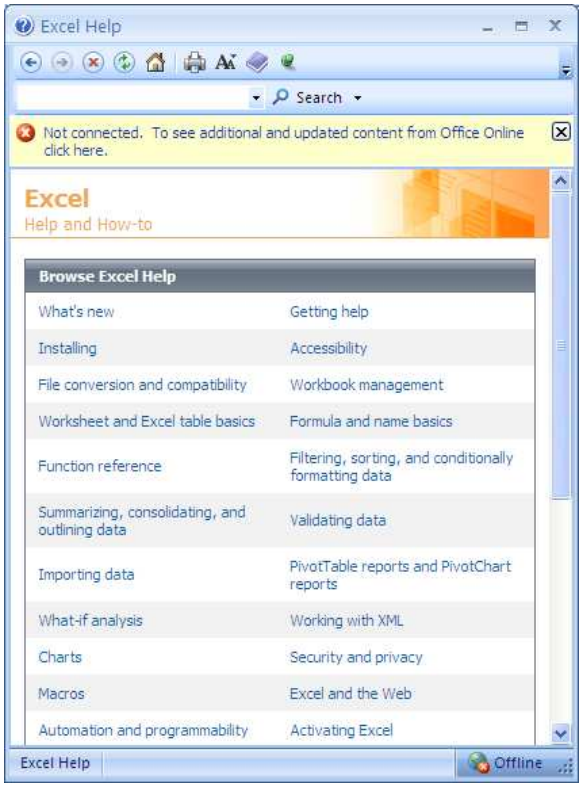


Figure 1.1: Microsoft Excel 2007 help interface

1.3 Homework

1.3.1 Mechanics and Techniques Problems

1.1. Two sets of train tracks run parallel to each other, except for a short distance where they meet and become one set of tracks over a narrow bridge. One morning, a train speeds onto the bridge. Another train coming from the opposite direction also speeds onto the bridge. Neither train can stop on the short bridge, yet there is no collision. How is this possible?

1.2. Identify the 5W+H for the second memo from the boss in exploration 1.2.3 (page 24).

	Memo Context	Problem Context
Who		
What		
Where		
How		
Why		
When		

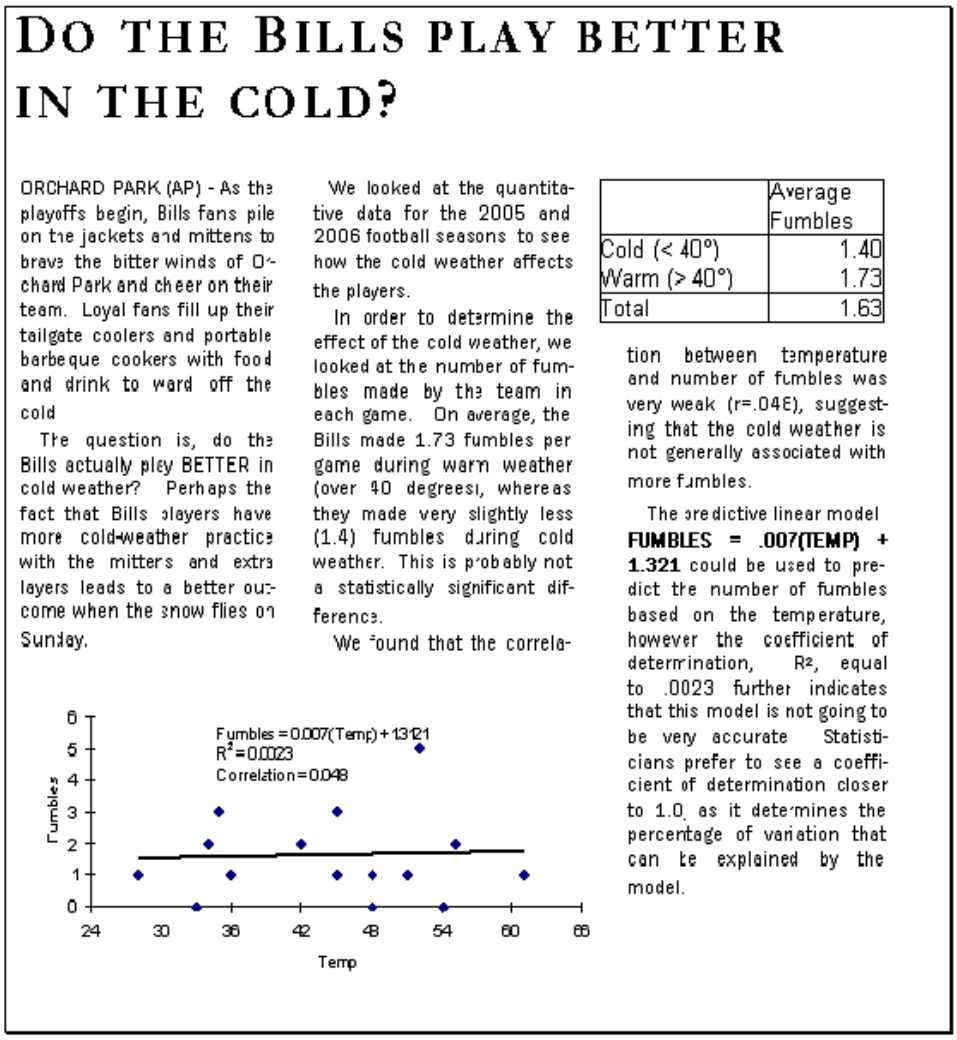
1.3. Identify the 5W+H for the news article in figure 1.2 (page 29):

	Memo Context	Problem Context
Who		
What		
Where		
How		
Why		
When		

1.3.2 Application and Reasoning Problems

1.4. Let's say you are a sports writer for a major national newspaper. You are asked to write an article to go with the one of the following headlines. Choose one and describe your hypothesis and how you would collect data to support that hypothesis.

- Big City? Less Safe!
- Are Major League Baseball Salaries too high?
- Chicago Cubs play better at night



DO THE BILLS PLAY BETTER IN THE COLD?

ORCHARD PARK (AP) - As the playoffs begin, Bills fans pile on the jackets and mittens to brave the bitter winds of Orchard Park and cheer on their team. Loyal fans fill up their tailgate coolers and portable barbeque cookers with food and drink to ward off the cold

The question is, do the Bills actually play BETTER in cold weather? Perhaps the fact that Bills players have more cold-weather practice with the mitters and extra layers leads to a better outcome when the snow flies on Sunday.

We looked at the quantitative data for the 2005 and 2006 football seasons to see how the cold weather affects the players.

In order to determine the effect of the cold weather, we looked at the number of fumbles made by the team in each game. On average, the Bills made 1.73 fumbles per game during warm weather (over 40 degrees), whereas they made very slightly less (1.4) fumbles during cold weather. This is probably not a statistically significant difference.

We found that the correlation between temperature and number of fumbles was very weak (r=.048), suggesting that the cold weather is not generally associated with more fumbles.

	Average Fumbles
Cold (< 40°)	1.40
Warm (> 40°)	1.73
Total	1.63

The predictive linear model **FUMBLES = .007(TEMP) + 1.321** could be used to predict the number of fumbles based on the temperature, however the coefficient of determination, R^2, equal to .0023 further indicates that this model is not going to be very accurate. Statisticians prefer to see a coefficient of determination closer to 1.0, as it determines the percentage of variation that can be explained by the model.

Figure 1.2: News article for Mechanics and Techniques problem 3 (page 28).

- Pentagon skimps on Health Care for Vets

1.5. Look again at the Gamma Technologies scenario, example 1 (page 10). The CEO contends that there is a problem with age-discrimination at the company. Choose one of the three managers who responded and describe what they believe is the chain of cause and effect.

1.6. Your boss asks you to respond to the memo below from Jenny Eggs...

> To: Oracular Consulting
> From: Jenny Eggs, Owner of Over-Easy Diner
> Date: Today
> Re: Unkind words
>
> As you may be aware, my restaurant, Over-Easy Diner, has been serving breakfast and lunch to the citizens of this fine town for the last 50 years.
>
> Recently I have overheard a number of comments from the servers indicating that the customers are complaining to them about the comfort of the chairs in the dining area. Last week an anonymous editorial appeared in our local paper branding us "The Worst Seat in Town".
>
> Can you help me solve this problem?

- What is the problem at Over-Easy Diner?
- How do we know there is a problem?
- Describe the cause/effect of this perceived problem.

1.3.3 Memo Problem

To: Analysis Staff
From: Director of Marketing
Date: May 11, 2008
Re: Salena Way RFP

I have received an RFP (Request For Proposal) from Salena Way, Director of Carnivorous Cruise Lines. Her RFP is enclosed in hard copy and also attached electronically (see page 32).

After you read and think about Ms. Way's problem, I want each of you to send me a preliminary proposal for how to deal with it. I will give you some feedback and you can resubmit your revision to me (I will post the deadlines on our intranet web site). I will then pass on your revised proposal to our marketing team, who will cost it out. I will write a cover letter and submit the final proposal to Ms. Way myself.

Our marketing team will need your proposal to include the following, so make sure you address each of them:

1. What is the perceived problem(s) and its consequences?
2. Possible reasons for the problem (The RFP suggests three possibilities. Make sure you address these and maybe consider one or two other possibilities).
3. A plan for gathering data to help identify the problem. You need to include a rough timeline for the whole data collection and analysis process.
4. Use your possible reasons and possible solutions (1 and 2 above) as a way of ensuring that your data collection gets you what you might need; that is, use these as a reality check to refine your thinking.
5. Identify any possible difficulties, problems or expenses (there will indeed be some) that might be encountered in collecting and analyzing such data. Don't include any dollar figures because our marketing team will do this.

To: Salena Way, Director of Carnivorous Cruise Lines
From: Director of Marketing, Oracular Consultants
Date: May 1, 2008
Re: RFP Regarding Entertainment Attendance

As you may be aware, cruise ship traveling has become big business. Our cruise line is now competing for customers of all age groups and socioeconomic status levels. We offer all types of cruises, from relatively inexpensive 3-4-day cruises in the Caribbean, to 12-15-day cruises in the Mediterranean, to several-month, around-the-world cruises. These have several features that attract customers, many of whom book 6 months or more in advance: (1) they offer a relaxing, everything-done-for-you way to travel, (2) they serve food that is plentiful, usually excellent, and included in the price of the cruise, (3) they stop at a number of interesting ports and offer travelers a way to see the world, and (4) they provide a wide variety of entertainment, particularly in the evening.

This last feature, the entertainment, presents a difficult problem for our ship's staff. A typical cruise might have well over a thousand customers, including elderly singles and couples, middle-aged people with or without children, and young people, often honeymooners. These different types of passengers have varied tastes in terms of their after-dinner preferences in entertainment. Some want traditional dance music, some want comedians, some want rock music, some want movies, some want to go back to their cabins and read, and so on. Obviously, our cruise entertainment director wants to provide the variety of entertainment our customers desire within a reasonable budget because satisfied customers tend to be repeat customers. The question is how to provide the right mix of entertainment.

As a part of an internal quality control study my department has been conducting, I recently took one of our 12-day cruises. The entertainment seemed to be of high quality and there was plenty of variety. A seven-piece show band played dance music nightly in the largest lounge, two other small musical combos played nightly at two smaller lounges, a pianist played nightly as a piano bar in an intimate lounge, a group of professional singers and dancers played Broadway-type shows about twice weekly, and various professional singers and comedians played occasional single-night performances. (There is also a moderately large onboard casino, but it tended to attract the same people every night and it was always closed when the ship was in port.) Although this entertainment was free to all passengers, much of it had embarrassingly low attendance. The nightly show band and musical combos, who were contracted to play nightly until midnight, often had fewer than a half dozen people in the audience, sometimes literally none. The professional singers, dancers, and comedians attracted larger audiences, but there were still plenty of empty seats. In spite of this, the cruise staff posted a weekly schedule, and they stuck to it regardless of attendance. In a short-term financial sense, it doesn't make much difference. The performers get paid the same whether anyone is in the audience or not, the passengers have already paid (indirectly) for the entertainment part of the cruise, and the only possible impact on our cruise line (in the short run) is the considerable loss of liquor sales from the lack of passengers in the entertainment lounges. The morale of the entertainers was not great; entertainers love packed houses (and so do we at Carnivorous!). Of course, as they usually argue somewhat philosophically, their hours are relatively short and they are still, after all, getting paid to see the world.

We need to get to the bottom of this. Off the top of my head, could it be that we have a problem with deadbeat passengers, or low-quality entertainment, or a mismatch between the entertainment offered and the entertainment desired? How do I go about finding out? Should we keep a strict schedule, or should we play it more by ear? We need a proposal that identifies the problem(s) and then offers a solution(s) within a reasonable time frame for a reasonable price.

(Adapted from *Data Analysis and Decision Making with Microsoft Excel* by Albright, Winston, and Zappe, Duxbury Press, New York, 1999)

Index