LOW PRICE EDITION **Premier12**

PEARSON Education

Management Information Systems

Tenth Edition

Raymond Mcleod
Jr. George P. Schell

Pearson Prentice Hall™ is a trademark of Pearson Education, Inc.
Pearson® is a registered trademark of Pearson Plc.
Prentice Hall® is a registered trademark of Pearson Education, Inc.

Credits and acknowledgments borrowed from other sources and reproduced, with permission, in this textbook appear on the appropriate page within text.

Microsoft® and Windows® are registered trademarks of the Microsoft Corporation in the U.S.A. and other countries. Screen shots and icons reprinted with permission from the Microsoft Corporation. This book is not sponsored or endorsed by or affiliated with the Microsoft Corporation.

ISBN 978-81-317-1949-7

First Impression, 2008

This edition is manufactured in India and is authorized for sale only in India, Bangladesh, Bhutan, Pakistan, Nepal, Sri Lanka and the Maldives. Circulation of this edition outside of these territories is UNAUTHORIZED.

Published by Dorling Kindersley (India) Pvt. Ltd., licensees of Pearson Education in South Asia.

Head Office: 482, F.I.E., Patparganj, Delhi 110 092, India.
Registered Office: 14 Local Shopping Centre, Panchsheel Park, New Delhi 110 017, India.

Printed in India by Baba Barkha Nath Printers.

BRIEF CONTENTS

CONTENTS

PREFACE

A textbook must be current, present concepts in an easy-to-understand format, and enable students to be active participants in learning. *Management Information Systems* has these features. The dynamic nature of the information technology and information systems field requires managers to be aware of both current and emerging technologies. Students are faced with complex subjects and need a clear, concise explanation to be able to understand and use the concepts in their careers. By helping you engage with projects that reinforce concepts, *Management Information Systems* creates a learning experience that will last.

The text offers a solid organization based on logical layout, thorough explanations, and a solid theoretical base.

- *Logical Layout* You will find the text well organized with the topics flowing logically from one chapter to the next and from one section to the next. We do not use terms in a chapter without first defining them. A glossary is included. Chapters begin with learning objectives, and key terms and concepts are included at the end. Chapter questions direct you to examine key points made in the chapter. The key terms, concepts, and questions are presented in the same sequence in which they appear in the chapter. Twelve projects comprise the last section of the book and are designed to reinforce concepts from the text.
- *Thorough Explanations* Complete coverage is provided for each topic that is introduced. Emphasis has never been on the number of topics covered but rather on the number covered well. Explanations are written so that students can understand the concept and relate it to other concepts presented in the text.
- *Solid Theoretical Base* The text builds on a strong base of MIS literature in describing current theory and practice of management information systems. References to current academic and professional journals are found throughout the text.

These three features—logical layout, thorough explanations, and a solid theoretical base—give you an advantage in learning about the complex and changing field of business information systems technology.

Management Orientation with Technical Accuracy

A management orientation is the appropriate perspective for business students, but that cannot come at the expense of technical accuracy. Information technology touches almost every aspect of an organization. Understanding the trends in technology gives managers an advantage over those who simply respond to change. Information systems are built upon technologies and those systems support decisions at every level of management.

When you become a manager, you will have many opportunities to apply the material in this text. In your career, you will interact with systems analysts, network specialists, database administrators, and others who use technology to develop managerial systems. Regardless of where you apply your managerial expertise, this text will give you the perspective to use technology to achieve organizational goals.

New Organization

There has been a common thread of concepts throughout all nine previous editions of this book. Although this edition has been extensively rewritten, the proven framework of concepts has been continued. The package of 11 chapters followed by 12 projects has been continued from the previous edition, but chapter content has been modified when necessary to accommodate changing technology and applications.

The text is subdivided into four parts, the last part being the 12 projects. The first part, Chapters 1 through 4, deals with essential concepts. The history of computing technology, using technology for competitive advantage, the role of the Web and the Internet in commerce, and roles of information users in organizations are explored. After you complete this part, you will understand how information systems and technology shape the business world.

Chapters 5 through 8 cover information resources. These resources are assets for the organization that are utilized to achieve organizational objectives. The days are long gone when managers thought of computers as an expense. Managers who do not recognize information systems and technology as a valuable asset now find themselves at a serious competitive disadvantage.

Managing information and technology is the theme for Chapters 9 through 11. The last chapter highlights information in action. Ultimately, managers make decisions and the value of a decision is built upon the supporting information and programs. Because you cannot manage what you do not understand and the role of information systems and technology is so central to decision making, a course in management information systems is necessary to prepare for becoming a manager.

Projects

Projects are presented at different skill levels and some cover the same concepts using different examples. Your instructor can choose to assign a limited number of projects or to assign multiple projects in order to achieve a wider and deeper understanding of the topic. The projects are implemented using Microsoft Office software because it is the most popular software used for personal productivity.

Material to Encourage Discussion

All chapters contain at least one boxed insert entitled "Highlights in MIS" that relates the chapter material to the use of information technology in business and industrial organizations. In essence, these inserts describe how firms have been either successful or unsuccessful in applying the principles of information management.

There is a brief case at the end of each chapter reflecting concepts from the chapter. These cases encourage you to consider the concepts that have been presented and then apply those concepts to a situation you might find in an organization. Different people in an organization can view the same facts from different points of view and the cases will enable you to consider some of those views.

You are encouraged to discuss the "Highlights in MIS" and the cases. Talk with your instructor and your classmates. Discussing your insights and viewpoints with others is a good way to attain a deeper understanding of the chapter material.

Proven Chapter Pedagogy

Each chapter begins with learning objectives and an introduction, and ends with key terms, key concepts, questions, topics for discussion, problems, and case problems. The concepts and discussion topics focus attention on the important chapter elements. The questions and problems test knowledge and enable application of the material in a creative way.

Strong Ties to the Literature

Footnotes throughout the text tie the material to academic and professional literature. Many references are "classics" that have withstood the test of time. Other references shed light on applications that are just emerging. Therefore, what is given is not only a look at the field today but an appreciation for how this point was reached. An understanding of how this point was reached can provide you with an idea of what is to come.

A Complete Supplement Package

A complete set of materials is available that will assist students and instructors in accomplishing course objectives.

Instructor's Resource CD-ROM Available to adopting faculty, the Instructor's Resource CD-ROM contains all of the supplements in one convenient place: IM, TIF, TestGen, PPTs, and Image Library.

- *Instructor's Manual (IM) and Test Item File (TIF)* The IM, written by the authors, includes suggestions for designing the course and presenting the material. Each chapter is supported by answers to end-of-chapter questions and problems, and suggestions concerning the discussion topics and cases. The TIF consists of true-false and multiple-choice questions, plus a 10-point miniquiz for each chapter. The TIF content is provided in both Microsoft Word and in the form of TestGen on the IR CD-ROM.
- *TestGen* This computerized package enables instructors to custom design, save, and generate classroom tests. The test program permits instructors to edit, add, or delete questions from the test banks; edit existing graphics and create new graphics; analyze test results; and organize a database of tests and student results. This new software allows for greater flexibility and ease of use. It provides many options for organizing and displaying tests, along with a search and sort feature.
- *PowerPoint Slides* A set of PowerPoint slides accompanies each chapter and features bulleted items that provide a lecture outline as well as key figures and tables from the text.
- *Image Library* Text figures and tables, as permission allows, are provided in a format by which they can be imported into PowerPoint for class lectures. Each chapter is organized in its own folder for convenient use.

MyCompanion Website www.prenhall.com/mcleod

The Prentice Hall MyCompanion Website includes support for students and instructors. These support materials enhance the learning experience.

The student side of the Web site provides:

- *Project Database Files* The authors have provided database files for student to use with Projects 9–12 from the text.
- *Internet Links* Throughout the text are Web site addresses where related material can be obtained from the World Wide Web. These Web locations provide valuable information that, when used with the text material, provides a complete, up-to-date coverage of business computing.
- *PowerPoint Slides*
- *Glossary*

The instructor side of the site contains:

- *Instructor's Manual (IM)*
- *Test Item File (TIF)* Available in Microsoft Word and in converted WebCT/Blackboard files.
- *Image Library*

Video A video cassette covering various topics in MIS is available to adopters.

Acknowledgments

Throughout the text the authors frequently use the term "we." The authors are not always referring to themselves but also to many people who have made valuable contributions. The people at Prentice Hall played key roles. The dedicated staff includes executive editor Bob Horan, editorial assistant and project manager Ana Cordero, managing editor Cindy Regan, production editor Anne Graydon, marketing manager Debbie Clare, and media project manager Peter Snell.

The materials in the text are based on thorough testing in the classroom. The projects, the questions, the presentation of material, and so much more have been experienced by the authors' students. We would like to thank our students for their feedback and suggestions.

Reviewers and Other Support We also want to thank others who provided valuable support, including the following reviewers of this and past editions:

Marzie Astani, *Winona State University*
Michael Bartolacci, *New Jersey Institute of Technology*
David Bradbard, *Winthrop University*
Nora Braun, *Augsburg College*
Chia-Chao Chang, *University of Michigan (Barbon)*
Jack Cook, *SUNY Geneseo*
Robert Donnelly, *Goldey-Beacom College*
Charla Griffy-Brown, *Pepperdine University*
David T. Jones, *California University of Pennsylvania*
Robert M. Laurie, *University of Maryland University College Asia*
Donald Masselli, *Northwood University*
Richard Murphy, *Marist College*
Masoud Naghedolfeizi, *Fort Valley State University*
Julio Pontes, *University at Albany (State University of New York)*
Susan Pratt, *Graceland University*
Robert Richardson, *Iona College*
Rolf Schomburg, *Concordia-St. Paul College*
Randall Smith, *University of Virginia*
George Strouse, *York College*
Mohammad Syed, *Miles College*
Victoria Ungureanu, *Rutgers University*
David Whitney, *San Francisco State University*
Jim Wood, *Arkansas Tech University*
Barry Wray, *University of North Carolina (Wilmington)*
Sancy Wu, *Texas A&M University*

Even though we have received much help along the way, we alone are responsible for the manner in which the material is presented. Therefore, any shortcomings are our own.

Raymond McLeod, Jr.
Austin, Texas

George P. Schell
Wilmington, North Carolina

ABOUT THE AUTHORS

RAYMOND MCLEOD, JR. is Adjunct Professor at the University of Texas at Austin. Findings of his research have appeared in such journals as *California Management Review*, *MIS Quarterly*, *Journal of Management Information Systems*, *Decision Sciences*, *Journal of Systems Management*, *IEEE Transactions on Engineering Management*, and *Communications of the ACM*. In addition to coauthoring *Management Information Systems* with Dr. George Schell, Dr. McLeod is coauthor with William G. Zikmund and Faye W. Gilbert of *Customer Relationship Management: Integrating Marketing Strategy and Information Technology*, (Wiley, 2003), and co-author with Eleanor Jordan of *Systems Development: A Project Management Approach*, (Wiley, 2002). He also authored *Information Systems Concepts* (Macmillan, 1994) and *Introduction to Systems Analysis and Design: An Organizational Approach* (Dryden, 1994). He has served on the editorial boards of the *Journal of Management Information Systems*, *Data Base*, *Information Resources Management Journal*, and the *International Journal of Information Technology Education*. He is past chair of the ACM Special Interest Group for Computer Personnel Research (SIGCPR).

GEORGE P. SCHELL is Professor of Management Information Systems at the University of North Carolina at Wilmington. He received his B.A. in Business Administration and M.A. in Management Science from the University of Florida. His Ph.D. is from Purdue University in Management Information Systems.

Professor Schell has published in the *Communications of the ACM*, *Information and Management*, *Computer Personnel*, and other scholarly journals. He has also been listed in *Who's Who in American Education*. Distance education and Web-based courses have been developed and taught by Dr. Schell. He continues to be active in consulting and professional service.

PART 1

Essential Concepts

The computer has been used in business since the mid-1950s. Since then, computer hardware and software technology and how that technology is applied to business problems have changed dramatically. The biggest changes in hardware have been the trend toward smaller and more powerful systems and the linking of computers of all sizes to form communications networks. The biggest change in software technology has been the move away from customized programming to the use of prewritten software systems and applications written by end users.

Hardware and software technologies are physical systems; firms also have physical resources, such as machines, materials, and human resources. The data and information processed by the computer and stored in its storage units can be viewed as a virtual system. The data and information represent the physical resources that they describe. The increasing use of the computer as a virtual system to help managers manage the physical firm, not just merely account for transactions, has been the big breakthrough in business computer applications.

Competitive advantage can be achieved just as effectively, or more so, with virtual resources as with those of a physical nature. Achieving competitive advantage with virtual resources requires the development of a strategic information plan that looks into the future to identify projected computer uses and the information resources needed.

Even though advances in computer use have been substantial, the most dramatic business impact of all has been achieved through the use of the Internet and the World Wide Web. This impact can be seen in the increasing popularity of electronic commerce—the linking of businesses to other businesses (business-to-business, or B2B) and to customers (business-to-customer, or B2C). Today's businesses have the option of using a virtual store, a brick-and-mortar establishment, or both.

Fifty years ago, none of these innovations in computing and communications would have been thought possible by even the most enthusiastic of computer visionaries. Today, they are part of the daily routine for both information specialists and end users.

Chapter 1

Introduction to Information Systems

Learning Objectives

After studying this chapter, you should

- Understand how computer hardware has evolved to its present level of sophistication.
- Know the basics of computer and communications architectures.
- Understand the distinction between physical and virtual systems.
- Describe how business applications have evolved from an initial emphasis on accounting data to the current emphasis on information for problem solving.
- Understand what enterprise resource planning systems are and the reasons for their popularity.
- Know how to tailor information systems to managers based on where they are located in the organizational structure and what they do.
- Understand the relationship between problem solving and decision making and know the basic problem-solving steps.
- Know what innovations to expect in information technology.

Introduction

Computers have been used for business applications since the mid-1950s. Since then, dramatic improvements have been made in both hardware and software, making it possible for the benefits of computer processing to be enjoyed by individuals as well as organizations.

The first widely marketed computer was the UNIVAC I, installed first at the U.S. Census Bureau in 1951 and then at General Electric (GE) in 1954. International Business Machines (IBM) quickly responded with a complete product line that led to the System/360 in the 1960s—the first computer to support multiple users at the same time.

Minicomputers, which were smaller than large mainframes and popular with scientific users, appeared in the 1970s. It didn't take long for the trend to smaller computers to gain momentum. Microcomputers emerged on the scene in the early 1980s; these were aimed not only at small firms, but at individual users as well. IBM's personal computer, or PC, bestowed legitimacy on the small-computer movement. A good measure of the improvements in hardware technology is Moore's Law, which predicts the doubling of computer power every 18 months.

Computers began as machines that were as large as a room. These computers performed simple tasks such as adding numbers quickly. Vacuum tubes the size of small light bulbs provided much of the circuitry. Transistors and chips on silicon wafers replaced those early electronics, and the resulting lower manufacturing costs led to a growing demand for computers. Computer-processing speeds have continued to increase as the size of computer circuits has decreased. Because the speed of electricity moving through the circuits is constant, decreasing the size of a computer circuit by half will double its speed. This guiding principle of computer circuit design, miniaturization, continues to increase computer-processing speeds and decrease computer costs.

Communications and computers go hand-in-hand. Swiping a credit card at a store would be pointless if the store's computer and the credit card company's computer were unable to communicate. However, telephone systems were originally designed to accommodate human conversations, not the high speed and precise communications required between computers. Communication between computers has increased as computer use has grown. Communication has leapt from simple transmission down copper wires to the realm of wireless radio waves and fiber-optics.

The first business applications involved the processing of accounting transactions. The systems were virtual systems in that they processed and maintained data that represented the physical system of the firm. In addition, the firm communicates with its environment and has a self-controlling capability.

Once accounting transaction processing systems were in place, firms shifted their systems focus to providing information to the firm's managers for problem solving. The first information-oriented systems were called management information systems (MISs), *and their objective was broad support for all managers of an organizational unit. At about the same time, word processing introduced a suite of applications that eventually made the virtual office concept a reality. The next major step was the refinement of the MIS concept to produce a class of systems called* decision support systems (DSSs), *which were aimed at specific managers and particular problems. The first DSSs emphasized outputs in the form of reports and the results of mathematical simulations. They were subsequently expanded to encompass group problem solving, artificial intelligence, and on-line analytical processing.*

Most recently, firms have undertaken projects to integrate all of their information systems across the firm to form an enterprise resource planning system.

Users of these information systems may include managers and nonmanagers inside the firm as well as persons and organizations outside the firm. In this book, we focus on the managers. Managers are an important group of users because information is so critical to what they do. Managers exist on different organizational levels and in various business areas. Regardless of their place in the organization, all managers perform certain management functions and play managerial roles that require information to solve problems and make decisions. Managers require information to identify problems, develop alternative solutions, select the best ones, and review the consequences of their decisions.

The future of information technology indicates a continued trend toward decreasing size and increasing mobility. Computer manufacturers are exploring such devices as keyboards that are projections of light onto a flat surface and a digital pen that remembers what it has written. Mobile, wireless, small, *and* inexpensive *are the words that describe today's information technology. In the future, you'll be able to access information technology anyplace, anytime.*

HISTORY OF INFORMATION SYSTEMS

A review of the history of information systems includes a look back at how hardware has evolved and how it has been applied over time. In the half century since the first general-purpose digital computer was installed in a business organization, hardware has experienced many-fold increases in speed and capacity along with dramatic reductions in size. Concurrently, computer applications have evolved from relatively straightforward accounting processes to systems designed to support managers and other problem solvers.

The Evolution in Computer Hardware

Computers as we know them today can be traced back to a machine called the Electronic Numerical Integrator and Calculator (ENIAC), which was developed in 1946 by John W. Mauchly and J. Presper Eckert, two engineers at the University of Pennsylvania. ENIAC was the predecessor of the Remington Rand UNIVAC I, which was the first widely marketed universal automatic computer.

The first UNIVAC I was installed in a government organization, the U.S. Census Bureau, in 1951. Three years later, the same type of machine was installed in the first business organization, General Electric. Figure 1.1 is a photograph of a UNIVAC. These machines performed fewer than 2,000 calculations per second, which is extremely slow compared to the 2 billion or more instructions per second that are common for today's smallest and least expensive microcomputers. These early computers, called *mainframes*, focused on a single task requested by a single user. The term **mainframe** is still in use today, but now it is used to describe the large, centrally located computers typically found in large organizations.

Although IBM was not the first computer manufacturer, it was not long before it became the industry leader. By the end of the 1950s, it had amassed a full product line, and in the mid-1960s it revolutionized the computer industry by introducing the IBM System/360 line of computers. These computers were the first to concurrently perform multiple tasks requested by multiple users. Although a computer processor actually performs only one task at a time, the term **multitasking** refers to the fact that more than one user appears to be working on the computer at the same time. This is possible because the computer processes pieces of each user's application, and some of the pieces may be interspersed with one or more other applications. Before the System/360, one user started, processed, and completed an entire application before

Figure 1.1 **Computer Scientists Harold Sweeney (left) and J. Presper Eckert (center) Demonstrate the UNIVAC Computer to Walter Cronkite as It Predicts the Winner of the 1952 Presidential Election**

Source: Courtesy of the Unisys Corporation.

another user could access any computer resources. Systems such as the System/360 were very expensive by today's standards and could only be afforded by large organizations.

Smaller Computers

During the early years of computing, in most firms the computer department monopolized the computers. Users were not allowed to access the computers, which were housed in the central computing facility. Users had to communicate their information needs to **information specialists**—employees who have a full-time responsibility for developing and operating information systems. Examples of information specialists are systems analysts, programmers, database administrators, network specialists, and Webmasters. As the computer became more popular, it became more difficult for information specialists to keep up with demand; backlogs of jobs waiting for computer resources became commonplace. Users became impatient and began to demand access to computer-based data without having to go through information specialists. Some computer manufacturers recognized this need to make computer resources available to users and responded by manufacturing and marketing computers considerably smaller and less expensive than mainframes.

The first small-scale systems were called **minicomputers**. They were quickly followed by an even smaller computer called the **microcomputer**, or **micro**. Whereas the minicomputer was targeted at small organizations, the microcomputer was seen as a computer that could be owned and operated by an individual. Apple and the Tandy Corporation were pioneers in the microcomputer market.

When IBM introduced its microcomputer, called the *personal computer*, or *PC*, in 1982, both the IBM product and its name were universally adopted, and today the term **personal computer (PC)** is used, along with *microcomputer*, to describe the small, relatively inexpensive and powerful systems used for both business and personal applications. Figure 1.2 is a photo of an IBM ThinkPad (now Lenovo ThinkPad) notebook computer. The ThinkPad weighs only 4 pounds, costs around $1,500, and performs calculations 750,000 times faster than the UNIVAC.

Figure 1.2 **The Lenovo ThinkPad X41 Tablet**

Source: Courtesy of the Lenovo Group Limited.

Table 1.1

Salary Comparisons

YEAR	FRIEND	YOU
1	$40,000	$5,000
3	$57,600	$20,000
6	$99,533	$80,000
9	$171,993	$320,000
12	$297,203	$1,280,000
15	$513,567	$5,120,000

Moore's Law

Processor speed has increased tremendously over the years since IBM introduced its first microcomputer. The term **Moore's Law**, named after Gordon Moore, one of the founders of Intel, was coined in the 1960s. It originally stated that the storage density of integrated circuits on a silicon chip doubled about every year. By the 1970s, the rate of doubling had increased to 18 months, a pace that continues today. What this means to users is that the power of a computer doubles about every 18 months for a given cost. If you could purchase a computer 15 years from today, it would be 1,024 times as powerful, yet cost the same as today's model. Fifteen years divided by 1.5 (18 months equals 1.5 years) yields 10, and 1,024 is 2 raised to the 10th power. In 30 years, the power would be 1,024 times 1,024, or 1,048,576 times as powerful (i.e., a million times as powerful for about the same cost).

The impact of Moore's Law is difficult for many people to comprehend. Managers who don't grasp the implications are frequently forced to react to changes in information technology instead of planning for them and using the changes for competitive advantage. The illustration of salaries in Table 1.1 should make the force of Moore's Law apparent to you. Say that your friend takes a job with a starting salary of $40,000 and a guaranteed raise of 20 percent every year. You take a job with a starting salary of $5,000 but your salary doubles every year and a half (based on Moore's Law). Wouldn't you rather be earning more than $5 million dollars a year in 15 years?

INTRODUCTION TO COMPUTER ARCHITECTURE

When people think of computers, they often think of the collection of the computer processor and input and output devices, such as those illustrated in Figure 1.3. The largest mainframe computer and the personal computer on your desk have a similar architecture. The computer's

***Figure 1.3* The Lenovo ThinkCentre M51**

Source: Courtesy of the Lenovo Group Limited.

hardware is controlled by the operating system. Application software performs tasks for the user, such as word processing, performing calculations on spreadsheets, manipulating information via databases, and more.

At the core of a computer is its processor. The processor, which is controlled by an operating system such as Windows XP, manages the input and output devices, data storage devices, and operations on the data. The central processing unit (CPU) controls all the other components. Random access memory (RAM) acts as the temporary workspace for the CPU; the greater the work area, the more quickly the CPU can accomplish its tasks. The CPU and RAM reside on the computer's motherboard, the circuit board that all the other devices are plugged into. The CD-ROM, USB flash drives, and hard disk (also known as the hard drive) are storage devices, but unlike RAM they offer permanent, not temporary, data storage. These devices are illustrated in Figure 1.4.

When used in conjunction with the keyboard, monitor, mouse, and printer, the microcomputer can be used to support managerial decision making.

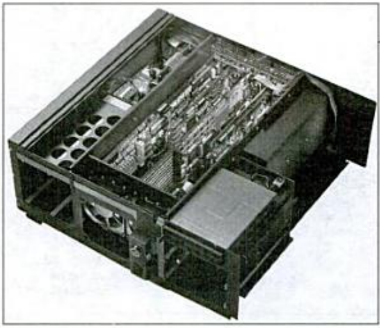


***Figure 1.4* Computer Hardware Components**

Source: Courtesy of Almay Images Royalty Free. © Wide Stock/ Almay.

INTRODUCTION TO COMMUNICATIONS ARCHITECTURE

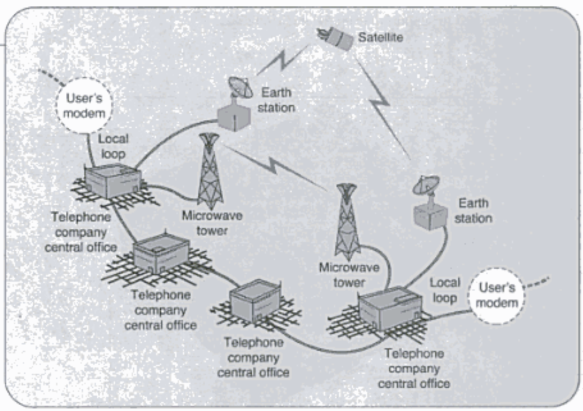
Communications between computers are constrained by the fact that telephone communications between people came first. Telephone communications standards and procedures were never meant to accommodate the extremely fast digital communications required between computers. Figure 1.5 illustrates the different paths that voice and data communications can take. Notice that for data communications, both the beginning and end of the journey require a connection to a modem. Any computer that uses the public telephone system to communicate with other computers requires a modem. A **modem** is a hardware device that modulates the digital signals from a computer (either on or off, like a light switch) into analog signals (a continuous wave, such as the sound of a voice), and vice versa.

Communications between computers that do not utilize the public telephone system are generally much faster. Such direct communications standards were developed after the standards were established for public telephone systems. Now computers can communicate over wireless networks. Your computer at home may use a modem connected to your telephone running at 56,000 bits per second (56 Kbps) or to your cable television connection running at speeds as high as 2 million bits per second (2 Mbps). The most common wireless networks exchange data at 11 million bits per second (11 Mbps), but speeds of 54 Mbps are possible. Networks within a firm often run 10 to 100 Mbps.

As these new types of communications emerged, new types of modems were required. Several types of "digital" modems are available. Some connect to the cable that brings television signals into the home; others are connected to phone lines. The availability of digital modems depends on the cable and phone service in your area. These devices will be discussed further in Chapter 5.

The wireless revolution continues. However, the single cloud on the horizon of wireless communications is security. Although wireless networks are cheap and easy to install, most users who set them up do not implement security features. The simplest fix to the problem is to purchase firewall hardware and/or software when the wireless network is purchased. In

Figure 1.5 **Communications Architecture**



fact, many vendors of wireless network hardware automatically set security features during the installation process; users must deliberately turn them off.

THE EVOLUTION IN COMPUTER APPLICATIONS

Information systems are virtual systems that enable management to control the operations of the physical system of the firm.

The **physical system** of the firm consists of tangible resources—materials, personnel, machines, and money. The **virtual system** consists of the information resources that are used to represent the physical system. For example, an inventory storeroom containing inventory items is a physical system, and the computer-based inventory master file is a virtual system that represents the physical system. Figure 1.6 shows the physical system of a firm that transforms input resources into output resources. The input resources come from the firm's environment, a transformation occurs, and then the output resources are returned to the same environment.

The physical system of the firm is an **open system** that interacts with its environment by means of physical resource flows. An information system is also an open system. A **closed system** is one that does not communicate with its environment. A truly closed system would not interact with customers, managers, or anyone else and is not of interest to developers and users of information systems.

Although Figure 1.6 represents a generic firm, it is easy to see how it fits a manufacturing operation in which raw materials are transformed into finished products. The three other physical resources—machines, money, and human resources—flow through the system as well.

Transaction Processing Systems

Before the computer came on the scene, the firm's virtual systems were a combination of manual processes, key-driven bookkeeping machines, and punch-card systems that processed the firm's data. **Data** consist of facts and figures that are generally unusable because of their large volume and unrefined nature. Precomputer systems processed payroll, inventory, and billing data and general ledger transactions. It was only natural that these processes would become the first computer applications. After all, these processes were well understood, and computers could increase the speed and accuracy of such tasks.

The first computer-based systems were called *electronic data processing (EDP) systems*. Later the name *accounting information system (AIS)* was coined. Today, the term **transaction processing system** is common. Such systems share a common bond in that they process data that reflect the activities of the firm.

Figure 1.7 is a model of a transaction processing system. The input, transformation, and output elements of the physical system of the firm are at the bottom. Data are gathered from throughout the physical system and the environment and entered into the database. Data processing software transforms the data into information for the firm's management and for individuals and organizations in the firm's environment. **Information** is processed data that is meaningful; it usually tells users something that they did not already know.

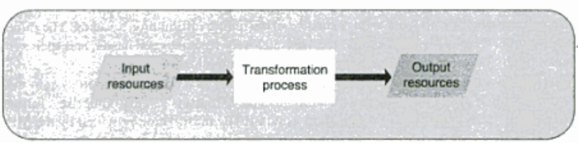


Figure 1.6 **The Physical System of the Firm**

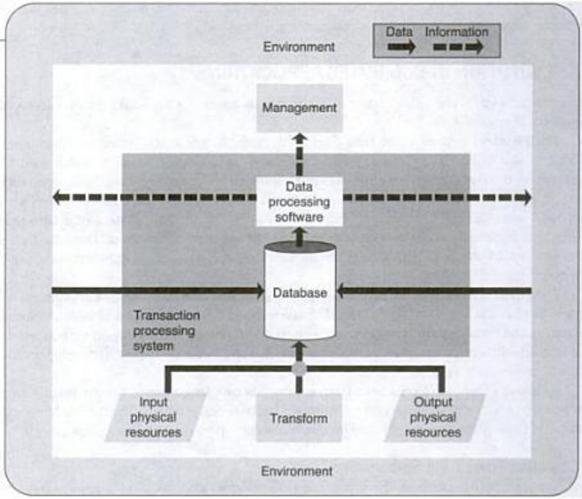


Figure 1.7 **A Model of a Transaction Processing System**

It is important to recognize the information flow to the environment. Much, perhaps most, of the information produced by the transaction processing system is intended for use by persons or organizations outside the firm.

Management Information Systems

With the transaction processing systems up and running, both the firm's information specialists and computer manufacturers wanted to continue the increase in computing activity, so they sought new application areas. It did not take them long to realize that the information output of transaction processing systems left much to be desired. The systems were generally incapable of transforming the volumes of data into aggregated, sorted, organized, and processed information needed by managers.

Over time, as managers learned more about the computers they became aware of the underlying logic of the processes that they followed in solving problems, and they were better able to describe their information needs. Information specialists, in turn, learned the basics of management and how to work with managers in designing information systems. The information systems were redesigned so that they more closely fit managers' needs, and such systems eventually became established as a major computer application area.

We define a **management information system (MIS)** as a computer-based system that makes information available to users with similar needs. MIS users usually comprise a formal organizational entity—the firm or a subsidiary subunit. The information provided by the MIS describes the firm or one of its major systems in terms of what has happened in the past, what is happening now, and what is likely to happen in the future. The MIS produces this information through the use of two types of software:

- *Report-writing software* produces both periodic and special reports. Periodic reports are coded in a programming language and are prepared according to a schedule. Special reports, often called *ad hoc reports*, are prepared in response to unanticipated information needs. Today's database management systems have features that quickly generate reports in response to requests for specific data or information.
- *Mathematical models* produce information as a result of simulations of the firm's operations. Mathematical models that describe the firm's operations can be written in any programming language. However, special modeling languages make the task easier and faster.

The output information generated is used by problem solvers (both managers and professionals) to make decisions to solve the firm's problems.

Consider the MIS model in Figure 1.8. The database contains the data provided by the transaction processing system. In addition, both data and information are entered from the environment. The environment becomes involved when the firm interacts with other organizations, such as suppliers, to form an **interorganizational information system (IOS)**. In that case, the MIS supplies information to other members of the IOS as well as to the firm's users.

Virtual Office Systems

In 1964, computer technology was applied to office tasks when IBM introduced an electric typewriter with a magnetic-tape capability. The typewriter could store typed material on the magnetic tape and retrieve the material when it was needed. The application was called word processing. This was the beginning of **office automation**, which is the use of electronics to facilitate communication. Additional applications include e-mail, voice mail, electronic calendaring, audio conferencing, videoconferencing, computer conferencing, and facsimile (fax) transmission. Today, these applications account for a major portion of a firm's use of the computer as a communications vehicle.

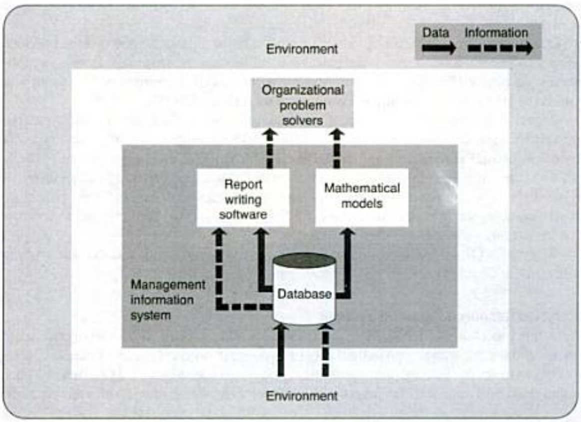


Figure 1.8 **An MIS Model**

These systems came from modest, clerical beginnings. But today they are generally referred to as **personal productivity systems**. Today, managers use technology to self-manage some of the clerical tasks that supported managers in the 1960s. For example, managers use personal productivity systems to maintain calendars and address books that contain mailing addresses, e-mail addresses, and more. Phone numbers and schedules may be kept in cell phones or personal digital assistants (PDAs).

Technology has not burdened managers with clerical tasks. By using technology to remove unnecessary obstructions to communications between managers and others, technology has made managers much more efficient. Today, managers rapidly issue communications via e-mail and a distribution list instead of dictating a memo, having someone else type it, checking the memo for errors, and finally sending a corrected memo to others.

The ability of the office automation applications to be performed anywhere gave birth to the concept of a **virtual office**; that is, the performance of office activities independent of a particular physical location. For example, managers can engage in a videoconference without all gathering at the same physical location. Virtual office systems have made managers more available to customers and to others within the firm.

Decision Support Systems

Some management information systems failed, and these failures convinced information specialists that there had to be another way to help problem solvers make decisions. It was not until 1971, however, that the term *decision support system* was coined by G. Anthony Gorry and Michael S. Scott Morton, both MIT professors.[1] They believed that systems should be tailored to specific problem solvers and specific problems. A **decision support system (DSS)** is a system that assists a single manager or a small group of managers to solve a single problem. An example is a DSS designed to help a sales manager determine the best commission rate for the sales force. DSSs take a rifle approach to problem solving, whereas MISs take a shotgun approach by providing a large group of problem solvers with information to solve a wide range of problems.

Figure 1.9 depicts a DSS model. At the top of the diagram are the three sources of information that is delivered to users—a relational database, a knowledge base, and a multidimensional database.

DSS outputs were originally produced from a relational database and included periodic and special reports and outputs from mathematical models. Next, group decision support capability was added by means of group-oriented software called **groupware**. The groupware enabled the DSS to act as a **group decision support system (GDSS)**.

Recent additions to DSSs include artificial intelligence and on-line analytical processing. **Artificial intelligence (AI)** is the science of providing computers with the ability to display behavior similar to that of an intelligent human. Artificial intelligence is built into the DSS by means of a knowledge base of information about a problem area, and an inference engine that can analyze the contents of the knowledge base. On-line analytical processing (OLAP) involves the storage of data in a multidimensional form to facilitate the presentation of an almost infinite number of data views.

We address OLAP in Chapter 8 and provide more detail on DSSs, GDSSs, and artificial intelligence in Chapter 11.

Enterprise Resource Planning Systems

Transaction processing systems, MISs, and DSSs were all developed without an overall master plan. Essentially, each sprang up individually in response to different needs. During the 1990s, firms began to see the value of integrating these systems so that they would function as a coordinated unit. Software vendors responded by developing standardized software packages

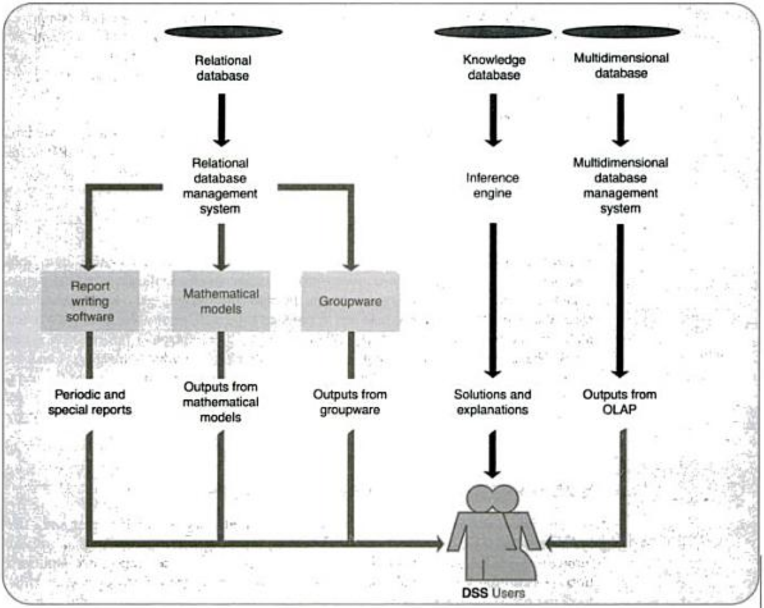


Figure 1.9 **A DSS Model**

aimed at meeting the needs of practically all types of organizations. The vendors named their products *enterprise resource planning (ERP) systems*. An **enterprise resource planning (ERP) system** is a computer-based system that enables the management of all of the firm's resources on an organization-wide basis.

The tremendous growth in ERP software during the late 1990s can be attributed to several factors, including the Y2K problem, the difficulty in achieving enterprise-wide systems, the flurry of corporate merger activity, and a "follow the leader" competitive strategy. The Y2K problem was the difficulty faced by computer programs that stored years in a two-digit format, such as storing the year 2000 as 00. When an application subtracted the year 2000 from 1998, it would actually compute 00 minus 98 and produce a result of –98, which could cause the application to give incorrect answers or simply stop running. Many people feared that the Y2K problem would cause worldwide computer failures.

ERP software was marketed as being Y2K compliant to assure firms that the information systems being replaced would not suffer errors caused by the date change from 1999 to 2000. The theory that Y2K was a driving force for implementation of ERP software was given credence when the sales growth rates of major ERP vendors slowed in 1999.[2]

Only a few vendors supply ERP software. The world's two largest software companies, Microsoft and IBM, do not make ERP software, yet they run large portions of their businesses using software from ERP vendors.[3] One ERP provider, SAP, is a large multinational company based in Germany; however, the majority of its ERP sales are in the United States. Oracle and Siebel are SAP's main competitors. PeopleSoft was formerly a competitor, but in January 2005 Oracle acquired PeopleSoft.

The ERP industry consists of more than just ERP vendors. Organizations often pay three to seven times the amount of the software price for consultants, training, and other ERP-related items.[4] An ERP system requires an enormous financial commitment from the organization.

INFORMATION SYSTEM USERS

The first users of computer output were clerical employees in the accounting area. Some information, such as that produced as a by-product of accounting applications, was also made available to managers. When firms embraced the MIS concept, emphasis shifted from data to information and from clerical employees to problem solvers. Systems were developed specifically for problem-solving support. Although the term *management information system* implies otherwise, managers were not the only beneficiaries of MISs; nonmanagers and professional staff used the output as well. However, in this text we will emphasize the use of MISs by managers. The reason for this approach is that before long you will be a manager, and the purpose of the text is to prepare you to use the firm's computer resources so that you will become a successful manager.

MANAGERS AS INFORMATION SYSTEM USERS

Because managers are individuals, their information needs vary widely. However, some useful frameworks have been developed that make it possible to address the role of information in problem solving. High-quality information systems cannot be developed unless information systems professionals and managers understand the managerial framework upon which modern organizations are based.

Where Managers Are Found

Managers exist on various managerial levels and within various business areas of the firm.

MANAGEMENT LEVELS Management theorist Robert N. Anthony coined names for the three primary management levels—top, middle, and lower.[5] Managers at the top of the organizational hierarchy, such as the president and vice presidents, are often referred to as being on the **strategic planning level**, recognizing the fact that their decisions will often impact the entire organization for years to come. Middle-level managers include regional managers, product directors, and division heads. Anthony calls this **the management control level**, because mid-level managers have the responsibility to put plans into action and ensure that goals are met. The middle-level is sometimes called the tactical level. Lower-level managers include department heads, supervisors, and project leaders—persons responsible for accomplishing the plans specified by managers on upper levels. This lowest level has been called the **operational control level**, because it is here that the firm's operations actually occur.

It is important for those designing information systems to take into account the manager's level, because such systems can influence both the sources of information and how information is presented. The upper graph of Figure 1.10 shows that managers on the strategic planning level place greater emphasis on environmental information than do managers on

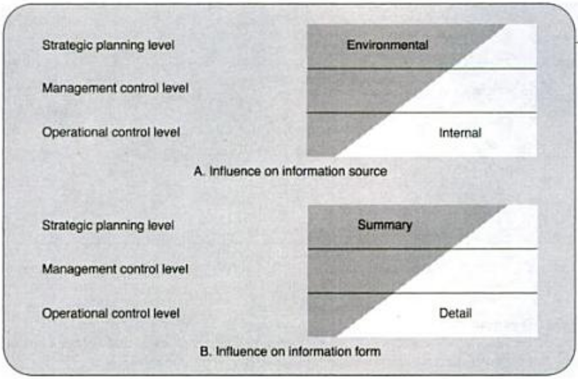


Figure 1.10 **Management Level Can Influence Both the Source and Presentation Form of Information**

the lower levels, and that managers on the operational control level regard internal information as most vital. The lower graph shows that strategic-planning-level managers prefer information in a summary format, whereas operational-control-level managers prefer more detail.[6]

Business Areas In addition to the organizational levels, managers can be found in various business areas. The three traditional business areas are marketing, manufacturing, and finance. Recently, two additional areas have assumed major importance—human resources and information services. Figure 1.11 illustrates how managers can be grouped by level and business area in a manufacturing firm.

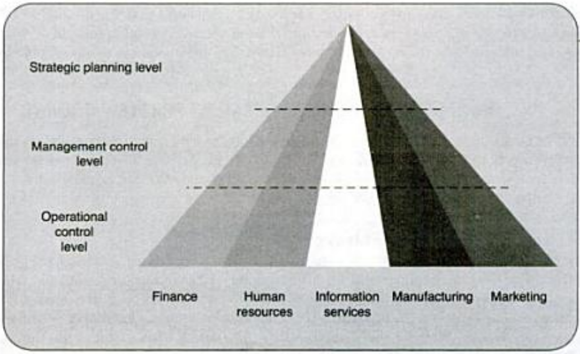
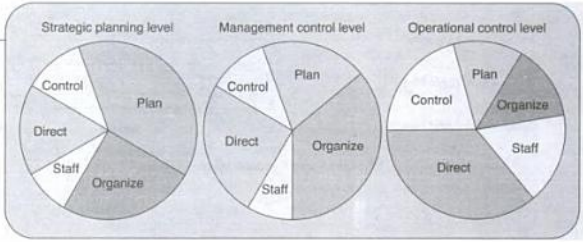


Figure 1.11 **Managers Can Be Found on All Levels in All Business Areas of the Firm**

Figure 1.12
Management Level May Influence the Relative Emphasis on the Management Functions



What Managers Do

Despite the obvious differences that exist between management levels and between business areas, all managers perform the same functions and play the same roles.

MANAGEMENT FUNCTIONS Around 1914, the French management theorist Henri Fayol recognized that managers perform five major **management functions.** First, managers *plan* what they are to do. Then, they *organize* to meet the plan. Next, they *staff* their organization with the necessary resources. With the resources in place, they *direct* them to execute the plan. Finally, they *control* the resources, keeping them on course.

All managers, regardless of their level or business area, perform these functions to some degree. Managers at different levels emphasize different functions. Figure 1.12 illustrates how a manager's management level may emphasize various management functions.

MANAGERIAL ROLES Henry Mintzberg, a professor at McGill University in Montreal, decided that Fayol's functions did not tell the whole story. He developed a more detailed framework consisting of 10 **managerial roles** that managers play that involve interpersonal, informational, and decisional activities. These roles are listed and defined in Table 1.2. These management functions and managerial roles provide useful frameworks when designing information systems to support managers as they make decisions to solve problems.

THE ROLE OF INFORMATION IN MANAGEMENT PROBLEM SOLVING

It would be an oversimplification to say that problem solving is the most important activity that a manager performs. The job is more complex than that. Other activities, such as communications, are also important. However, it is safe to say that problem solving is a key activity—often determining the difference between a successful and unsuccessful management career.

Problem Solving and Decision Making

The outcome of a problem-solving activity is a solution. It is easy to get the idea that a problem is always something bad, because we seldom phrase taking advantage of a situation in the same way that we phrase correcting a bad situation. We incorporate opportunity seizing into problem solving by defining a **problem** as a condition or event that is harmful or potentially harmful to a firm or that is beneficial or potentially beneficial. It bears repeating that the outcome of the problem-solving activity is a **solution**.

Table 1.2

Mintzberg's Managerial Roles

INTERPERSONAL ROLES	*Figurehead* The manager performs ceremonial duties, such as giving visiting dignitaries tours of the facilities. *Leader* The manager maintains the unit by hiring and training the staff and providing motivation and encouragement. *Liaison* The manager makes contacts with persons outside the manager's own unit—peers and others in the unit's environment—for the purpose of attending to business matters.
INFORMATIONAL ROLES	*Monitor* The manager constantly looks for information bearing on the performance of the unit. The manager's sensory perceptors scan both the internal activity of the unit and its environment. *Disseminator* The manager passes valuable information along to others in the unit. *Spokesperson* The manager passes valuable information along to those outside the unit—superiors and persons in the environment.
DECISIONAL ROLES	*Entrepreneur* The manager makes rather permanent improvements to the unit, such as changing the organizational structure. *Disturbance handler* The manager reacts to unanticipated events, such as the devaluation of the dollar in a foreign country where the firm has operations. *Resource allocator* The manager controls the purse strings of the unit, determining which subsidiary units get which resources. *Negotiator* The manager resolves disputes both within the unit and between the units and its environment

During the problem-solving process, managers engage in decision making, which is the act of selecting from alternative courses of action. A **decision** is a particular selected course of action. Usually, the solving of a single problem requires multiple decisions.

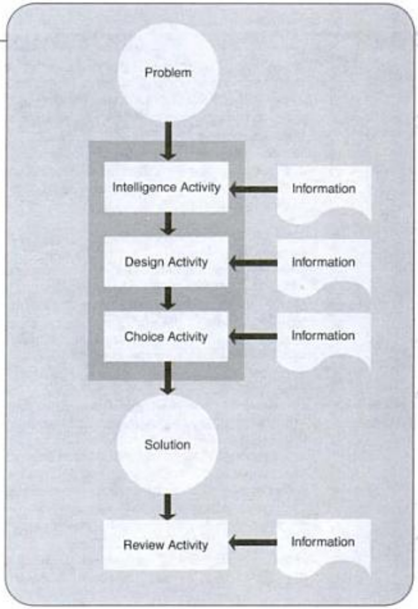
Problem-Solving Phases

Herbert A. Simon, a Nobel Prize–winning management scientist, is credited with defining four basic phases of problem solving that are universally recognized. According to Simon, problem solvers engage in:[7]

- *Intelligence activity*. Search the environment for conditions calling for a solution.
- *Design activity*. Invent, develop, and analyze possible courses of action.
- *Choice activity*. Select a particular course of action from those available.
- *Review activity*. Assess past choices.

To perform each activity, the problem solver must have information. Figure1.13 illustrates this support. Information systems, developed either by users or information specialists, provide this information.

Figure 1.13
Information Supports Each Problem-Solving Phase



THE FUTURE OF INFORMATION TECHNOLOGY

The future of information technology will be driven by the reduced cost and increased power of both computers and communications. The power of computers is measured in processing speed, storage capacity, and the variety of input and output devices. Communications power is measured by cost and transmission speed, such as the amount of data that can be communicated in a specified amount of time. Business organizations have always shown an appetite for inexpensive assets that have the power to change their operations.

Computers and communications are converging. Cell phones have browser, e-mail, and photo capabilities and editing features. Canesta, Inc. has developed a keyboard made only of light. It is an image of a keyboard that can be projected onto any flat surface. Logitech has developed the io, a digital pen. The roller in the pen works much like the roller ball in a computer mouse, but the pen "remembers" all the words written and images drawn. The user simply places the pen in a cradle and uploads the text and images created with the pen.

These advances indicate that in the future computing will be low cost, small in size, mobile, and connected. To take advantage of these new possibilities, managers must learn to incorporate information systems into decision making.

Highlights in MIS

The World's Smallest Logic Circuit[8]

IBM scientists have reported a startling breakthrough in circuit design. Rather than constructing a circuit from silicon transistors, which is currently the state of the art, scientists are using carbon monoxide molecules on a flat copper surface. The circuit makes calculations in much the same way as billiard balls roll on a billiard table. The copper atoms on the surface form tiny hollows into which the carbon monoxide molecules can settle. When three molecules settle close together, forming a "V-shape," the two outside molecules force the center one to move to the next space. When the molecules are positioned in the proper positions and then nudged with an instrument in the same manner as when a cue stick strikes a billiard ball, the molecules begin to collide and eventually settle in positions that represent the solution to the calculation.

The molecular circuit is smaller than a trillionth of a square inch. To give you an idea of how small this is, a silicon transistor circuit requires up to 260,000 times as much space. Although the molecular design is currently impractical because setting up the molecules for the calculation and reading the results takes a long time, the approach does offer potential for the future. It is anticipated that silicon transistor technology will reach a physical barrier in the next decade or two. Maybe by then the billiards approach will have been refined to a point where it is practical.

Summary

Summary

The first computers, called *mainframes*, were very large and were only affordable to the largest firms. Innovations in hardware technology made small, powerful computers possible. IBM named its microcomputer a *personal computer*, or *PC*, and that name stuck, not only for IBM's computers, but for those produced by others as well. The term *personal computer* was more than a catchy phrase; it described the sense of ownership that managers felt once they could access and manipulate their own data. A good measure of the rapid innovations in hardware technology is Moore's Law, which asserts that the power of a computer doubles every 18 months. The consequence of Moore's Law is that in 30 years the computer on your desk will be more than a million times more powerful for the same cost.

The architecture of the computer (CPU, RAM, storage, and other features) will remain the same for some time to come. But the implications of the increased power, smaller size, expanded communications, and falling costs of microcomputers cannot be ignored. Advances in technology enable users to access more data more quickly, and then analyze it with sophisticated analysis techniques. The constancy of computer architecture ensures that it will remain familiar, which means that managers need only understand how to use increasing computer power to their advantage.

Communications technology has changed dramatically. Currently, the trend is toward wireless technologies. The main concern with wireless communications is security. Many users do not use the security features available to them. Manufacturers of wireless communications equipment have begun to incorporate features that automatically turn security options on.

Information systems are virtual systems; their data represents the physical system of the firm. Businesses are open systems, because they interact with their environment.

The first information systems performed the firm's accounting functions and were called *transaction processing systems*. Once those systems were installed, firms turned their attention toward using computer systems to provide information to managers. *Management information systems (MISs)* were developed to provide support for large groups of managers, perhaps all of the managers in the firm. The introduction of MISs was accompanied by the emergence of office-oriented applications that evolved into what is known today as the *virtual office*. *Decision support systems (DSSs)* were then developed to help one or a few managers make particular decisions. This approach was so successful that it was broadened to include group problem solving, and new features, including artificial intelligence and on-line analytical processing, were incorporated into these systems. *Enterprise resource planning (ERP) systems* have been developed to integrate all these separate systems into one overall system to manage all of the firm's operations.

Information systems are used by managers, nonmanagers, professionals, and persons outside the firm. Managers can be found at different management levels and in different business areas. Managers make decisions to solve problems as they perform certain functions and play certain roles. The information provided to managers is most effective when it recognizes and supports these functions and roles.

Understanding technology and its impact on decision making is crucial to good management. You will be in the job force long enough to see amazing changes in technology. The skills that you learn today for spreadsheets and word processors are valuable, but the ability to adapt and utilize technology in decision making tomorrow is far more important.

Key Terms

mainframe
multitasking
information specialist
minicomputer
microcomputer, micro
personal computer, PC
modem
open system
closed system
data
information
office automation
personal productivity system
virtual office
groupware
problem
solution
decision

Key Concepts

- Moore's Law
- physical system
- virtual system
- transaction processing system
- management information system (MIS)
- interorganizational information system (IOS)
- decision support system (DSS)
- group decision support system (GDSS)
- artificial intelligence (AI)
- enterprise resource planning (ERP) system
- strategic planning level
- management control level
- operational control level
- management functions
- managerial roles
- problem-solving phases

Questions

1. When did personal computers first appear?
2. What is an information specialist? Provide four examples.
3. What are the main functions of the CPU and RAM?
4. How is the communications speed of a cable modem different from a traditional modem that connects to a telephone line?
5. What data transmission speeds can you expect for direct computer-to-computer communications? What is a common transmission speed you might find for wireless computer communications?
6. Is a computer a virtual system, a physical system, or both? Explain.

7. In what way is a computer an open system?
8. Does a transaction processing system produce information or data? Explain.
9. Where are the users of the transaction processing system located in the organization? Are they at the top, middle, or bottom?
10. Distinguish between a periodic report and a special report.
11. How do personal productivity systems make a manager more efficient?
12. How does the focus of a DSS differ from that of an MIS?
13. Why are group decision support systems important?
14. Why is planning more likely to occur at higher levels of management and control more likely to occur at lower levels of management? Does this influence the types of information systems developed for different levels of management?
15. Why were firms especially attracted to enterprise resource planning systems in the late 1990s? Are those attractions still valid?
16. Identify the five major management functions described by Henri Fayol.
17. Which concept explicitly recognizes the importance of information in management—management functions or managerial roles?
18. What are the four stages of problem solving, according to Herbert A. Simon?
19. If present trends continue, what will be four features of future computers?

Topics for Discussion

1. Why would a manager want to solve a "good" problem?
2. How does a manager engage in Simon's intelligence activity?

Problems

1. Assume that Moore's Law will hold true from 2005 through 2020. Prepare a table showing the increase in power for each year over the 15-year time line.
2. Assume that you are director of recruiting for a large firm in your area that recruits graduates of your college. Describe the type of report that you would need to perform each of Fayol's management functions. You will need to describe five reports. *Hint:* What would you need to know to plan a recruiting campaign, what would you need to know to organize a recruiting campaign, and so on?

Case Problem

Freeway Ford

You are a management consultant working for Franklin Absolom, the majority stockholder for a group of 10 automobile dealerships. He has asked you to spend several days at Freeway Ford, a dealership that is not performing up to its potential. You are not to go "looking for trouble"; instead, your assignment is to find ways to help management at the dealership take advantage of opportunities.

One day while you are talking with James Kahler, the sales manager for Freeway Ford, you realize that the dealership only uses transaction processing systems—it is not realizing the full potential of the information it has gathered for managerial decision making. For example, Freeway Ford knows the purchase date and owner of every car it sells, but it never contacts owners about routine maintenance. Freeway Ford knows that people who purchase a new car

Case Problem continued

generally trade it in for another new car 3 to 4 years later, but the dealership does not contact these previous customers.

Another opportunity comes from used car purchasing and sales. Every car has a vehicle identification number (VIN), and the dealership uses this number to check for known problems with a used car before it makes a purchase. A data bank of car insurance claims histories and major repair histories is kept on a set of CDs that is sent to the dealership each month. At the dealership, the VIN is entered into a personal computer that accesses the CDs. However, the dealership buys 100 to 400 used cars a month from other locations. Sometimes the used car buyer is at an auction and does not have access to a computer. Sometimes the buyer is at an estate sale or other private sale. Currently, these are "blind" sales in that they are made without reviewing current VIN information, because the buyer cannot get to a computer and use the CDs to check the car's history.

You know that Freeway Ford collects data but the dealership is not processing the data to produce information. Also, the used car buyers' lack of access to the VIN database could be costing the dealership thousands of dollars each month. You decide that your report to Absolom and Kahler should highlight these two opportunities.

ASSIGNMENT

1. In a brief summary (no more than two paragraphs), explain the difference between data and information as it applies to the data collected by Freeway Ford when it sells a car. What data should be processed into information at Freeway Ford?
2. How can the used car buyers access the VIN information when the buyer is not at the Freeway Ford location?
3. How could you expand your suggestions to the entire enterprise of 10 dealerships?

Case Problem

SPENDING ON PERSONAL COMPUTERS

You are working with a group of managers to plan resource needs over the next 6 years at your company. One set of resources, personal computers, has caused a lot of concern among the managers. The company has 1,000 professional staff members, and each one has a personal computer. The cost of a personal computer is estimated to be $1,500 per professional staff member.

The professional staff is expected to grow by 10 percent per year over the next 6 years. The managers don't think the company can afford to continue purchasing computers for each staff member. They assume that the cost of computers increases each year, just like everything else. However, you know that Moore's Law predicts that the cost of computers decreases by half every 18 months. You need to prove that the company can afford to provide a personal computer to every professional staff member.

ASSIGNMENT

1. Create a table like the one that follows and fill in the blanks. Note that year 0 is the current year, and you know the cost for a computer as well as the number of professional staff who are employed. (*Hint:* Based on yearly staff increases of 10%

Case Problem continued

per year, the number of professional staff after one year will be $1{,}000 \times 1.10 = 1{,}100$. After three years there will be 1,311 professional staff [$1{,}000 \times 1.10 \times 1.10 \times 1.10$]). Use Moore's Law to predict the cost of computers, assuming that professional staff will require the same computer power in 6 years as they require now and that the price will drop accordingly.

YEAR	NUMBER OF STAFF	PC COST	TOTAL COST
0 (current year)	1,000	$1,500	$1,500,000
3 years	1,331		
6 years	1,771		

2. Write a short explanation (8 to 10 sentences) as to why in 6 years it will cost only about $166,000 for PCs even though the number of staff will have increased.

NOTES

[1] G. Anthony Gorry and Michael S. Scott Morton, "A Framework for Management Information Systems," *Sloan Management Review* 13 (Fall 1971), 55–70.
[2] Richard W. Oliver, "ERP Is Dead! Long Live ERP!" *Management Review* 88 (November 1999), 12–13.
[3] Michael H. Martin, "Smart Managing," *Fortune* 137 (February 2, 1998), 149–151.
[4] August-Wilhem Scheer and Frank Habermann, "Making ERP a Success," *Communications of the ACM* 43 (April 2000), 57.
[5] Robert N. Anthony, *Planning and Control Systems: A Framework for Analysis* (Cambridge, MA: Harvard University Press, 1965).
[6] Figure 1.11 is a conceptual representation of a condition that is believed to exist but for which there is very little supporting evidence. Other diagrams in this text are of this type. The diagrams provide useful guidelines, but it is important to recognize that each manager has unique information needs.
[7] Herbert A. Simon, *The New Science of Management Decision*, rev. ed. (Upper Saddle River, NJ: Prentice Hall, 1977).
[8] Kenneth Chang, "Scientists Shrink Computing to Molecular Level," *New York Times*, October 25, 2002, A-18.

Chapter 2

Information Systems for Competitive Advantage

Learning Objectives

After studying this chapter, you should

- Know the general systems model of the firm.
- Understand the eight-element environmental model as a framework for understanding the environment of a business organization.
- Understand that supply chain management involves the planning and coordination of physical resources that flow from the firm's suppliers, through the firm, and to the firm's customers.
- Recognize that competitive advantage can be achieved with virtual as well as physical resources.
- Understand Michael E. Porter's concepts of value chains and value systems.
- Know the dimensions of competitive advantage.
- Recognize the increasing challenges from global competitors and the importance of information and coordination in meeting those challenges.
- Understand the challenges of developing global information systems.
- Know the basic types of information resources available to the firm.
- Know the dimensions of information that should be provided by an information system.
- Know how to manage knowledge in the form of legacy systems, images, and knowledge.
- Understand how a firm goes about strategic planning—for the firm, its business areas, and its information resources.

Introduction

The general systems model of the firm provides a good template for analyzing an organization. It highlights the elements that should be present and how they should interact. In the same manner, the model of the eight environmental elements of a firm provides a good way to come to grips with the complexity of how the firm interacts with its environment. An integration of the general systems model and the eight-element environmental model provides the foundation for a concept receiving much current attention—supply chain management.

During recent years, the topic of competitive advantage has been the focus of much discussion. Usually, competitive advantage is achieved by managing physical resources, but virtual resources can also play a big role. Michael E. Porter is credited with shedding the most light on the competitive-advantage concept and contributing the ideas of value chains and value systems, which are compatible with taking a systems view of the firm and its environment. The firm's executives can use information to gain strategic, tactical, and operational advantages.

A broad view of competitive advantage recognizes the organizations that compete with the firm as well as professionals and staff in other countries that compete with the firm's employees for jobs. Multinational corporations often outsource tasks to other organizations in order to achieve an economic advantage. Firms that do business globally have special needs for information and coordination. A firm's information resources include hardware, software, information specialists, users, facilities, databases, and information. Information has four desirable dimensions: relevancy, accuracy, timeliness, and completeness.

Substantial advantages accrue to corporations that achieve coordination through the use of information resources. Multinational corporations face significant challenges in the form of politically imposed constraints, cultural and communications barriers, technological problems, and lack of support from subsidiary managers.

The task of knowledge management is changing continually. Firms have been using computers since the 1950s, and data formats and storage techniques have changed considerably since then. However, the data in older legacy systems provide valuable insights into business trends and operations. Most legacy systems only stored text and numbers, but today images are also an important part of information systems. Knowledge management recognizes that information represents the firm's knowledge resource. Knowledge management is required to organize, access, and leverage the firm's data and information for decision making.

The firm's executives perform strategic planning for the entire organization, the business area, and the information resources. The chief information officer (also called the chief technology officer) plays a key role in all types of strategic planning. A strategic plan for information resources identifies the objectives that the firm's information systems should meet in the coming years and the information resources that will be necessary to meet those objectives.

THE FIRM AND ITS ENVIRONMENT

In Chapter 1, you learned that a firm is a physical system that is managed through the use of a virtual system. The physical system of the firm is an open system in that it interfaces with its environment. A firm takes resources from its environment, transforms the resources into products and services, and returns the transformed resources to the environment.

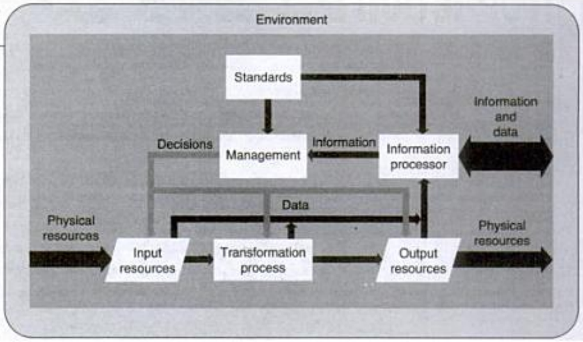


Figure 2.1 **The General System Model of the Firm**

The General Systems Model of the Firm

Figure 2.1 shows this flow of resources from the environment, through the firm, and back to the environment. The flow of physical resources is at the bottom; the flow of virtual resources is at the top. This diagram depicts the **general systems model of the firm**; it presents an architecture for all types of organizations in the form of a system.

THE PHYSICAL RESOURCE FLOW The firm's physical resources include personnel, material, machines, and money. Personnel are hired by the firm, transformed to higher skill levels through training and experience, and eventually leave the firm. Material enters the firm in the form of raw inputs and is transformed into finished goods, which are then sold to the firm's customers. Machines are purchased, used, and eventually scrapped or traded in on newer machines. Money enters the firm in the form of sales receipts, shareholder investments, and loans and is transformed into payments to suppliers, taxes to the government, and returns to stockholders. While in the firm, the physical resources are used to produce the products and services the firm provides to its customers.

THE VIRTUAL RESOURCE FLOW The arrows in the upper part of Figure 2.1 show the flow of virtual resources—data, information, and information in the form of decisions. The two-way flow of data and information that connects the firm to its environment is shown to the right.

THE FIRM'S CONTROL MECHANISM The elements that enable the firm to control its own operations include (1) the performance standards the firm must meet if it is to accomplish its overall objectives, (2) the firm's management, and (3) an information processor that transforms data into information.

THE FEEDBACK LOOP The feedback loop is composed of the virtual resources. Data are gathered from the firm and from the environment and entered into the information processor, which transforms it into information. The information is made available to managers, who make decisions to affect necessary changes in the physical system.

Management is guided in its decision making by the firm's performance standards. These performance standards can also be used by the information processor to determine when the firm is not performing as planned.

The Firm in Its Environment

The general systems model of the firm makes it easy to see the importance of the environment to a firm's success. A firm exists for the purpose of providing products and services that meet environmental needs. Equally important, a firm cannot function without the resources that the environment provides.

The environment varies from firm to firm. A bank has a different environment than does a sporting goods store or a church. However, we can identify eight major elements that exist in the environments of all firms.[1] These **environmental elements** are organizations and individuals that exist outside the firm and that have a direct or indirect influence on it. These eight elements exist in a larger system called a *society*. Figure 2.2 depicts the **eight-element environmental model**.

Suppliers, also called **vendors**, supply the materials, machines, services, people, and information that the firm uses to produce its products and services. These products and services are marketed to the firm's **customers**. **Labor unions** are organizations of both skilled and unskilled workers for certain trades and industries. The **financial community** consists of institutions such as banks and other lending institutions that influence the financial resources that are available to the firm. **Stockholders and owners** are the persons who invest money in the firm; they are the ultimate owners of the firm. **Competitors** include all of the organizations that compete with the firm in its marketplace. The **government**, on the national, state or province, and local levels, provides constraints in the form of laws and regulations and also provides assistance in the form of purchases, information, and funds. The **global community** is the geographic area where the firm performs its operations. The firm demonstrates its responsibility to the global community by respecting the natural environment, providing products and services that contribute to quality of life, and conducting its operations in an ethical manner.

Environmental Resource Flows

The firm is connected to its environmental elements by **environmental resource flows**. Some of the resources flow more frequently than others do. Common flows include information flow from customers, material flow to customers, money flow to stockholders, and raw materials flow from suppliers. Less frequent flows include money flow from the government (such as for research), material flow to suppliers (returned merchandise), and personnel flow to competitors (employees "pirated" by other firms).

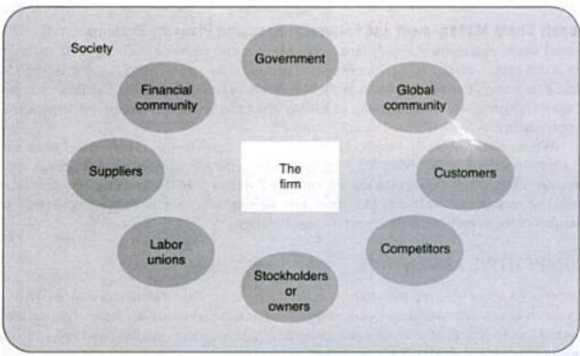


Figure 2.2 **Eight Environmental Elements**

Not all resources flow between the firm and all its environmental elements. For example, machines normally do not flow from the firm to stockholders, and money should not flow to competitors. The only resource that connects the firm with all the elements is information, and the firm strives to make the information connection with competitors a one-way flow.

MANAGING THE PHYSICAL RESOURCE FLOWS—SUPPLY CHAIN MANAGEMENT

The pathway that facilitates the flow of physical resources from suppliers to the firm and then to customers is called the **supply chain**. The flow of resources through the supply chain must be managed to ensure that it occurs in a timely and efficient manner; this process is called **supply chain management**. Supply chain management consists of the following activities:

- Forecasting customer demand
- Scheduling production
- Establishing transportation networks
- Ordering replenishment stock from suppliers
- Receiving stock from suppliers
- Managing inventory—raw materials, work-in-process, and finished goods
- Executing production
- Transporting resources to customers
- Tracking the flow of resources from suppliers, through the firm, and to customers

The firm's information system can be used in performing each of these activities.

Electronic Systems

As resources flow through the supply chain they can be tracked electronically, step-by-step. As resources move through the supply chain, actions are recorded in computer terminals located at suppliers' sites, in the firm's receiving area, in the firm's inventory and production areas, in the firms' shipping areas, in the vehicles used by the transporters, and at customers' sites. Data are entered into the terminals either by keyed input, bar-code scanning, or radio frequency ID. As the data are captured, the firm's information system is updated to reflect the current location of the resource being tracked. The ability to track the flow of the resources as it occurs contributes to supply chain management.

Supply Chain Management and Enterprise Resource Planning Systems

Supply chain management is only one aspect of enterprise resource planning (ERP) systems, yet it can play a crucial role in operations. The use of the same ERP system vendor (SAP, Oracle, or some other) by members in the supply chain helps to facilitate the flow of supply chain information. However, the cost of ERP systems can be high, and not every member in a supply chain may wish to purchase ERP software.

When one member of a supply chain has substantial power over the other members, such as a large retailer like Wal-Mart has over its suppliers, the more powerful member can apply pressure on the other members to use the same ERP software. In that case, the transfer of data from one member to another is facilitated and all members benefit, but the most powerful member of the supply chain receives the most benefit.

COMPETITIVE ADVANTAGE

As firms go about meeting the product and service needs of their customers, firms strive to obtain an advantage over their competitors. They can achieve this advantage by providing products and services at a lower price, providing higher quality products and services, and meeting the special needs of certain market segments.

What is not always obvious is the fact that a firm can also achieve competitive advantage through the use of its virtual resources. In the information systems field, **competitive advantage** refers to the use of information to gain leverage in the marketplace. Note that the firm's managers use virtual as well as physical resources in meeting the strategic objectives of the firm.

Porter's Value Chains

Harvard professor Michael E. Porter is the person who is most often identified with the topic of competitive advantage. His books and articles have provided guidelines and strategies for firms attempting to gain an advantage over their competitors.[2]

Porter believes that a firm achieves competitive advantage by creating a **value chain**, illustrated in Figure 2.3, that consists of the primary and support activities that contribute to margin. **Margin** is the value of the firm's products and services minus their costs, as perceived by the firm's customers. Increased margin is the objective of the value chain.

Firms create value by performing what Porter calls **value activities**. Value activities are of two types: primary and support. The **primary value activities** are shown on the lower layer of Figure 2.3 and include inbound logistics that obtain raw materials and supplies from suppliers, the firm's operations that transform the raw materials into finished goods, outbound logistics that transport the goods to customers, marketing and sales operations that identify customer needs and obtain orders, and service activities that maintain good customer relationships after the sale. These primary value activities manage the flow of physical resources through the firm.

The **support value activities** appear on the upper layer of Figure 2.3 and include the firm's infrastructure—the organizational setting that influences all of the primary activities in a general way. In addition, three activities influence the primary activities separately or in some combination—human resources management, technology development, and procurement (or purchasing). Each value activity, whether primary or support, contains three essential ingredients: purchased inputs, human resources, and technology. Also, each activity uses and creates information. For example, information specialists in the information services unit may combine purchased commercial databases, leased computing equipment, and custom-developed programs to produce decision-support information for the firm's executives.

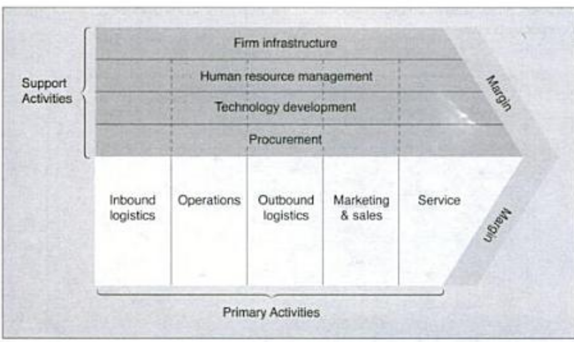


Figure 2.3 **A Value Chain**

Source: Represented with permission of The Free Press, a division of Simon & Schuster Adult Publishing Group, from *Competitive Advantage: Creating and Sustaining Superior Performance*, by Michael E. Porter. Copyright © 1985 by Michael E. Porter. All rights reserved.

EXPANDING THE SCOPE OF THE VALUE CHAIN Management must be alert to additional advantages that can be achieved by linking the firm's value chain to those of other organizations; such linkages result in an **interorganizational system (IOS)**. The participating firms are called **business partners**; they work together as a single coordinated unit, creating a synergy that cannot be achieved by working alone.

A firm can link its value chain to those of its suppliers by implementing systems that make input resources available when needed. An example is a just-in-time (JIT) agreement with a supplier to ship raw materials so that they arrive just hours before they are to be used in the production process. JIT helps to minimize storage costs of materials. A firm can also link its value chain with those of its distribution channel members, creating a **value system**. An example is an airline that allows travel agents as well as individual customers to access the airline's computerized reservation system to make flight reservations.

When the buyers of the firm's products are *organizations*, their value chains can also be linked to those of the firm and its channel members. For example, a pharmaceutical manufacturer can attach retailers' price labels to its products prior to shipment, thus saving retailers the expense of doing so. When the buyers are *individual consumers*, they can use their computers to log onto the firm's Web site to obtain information and make purchases. Figure 2.4 illustrates a value system.

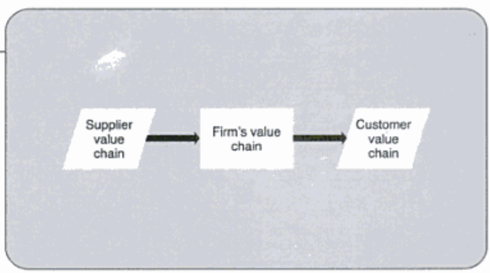
Because each value activity includes an informational component, managing the firm's information resources is a key step to achieving competitive advantage.

The Dimensions of Competitive Advantage

Competitive advantage can be realized in terms of achieving strategic, tactical, and operational advantages. At the highest managerial level—the strategic planning level—information systems can be used to change the direction of the firm to achieve strategic advantage. At the management control (middle) level, managers can specify how the strategic plans will be implemented, creating tactical advantage. At the operational control (lower) level, managers can use information technology in a variety of ways for data capture and information creation that ensures operating efficiencies, achieving operational advantage.

STRATEGIC ADVANTAGE A **strategic advantage** is one that has a fundamental effect in shaping the firm's operations. Information systems can be used to create a strategic advantage. For example, a firm may decide to convert all of its existing data into a database with standard interfaces (such as a Web browser interface) for possible sharing with business partners and customers. Standardized databases accessible via Web browsers would reflect a strategic shift in corporate position.

Figure 2.4 **A Value System**



This strategy may cause operations to be fundamentally affected in a number of ways. First, existing access may be via proprietary computer software, and the change would cause the firm to consider purchasing standard reporting software from an outside vendor or hiring an outside firm to design and develop the new reporting systems. Also, mobility of report access is affected, because users will no longer require direct access to the firm's computer resources; any connection to the Internet would enable the user to use a Web browser to access reports from virtually anywhere in the world. In a similar vein, potential suppliers and customers anywhere in the world would have potential access to the firm's raw materials and finished goods inventory levels, speeding the firm's buying and selling transactions.

Security cannot be ignored with this example of a strategic change in information systems. Greater dangers come with the greater opportunities for profits associated with Web access to the firm's information. Will a hacker pose as a vendor or customer in order to gain access to the database and damage the firm's information resource? Will a competitor access the information as part of corporate espionage? The strategic level establishes the firm's direction and destination, but there still needs to be a plan to accomplish a strategy that recognizes the importance of security.

TACTICAL ADVANTAGE A firm achieves a **tactical advantage** when it implements a strategy in a better way than its competitors. In our example, customer service may be enhanced by offering customers direct access to information. All firms want satisfied customers, because customer satisfaction results in repeat purchases.

Assume that a previous customer wishes to purchase $150 worth of computer paper from your firm. The purchase of such office supplies is routine, and the information system notes that the customer has made purchases totaling $800 during the month and that there is a 5 percent discount of purchase costs over $1,000 during any month. Previous purchases plus the current purchase total $950, just below the amount that triggers a discount.

The information system notes that the purchaser is just below the discount-trigger amount; it can help the firm achieve a tactical advantage in several ways. First, the customer sees the 5 percent discount as a reason to continue purchasing products from the firm. Second, the information system may suggest which products the customer may wish to purchase. The firm is not only encouraging customer loyalty, it may also be increasing its profit on the sale.

What if the customer routinely purchases paper but not toner cartridges? It would be safe to assume that the customer must be purchasing the toner from another supplier. This is an opportunity for the firm to offer its toner at a low price (the 5% discount) and possibly win future toner purchases from the customer.

The discount itself is an inducement to the customer, but it may also benefit the firm economically. By getting the additional $50 on this order ($1,000 minus $950), the firm saves the expense of processing a second order. Remember, the next order from this customer may reach the $1,000 level, and the firm would have the expense of processing the second order and providing the discount. Providing the discount on this order saves the firm the cost of processing a second order. Even more expenses are saved by the firm because it will make, fill, and ship a single shipment, not two.

The strategic decision was to make the firm's information system available to customers for improved customer service. The firm developed a tactical information system that not only increases customer satisfaction, but also improves profitability.

OPERATIONAL ADVANTAGE An **operational advantage** is one that deals with everyday transactions and processes. This is where the information system interacts directly with the process.

A Web site that "remembers" customers and their preferences through past transactions would reflect an operational advantage. Browsers often have **cookies,** small files of information on the user's computer, that can store account numbers, passwords, and other information pertinent to the user's transactions. This is a valuable convenience to the customer, and it directly benefits the firm. It is true that customers who use the Web to enter their purchases save the firm from the expense of paying a clerk to enter the data, but that is a minor benefit.

User-entered data are more likely to be accurate. Because the data are not communicated orally to someone else, it cannot be misunderstood during communication. When the information (name, address, and so on) can be retrieved from an earlier record, the data have an even greater likelihood of accuracy. Also consider the sense of ownership of the user-entered data. If the data are not accurate, the user does not blame the firm. For a variety of operational reasons, Web access to the firm's information systems improves customer relations.

The three levels of competitive advantage work together. Information systems that are impacted by all three levels have the best chance to increase a firm's performance substantially.

CHALLENGES FROM GLOBAL COMPETITORS

A **multinational corporation (MNC)** is a firm that operates across products, markets, nations, and cultures. It consists of the parent company and a group of subsidiaries. The subsidiaries are geographically dispersed, and each one may have its own unique goals, policies, and procedures.

You should not limit your thinking of global competitors to other organizations; professionals and staff working in other counties who compete for the same jobs as those in the host country may also be considered competitors. More and more U.S. firms are outsourcing some of their operations to other countries. India has been the leading destination, but China, Ireland, Scotland, Russia, and other countries in Eastern Europe and Southeast Asia are playing increasing roles. China is becoming an especially big player. In fact, some Indian outsourcing firms are, in turn, outsourcing their work to China.

The main reason to outsource is economic. Chinese labor costs are about 25 percent of U.S. labor costs.[3] However, outsourcing does have its disadvantages. One that is especially critical to IT outsourcing is the protection of intellectual property rights (IPR), which are not adequately protected in many countries. One way to address the IPR problem is to acquire a foreign-owned outsourcer. For example, in 2004 IBM bought Daksh eServices, one of India's largest call-center companies. At the time, IBM had more than 9,000 employees in India who developed software systems; purchasing Daksh eServices allowed IBM to acquire the firm so that IPR issues with the outsourcer would be avoided.[4]

The Special Need for Information Processing in an MNC

Although all firms have a need for information processing and coordination, these needs are especially crucial for the MNC. The MNC is an open system that seeks to minimize uncertainty in its environment. In this context, *uncertainty* is "the difference between the amount of information required to perform the task and the amount of information already possessed by the organization."[5] Most MNC executives recognize that they can cope with their environmental influences by making good use of information technology.

The Special Need for Coordination in an MNC

Coordination is key to achieving competitive advantage in the global marketplace. Companies that are unable to gain strategic control of their worldwide operations and manage them in a globally coordinated manner will not succeed in the international economy.[6]

The bad news for MNC executives is that the challenges of coordination are greater for the MNC than for a firm that restricts its activities to its home country. The difficulty arises from the fact that the resources used by the MNC are widely distributed. Dispersed information resources—hardware, software, and personnel—are difficult to manage and may be governed by conflicting business practices. The good news is that improvements in information technology, methodology, and communications have made global coordination much easier. But even with these improvements, coordination remains a big challenge.

The Advantages of Coordination

Many of the advantages that accrue to the MNC by virtue of having good information-processing capabilities are based on its ability to coordinate. The advantages of coordination include the following:[7]

- Flexibility in responding to competitors in different countries and markets
- Ability to respond in one country—or in a region of a country—to a change in another country
- Ability to keep abreast of market needs around the world
- Ability to transfer knowledge between units in different countries
- Reduced overall costs of operation
- Increased efficiency and effectiveness in meeting customer needs
- Ability to achieve and maintain diversity in the firm's products and in how products are produced and distributed

All of these advantages are due to reductions in the time and cost of communications made possible through use of the firm's information resources.

CHALLENGES IN DEVELOPING GLOBAL INFORMATION SYSTEMS

The development of any type of information system can be a challenge but when the system spans international boundaries developers must address several unique constraints. The term **global information system (GIS)** has been coined to describe an information system that consists of networks that cross national boundaries.[8] The following are just some of the constraints that GIS developers must address.

Politically Imposed Constraints

The national governments in the countries where subsidiaries are located can impose a variety of restrictions that make it difficult for the parent firm to include subsidiaries in the network. A common restriction is limited access to high-speed communications. Because the telephone infrastructure is frequently owned and operated by the government, not private firms, this can be a formidable barrier.

Cultural and Communications Barriers

Interaction with technology can vary greatly among cultures. GIS interfaces need to be consistent even as different languages are used. As a result, most GIS interfaces rely on graphics and icons for interactions with users and less on commands typed into fields. In addition, the issue of GIS design may be settled by offering multiple formats that yield the same functionality. If a firm decides to establish a GIS, it must be willing to adapt its systems to the varied needs of a global population.

Cultural barriers also influence the design of a GIS. In some societies, technology use is considered a menial task, whereas in others it is seen as a sign of social importance.

RESTRICTIONS ON HARDWARE PURCHASES AND IMPORTS National governments seek to protect local manufacturers and stimulate foreign investment in local manufacturing by specifying that only equipment produced or assembled in that country is to be used. This requirement can affect the interoperability of different hardware and software systems.

RESTRICTIONS ON DATA PROCESSING National policy may dictate that data be processed within the country, rather than transmitted out of the country and processed elsewhere.

RESTRICTIONS ON DATA COMMUNICATIONS The most publicized data communications restriction is that put on transborder data flows. **Transborder data flow**, or **TDF**, is the movement of machine-readable data across national boundaries. TDF legislation, which began in the 1970s, has been enacted by many countries as a way to protect the personal privacy of their citizens.

Technological Problems

MNCs are often plagued with problems related to the level of technology that exists in subsidiary countries. In some countries, reliable power sources are not available, resulting in frequent power outages. Telecommunications circuits often can only transmit data at slow speeds, and the transmission quality may be poor. Software can also be a problem. Because many countries do not honor software copyrights and condone black-market software, some software vendors refuse to do business in certain countries.

Lack of Support from Subsidiary Managers

The managers of subsidiary offices often are part of the problem. Some are convinced that they can run their subsidiaries without help, and they view headquarters-imposed regulations as unnecessary. Some subsidiary managers are paid based on profitability, and they will drag their feet when they think that corporate solutions will reduce their earnings. Foreign office management may also view the GIS as a "Big Brother" type of surveillance. Middle-level managers may fear being bypassed by the new information links that funnel operational data to the parent.

With all of these potential problems, it is a minor miracle that MNCs ever attempt GISs. Although it is impossible to eliminate the problems completely, their effects can be minimized by following a well-thought-out strategy that is incorporated into the strategic plan for information resources. We discuss such a plan later in the chapter.

KNOWLEDGE MANAGEMENT

A firm's **information resources** consist of:

- Computer hardware
- Computer software
- Information specialists
- Users
- Facilities
- Databases
- Information

When managers decide to use information to achieve competitive advantage, they must manage these resources in order to achieve the desired results. Information is like any other resource, it requires management. The managers ensure that the necessary raw data are gathered and then processed into usable information. The managers then ensure that the appropriate individuals receive the information in the proper form at the proper time so that it can be used. Finally, the managers discard information that has outlived its usefulness and replace it with information that is current and accurate. All of this activity—acquiring data, processing data into information, using and communicating information in the most effective way, and discarding information at the proper time—is called **knowledge management**.

The Dimensions of Information

As the system developers (users as well as information specialists) define the output that the information processor is to provide, they consider four basic dimensions of information.[9] These desirable dimensions contribute to information value.

- **Relevancy.** Information has relevancy when it pertains to the problem at hand. The user should be able to select the data that are needed without wading through a volume of unrelated facts. Only when data are relevant to the decision to be made should it be called "information."
- **Accuracy.** Ideally, all information should be accurate. However, features that contribute to system accuracy add to the cost of an information system. Because of this, users are often forced to settle for less than 100 percent accuracy. Applications involving money, such as payroll, billing, and accounts receivable, seek 100 percent accuracy. Other applications, such as long-range economic forecasts and statistical reports, often can be just as useful when the data are less than 100 percent accurate.
- **Timeliness.** Information should be available for decision making before crisis situations develop or opportunities are lost. Users should be able to obtain information that describes what is happening now, in addition to what has happened in the past. Information that arrives after a decision has been made is of no value.
- **Completeness.** Users should be able to obtain information that presents a complete picture of a particular problem or solution. However, systems should not drown users in a sea of information. The term **information overload** suggests that harm can come from having too much information. Users should be able to specify the amount of detail that is needed. Information is complete when it has the correct amount of aggregation and supports all areas of the decision being made.

It is usually best to let the users specify the dimensions of the information that they need. When necessary, information specialists can help users approach this task in a logical manner.

The Changing Nature of Knowledge Management

Early knowledge management focused on the transaction processing systems that processed customer orders, maintained inventory records, calculated payroll amounts, and performed similar tasks. As such, information systems were considered to be "low level," because they dealt with tasks given to the "lower levels" of the organization. Today, organizations recognize that information systems capture the knowledge held in the organization, and organizations must manage that knowledge.

LEGACY INFORMATION SYSTEMS Those managing and controlling information in a modern firm must recognize the limitations of past technologies. Earlier information systems and hardware and software that are incompatible or only partially compatible with current information technology are called **legacy systems**. Although the data captured by legacy systems produce primarily historical information, that information is still valuable.

Most legacy data can be converted and utilized by new technologies. The text and numbers that often make up legacy files can be imported into modern databases. Data capture may require that old data values be updated with new values. For example, obsolete product numbers may be replaced with current numbers. Other steps may be necessary to merge the textual and numerical data into the current database. Firms make a decision about the amount of legacy data to capture based on their expectations of additional profits that could be realized from the legacy data.

One problem with converting legacy data is that such data may not be available in digital format. Some legacy data may only exist on paper printouts. This data can still be captured as images.

IMAGE MANAGEMENT Digital photographs of printouts can be stored as computer files that can be referenced by the firm's current information systems. Special computer software exists that will translate images of textual and numerical data into a word processing file. The translation accuracy of these software systems depends on several factors, but is generally

Figure 2.5 **Common Image Management Formats**

COMMON IMAGE MANAGEMENT FORMATS

JPG – Joint Photographics Expert Group
used mainly for Web images, achieves reduction of file size over most other formats

GIF – Graphics Interchange Format
used mainly for Web images, uses only 256 colors, achieves some file size reduction, most commonly used for black and white images and for animated images

TIFF – Tagged Image File Format
bit mapped images that require a large amount of storage space but can be rendered in most resolutions without loss of image quality

BMP – the standard bit mapped image format for Windows can require large amounts of storage

WMF – Windows Metafile Format
format for graphics that are exchanged between Microsoft Windows-based applications (such as Word, Excel, and so on)

between 80 and 95 percent. The firm must decide whether the expense of achieving 100 percent accuracy exceeds the benefits. Achieving 100 percent accuracy involves the use of personnel to read and verify the translation made by the software.

The role of images has expanded with the advent of Web sites. Effective Web sites are very visual—photographs of the firm's logo, products, employees, and other images can help users navigate the Web site. Image management increases as the number of images grows; images require a great deal of storage space compared to textual and numerical data. A consistent image format may be required so that all applications in the firm can utilize the images. Figure 2.5 lists several popular image formats.

All of a firm's knowledge management activities can be carried out within the scope of a strategic plan that is especially tailored to the information resources.

STRATEGIC PLANNING FOR INFORMATION RESOURCES

The first firms to use computers placed the responsibility for managing the information resources in the hands of a special unit of information professionals. This unit, called *information services (IS)*, is managed by a manager who may have vice-presidential status. The accepted practice today is to establish information services as a major business area and include its top manager in the senior group of executives, such as the executive committee, who make key decisions for the firm.

The Chief Information Officer and the Chief Technology Officer

The term *CEO*, for "chief executive officer," is firmly implanted in business vocabulary to describe the person (president or chairperson of the board) who exerts the most influence on the direction of the firm. Terms such as *CFO*, for "chief financial officer," and *COO*, for "chief operating officer," have been coined as well. Similar terminology has been created for the information services manager. First, the term *CIO*, for "chief information officer," was used; more recently, the term *CTO*, for "chief technology officer," has emerged. These terms imply the key role that the top information services manager should play. The chief

information officer (CIO) or **chief technology officer (CTO)** is the highest-level manager of information services. This person contributes managerial skills to solving problems relating not only to the information resources, but also to other areas of the firm's operations.

The CIO or CTO can position information services as a vital element in the organizational structure of the firm by taking the following advice:[10]

- Spend time with the business and in business training. Learn the business, not just the technology.
- Actively seek partnerships with business units and line management—don't wait to be invited.
- Focus on improving business processes.
- Explain IS costs in business terms.
- Build credibility by delivering reliable IS services.
- Be open to ideas from outside the IS area.

From this point on in the text, we will use the term CIO when describing the highest-level manager of information services.

Strategic Planning for the Enterprise

When a firm organizes its executives into an executive committee, this group invariably assumes a strategic planning responsibility for the entire firm. At a minimum, the executive committee consists of the president and the vice presidents of the firm's business areas. This committee determines the organization's strategic business plan.

Once a plan is in place, the executive committee monitors performance throughout the year and takes appropriate action, as needed. In some cases, the plan can be modified to reflect changing situations. Also, the committee can initiate decisions aimed at ensuring that the plan's goals are met.

Highlights in MIS

9/11—Not the End of Globalization[11]

Some parties, including a professor at the London School of Economics, concluded that the terrorist acts of September 11, 2001, marked the end of globalization. The assumed basis for this belief was that nations would build walls to keep everyone else out. Now, years later, this has still not occurred. In fact, the opposite is happening.

In building a case that 9/11 was a blow *for* globalization, one can begin with the observation that the terrorists were from those parts of the world that have been the least global, the least open, and the least integrated with the rest of the world—Afghanistan, Pakistan, Yemen, and Saudi Arabia. They are a product of those parts of the world that have not embraced globalization. At the opposite extreme are China and India, the two largest countries in the world, representing one-third of the world's population. These countries have taken a strong globalization stance, recognizing that opening up their boundaries is a way to lift their people from poverty.

India is a case study of the benefits of globalization. In Bangalore, India's Silicon Valley, thousands of young Indians have been able to achieve social mobility not through caste, land, or heredity, but through their technical expertise. These young adults work for software firms that develop software for the world's largest organizations.

What this means is that globalization is creating a generation of young people who are more interested in joining the world system than blowing it up.

Strategic Planning for Business Areas

When a firm's executives are fully committed to strategic planning, they see a need for each business area to develop its own strategic plan. The business area plans detail how those areas will support the enterprise as it works toward its strategic objectives.

One approach to business area strategic planning is for each area to establish its own plan independent of the others. However, such an approach does not ensure that the areas will work together well. Figure 2.6 shows how the various business areas should cooperate in their strategic planning processes. The arrows represent flows of information and influence.

During the past few years, the IS unit has probably devoted more attention to strategic planning than have most of the other business areas. The term used to describe this activity is *strategic planning for information resources (SPIR).*

THE SPIR APPROACH **Strategic planning for information resources (SPIR)** is the *concurrent* development of strategic plans for information services and the firm so that the firm's plan reflects the support to be provided by information services. The IS plan reflects future demands for systems support. Figure 2.7 illustrates the manner in which each planning process influences the other.

Figure 2.6 **The Business Areas Should Cooperate in Developing Their Strategic Plans**

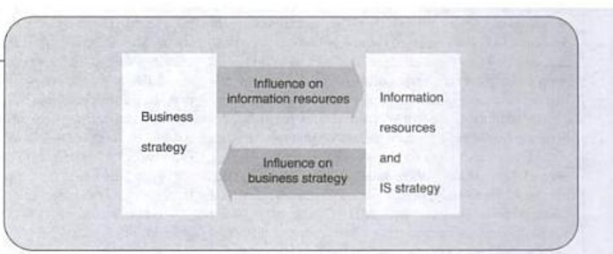


Figure 2.7 **Strategic Planning for Information Resources**

Source: William R. King, "Strategic Planning for Management Information," *Information Resources Management Journal*, Copyright © 1988, Idea Group Inc., www.idea-group.com. Reprinted with permission of the publisher.

Core Content of a Strategic Plan for Information Resources

Different organizations create different strategic plans for information resources, but two core topics should be included in every plan (see Figure 2.8):

- The objectives to be achieved by each category of systems during the time period covered by the plan
- The information resources necessary to meet the objectives

An Example Strategic Plan for Information Resources

Figure 2.9 is an example of an SPIR. It is a self-contained report that includes an executive summary, spells out the goals of the firm's information services unit, defines the scope of the IT services in three organizational units, and summarizes a work plan for implementing systems that will enable the firm to meet its IS goals.

This is a fairly modest SPIR. Such plans can go into considerably more detail, depending on the needs of the firm.

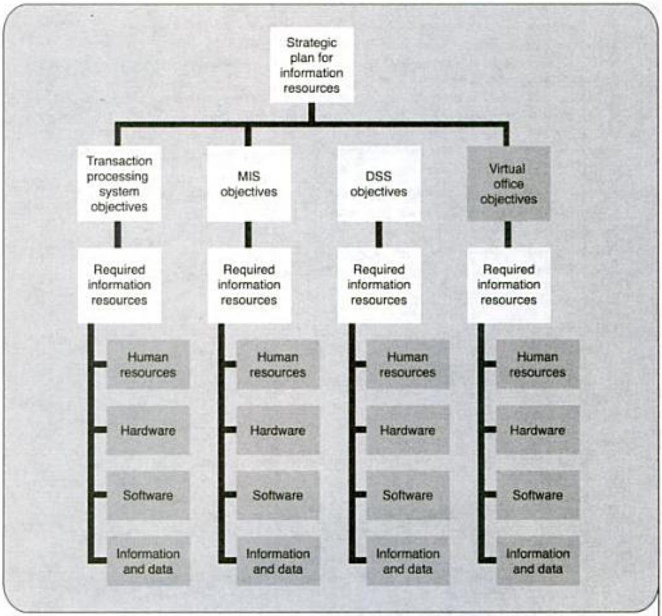


Figure 2.8 **Basic Framework of a Strategic Plan for Information Resources**

A SAMPLE STRATEGIC PLAN FOR INFORMATION RESOURCES

Executive Summary

The Strategic Plan for Information Resources (SPIR) has been developed to support the Strategic Business Plan by assembling and applying the information resources that are necessary to achieve the strategic objectives. The SPIR is organized into four sections:

- Information Technology Mission Statement
- Information Technology Goals
- Scope of Information Technology Services
- Information Technology Work Plan

Information Technology Mission Statement

The mission of information technology is to provide the highest quality of information services in a supportive environment that promotes creativity, personal growth, interaction, diversity, and professional development so that the firm can leverage technology to help attain corporate objectives.

Information Technology Goals

The information technology mission will be accomplished by pursuing the following goals:

1. Build a competitive advantage in use of information technology.
2. Develop information systems that meet the needs of employees on all organizational levels and also environmental business partners.
3. Stay current on evolving information technologies so as to meet the needs of our customers.
4. Maintain operational stability and reliability in all of our information resources—people, data, facilities, hardware, and software.
5. Maintain an ongoing education and training program designed to achieve efficient and effective use of all of the information resources.

Scope of Information Technology Services

Information technology services consist of the following:

Administrative Services

- Budgeting and fiscal review
- Human resources
- Management reporting
- Stockholder relations

Engineering Services

- Strategic planning and implementation
- Capacity planning
- Network design, maintenance, troubleshooting, and administration
- Server installations
- Contingency planning and backup

Technology Services

- Technical support in the form of help desk and call management services
- User education and training
- Database management services
- Document management services
- System development and support
- World Wide Web access
- Computer graphics
- Hardware troubleshooting, upgrading, and replacement
- Antivirus and firewall services
- Systems administration and maintenance
- Systems audits

Information Technology Work Plan

Seven key projects have been identified to be completed during the next 3 year period.

Prior to beginning each project, a project management mechanism will be developed specifying the following:

- Required tasks
- Person(s) or organizations responsible for completion of the tasks
- Estimated amount of time required for each task

All projects will be managed using Gantt charts and network diagrams.

All projects with the exception of the knowledge-based RFP system will be accomplished with internal IT resources. The RFP system will be designed and implemented by consultants.

The projects and their estimated person-months include the following. The first person listed is the project manager. Additional persons are support personnel.

Project	Project Manager(s)	Estimated Person-Months
1. Upgrade from Windows 95 to Windows XP.	Carolyn Wright	0.2
2. Replace GroupWise e-mail system with an integration of Microsoft's Digital Dashboard and the corporate relationship management system.	Danny Cho Carolyn Wright	3.0
3. Implement the Outlook Telephony Interface, enabling the retrieval of e-mail from any Touch Tone telephone by calling a toll-free number.	Danny Cho Carolyn Wright	2.5
4. Conduct Java benchmark comparison of Oracle9i Application Server, IBM WebSphere, and BEA WebLogic.	Danny Cho Carolyn Wright	2.0
5. Deploy departmental-based intranet for library services and human resources information and services.	Robin Birdsong Carolyn Wright	4.0
6. Implement a Web-based human resources information system.	Robin Birdsong Carolyn Wright	18.0
7. Implement a knowledge-based system to determine personnel, production facility, and material needs in response to RFPs.	Paul Sanchez KBS Consultants	96.0

Figure 2.9 **A Sample Strategic Plan for Information Resources**

Summary

Two types of resources flow through the general systems model of the firm: physical resources and virtual resources. A feedback mechanism enables the flow of virtual resources (data, information, and decisions) to connect the physical system with the control mechanism. The control mechanism consists of standards, management, and an information processor.

The environment of a business organization consists of suppliers, customers, the labor force, the financial community, stockholders and owners, competitors, the government, and the global community. All of these elements are connected to the firm by flows of physical and virtual resources. Both physical and virtual resources can be used to achieve a competitive advantage.

Physical resources flow from suppliers in the firm's environment to the firm and to its customers through a channel called the *supply chain*. This flow can be monitored electronically with data inputs in terminals located at each point along the chain. The management's ability to track the flow contributes to supply chain management.

Information systems can be used to provide the firm with competitive advantage. The leading proponent of competitive advantage is Michael Porter, who developed such concepts as value chains and value systems.

Information systems can achieve competitive advantage on three levels: strategic, tactical, and operational. Strategic planning level managers may seek strategic advantage by using information systems to differentiate the firm from its competition. Management control level (middle) managers may seek tactical advantage by directing the design of information systems that have common interfaces, such as Web browsers to access the Internet, enabling customers to have immediate access to information. Managers at the operational control (lower) level may seek operational advantage by developing information systems that offer complementary products as customers access their orders as a way to increase sales and support customer satisfaction at the same time. When all three levels work toward the same goal, the greatest profit potential can be achieved.

Firms that operate globally are called *multinational corporations (MNCs)*. These firms are facing increasing challenges from global competitors. When defined broadly, these global challengers include outsourcers that perform the same jobs that the firm performs in the original country. MNCs have can use information processing to achieve coordination, which offers some real advantages.

Firms that develop global information systems (GISs) do so in the face of great challenges. Some of these challenges are political, some are reflected in the form of cultural and communications barriers, some are due to technology, and others reveal themselves in the form of lack of support from subsidiary managers.

Knowledge management is the process of organizing a firm's information so that it can be captured, stored, processed, and used by decision makers. The firm's information resources consist of hardware, software, information specialists, users, facilities, databases, and information. Information delivered in the proper form has relevancy, accuracy, timeliness, and completeness.

Information technology changes rapidly; a consequence of this is that data gathered with older systems may not be compatible with current technology. Legacy systems are important because they can provide key historical data from which trends can be projected. Sometimes legacy systems cannot provide data in a digital format. If printouts of legacy data are available, they can be scanned and stored as digital images. Images are also important for Web sites.

The chief information officer (or chief technology officer) plays a key role in strategic planning for the enterprise, the business areas, and information resources. *Strategic planning for information resources (SPIR)* identifies the objectives that information systems are to achieve in the future and the information resources that will be required. The key to SPIR is to develop the strategic plan for the firm and for information resources at the same time.

KEY TERMS

interorganizational system (IOS)
multinational corporation (MNC)
global information system (GIS)
knowledge management
information overload
legacy systems
chief information officer (CIO), chief technology officer (CTO)

Key Concepts

- general systems model of the firm
- eight-element environmental model
- environmental resource flows
- supply chain
- competitive advantage
- value chain
- value system
- dimensions of information
- strategic planning for information resources (SPIR)

Questions

1. Why are standards provided to the information processor in the general systems model of the firm?
2. What are the eight environmental elements?
3. What provides the connections between the firm and its environment?
4. What is margin? How does it relate to competitive advantage?
5. What are Porter's primary value activities? What are his support value activities?
6. What is a value chain?
7. What is a value system?
8. How can a firm achieve strategic advantage from an information system that processes customer sales orders?
9. Explain how you would achieve a tactical advantage by tying a sales order system to a customer service system.
10. How would you design an information system to take advantage of operational opportunities?
11. What are the features that distinguish a multinational corporation (MNC)?
12. What is a source of uncertainty for an MNC?
13. How do the executives of an MNC respond to uncertainty?
14. What single word describes the key to achieving competitive advantage for an MNC?
15. Identify three ways that cultural and communication barriers can pose challenges in developing a global information system.
16. List the seven types of information resources. Place an asterisk next to those that are always located in information services.
17. Identify four dimensions of information that a manager should consider.
18. What is knowledge management?
19. Comment on the following statements:
    a. Information produced by the information processor should be free of errors.
    b. An information processor should provide the manager with as much information as possible.
20. Why should an organization capture data from its legacy systems?
21. How has the increased use of Web sites by firms increased the importance of image management?
22. Could a manager be a CIO even though he or she does not have that title? Explain.
23. Would a degree in business administration help a CIO? Explain.
24. What are the two basic elements that should be included in a strategic plan for information resources?

Topics for Discussion

1. The general systems model of the firm shows environmental data and information going to the information processor. Would there be any instances when data and information would flow directly to management?
2. How has the firm's collection of data across multiple information system platforms over many years (resulting in legacy systems) impacted the firm's ability to make decisions?
3. Where are the information resources located that are the subject of the strategic plan for information resources?
4. Is an MNC's GIS any different from the MIS of a domestic firm? Explain.

Problems

1. Write a paragraph describing how the general systems model of the firm applies to a manufacturing firm— say a small company that manufactures window air-conditioning units. Take each element in the model and resource flow and explain how it fits the manufacturer.
2. Repeat Problem 1, but this time apply the general systems model to describe a small law firm of three attorneys, a legal assistant, and a secretary. Each person has a desktop computer that is used for e-mail and Internet access.

Case Problem

Water Equipment Technology Company of Mexico

Water Equipment Technology Company (WETCO) is a Chicago-based manufacturer of industrial wastewater treatment systems. It has subsidiary operations around the world, including in Mexico. Emilio Chavez, the president of WETCO Mexico, has recently decided to implement SPIR. WETCO Mexico has a large computing operation, but it has never had a strategic information plan. Chavez sent e-mail messages to the other members of the executive committee, advising them of his intentions and asking for their ideas.

He has received replies from all three members of the committee—Benito Flores, the vice president of manufacturing and sales; Juan Alvarez, the vice president of finance; and Betty Wilson, the vice president of information systems. President Chavez reads the e-mail replies:

> FROM: BENITO I have given the subject of SPIR a great deal of thought since we discussed it in the last executive committee meeting. I would like to see manufacturing and sales develop our own strategic plan independently of the rest of the organization—including IS. We have a large amount of computing equipment that we use for our own applications and we are in the best position to know how to use it. There's no reason why another area should tell us how to use our information systems. Let Betty and Juan do the same thing—develop their own strategic plans as they see fit.

> FROM: JUAN Thanks for the opportunity to voice my views. I think that all three vice presidents should work together in developing a single strategic plan. We have a good working relationship and cooperate on many other activities. There is no reason why a joint approach to SPIR would not work.

> FROM: BETTY IS should prepare the strategic information resources plan for all of WETCO Mexico. Juan and Benito have enough responsibility in their own areas, so that they should not be asked to devote their valuable time to IS problems. Give IS the total strategic planning responsibility.

After Chavez has read all three replies, he leans back in his chair and says, "Our next executive committee meeting should really be exciting."

ASSIGNMENT

1. Explain the advantages and disadvantages of each of the three approaches given by the vice presidents.
2. Which approach should WETCO Mexico take and why?
3. How should the strategic plan for information systems at WETCO Mexico relate to other WETCO subsidiaries?

Case Problem

A Day Late, and Thousands of Dollars Short

You've been manager at Zymurgy Distributors for only 3 months. It is your first job out of college and a big break. One of the reasons you were hired was that you had worked as a student intern for Zymurgy for 2 years during the Wing Thing Fair. The Wing Thing was really a contest among restaurants, fast-food vendors, and people around town that think they have the best recipe for barbeque wings. You always thought the name was stupid, but you couldn't ignore the 30,000 to 35,000 people who attended every year.

Case Problem continued

Each year Zymurgy Distributors has the beer concession for the fair. The profits usually amount to about $2 per attendee. That's more profit in a weekend than your yearly salary plus bonus. You were in charge of deciding which beers to sell at the Wing Thing this year, and you were desperate to make the right decision.

How much light beer versus regular beer? How much of premium and specialty beers? How many beer stations should be located around the fair? Where should they be located? How many people should you hire to staff the beer stations? Lots of questions, and you were responsible for having the correct answers.

But this year, things were bad. Thirty-nine thousand people attended, a new record. But the profits from beer sales were less than $50,000. You should have made almost $80,000 in profits. You knew you did badly, and the visit from your boss just made it worse. You wouldn't get fired, but there wouldn't be a bonus this year. Even worse, your boss wants to take the Wing Thing away from you next year.

To keep the Wing Thing, you'll have to analyze what you did wrong, explain to your boss how you'd fix the problem, and make a great plan for next year. You've been thinking about what went wrong, and you have plenty of ideas.

One thing was that you were unsure of yourself, and so you hired a marketing consultant to make recommendations. That report was mailed to you and arrived the Monday after the Wing Thing weekend. Several pieces of information were in the report. One prediction was that 10 percent of the people at the fair would bring a pet. That was interesting, but it didn't help to predict beer sales.

Age and gender have been two good predictors in the past. People aged 21 to 25 tend to purchase less-expensive beers. Those older than 25 tend to purchase more-expensive beers, which have a higher profit margin. Women tend to drink more light beer.

Weather is also a predictor. The warmer the day, the more beer that will be sold. The weather forecast for the next two days has always been pretty accurate, so you could have used that information to predict beer sales.

Assignment

1. Information should be timely, accurate, complete, and relevant. Discuss the information you received from the consultant in these terms. Be as specific as you can. Don't just say something was wrong, explain why it was wrong and what could have made it right.
2. Assume your boss lets you run Wing Thing beer sales next year. Also assume that you want to collect information during Wing Thing that will help predict beer sales for the following year. What information should you collect? How is the information timely, accurate, relevant, and complete?

Notes

[1]Richard J. Hopeman, *Systems Analysis and Operations Management* (Columbus, OH: Charles E. Merrill, 1969), 79–103.
[2]For more information on competitive advantage, see Michael E. Porter, "How Competitive Forces Shape Strategy," *Harvard Business Review* 57 (March–April 1979), 137–145 and Michael E. Porter, *Competitive Advantage* (New York: Free Press, 1985).
[3]Abe De Ramos, "The China Syndrome," *CFO* (October 2003), 74–77.
[4]Jim Middlemiss, "Riga to Manila to Mumbai," *Wall Street & Technology* (December 2004), 39–40.
[5]William G. Egelhoff, "Information-Processing Theory and the Multinational Enterprise," *Journal of International Business Studies* 22(3) (1991), 343.
[6]Jahanjir Karimi and Benn R. Konsynski, "Globalization and Information Management Strategies," *Journal of Management Information Systems* 7(4) (Spring 1991), 7.
[7]Based on Karimi and Konsynski, 9.
[8]Karimi and Konsynski, 18.
[9]For the classic description of information value, see Robert W. Zmud, "An Empirical Investigation of the Dimensionality of the Concept of Information," *Decision Sciences* 9 (April 1978), 187–195.
[10]Jeff Moad, "Why You Should Be Making IS Allies," *Datamation* 36 (May 1, 1990), 26ff.
[11]Based on Thomas L. Friedman, "Globalization, Alive and Well," *New York Times*, September 22, 2002, WK-13.

Chapter 3

Using Information Technology to Engage in Electronic Commerce

Learning Objectives

After studying this chapter, you should

- Recognize the importance and advantages of electronic commerce.
- Understand how electronic commerce is being blended into everyday business processes.
- Understand the difference between business-to-business electronic commerce and business-to-consumer electronic commerce.
- Be familiar with examples of good business-to-business electronic commerce and business-to-consumer electronic commerce.
- Know the role that interorganizational systems, the Internet, and the World Wide Web play in electronic commerce.
- Know what factors influence the adoption of interorganizational systems.
- Recognize the movement from electronic data interchange to various Web-standard data exchange practices.
- Understand why many firms choose to have both a virtual store and a physical store.

Introduction

Electronic commerce, also called e-commerce, is the use of communications networks and computers to accomplish business processes. The popular view is that e-commerce is the use of the Internet and computers with Web browsers to buy and sell products. Although this is true, it is only a small part of e-commerce. Most e-commerce occurs between businesses, not between businesses and consumers.

Businesses have been exchanging data electronically for years in their efforts to make operations more efficient. The communications lines they use are often leased from telephone companies (AT&T, MCI, and others), and special communications hardware is used at each end of the line to facilitate the data transfer between the businesses' computers. Standard data exchange formats have been established so that any business that wants to exchange data electronically can do so. The business-to-business exchange of data supports e-commerce.

Business-to-consumer e-commerce is a more recent development, and it seems that everyone is surfing the Web to buy books and music. Business-to-consumer sales are very small compared to business-to-business sales, but they still represent an opportunity for great growth and profit. A firm must understand the role that the Internet and the World Wide Web play in providing the infrastructure required for e-commerce to exist.

Although e-commerce is currently considered to be a distinct type of commerce, soon it will be just another facet of everyday business transactions. The telephone, invented in 1876, can give us some perspective. Like the Internet and Web, the practical applications for the phone only occurred once it was widely used. Businesses used phones first; they were simply too expensive to have in every household. Once the phone became inexpensive, it became widely popular, and businesses began to devise ways for customers to use phones to interact for sales and service. Businesses grow and change in order to take advantage of technology, whether that technology is the phone or the World Wide Web.

ELECTRONIC COMMERCE

Some people define electronic commerce (also called e-commerce) very narrowly. Their narrow definition would only include business transactions that deal with customers and suppliers, connecting their respective computers via the Internet. Such a narrow definition implies that only those transactions crossing the boundary of the firm can be classified as e-commerce. If a transaction stays within the boundaries of the firm, these people would call it an *electronic business transaction*. Delineating internal versus external transactions as electronic business or electronic commerce is not very helpful, because most people consider electronic business and electronic commerce to be the same thing.

We take the broad view of e-commerce, that it can facilitate the internal as well as external operations of the firm. With this view, the terms *electronic business* and *electric commerce* are synonyms. Many of the firm's operations are internal—they are performed within the boundaries of the firm by the business areas of finance, human resources, information services, manufacturing, marketing, and others. Businesses have become physically dispersed, with plants located across a country, or even across the world. Also, business areas themselves act as suppliers or customers to other areas of the organization. Under our broad definition, a business transaction that uses network access, computer-based systems, and a Web browser interface qualifies as **electronic commerce (e-commerce).**

E-Commerce Beyond the Boundary of the Firm

It is useful to distinguish between the two types of e-commerce that occur with entities beyond the firm's boundary. **Business-to-consumer (B2C) e-commerce** refers to transactions between a business and the final consumer of the product; **business-to-business (B2B) e-commerce** refers to transactions between businesses in which neither one is the final consumer. For example, in the distribution chain from manufacturer to wholesaler to retail store to consumer, all transactions from one entity to the next are B2B until the transactions between the retail store and consumer, which are B2C.

B2B transactions involve relatively few people, generally those in the information systems groups of the companies affected. The people involved in B2B transactions are usually highly trained in the use of information systems and familiar with the business processes affected by the transactions. Because the transactions are between businesses, the number of B2B transactions may be relatively small but the dollar values quite high. A single transaction between a manufacturer and wholesaler may involve thousands of units of a product and millions of dollars.

B2C transactions require fundamental design differences. Customers may not have expertise with information technology, so the Web site must offer instructions and help. If the consumer is communicating with the business over a slow telephone connection, the number of displayed images may need to be reduced. Payment arrangements need to be incorporated into B2C systems (B2B systems typically capture payment information in systems separate from the electronic commerce system). All of these differences combine to require that B2C sites have fast download times, instructions for site navigation, shopping carts that can be loaded and unloaded before the actual purchase, and methods for storing a user profile (address, credit card numbers, and such). Sites such as WWW.1800FLOWERS.COM, WWW.HOMEDEPOT.COM, WWW.USPS.GOV (U.S. Postal Service) have been recognized by many Web site reviewers as being well designed for B2C transactions.

Government is increasingly participating in **electronic government** (sometimes referred to as **e-gov**). Residents of North Carolina can link to the Click@DMV site on its Department of Motor Vehicles Web page (WWW.DMV.DOT.STATE.NC.US) to renew their license plates. New York City (WWW.NYC.GOV) allows citizens to pay parking fines and other charges online. The Internal Revenue Service (WWW.IRS.GOV) provides a wide variety of services, from free filing of income tax forms to online classes to help people prepare their taxes. As you think about e-commerce, a broad view is required to take advantage of the new possibilities.

Information services play a pivotal and changing role in the firm's relation to the environment. In the past, customers were not the main concern for information services; however, customers are becoming increasingly more important and will become a primary focus for the majority of firms in the future. All transaction interfaces from customer to supplier to government and others are being impacted by the widespread acceptance of e-commerce.

Anticipated Benefits from E-Commerce

Firms engage in e-commerce in order to achieve improvements throughout the organization. These improvements are expected to result in three main benefits:

- Improved customer service before, during, and after the sale
- Improved relationships with suppliers and the financial community
- Increased economic return on stockholder and owner investments

These benefits contribute to the firm's financial stability and enable it to better compete in a business world that is employing more and more computer technology. Note that increased profit was not listed as an anticipated benefit from e-commerce. Profits are the result of an organization accomplishing its goals; e-commerce is a powerful supporting tool that can help an organization accomplish its goals.

E-Commerce Constraints

In a 1996 survey, 60 percent of responding firms indicated that they had not implemented e-commerce and had no plans to do so within the next 3 years.[1] Even as of 2004, the U.S. Department of Commerce reported that only 2.3 percent of all fourth-quarter retail sales were executed as e-commerce. Firms that had implemented systems were using them primarily for transactions with suppliers and customers (at about the 90% level), and the main processes dealt with purchase orders, transfers of payment, and invoices. When asked the reasons for their caution, the firms listed three constraints in the following order:

- High costs
- Security concerns
- Immature or unavailable software

Each of these constraints is being challenged as information technology and systems become increasingly popular. The cost of computing resources inevitably decreases. As described in Chapter 1, Moore's Law predicts the doubling of computer power every 18 months. As power doubles every 18 months, the cost of e-commerce decreases.

Security is an issue for B2C and B2B transactions. Firms commonly use secure telecommunications networks that are monitored constantly for unauthorized access. These networks have proven to be very secure for large firms. Companies such as VeriSign (WWW.VERISIGN.COM) have added security measures that bring a high level of trust to Internet transactions. With present encryption technologies and secure Web sites, there is little reason to fear unauthorized access of consumer information. Consumers are much more likely to throw out sensitive information, such as credit card numbers, in the garbage than to have their information compromised on the Internet.

Even though the 2004 percentage of e-commerce retail sales was small compared to wholesale sales (B2B), the dollar figure was over $69 billion. The Department of Commerce reports that the percentage of retail sales that were electronic commerce (B2C) rose from 0.7 percent in the fourth quarter of 1999 to 2.3 percent by the fourth quarter of 2004.

Scope of E-Commerce

As you read this section, understand that e-commerce is dynamic and the scope of its influence can change in just a few months. You should visit WWW.CENSUS.GOV and link to the E-Stats Web page to find the most current e-commerce figures.

E-commerce accounted for almost $1.7 trillion of economic activity in the United States during 2003. It has achieved an annual growth rate of over 15 percent each year for the last 5 years. This growth rate may slow at some point, but it is likely to continue for the next several years. The amount of economic impact varies from industry to industry, but approximately 94 percent of e-commerce is B2B, leaving 6 percent for B2C.

More than 21 percent of sales from U.S. manufacturing plants ($843 billion) in 2003 were the result of e-commerce. Almost 17 percent of sales from wholesalers ($730 billion) were e-commerce. The percentage of e-commerce conducted in the retail sales sector is about 2 percent. It is only because of the high dollar amount of retail sales, compared to other segments of industry, that B2C accounted for more than $69 billion of U.S. electronic commerce activity in 2004.

E-commerce is particularly important to certain segments of the U.S. economy simply because it accounts for a large percentage of sales dollars in those segments. Table 3.1 shows some examples that highlight the impact of e-commerce in certain areas. Note the increased percentage of e-commerce sales as a part of total U.S. sales from 2000 to 2003. Electronic commerce has matured to the point where it has become vital to the economy, and its importance continues to grow.

Table 3.1

Percentage of E-Commerce Sales Versus Total Sales in Selected Industry Segments

	E-Commerce % of Total Sales	
Industry Segment	2000	2003
Apparel manufacturing	20%	24%
Transportation equipment manufacturing	46%	50%
Motor vehicle wholesaling	20%	25%
Drug wholesaling	40%	49%
Travel and reservation retail	24%	25%

Source: U.S. Census Bureau (WWW.CENSUS.GOV).

The Path to E-Commerce

When a firm determines that the anticipated benefits outweigh the costs and decides to implement e-commerce, it understands that implementation could be a large task. The strategic business plan embodies the commitment to use e-commerce to achieve competitive advantage. The firm first gathers business intelligence so that it can understand the potential role that each of the environmental elements will play.

BUSINESS INTELLIGENCE

Engaging in e-commerce is not a decision that should be made without first gaining knowledge about the firm and its relationships with its customers, competitors, suppliers, and other external entities. **Business intelligence (BI)** is the activity of gathering information about the elements in the environment that interact with the firm.

External Databases

Companies do not have to gather environmental information themselves. A number of important commercial databases are available that provide information on virtually any subject. LEXIS-NEXIS (WWW.LEXISNEXIS.COM) provides legal, financial, and government information from a wide variety of sources. For a fee, the firm will provide analyses of the information requested. DIALOG (WWW.DIALOG.COM) covers news, business, government, and other sources. DowJones.com (WWW.DOWJONES.COM) offers a wide variety of information on financial matters. Global eXchange Services (WWW.GXS.COM) sells services aimed at integrating electronic transactions for global supply chains. These are only a few of the companies that provide data and data services to firms.

Firms use these databases to gather business intelligence because it is faster and less expensive than trying to research a wide array of information sources. Reuters (WWW.REUTERS.COM) can search and analyze news media for subjects of concern to a firm much more effectively and efficiently than most firms can do for themselves. The value that these commercial databases bring to the firm is their wide knowledge of information sources.

ThomasNet (WWW.THOMASNET.COM) is an example of a database that provides a great deal of information for free and also offers services for a fee. Thomas Register provides an index of over 170,000 U.S. and Canadian manufacturers and can be used to obtain information on products and their suppliers. All records provide the name, address, telephone number, and industry code for companies, as well as brand names, trademarks, and descriptions of the company's products. Also, many records provide such information as the number of employees and executive names and titles.

Government databases are another important source of information. The Library of Congress (WWW.LOC.GOV) offers a wide range of topics for researchers in many fields. The Census Bureau (WWW.CENSUS.GOV) contains a treasure trove of information concerning the demographics of people in the United States. Information is provided in a number of formats and can be as general as an industry or as specific as a county. The Bureau of Labor Statistics (WWW.BLS.GOV) has information about inflation, wages, international data, and much more. Firms can tap into the Securities and Exchange Commission records (WWW.SEC.GOV) to view various required financial filings via the EDGAR databases. EDGAR is the Electronic Data Gathering, Analysis, and Retrieval system. The federal government and many state governments are under a mandate to make public information available via the Internet.

Firms are becoming more inclined to initiate their own external searches for market intelligence. External searches have been helped by the fact that more and more firms are placing information about themselves on the Web. Search engines are the most popular means for people to obtain information available from the Web.

Search Engines

A **search engine** is a special computer program that asks a user for a word or group of words to be found. The program then searches the content of Web sites on the Internet to see if the word or words are on any Web sites. For example, you might use a search engine to find the availability of a motel room (Figure 3.1). For our purposes, the specialized programs that index the sites and create directories of site categories will be considered subparts of the search engine. Customers interested in B2C e-commerce frequently begin their transaction by using search engines to locate possible vendors. Search engines estimate the usefulness of the sites that contain the words and present the requestor with the addresses of Web sites and documents that contain the chosen words.

Yahoo! (WWW.YAHOO.COM), Excite (WWW.EXCITE.COM), AltaVista (WWW.ALTAVISTA.COM), MSN (WWW.MSN.COM), Google (WWW.GOOGLE.COM), and AskJeeves (WWW.ASKJEEVES.COM) are just a few of the popular search engine sites and portals available to users to search Web-accessible information. The sites are organized in a manner that makes them easy to use. Searches can be simple or use advanced features to look for complex combinations of key words. There is no charge for the use of these search

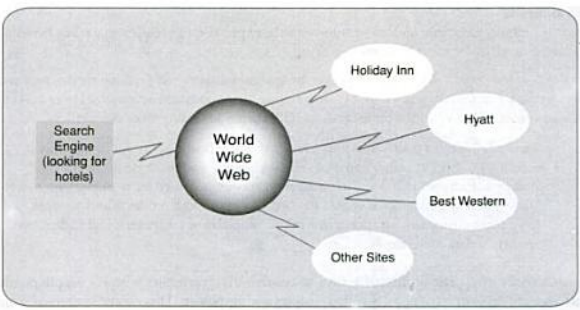


Figure 3.1 **Search Engines Explore the Internet to Find Sites Containing Information You Seek**

engines. However, some organizations pay the search engine company to display their products first in the search list results.

The first step toward achieving e-commerce is to gain a thorough understanding of the environment in which the commerce will be conducted. Much of this intelligence can be gathered by noncomputer means, such as through surveys, observations, informal conversations, field reports, newspaper and trade paper articles, and so on. However, computer databases make it possible to scan large volumes of information quickly, easily, and thoroughly.

E-COMMERCE STRATEGY AND INTERORGANIZATIONAL SYSTEMS

The problem of determining the best e-commerce strategy has several possible solutions. However, the strategy that is most often mentioned is one in which the elements are linked with transmissions of electronic data. The name given to this strategy is the *interorganizational system (IOS)*. A term frequently used with IOS is **EDI**, which stands for **electronic data interchange**. The two terms are often used interchangeably, but when a distinction is drawn, EDI is considered to be a subset of an interorganizational system.[2] Electronic data interchange is one means for achieving an interorganizational system. Extranets, similar to the Internet but limited to selected and trusted business partners, are beginning to take the place of EDI in some organizations.

THE INTERORGANIZATIONAL SYSTEM

We have recognized how the firm can establish electronic linkages with other firms to create an **interorganizational system (IOS)** so that all of the firms work together as a coordinated unit, achieving benefits that each could not achieve alone. The participating firms are called **trading partners, business partners,** or a **business alliance.** In Chapter 1, we recognized that the MIS database contains data from both the transaction processing system and the firm's environment. Some of the environmental data comes from the IOS trading partners.

E-commerce is fundamental to interorganizational systems. The rapid and secure exchange of vast amounts of data is critical to support the transactions of the organizations that use information technology to compete. Without communication networks and computer processing capabilities, organizations would be virtual islands of production, with little ability to account for the services and products that create their vitality. E-commerce and EDI are the highways of interorganizational systems.

IOS Benefits

Trading partners enter into an IOS venture with the expectation of realizing two key benefits: comparative efficiency and bargaining power.[3]

COMPARATIVE EFFICIENCY By joining an IOS, the trading partners can produce their goods and services with greater efficiency and, in turn, provide their goods and services at lower costs to their customers. This gives the partners in an IOS a price advantage over competitors.

- *Internal efficiency* consists of improvements in the firm's own operations, thus enabling the firm to gather and analyze data quickly and make decisions faster.
- *Interorganizational efficiency* includes improvements gained by working with other firms. These improvements enable the firms to offer more products and services, serve more customers, shift certain work to suppliers or customers, and gather environmental data more easily.

BARGAINING POWER The ability of a firm to resolve disagreements with its suppliers and customers to its own advantage is called its **bargaining power**. This power is derived from three basic areas: by offering unique product features, by reducing search-related costs, and by increasing switching costs.

- **Unique product features.** The electronic linkages of the IOS enable firms to offer better service to their customers in the form of easier ordering, quicker shipments, and faster response times to requests for information. This better service becomes a feature of the firm's products, making them more appealing than similar products offered by competitors.
- **Reduced search-related costs.** By belonging to an IOS, a firm can reduce the "shopping" costs that its customers incur in searching for a supplier, identifying alternative products, and getting the lowest price. Because the firm is a customer of its suppliers, the firm can realize the same shopping-cost reductions when ordering from its suppliers.
- **Increased switching costs.** A firm would like to make it expensive, in cost and/or convenience, for customers to switch to a competitor. An IOS achieves this benefit by providing customers with such information resources as hardware, software, and data communications channels that would have to be replaced if products were purchased from another firm.

Vendor stock replenishment is a special type of IOS in that the customer trusts the supplier enough to allow the supplier to access its computer-based inventory system. The supplier can initiate the replenishment process by electronically monitoring the firm's inventory levels. This will require the firm to grant database access to the supplier. For protection, the firm may make a copy of some less-sensitive parts of the database and give the supplier access only to that copy instead of the firm's entire database system.

EDI

EDI consists of direct computer-to-computer transmissions of data in a machine-readable, structured format. Although EDI is an older technology, it is important because it facilitates the vast majority of B2B e-commerce. The transmissions enable data to be transmitted and received without rekeying.[4] The communications lines, communications hardware, and support services for EDI are generally provided by telephone companies (AT&T, MCI, and others).

When the services that operate and manage the communications line (sometimes called the circuit) are provided in addition to the line itself, it is referred to as a **value-added network (VAN)**. Some argue that a VAN is simply an EDI that has been outsourced to a vendor. That view is simplistic. The vendor that provides a VAN provides expertise concerning what communications line is required, how it should be supported, opportunities and threats from the line, and a host of other valuable insights.

EDI is the dominant implementation of an IOS. More than two-thirds of e-commerce is conducted using EDI, compared to other IOS alternatives.[5] Although more costly (it can cost $5,000 to $30,000 to connect for a year with a single vendor or customer) and cumbersome than newer IOS communication systems, EDI is still the leading method.

Extranet

Extranets are another means of establishing an IOS. They enable the sharing of sensitive computer-based information with other firms using information technology commonly associated with the Internet. Firms use extranets in collaboration with trusted suppliers and large customers. Security and privacy are serious concerns, so extranets are generally secured behind a firewall. A firewall permits only authorized users to access the firm's information. Extranets allow for the same type of data exchange as EDI but incorporate the common protocols and communication networks of the Internet so that firms do not have to use the more costly software and communications hardware associated with EDI.

The cost of equipment to establish EDI may be more than the organization is willing to pay. For companies that want low costs and still have the speed of the Internet, extranets may be a good solution. Extranets use the Internet for communications and standard Web browsers for navigating to sites and exchanging data. Encryption methods that keep messages secret are easy to use. One method, *Pretty Good Privacy*, typically known as *PGP* (WWW.PGP.COM), is extremely secure, easy to use, and inexpensive.

Proactive and Reactive Business Partners

When a firm decides to adopt an IOS, it can do so in a proactive or reactive way. The IOS sponsor typically takes a proactive approach, stimulating interest in the IOS and encouraging participation in the network. The participants typically respond in a reactive manner, accepting or rejecting the sponsor's offer to adopt IOS.

In Table 3.1, you learned that half of transportation equipment manufacturing sales are accomplished via e-commerce. This reflects the fact that the large automobile manufacturers have adopted EDI systems for acquiring supplies from vendors. The manufacturers took a proactive approach, and their suppliers were forced to react by either adopting the EDI system or losing the customer.

Adoption Influences

In a 1995 *Decision Sciences* article, MIS professors G. Premkumar and K. Ramamurthy studied the factors that can influence the decision to adopt an IOS. They identified four factors that determine whether the firm will be proactive or reactive.[6]

Figure 3.2 illustrates the influences. Two are internal and two are environmental.

- **Competitive pressure.** When the firm is in a poor position in relation to its competitors or when industry or trade associations provide strong pressure, the firm will adopt an IOS, such as EDI, in a reactive way. Later researchers[7] have suggested that competitive pressure is the most frequent reason firms adopt EDI.
- **Exercised power.** When a firm can exert power over other members of the IOS, it will be proactive in adopting IOS. Some firms are so powerful that they can demand that their trading partners either use IOS or take their business elsewhere.

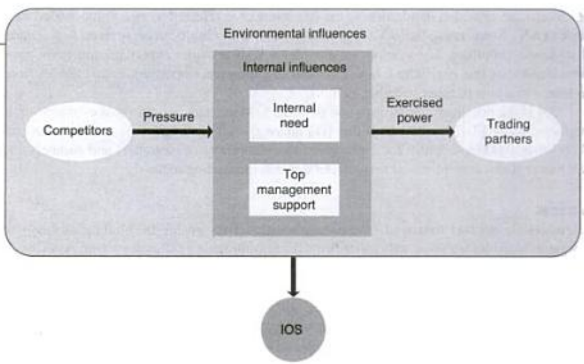


Figure 3.2 **Internal and Environmental Influences on IOS Adoption**

- **Internal need.** When the firm sees that participation in the IOS is a way to improve its own operations, it will approach IOS in a proactive manner.
- **Top management support.** Regardless of whether the firm acts in a proactive or reactive manner, top management support always influences the decision. When significant benefits from IOS are intangible, top management support is critical.

Indirect IOS Benefits

Some of the benefits of such interorganizational systems as EDI and extranets are derived directly from the technology. These are the *direct benefits* of reduced data entry errors, lower costs, and increased operational efficiency. *Indirect benefits* include the increased ability to compete, improved relationships with trading partners, and better customer service.[8]

Figure 3.3 shows this relationship between direct and indirect benefits.

- **Reduced errors.** By not having to key incoming data into the system, data entry errors can be reduced. A study by EDI Group Ltd. found that the error rate can decline from 10 percent of the data entered without EDI to less than 5 percent with EDI.[9]
- **Lower costs.** Cost reductions can be realized by eliminating redundant steps, eliminating paper documents, and reducing the manual labor of routing paper documents through the organization.[10] Cost reductions for all types of documents can range from $1.30 to $5.50 per document, and they can be even higher for purchase orders. The cost of preparing a purchase order in a conventional way can range from $75 to $350. With an IOS, the cost can be reduced to as low as $5. These cost savings outweigh the hardware, software, and personnel costs of EDI. The costs of extranets are very small compared to EDI; therefore, their transaction cost reductions are even greater.

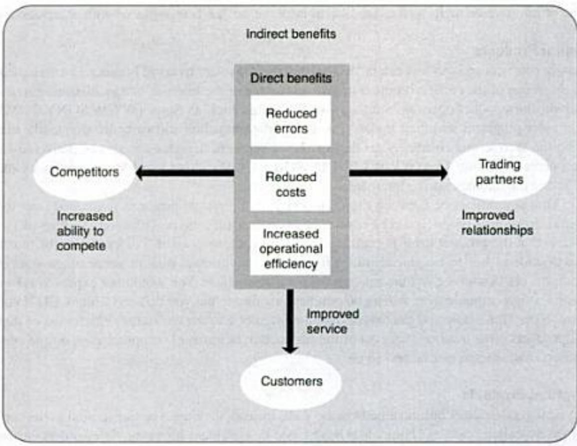


Figure 3.3 **IOS Direct and Indirect Benefits**

- **Increased operational efficiency.** The IOS benefits of internal and interorganizational efficiency are made possible to a large extent by EDI and extranets. By replacing paper documents in each of the flows with electronics, many opportunities for improved efficiency are possible.
- **Increased ability to compete.** The combination of reduced costs and unique product features made possible by the IOS make it exceedingly difficult for competitors to match the firm's product in terms of cost and service offerings.
- **Improved relationships with trading partners.** By entering into a formal system with trading partners, good relations come about naturally—as a by-product of the business activity. All participants realize that they are working toward the same ends and gain mutual advantage.
- **Improved customer service.** The speed of electronic communications enables the firm to respond quickly to customer orders and requests for service. When combined with the reduced error rate and the ease with which the customer can shop for products, the result is improved customer service.

The direct benefits, often measurable in dollars, can provide a solid economic justification for using an IOS. The indirect benefits, however, can well be viewed by top management as the most important reasons for approving an IOS strategy.

B2C STRATEGIES FOR E-COMMERCE

B2B e-commerce dwarfs the dollar value of B2C e-commerce. Only about 6 percent of e-commerce dollars are generated by B2C. So, why is it important to understand business strategies for B2C e-commerce?

Two reasons are that more products and services are becoming available for digital delivery and more consumers are overcoming their reluctance to purchase using the Web. Higher communications speeds for computers in homes has made delivery of digital products practical. Fear of information theft, such as credit card information, has been replaced with acceptance.

Digital Products

Certain products and services can be delivered to the consumer over the Internet. Entertainment has been one of the earliest products to take advantage of the Internet. Songs, albums, movies, and similar products can be bought from Web sites such as Sony (WWW.SONY.COM). Computer programs and their updates, such as virus protection software, are frequently sold using the Web so that customers get the very latest versions. Services can also be delivered via the Internet. Lending Tree (WWW.LENDINGTREE.COM) allows users to get mortgages and refinance their homes via the Internet.

One key difference between digital products and physical products purchased over the Web is that digital products can be consumed as soon as they are downloaded. Another difference is that the product itself is transferred to the purchaser's asset. For example, the music you download has to be placed into a file or onto a compact disk or some other storage medium. The consumer, not the seller, pays for that medium. You would not expect to take a blank CD into a music store when you purchase an album, but you do need a blank CD if you want to play the music you purchased over the Internet on your car stereo. Purchasers of digital products incur a substantial cost of the transaction in terms of computer cost, online connection fees, storage media, and so on.

Physical Products

Physical goods cannot be consumed via the Web; instead, they must be transported to the consumer. So-called "catalog" companies have faced this problem for years. Sales orders can be taken over the Web, but shipment has to be arranged. The U.S. Postal Service provides several classes of delivery depending upon the size and weight of the item being mailed. Parcel post is frequently the least expensive mode provided, but it generally takes the longest time for delivery.

The growth of private mail/shipping companies such as FedEx and UPS has indirectly aided retail e-commerce. These companies, and others, provide a number of alternative shipment methods for different prices. Urgent shipments can be delivered to the consumer within 24 hours from virtually any point in the world. Slower-than-standard methods can be offered that let the consumer reduce shipping costs. Firms engaging in e-commerce can simply use a private mail/shipping company instead of providing the service themselves.

Most of the popular mail/shipping companies offer a service that complements a firm's B2C activity. A shipping number is assigned to each package generated by the sale. Customers can use the shipper's Web site to track the progress of the package from the firm until its delivery to their doorstep. If the firm were to use a vague "3 to 10 working days" shipment time required between purchase and delivery, it could be a barrier to B2C sales. With access to the shipper's Web site, the consumer has more information and control over the delivery. Online tracking can make B2C sales attractive.

Virtual Versus Hybrid Sales

Virtual sales are those made by a firm that does not operate a physical storefront. With virtual sales, there is no store in which a customer can enter and purchase the product. **Hybrid sales** occur when firms have both a physical storefront and a Web site where customers can purchase products. Both of these retail sales strategies need to inform the customer of product cost and features, arrange customer payments, and achieve product delivery.

A difficulty faced by firms offering virtual sales is providing necessary product information without overwhelming the customer. Another impediment is that images are large files, and communicating them from the Web site to the customer's computer takes time. The problem can be lessened by restricting the number of images displayed until the customers have focused their search to a relatively few choices. The Web site of Office Depot (WWW.OFFICEDEPOT.COM) is a good example of this strategy (see Figure 3.4).

Figure 3.4 **Home Page for Office Depot**

Source: © Office Depot, Inc. Used with permission.

Office Depot's opening Web page has few images but provides a number of links to pages that search for different classes of products. If the customer wishes to purchase paper for a laser printer, it may take five successive mouse clicks to view the product, but each page loads very quickly. The customer can go directly to the product by simply typing the request into a search box and letting the site search for the product. The fewer mouse clicks required to get to the product the better, but it is far more important to be fast than to reduce mouse clicks.

Product comparison in a physical store is aided by a salesperson. A Web site can provide the same information and, if well designed, much more. Once the customer has navigated to the desired product, the Web site can provide links to similar products, reviews of the product by experts and other customers, images and physical descriptions of the product, and other information. Some customers appreciate a "human touch" in the sales process, but Web sites can provide far more information than most salespeople.

Payment over the Internet has suffered from bad press. Although credit card information used to make a purchase over the Internet can be stolen, the risk is very small, much smaller than other credit card uses. When you use your credit card to pay your restaurant bill, did the waiter copy the card number for personal use later? You throw out old credit card statements and carbon copies in the trash; did the janitor who emptied the trash keep your credit information? You phone a florist for flowers and give your credit card number; how do you know that the clerk will not charge more flowers to that card? These scenarios have proven to be much more conducive to credit card fraud than using the Internet. Coupled with the efforts of credit card companies and firms such as VeriSign (WWW.VERISIGN.COM), which certify secure data transfer, credit card payments over the Internet to reputable firms are probably one of the most secure means of payment.

An increasing popular way of paying for purchases is PayPal.[11] eBay owns PayPal (WWW.PAYPAL.COM) and uses it for payments of purchases at its auction site. However, eBay accounts for a small percentage of e-commerce, and PayPal wants a larger audience. PayPal can be used to send money from a bank account or credit card to anyone with an e-mail address in 45 countries. People can use it to send money to anyone with a PayPal account, and there are over 70 million PayPal accounts worldwide. eBay is planning on extending PayPal into China by the end of 2005.[12] As of mid-2005, eBay had more than 11 million registered users and expected to add 4 million new users per year. eBay believes China could be its second largest market (after the United States) within 5 to 10 years.

Virtual sales are used most frequently when the firm either cannot construct a physical storefront or finds a physical storefront to be economically unjustified. For example, 1-800-flowers (WWW.1800FLOWERS.COM) does not have physical stores, because its business model is to provide flowers across the United States and a few other countries. It would be costly to build florist shops everywhere it wishes to do business, especially when florist shops already exist in those places. Instead, 1-800-flowers acts as a broker to gather and solicit orders that are in turn given to local florists to prepare and deliver.

Hybrid sales are sometimes called *brick-and-click* operations. Most firms have a storefront because it is necessary to their business plans. Office Depot had storefronts before sales over the Internet were possible. Also, the stores act as showcases for products ranging from desks and chairs to pencils and paper. Some products, such as chairs, are more likely to be sold when customers can physically interact with them.

At the same time, Office Depot wants to offer its customers the convenience of shopping over the Web. Products such as printer paper do not require physical contact before a purchase. The time saved by not having to drive to the store is an added convenience for the customer. A number of organizations offer free delivery when the purchase is more than a certain dollar amount. Although free delivery seems like a one-sided inducement to the customer, it actually helps Office Depot.

B2C sales mean that Office Depot can keep less inventory at its stores. Less inventory means that less floor space at the store is devoted to inventory, and therefore more floor space is available for sales. Office Depot can build smaller stores (which reduces its cost of operations) when new stores are needed. At existing stores, more floor space can be devoted to actively selling products, which in turn yields higher sales at the stores.

Electronic Government

Governments can also benefit from e-commerce. One example is Polk County in Florida. The Polk County Tax Collector's Office used an online service to auction property tax certificates in 2005.[13] Tax certificates are a way for county governments to collect unpaid property taxes. An individual (or company) bids for a lien on a property having overdue taxes, pays the taxes, and collects the taxes from the owner, plus an amount of interest for the taxes owed. The county government determines when the certificate purchaser can claim the property if the overdue taxes are never paid. If the property owner pays the unpaid taxes and satisfies the tax certificate, then the owner keeps the property.

Why is this important? Typically, very few people are aware of tax certificates, so their auctions bring little revenue to the county government. Polk County had over 23,000 parcels of property with overdue taxes in 2005. With the online certificate sale, 15,460 certificates were auctioned, raising over $12 million for the county. E-commerce can benefit governments as well as public and private organizations.

THE NEXT STEP FOR E-COMMERCE

The challenge to e-commerce is more than the types of goods offered; it is the technology behind commerce. Many consumers are more comfortable with cell phones than with computer keyboards. Businesspeople are looking for wireless connections everywhere that cell phone service is available.

Mobile Commerce

Mobile commerce (m-commerce) is the use of cell phones and personal digital assistants (PDAs) to engage in wireless e-commerce. It is expected to be a $40 billion per year global industry by 2009.[14] As cellular telephone technology has evolved through analog and digital generations, the term **third generation (3G) telecommunications** has been loosely applied to data-capable wireless technologies. One of the reasons m-commerce has received little attention in the United States is that although European companies began purchasing license fees for 3G in 2000, the first U.S. company to offer such voice/data service was AT&T Wireless in 2004.[15]

Early applications of m-commerce have included news services, financial information alerts/transactions, and banking. Movie ticket purchases and parking payments are two applications gaining acceptance in Europe and Japan. Retail sales have seen slow growth, but there appears to be growing acceptance for m-commerce payments at fast-food restaurants.

Japan, the first country in the world to have a 3G carrier, has become an m-commerce leader.[16] The Japanese telecommunications carrier NTT DoCoMo, Inc. has purchased more than 30 percent of Sumitomo Mitsui Financial Group's credit card business. The purchase represents a move to financial services, because almost all Japanese adults have a cell phone and the cell phones can be used to conduct financial transactions. In contrast, only about 40 percent of the adult U.S. population has a cell phone.

Business-Class Wireless Everywhere

Wireless Internet hot spots are adequate for casual and personal Web use, but checking e-mail in a Starbucks coffee shop is not sufficient for business professionals. Hot spots are generally created using a wired connection (for its high communications speed) and then broadcast via a wireless access point to an area approximately 100 meters from the access point. The dependence on a wired communications link and the small distance covered by a wireless access point make pervasive wireless access impossible. Sufficiently fast wireless communication over the same communications carrier as cell phones would enable **business-class wireless computing** virtually everywhere.

Verizon offers a broadband access plan that runs at speeds from 400 to 700 kilobits per second,[17] about one-quarter to one-half the speed of wireless communications one is likely to receive at a Starbucks' hot spot. However, the service is available in many metropolitan areas and it not limited to the nearest access point for a wired network.

Such freedom and speed comes at a cost. First, users must buy a cellular card for their laptops to access the cellular communications signal. Novatel, Kyocera, and other manufacturers offer cards that cost from $50 to $75. Second, monthly network access of charges may be $80 per month or more. However, when you consider that the cost of cable modem access to high-speed data connections for your home costs $50 or more, the extra cost may be small compared to not needing the cable modem and being able to access the Internet from anywhere in your city.

USING THE INTERNET

E-commerce would not be possible without a network to connect customers with organizations. The origin of the **Internet** can be traced to 1969, when the U.S. government established a network called ARPANET. Efforts beginning in 1989 led to what is known today as the World Wide Web.[18] ARPANET demonstrated that it was possible for a person to request and receive data over a complex network that included many computers and network connections.

The World Wide Web

In 1989, Tim Berners-Lee, a computer scientist working at CERN, the European Particle Physics Laboratory, came up with a better way for physicists to communicate. The idea was to use **hypertext**—electronic documents that are linked together. As conceived by Berners-Lee, physicists would be able to click on words or phrases displayed on their computer screens and retrieve the hypertext. The idea became a reality in mid-1992 in the form of the World Wide Web. It is also possible to transmit **hypermedia**—multimedia consisting of text, graphics, audio, and video—over the World Wide Web. The **World Wide Web**, also called the **Web** and **WWW**, is information accessible via the Internet whereby hypermedia documents (computer files) are stored and then retrieved by means of a unique addressing scheme.

The Internet provides the network architecture, and the Web provides the method for storing and retrieving its documents. The terms *Internet* and *World Wide Web* are frequently used as if they mean the same thing. This is not really a problem, but you should remember that the Internet is the global communications network that connects millions of computers. The World Wide Web is the collection of computers acting as content servers that host documents formatted to enable the viewing of text, graphics, and audio as well as allowing linkages to other documents on the Web. These servers and the users that access

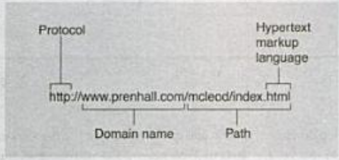


Figure 3.5 **World Wide Web Terminology**

them are connected by the Internet. Here we list some common WWW terms. Figure 3.5 illustrates how the protocol, domain name, and path are used.

- **Web site.** A collection of Web pages (generally located on a single computer) linked to the Internet that hosts hypermedia files that can be accessed from any other computer on the network by means of hypertext links.
- **Hypertext link.** A pointer consisting of text or a graphic that is used to access hypertext stored at any Web site address.
- **Web page.** A hypermedia file stored at a unique Website address.
- **Home page.** The first page of a Web site. Other pages at the site can be reached from the home page.
- **Browser.** Software that is designed to find and read files on the Internet that are written in hypertext markup language (HTML).
- **Universal Resource Locator (URL).** The unique address of a Web page.
- **Protocol.** A set of standards that govern the communication of data. HTTP (HyperText Transport Protocol) is the protocol for hypertext. Another common protocol on the Web is FTP (file transfer protocol). In a URL, the protocol name is followed by a colon (:) and two slashes (//).
- **Domain name.** The address of the Web site where a Web page is stored.
- **Path.** A certain directory/subdirectory and file at the Web site. HTML (or HTM) is the suffix for the program code that designates hypertext files.

Netscape Navigator was an early browser for viewing Web content that is still used. The most popular Internet browser is Microsoft's Internet Explorer. In 2005, about 89 percent of U.S. users accessed the Web via Internet Explorer.[19] The Netscape browser has not been a serious competitor to Internet Explorer for some years, but it still enjoys some use. A free browser product from Mozilla (WWW.MOZILLA.ORG) called FireFox has a market share of almost 7 percent and is growing in popularity. FireFox was named one of the 100 best products by *PC World Magazine* in its July 2005 issue.

File Transfer Protocol With the file transfer protocol (FTP), users can copy files onto their computer from any Web site. Many FTP sites offer transfer of data in one direction only. Some firms host FTP sites off their main premises to provide files containing product information, software updates, news releases, and other information. Sensitive data are not stored at the off-premises site, and large volumes of Internet traffic do not hinder the firm's operations because the firm's computer resources are physically separated from the off-premises site.

Highlights in MIS

GET YOUR RED HOT WEB DOMAIN HERE

Have you ever considered getting your own Web domain? You can; it's easy and not very expensive. Many businesses can create a Web address for you and host your Web site. NetworkSolutions operates a domain name site at WWW.NETWORKSOLUTIONS.COM. Even Yahoo! (WWW.YAHOO.COM) offers domains as part of its Yahoo! Small Business service. You can enter the domain name you want to register and see if it is available.

Once you pay the fee to register your domain name, the company performing the registration process will ask you some questions about the domain name. Do you want to host Web pages? Do you want an e-mail address to the domain name? What about selling products via the Web site? All of these options are available for a monthly or annual fee.

Web domains are not just for large businesses; you can have your own personal Web domain. Go to WWW.NET-WORKSOLUTIONS.COM and see if your name is registered yet. If not, claim it, and you can start your own e-commerce business right now!

CYBERSPACE AND THE INFORMATION SUPERHIGHWAY

Two other terms are also associated with the Internet and the Web—*cyberspace* and the *information superhighway*. The term **cyberspace** was coined in 1984, when author William Gibson used it in his book *Neuromancer*[20] to describe a society that had become a slave to technology. Today, cyberspace means the world of the Internet and the World Wide Web.

The term **information superhighway** is used in the same context, but there is not complete agreement concerning its eventual impact on society. The term is normally used to describe a positive force that gives everyone access to the wealth of information that exists in our modern society. Dissenters, however, fear that the information superhighway will be exploited by businesses as a way to push their wares on an unsuspecting and naïve public and not as a means of communicating worthwhile information.[21]

The superhighway analogy is very useful. Although the road does not have a per use charge, fees are paid via taxes and other regulatory surcharges. Governments pour billions of tax dollars into the Internet infrastructure each year. The user traveling the information superhighway needs a computer in much the same way that a highway user needs a vehicle. Both involve training costs and offer numerous benefits.

Internet Standards

A major reason why the Internet and the Web have been received with open arms by computer users around the world is because the two work together as a single system that can be used from any computer platform. A user at a Dell PC or a Sun workstation can retrieve the same Web page as can a user with an Apple PowerBook. To make this possible, everyone contributing to the Internet and Web architecture must follow the same rules.

Two organizations have assumed roles of leadership in establishing Internet and Web standards. The Internet Society was formed in 1992 to promote commercial Internet use and has delegated responsibility for Internet standards to the IETF (Internet Engineering Task Force). Web standards come from the World Wide Web Consortium (W3C).

BUSINESS APPLICATIONS OF THE INTERNET

Simply put, the Internet can be used for any business application that involves data communication, including communications inside the firm as well as with the environment. Unlike proprietary networks, the Internet can be used with any computer platform without making a special effort. This is an important advantage. Also, the Web protocol and browsers are much easier to learn and use than the query languages that are normally used to retrieve information from databases. The Internet makes it possible to transmit a wider variety of media than many firms handle over their conventional networks.

The phenomenal growth of the number of Internet host sites has made the Internet a source of information that cannot be ignored. The Internet Software Consortium (WWW.ISC.ORG) has charted the rise in domain names from just a handful in the early 1990s to over 353 million in July 2005. These new domains represent possible new customers, suppliers, and business partners.

All areas of the firm can use the Internet, but one important area is supply chain management. In particular, supply chain management for health-care providers is attracting attention because of the rapidly rising costs for medical services. Retailing applications are also important and provide a good counterpoint to the B2B example of supply chain management.

E-Commerce and Hospital Supply Chain Management

Health care is primarily concerned with improving patients' health outcomes and serving patients' needs. Every health-care dollar spent on ordering medical supplies and interacting with vendors is a dollar that will not be spent on direct patient care. Hospitals must order supplies, and it is critical to patient service that the correct medical supplies be available for patient needs.

Hospitals already conduct most of their purchasing online. The economic benefits of online purchasing as a replacement of manual purchasing are only about 5 percent compared to the benefits realized from fewer purchase order errors, better product standardization, improved contract compliance, and other managerial concerns.[22]

Hospitals can use a standard protocol such as the Internet to replace EDI, which requires a separate connection between each vendor and the hospital. Cap Gemini Ernst & Young has outlined a clinical commerce exchange that is used over the Internet instead of EDI.[23] For every 15 vendors that can be moved from EDI to the commerce exchange, it is estimated that a hospital will save $100,000 in information technology costs. Because hospitals have hundreds, sometimes thousands, of vendors, the savings are substantial.

Global Healthcare Exchange (WWW.GHX.COM) helps hospitals implement clinical commerce exchanges. It helped one client, the Cape Fear Valley Health System in North Carolina, to establish a new commerce exchange connection with a vendor in an hour. In the past, it normally took the hospital several weeks to connect to a new vendor using EDI.

The speed and ease of connection to a new vendor for e-commerce is a strong incentive for change. However, the experiences of Cape Fear Valley System point to important managerial changes. First, under the previous system the purchaser tended to buy whatever the doctor or other clinician wanted, regardless of price. Time was not available to analyze the purchase request and find a less expensive substitute or a less costly vendor. The speed and efficiency of the commerce exchange allows the purchaser to seek out cost-saving alternatives. Second, the high cost of establishing an EDI ($5,000 to $30,000) keeps smaller vendors from being able to engage in e-commerce with hospitals. By joining the commerce exchange, which only requires Internet access, smaller vendors can compete with larger vendors. The result is lower purchasing costs for the hospital, and ultimately a lower cost to the patient.

Retailing Applications

The Web business application most familiar to the general public is retailing. Most of the large retail chains have established a Web presence. JCPenney opened its Web site in 1994, offering about 350 items. Wal-Mart opened its Web storefront in mid-1996 in hopes of targeting its products at more upscale customers than those who normally shop its stores.

Many retailers make their home pages directly accessible through the Web. Some prefer to combine with other stores in a collection sites called a **virtual mall** in hopes that a single mall name will be easier to recognize and find than their individual store name. A virtual mall may take a traditional mall view (i.e., collections of different types of stores). CyberTown Mall (WWW.CYBERTOWN.COM/MALLDIR.HTML) and 24Hour-Mall (WWW.24HOUR-MALL.COM) are two such collections of stores.

Some retailing operations are changing in the face of Web information. Autobytel.com, Inc. (WWW.AUTOBYTEL.COM) provides customers with a car inventory, financing, insurance, and other services. Amazon.com (WWW.AMAZON.COM) has grown from selling just books to offering music, videos, electronics, and even toys and games. Many goods and services once thought to be beyond the realm of the Web are finding an electronic connection.

Statistics on online purchases are interesting.[24] A 2005 study found that 70 percent of all adult shoppers in the United States use the Internet as an information source to help in their shopping, and 32 percent listed the Internet as their primary information source. Over 70 percent of Internet users make an online purchase during the year. The trend is for more and more online shopping. A 2003 survey from Harris Interactive (WWW.HARRIS-INTERACTIVE.COM) found that consumers aged 8 to 21 spent over 14 percent of their income online.

SUGGESTIONS FOR SUCCESSFUL INTERNET USE

Although the Web is relatively young, firms have identified keys to its successful use. The executives who make the strategic decisions in the firm should consider the following tips and assign responsibility for achieving these goals to the CIO and to the IS area:[25]

1. **Make sure your Web site is robust.** When you commit to a Web project, be prepared to go beyond the Web pages and link your databases to the Web by means of your applications. This will enable you to integrate the Web into your computer-based information system rather than to simply use it as a way to provide and obtain information. Integration with the firm's database is important.
2. **Make sure your browser and database structure are both flexible and intuitive.** This will enable you to handle future growth and provide users with quick access.
3. **Emphasize content.** Don't get so caught up in artwork, audio, and video that you overlook the real objective of providing information. When it comes to a robust content, it is hard to beat a narrative and tabular display.
4. **Update often.** Entice business partners and browsing customers to keep coming back. A daily update is not too often for many firms.
5. **Look beyond customers.** Use the Internet to improve communications with all of the elements of the firm's environment—except competitors, of course.
6. **Target content to specific users' needs.** Encourage viewers to register their names, addresses, and interests at your site. You can use this information to tailor your pages to users' needs.
7. **Make the interface intuitive.** Do everything you can to make the Web site as fast and efficient as possible. Use graphics sparingly, because they slow retrieval. Remember, design the interface from the perspective of the user, not that of the firm.
8. **Be in the right Web location.** If your Web site isn't generating as much traffic as you would like, consider linking it to other sites, such as those of trade associations and industry and professional organizations.

9. **Create a sense of community.** Involve users in your site by providing an opportunity for them to submit suggestions, complaints, and so on. Make use of interactive Web features such as bulletin board systems and e-mail.
10. **Get help if you need it.** Web work is highly specialized. Rather than develop an internal expertise yourself, it may make more sense to outsource your firm's Web development and maintenance to professionals.

These suggestions make the point that taking full advantage of the Web is more than just creating a Web page. A good Web presence requires more effort than most non-Web-related projects.

FUTURE IMPACT OF THE INTERNET ON BUSINESS

Internet users are a diverse group. Many are young, but older people (with more income to spend) have a substantial impact on the economic outlook for e-commerce. Even when money is not spent online directly, customers frequently use the Web to research their purchases before going to the store. About one in five who research a product on the Web make the purchase online; the other four go to the store to make the purchase.

E-commerce is growing in both the United States and worldwide. The United States has seen a sustained annual growth rate in e-commerce of almost 15 percent over the last 5 years. The overwhelming amount of e-commerce occurs between businesses. B2B e-commerce may not seem to impact consumers, but the lower prices and better customer service made available by B2B is what makes the business organization competitive.

The question yet to be answered is the impact that 3G phone service will have on B2C e-commerce. The United States has been slow to take advantage of this service, and Europe and especially Japan are moving ahead with innovative business applications. 3G cellular service enables business-class computing to be carried out anywhere in most metropolitan areas. It will also enable consumers with 3G phones to make purchases using their phone as a debit card or credit card. Even faster 4G phones have been tested in China and Japan and should soon be available.

By 2008, cellular phones should be used routinely for small purchases; they could even rival the current usage of debit cards. The bigger challenge will be their use for the purchase of expensive items. Japan is taking the lead position in the use of cellular phones for financial transactions. As the U.S. catches up with wider use of 3G cellular service, such as Verizon's "broadband" cellular service, it could become a world leader in e-commerce over cellular devices.

Summary

Firms typically implement e-commerce with the intention of improving customer service, solidifying relationships with suppliers and the financial community, and increasing the return on stockholder and owner investments.

B2B e-commerce is a significant and growing force for business transactions. In some industry segments, such as transportation equipment manufacturing and drug wholesaling, about half of all sales are accomplished via e-commerce. B2C e-commerce sales comprise only about 2 percent of all retail sales, but still represented over $69 billion of retail sales in 2004.

Commercial databases can provide a rich source of secondary data. Firms would be wise to take advantage of public and not-for-profit data sources. Determination of the best databases is influenced by both the business area of the firm and its responsibilities.

An IOS consists of trading partners. Firms enter into an IOS to gain benefits of comparative efficiency, which exists in both an internal and an interorganizational form, and to increase their bargaining power, which is derived from unique product features, reduced search-related costs, and increased switching costs.

One way to achieve an IOS is through electronic data interchange with the most common data flows connecting the firm to its suppliers. Firms are stimulated to adopt EDI because of competitive pressure, exercised power, internal need, and top management support. Direct EDI benefits of reduced errors, lower costs, and increased operational efficiency produce such indirect benefits as increased ability to compete, improved relationships with trading partners, and better customer service. EDI is the most frequent method of achieving an IOS, but Web-based methods are becoming more popular.

The data communications network that links trading partners can be achieved with direct connectivity whereby common carriers provide the circuits. The Internet is a global network of networks. Its navigation is facilitated by the World Wide Web. Although the Internet and Web offer great potential, there is opportunity for misuse.

Firms are using the Internet in many ways. Extranets are important because they allow trusted users beyond the organization's boundaries to access programs and data on the organization's network. Another application is called the intranet, and it consists of transmissions within the firm. Intranets use the networks within the firm and browser software associated with the Web but with the security of only allowing access to users inside the organization's network. Hospitals can use the Internet to conduct their purchasing online, using a clinical commerce exchange. Retailers can use the Internet to promote their products and, in some cases, deliver digital products to customers. Virtually any organization can use the Internet to support its processes.

Key Terms

electronic commerce (e-commerce)
business-to-consumer (B2C) e-commerce
business-to-business (B2B) e-commerce
electronic government (e-gov)
business intelligence (BI)
search engine
electronic data interchange (EDI)
trading partner
business partner
business alliance
bargaining power
vendor stock replenishment
value-added network (VAN)
extranet
virtual sale
hybrid sale
mobile commerce (m-commerce)
third generation (3G) telecommunications
business-class wireless computing
Internet
hypertext
hypermedia
World Wide Web (Web, WWW)
browser
universal resource locator (URL)
hypertext link
cyberspace
information superhighway
virtual mall

Key Concepts

- business-to-business (B2B) e-commerce
- business-to-consumer (B2B) e-commerce
- interorganizational system (IOS)
- digital products
- physical products

Questions

1. In terms of dollar impact, which is more important, B2B or B2C e-commerce? By how much?
2. Should the design of a B2B site be from the customer's point of view or from the firm's? Explain.
3. Should the design of a B2C site be from the customer's point of view or the firm's? Explain.
4. List three anticipated benefits of e-commerce.
5. Identify three reasons why firms were initially hesitant to engage in e-commerce.
6. What was the dollar amount of e-commerce in the United States in 2003? If past trends continue, what would your projection be for 2010?
7. Why would a firm use an external database instead of gathering business intelligence itself?
8. Which external database provides information about U.S. and Canadian manufacturers?
9. Identify the two basic benefits of an interorganizational system.
10. What is vendor stock replenishment?
11. Explain electronic data interchange.
12. Give three examples of digital products.
13. What costs do purchasers of digital products incur in their transactions?
14. Why would a firm sell products from both a physical storefront and a Web site?
15. What is mobile commerce?
16. How is Japan expanding business applications for customers who have a 3G cell phones?
17. What is the difference between the Internet and the World Wide Web?
18. How do hospitals use e-commerce for supply chain management?
19. What is a virtual mall?
20. Why should firms limit the number of images on a B2C Web site?
21. Where could you go on the Web to acquire a domain name for a Web site?

Topics for Discussion

1. What is the current percentage of retail sales generated by B2C e-commerce? How much do you think it will increase in the next 10 years?
2. Why will e-commerce become simply one more part of everyday business practice?
3. How will the increased speed and reduced costs of Internet communications affect e-commerce?
4. How secure are online credit card transactions compared to other credit card transactions, such as purchasing a meal at a restaurant?

Problems

1. Go to the U.S. Census Bureau's Web page for e-commerce statistics at WWW.CENSUS.GOV/E-STATS (it is very important that all letters in the URL are lowercase). Graph the quarterly e-commerce retail sales for all of the quarterly data you can find. Based on these figures, what do you believe will be the total e-commerce retail sales in the fourth quarter of 2010?
2. Financial information about many businesses can be found on the Securities and Exchange Commission Web site (WWW.SEC.GOV). If you are gathering business intelligence about a competitor, this may be a good place to start. Go to the SEC Web site and access EDGAR (Electronic Data Gathering, Analysis, and Retrieval) to search corporate financial filings. What was Microsoft's (ticker symbol MSFT) annual net income according to its most recent Form 10-K?

Case Problem

A Buck More

You, Jackie Goudet, are the leader of a team of three entrepreneurial students on your campus. You're an information systems major and working your way through school. Last year, when you were a junior, you assembled the team to form a company to buy back used books from students. The plan was simple, offer one dollar more for a used book than the campus bookstore would pay.

You found that two points of exit from the campus accounted for almost 90 percent of all traffic by cars, bikes, and pedestrians. Lucky for you, there was a large parking lot at both points of exit. Students were lured to your site because it was so convenient as they left classes (or final exams) and because you offered a dollar more for used books.

It was easy to make money. First, the campus bookstore didn't mind that you bought books from students; repurchasing used texts was a headache for the bookstore. Second, your costs were low because you didn't have to keep a store open all year and pay employees; you simply rented two trucks and parked one in each of the parking lots where students passed as they exited campus. Third, the student government association loaned you the money to buy back texts and you repaid the loan (without interest) when you sold the texts to the used text wholesaler. Because students considered your services a great convenience and because you offered better prices to students, the student government association was happy to help.

Your book buy-back operations gave you insight into a new and possibly more profitable venture: one-stop shopping. Students sell their old books and buy the books needed for the next semester at the same time. You're a senior this year, and when you graduate you and your friends have a chance to turn a small-time operation into a substantial profit-making business.

You ask your two fellow entrepreneurs to come to a meeting where you will lay out your ideas. Allen Turning is the computer expert. He designed the Web pages and information systems that have supported the book-buying operations. He is an information systems major and is experienced with databases, programming, Web-based information systems, and communications. Allen is a senior and will graduate with you.

Nina Cerro, also a senior, is an operations management major. She knows about logistics and designing systems operations. She was crucial in lining up the text wholesalers who purchased books from you, and she arranged favorable shipping terms to transport the texts to the wholesalers. Because transporting texts was a major cost of the operation, her expertise was valuable. Notes of the meeting follow.

JACKIE: *Hey, guys. I've got a good idea but it's a little risky. We've done pretty good with the book setup the last three semesters. We made over $20,000 profit each semester after we paid off everybody. Not bad for some part-time work.*

ALLEN: *That's true, but there was a lot of work behind the scenes. I mean, we had to get all the programs running. The Web pages looked great but they took a long time to make them*

Case Problem continued

come out the way we wanted. And we got lucky that the student government let us run the pages off their Web site so we didn't have to pay somebody for hosting.

And the cost of the laptops isn't included. I mean, well, we used our own stuff and just plugged into the truck's lighter outlet for power to run the laptops. We had a bunch of costs, they just were hidden. We just used our own computer stuff and we borrowed money and Web server space from the student government.

JACKIE: *You're right, we didn't have to pay for all the stuff we used. But the students made a lot more than $20,000; we bought back 35,000 to 40,000 books each semester. And student government didn't pay a penny, they were just using a computer that had been given to them. Before we helped them, they didn't even have their own Web page.*

So listen to my whole idea. We can form a real company and buy back books as our job. I mean, we've all gotten pretty good offers to work in companies but don't we really want to work for ourselves? Be our own bosses? We can do this, we just need to expand. I figure that if we work enough campuses we can make a lot more money than if we work for a company. But we need to sell books, not just buy them. And we need to really capitalize on convenience. The way I see it, we need to make a Web shopping cart like you see on a lot of Web sites. Allen, remember the Web hosting sites at WWW.INTELLI-NET.COM and WWW.PRECISIONWEB.NET that we learned about? Either one of them could host the site for us.

ALLEN: *Yeah. We even made some shopping-cart applications in one of our classes.*

NINA: *I get it, it's a kind of "shop-before-you-stop" idea. They tell us what books they are going to sell and what books they want to buy. When they drive by to sell their books, the books they want to purchase will be waiting to be picked up. Count me in!*

ASSIGNMENT

1. Assume you would buy back approximately 35,000 books at each campus each semester and sell about the same number. Your profits have been a little more than 60 cents per book (excluding the costs talked about in the case), so assume you'll also make about 60 cents when you sell a book. How many books need to be bought or sold in order to make a $100,000 profit?
2. Visit the WWW.INTELLI-NET.COM and WWW.PRECISIONWEB.NET sites and determine how much it would cost to have one of them host your Web page for e-commerce. You will still have students just walk up to your truck, but you expect most students will use the Web site to tell you the books they want to sell and buy.
3. This is not a virtual store, and you don't have a digital product. Explain how renting trucks and using a Web page for e-commerce substantially decreases your costs of doing business and increases your profits.

Case Problem

Less Painful Parking Tickets

You leave your apartment with plenty of time to arrive early for class. As you drive toward campus, you discover that a delivery truck has broken down and traffic is a mess. Now you are going to be late.

Everybody at school seems to already be parked, and you can't find a parking space. Time is running out, and you don't want to be late to class. You find an open spot, but there is a sign that reads "reserved for faculty." You say to yourself, "It's an open space and I might as well take it."

The good news is that you made it to class on time. The bad news is that when you return to your car it has a parking ticket. However, the university is having a contest to see who can design the best e-commerce solution for students to pay their parking fines. All of the contest winner's parking fines will be forgiven.

You've studied this problem in class. It is a classic B2C e-commerce problem. You know that the system will need information from the ticket, information from the person paying the fine, and a method for paying the fine. A Web page hosted by the university can capture the information needed. You can make this work.

Assignment

1. Determine what information from the ticket (such as ticket number) needs to be entered into the Web page. Determine what information from you needs to be entered—such as your student I.D., vehicle license number, parking decal number, and other information.
2. Create a drawing of what the Web screen should look like for capturing the information about the ticket and about you.
3. How would you verify the accuracy of the information that you enter onto the Web page?
4. How would you electronically pay the fine for the parking ticket?

Notes

[1]Alden M. Hayashi, "Is Corporate America Ready for E-Commerce?" *Datamation* 42 (October 1996), 54–56.
[2]G. Premkumar, K. Ramamurthy, and Sree Nilakanta, "Implementation of Electronic Data Interchange: An Innovation Diffusion Perspective," *Journal of Management Information Systems* 11 (Fall 1994), 158.
[3]H. Russell Johnston and Michael R. Vitale, "Creating Competitive Advantage with Interorganizational Information Systems," *MIS Quarterly* 12 (June 1988), 156–158.
[4]This definition paraphrases one in G. Premkumar and K. Ramamurthy, "The Role of Interorganizational and Organizational Factors on the Decision Mode for Adoption of Interorganizational Systems," *Decision Sciences* 26 (May–June 1995), 305.
[5]United States Department of Commerce E-Stats, May 11, 2005, available at WWW.CENSUS.GOV, link to "E-Stats."
[6]G. Premkumar and K. Ramamurthy, "The Role of Interorganizational and Organizational Factors on the Decision Mode for Adoption of Interorganizational Systems," *Decision Sciences* 26 (May–June 1995), 303–336.
[7]Anitesh Barua and Byungtae Lee, "An Economic Analysis of the Introduction of an Electronic Data Interchange System," *Information Systems Research* 8(4) (December 1997), 397–422.
[8]This classification of benefits comes from Charalambos L. Iacovou, Izak Benbasat, and Albert S. Dexter, "Electronic Data Interchange and Small Organizations: Adoption and Impact of Technology," *MIS Quarterly* 19 (December 1995), 469. The authors have generalized the benefits described in the article from the narrow EDI focus to the wider interorganizational systems focus.
[9]Karen D. Schwartz, "The Electronic Antidote to Slow Business," *Enterprise Reengineering* 3 (May 1996), 18.
[10]The following costs come from Schwartz, 18–19.
[11]Robert D. Hof, "PayPal Spreads Its Wings," *BusinessWeek*, May 23, 2005, 105.
[12]Doug Young, "eBay Plans PayPal Launch in China," *Reuters (Shanghai)*, July 7, 2005 (wire feed).
[13]Kyle Kennedy, "Polk's Tax Sale Goes Online This Year," *Knight Ridder Tribune Business News*, May 17, 2005 (wire feed).
[14]Aroonim Bhuyan, "The Whys and Hows of M-Commerce," *Knight Ridder Tribune Business News*, April 8, 2005 (wire feed).
[15]Jennifer M. DeFeo, "First U.S. 3G Voice/Data," *PC Magazine*, July 20, 2004.
[16]Ian Rowley, "$5,000? Put It on My Cell," *BusinessWeek*, June 6, 2005, 56.

[17]David Pogue, "Beyond Wi-Fi: Laptop Heaven But At a Price," *NYTimes.com*, June 23, 2005, C-1.
[18]For more details on Internet history, see Brad Schultz, "The Evolution of ARPANET," *Datamation* 34 (August 1, 1988), 71–74; and Robert E. Kahn, "The Role of Government in the Evolution of the Internet," *Communications of the ACM* 37 (August 1994), 15–19.
[19]WebSideStory, May 10, 2005, available at WWW.WEBSIDESTORY.COM/PRODUCTS/WEB-ANALYTICS/DATAINSIGHTS/SPOTLIGHT/05-10-2005.HTML.
[20]William Gibson, *Neuromancer* (New York: Ace Science Fiction Books, 1984), 51.
[21]See Jeff Johnson, "The Information Superhighway: A Worst-Case Scenario," *Communications of the ACM* 39 (February 1996), 15–17.
[22]Richard A. Perrin and Karen Conway, "Achieving the Promise of eCommerce (Part I of II)," *Healthcare Purchasing News* (April 2005), 58. (Also available at WWW.HPNONLINE.COM.
[23]David Mish and Richard Phillips, "e-Commerce Healthcare Supply Chain: The Clinical Commerce Exchange™ Model," *Cap Gemini*, Ernst & Young U.S. LLC, December 2004, 35–59.
[24]Shop.org, available at WWW.SHOP.ORG/LEARN/STATS_USSHOP_GENERAL.ASP.
[25]Vance McCarthy, "The Web: Open for Business," *Datamation* 41 (December 1, 1995), 32.

Chapter 4

System Users and Developers

Learning Objectives

After studying this chapter, you should

- Know that the organizational context for systems development and use is changing from a physical to a virtual structure.
- Know who the information specialists are and how they can be integrated into an information services organization.
- Be alert to new directions that the information services organization may take.
- Understand what is meant by "end-user computing" and why it came about.
- Appreciate that users, especially those with an end-user computing capability, are a valuable information resource.
- Know the benefits and risks of end-user computing.
- Be aware of the types of knowledge and skill that are important to systems development.
- Appreciate the value of managing the knowledge held by information specialists and users.
- Recognize the benefits and risks of the virtual office and the virtual organization.

Introduction

The firm's information specialists include systems analysts, database administrators, Webmasters, network specialists, programmers, and operators. These specialists were initially located in an information services unit, but later they began to be allocated to business areas. As firms evaluated the advantages and disadvantages of centralized and decentralized IS organizations, partner, platform, and scalable models were identified, with special networks added to ensure that objectives are met.

The firm should manage the knowledge represented by its information resources. This knowledge resides in systems, software, databases, and in the specialized knowledge held by computer users and information specialists.

As the first information systems were developed by information specialists, users were not expected (or permitted) to do more than specify their information needs. When user demand for more computer support exploded, specialists were unable to keep up. As a result, users sought to develop their own systems—a phenomenon called end-user computing. Today, many users do much of their own systems development, but some still rely completely on information specialists. Other users are capable of doing much of their own developmental work and rely on specialists for consulting services. A firm whose users are capable of participating in end-user computing enjoys an advantage over those whose users do not. End-user computing can produce real benefits, but it is not without its risks.

Regardless of whether systems are developed by information specialists or users, certain knowledge and skills are required. The knowledge represents material that can be learned, and the skills consist of natural capabilities, enhanced by education and experience.

The first office-automation applications were designed for use chiefly by secretarial and clerical personnel, but their use soon spread to managerial and professional ranks. These applications made possible a concept called the virtual office*, whereby workers do not have to be physically located at the office site in order to perform work. The virtual office movement, triggered by telecommuting and hoteling, became so popular that it was expanded to the concept of a virtual organization.*

Systems development is an evolving activity. The organizational setting and the roles played by the users and information specialists are changing continually.

THE BUSINESS ORGANIZATION

Information systems are developed and used in business organizations. In Chapter 1, you learned that managers can be found on all levels and in all business areas of the firm. The basic business areas of the firm are finance, human resources, information services, manufacturing, and marketing.

Information Systems Support for the Organization

Information systems have been developed to support the entire organization, executives, and the business areas. This framework is illustrated in Figure 4.1. The MIS is intended to meet the general information needs of managers throughout the firm; the executive information system is designed for use by the firm's strategic level managers; and the five information systems on the lower level of the figure address the unique information needs of those business areas.

These information systems are tailored to the physical organization, that is, the way that the physical resources (human, material, machine, and money) are allocated to the various

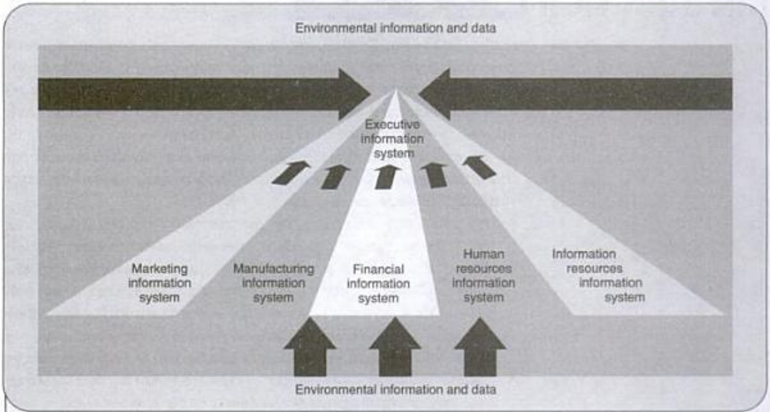


Figure 4.1
Information Systems Are Developed to Support Organizational Levels and Areas

physical areas of the firm—global subsidiaries, divisions, regions, districts, branches, and so on. Innovations in information technology have made it possible for many of the firm's activities to be conducted without the constraints of physical location. Such an organizational structure is called the *virtual organization*.

THE INFORMATION SERVICES ORGANIZATION

We have used the term *information services (IS)* to describe the unit of the firm that has responsibility for the majority of the information resources. Other names—*MIS division* or *MIS department* and especially *IT (information technology)*—are also popular.

The Information Resources

In Chapter 2, we identified information resources as encompassing computer hardware, computer software, information specialists, users, facilities, databases, and information. An abundance of these resources are typically located in information services and are the responsibility of the chief information officer (CIO). Information resources located in user areas are the responsibility of the user-area managers.

The Information Specialists

We use the term *information specialist* to describe the employee whose full-time responsibility is to contribute to the availability of information resources in the firm. The original information specialists included the systems analyst, programmer, and operator. Subsequently, the database administrator, network specialist, and Webmaster were added.

SYSTEMS ANALYSTS These specialists work with the users to develop new systems and improve existing systems. Systems analysts are expert at defining problems and in preparing written documentation on how the computer will assist in solving the problems.

DATABASE ADMINISTRATORS An information specialist who has responsibility for the database is called a *database administrator (DBA)*. The duties of the DBA fall into four major areas: planning, implementation, operation, and security. We will describe these duties in Chapter 6 when we address data resources.

WEBMASTERS The Webmaster is responsible for the content and presentation of the firm's Web site. The Webmaster must work with network specialists to ensure that the communications network between the firm and its customer and/or business partner is always open. Web sites rely heavily on images, and the Webmaster will generally have some expertise in graphics manipulation or design. Often a subordinate of the Webmaster will be responsible for making images available that are consistent and complementary among all of the pages at the Web site.

An important duty of the Webmaster is to track people who come to the firm's Web pages. These statistics can provide important information about the Web site's effectiveness. For example, the statistics may reveal that many customers begin the purchase process but cancel their transaction after moving from one page to another. This information and the sequence of pages accessed combined with the amount of time spent on each Web page can lead to a different design of the site. Customer relations can be greatly improved by Web sites that operate all day, every day, but poor Web site design can quickly wipe out any benefits.

NETWORK SPECIALISTS Network specialists work with systems analysts and users in establishing the data communications networks that tie together widespread computing resources. Network specialists combine expertise from the fields of computing and telecommunications. Maintaining network requirements for Web-based applications is especially difficult, because much of the communications take place beyond the boundaries of the firm.

PROGRAMMERS Programmers use the documentation prepared by the systems analysts to code computer programs that transform the data into information that is needed by the user. Some firms combine the functions of the systems analyst and programmer, creating a programmer analyst position.

OPERATORS Operators run the large-scale computing equipment, such as mainframe computers and servers, that is usually located in the firm's computing facilities. The operators monitor the consoles, change paper forms in the printers, manage libraries of tape and disk storage, and perform other similar duties.

All of these information specialists typically are combined with representatives of the user organization to form project teams that develop the systems. The specialists also have responsibility for maintaining the systems after they are implemented.

THE INFORMATION SERVICES ORGANIZATIONAL STRUCTURE

The information specialists in information services can be organized in various ways. The first organizational units were centralized in the firm, with practically all the information resources located in the IT unit.

The Trend from Centralized to Decentralized Structure

An organizational structure that is typical of a centralized operation is illustrated in Figure4.2. This particular structure is tailored to the system life cycle. The firm has assigned certain systems analysts and programmers to the development of new systems and other systems analysts and programmers to the maintenance of existing systems. Each group is managed by a manager. The operations, database administration, and network units contribute to both development and maintenance.

During the 1970s and 1980s, some firms began decentralizing many of their information resources by allocating them to the business units and granting the units the authority to

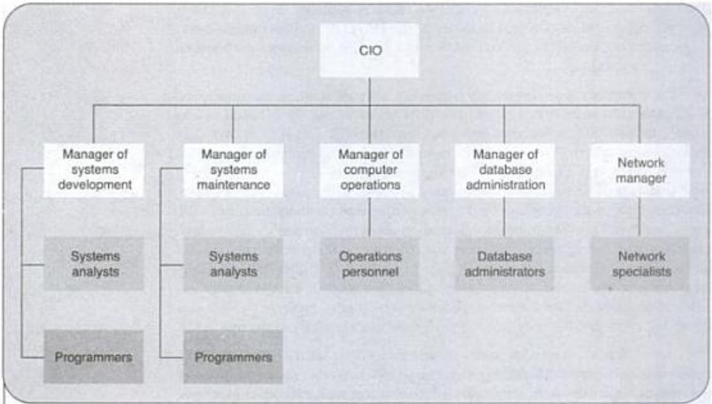


Figure 4.2 **An Organizational Structure for a Firm's Centralized Information Services Unit**

decide how the resources would be applied. Many areas appointed a **divisional information officer (DIO)** to manage the information resources in the areas.

Innovative Organizational Structures

Recognizing during the 1990s that both centralization and decentralization have their advantages, large firms sought to achieve a "centrally decentralized" organizational structure. This was accomplished by giving the corporate IS unit authority to make decisions concerning the IT infrastructure and business areas authority to make decisions about the strategic use of IT in their areas. This structure presented difficulties for two reasons. First, IT is now playing a more prominent role in the firm than in the past. Second, the rapid rate of technological change demands that a structure pay particular attention to developing information knowledge and skill in both system users and developers and utilizing information resources of all types available from vendors and consultants.

In response to this need, MIS researchers identified three innovative structures, called the *partner model*, the *platform model*, and the *scalable model*.[1] The basis for the **partner model** is that information services works with business areas in using information technology to achieve business innovation. The underlying assumption of the **platform model** is that information services will not actively initiate business innovations, but will provide the IT resources so that innovation can be accomplished by the business areas. Some firms, especially those with cyclical operations, have a need to quickly adjust the level of their information resources to respond to market conditions. The **scalable model** recognizes that resources must be obtained as soon as market opportunities arise and must be shed quickly when those opportunities no longer exist, keeping fixed costs to a minimum.

Figure 4.3 is a network model of the information services organizational structure that incorporates features of the partner, platform, and scalable models. The structure includes a **visioning network** that enables the CIO to work with top management in strategic planning for information resources, an **innovation network** that is used by the CIO to interface with

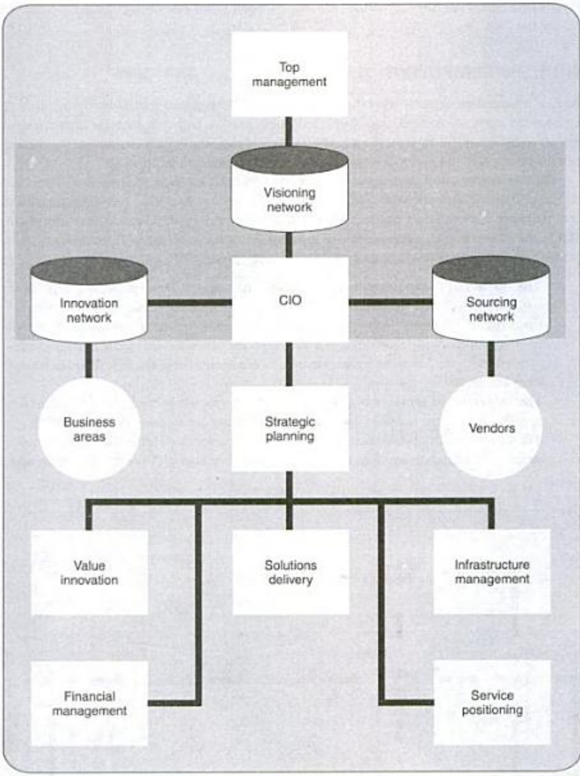


Figure 4.3 **A Network Model of Information Systems Organization**

Source: Adapted from Ritu Agarwal and V. Sambamurthy, "Principles and Models for Organizing the IT Function," *MIS Quarterly Executive* 1(1) (March 2002), 1–16.

business areas so that innovative applications can be developed, and a **sourcing network** that is utilized to interface with vendors for the purpose of acquiring information resources.

These innovative looks at organizational structure recognize that the IT function is not a self-contained unit housing all of the information resources and providing all of the information systems to users. It is necessary that (1) IT interface with both users and vendors and (2) responsibilities for certain functions be allocated to such specialists as divisional information officers and account managers. These views reflect an effort to make the IT unit a team player in the firm's use of information resources—sharing and delegating functions when it is best for the firm.

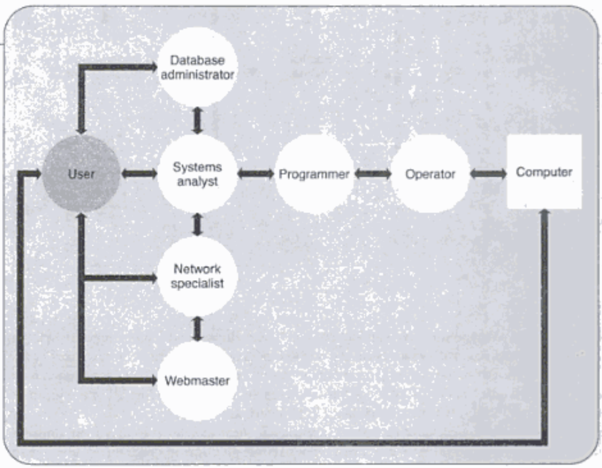
END-USER COMPUTING

The first information systems were developed with the information specialists doing all of the work for the users. This approach, illustrated in Figure 4.4, and still used for many systems projects today, shows how the information specialists are intermediaries, separating the user from the computer. The arrows represent two-way communications flows.

The late 1970s saw a growing interest on the part of users in developing their own computer applications, an approach called *end-user computing*. *End user* is synonymous with *user*; the user uses the end product of a computer-based system. **End-user computing (EUC)**, therefore, is the development by users of all or parts of their information systems. End-user computing evolved because of four main influences:

- **The impact of computer education.** During the early 1980s, the impact of good computer education programs in public and private schools, colleges, and industrial firms became apparent. Management ranks, especially on the lower levels, began to fill with people with good computer skills. As the years passed, these managers progressed to higher levels of management and continued their use of information systems and technology.
- **The information services backlog.** Information specialists have always had more work than they can handle. This situation became critical during the early 1980s, when users began making demands on information services for additional systems support. Information services could not respond fast enough to users' demands, and

Figure 4.4 The Traditional Communication Chain



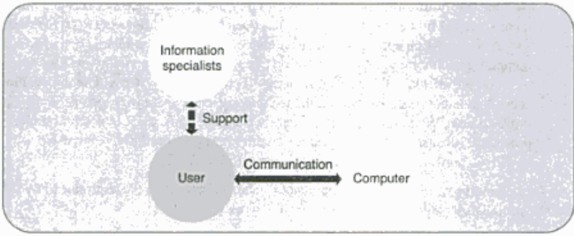


Figure 4.5 **The End-User Computing Communication Chain**

backlogs built up with jobs waiting to go on the computer. Some users had to wait 2 or 3 years for their jobs to work their way through the backlog.

- **Low-cost hardware.** During this same period, the market became flooded with low-cost microcomputers. Users could obtain their own hardware by placing an order at the local computer store by telephone and have the system delivered by taxicab.
- **Prewritten software.** Both hardware and software firms produced software that would perform basic accounting tasks as well as provide information for decision making. This prewritten software offered enhanced support and ease of use, and it enabled firms and individual users with little computer expertise to implement computer-based systems.

It is not necessary for end users to assume total responsibility for systems development, but they must do some portion of it. In many cases, the user will work with information specialists in jointly developing systems. Therefore, the EUC concept does not mean that the need for information specialists will disappear. Rather, it means that information specialists will assume more of a consulting role than they have in the past.

Figure 4.5 depicts an EUC scenario in which the user relies on information specialists for some degree of support.

USERS AS AN INFORMATION RESOURCE

The users of the firm's information system are important information resources who can make a real contribution to meeting strategic objectives and achieving a competitive advantage. This is especially true when the users can actively participate in systems development and practice end-user computing.

In deciding how the firm will use its information resources, top management must give considerable attention to the manner in which end-user computing will be conducted, so as to maximize its benefits and minimize its risks.

Benefits of End-User Computing

EUC makes possible two major benefits:

- **Match capabilities and challenges.** The shift in the workload for systems development to user areas frees up the information specialists to concentrate on organization-wide and complex systems, enabling them to do a better job in these areas. The specialists also have more time to devote to maintaining existing systems—an important area of responsibility.

- **Reduce the communications gap.** A difficulty that has plagued systems development since the first days of computing has been communications between the user and the information specialist. The user understands the problem area better than the computing technology. The combination of computer education, low-cost technology, and prewritten software enables users to create some systems. The information specialist, in contrast, is expert in the technology, but less knowledgeable in the problem area. When users develop their own applications, there is no communications gap, because there is no need for communication. Similarly, when users develop a portion of their systems, the gap is reduced.

These benefits result in the development of better systems than those produced by information specialists trying to do the majority of the work themselves.

Risks of End-User Computing

Conversely, when end-users develop their own systems, they expose the firm to a number of risks:

- **Poorly targeted systems.** End users may apply the computer to applications that should be performed some other way, such as manually.
- **Poorly designed and documented systems.** End users, although they may have high levels of technical competence, usually cannot match the professionalism of information specialists when it comes to designing systems. Also, in the rush to get systems up and running, end users tend to neglect the need to document their designs so that the systems can be maintained.
- **Inefficient use of information resources.** When there is no central control over acquisition of hardware and software, the firm can end up with incompatible hardware and redundant software. Also, end users may "reinvent the wheel" by developing systems that have already been developed by information services or other end users.
- **Loss of data integrity.** End users may not exercise the necessary care in entering data into the firm's database. Other users then use this erroneous data, assuming it to be accurate. The result is contaminated output that can cause managers to make the wrong decisions.
- **Loss of security.** End users may not safeguard their data and software. Computer criminals can gain access to the system and harm the firm in many ways. The increasing use of networks makes security increasingly important.
- **Loss of control.** Users develop systems to meet their own needs without conforming to a plan that ensures computer support for the firm.

Because of the potential benefits, the firm must develop a strategic plan for information resources that allows EUC to grow and flourish. As far as the risks are concerned, the same types of controls must be applied to user areas that have worked so well in information services.

EDUCATION CRITERIA, KNOWLEDGE, AND SKILLS NEEDED FOR CAREERS IN INFORMATION SERVICES

The development of information systems requires certain knowledge and skill. Information specialists apply this knowledge and skill on a full-time basis. Users apply them when they engage in end-user computing to any degree.

Systems Development Knowledge

Knowledge is something that can be learned, either through formal courses of study or through such individual efforts as reading and observation. The types of knowledge that enable someone to contribute to systems development efforts include computer literacy, information literacy, business fundamentals, systems theory, the systems development process, and systems modeling.

Computer literacy is the ability to use computer resources to accomplish necessary processing. **Information literacy** consists of understanding how to use information at each step of the problem-solving process—where that information can be obtained and how to share information with others. Although information literacy does not absolutely require computer literacy, the two go hand-in-hand to provide problem solvers with a powerful tool. **Business fundamentals** are those topics that are usually included in the undergraduate and graduate business core courses—accounting, finance, marketing, management, MIS, and operations. Most information systems are developed to support these fundamentals.

Systems theory describes how to depict phenomena as normative systems structures. The general systems model of the firm, presented in Chapter 2, is an example. The **systems development process** consists of the steps that are taken to develop an information system. The names **systems life cycle (SLC)** and **systems development life cycle (SDLC)** are used to describe this process, which we describe in Chapter 7. **Systems modeling** consists of the various ways to document a system. In most cases, the system's data and processes are modeled using such tools as entity-relationship diagrams, data flow diagrams, and class diagrams. We describe such tools in Chapters 6 and 7.

It is possible to identify not only types of knowledge and skill that are important for information specialists and users, but also how users can be subdivided into general management and their staffs. The *professional staff* includes such specialists as marketing researchers and management scientists, whereas the *clerical staff* consists of office personnel. Table 4.1 identifies whether knowledge is of major, intermediate, or minor importance. Keep in mind that these are general observations that can vary widely, depending on the organization, the personnel, and the system being developed.

Systems Development Skills

In the same manner, we can identify the different types of development skill that are important. Although these skills can be learned, individuals usually differ in their abilities due to natural gifts, and the learning process serves to refine them. Systems development skills include communications skills, analytical ability, creativity, and leadership.

Table 4.1

Knowledge Requirements

Knowledge	General Management	Professional Staff	Clerical Staff	Information Specialists
Computer literacy	Minor	Intermediate	Intermediate	Major
Information literacy	Major	Major	Intermediate	Major
Business fundamentals	Major	Major	Minor	Intermediate
Systems theory	Minor	Intermediate	Minor	Major
Systems development	Intermediate	Minor	Minor	Major
Systems modeling	Minor	Major	Minor	Major

Table 4.2

Skill Requirements

Skill	General Management	Professional Staff	Clerical Staff	Information Specialists
Communications	Major	Major	Intermediate	Major
Analytical ability	Intermediate	Major	Intermediate	Major
Creativity	Intermediate	Major	Intermediate	Intermediate
Leadership	Major	Minor	Minor	Intermediate

Communications skills involve the ability to transmit information to one or more people using verbal, written, or graphic communication. **Analytical ability** involves the study and ultimate understanding of a situation for the purpose of formulating a response or solution. **Creativity** is the generation of a completely or partly new idea or solution. Creativity is especially useful in the absence of experience or knowledge gained from learning about a similar phenomenon. **Leadership** is the ability to direct others to perform tasks. For general management, this is probably the most important skill, but it is also important for information specialists as they engage in managing a systems development project.

Table 4.2 shows the relative importance of these skills to general management, professional and clerical staff, and information specialists.

MANAGING THE KNOWLEDGE REPRESENTED BY THE FIRM'S INFORMATION RESOURCES

In Chapter 2, we identified the firm's information resources as including its hardware, software, information specialists, users, facilities, databases, and information. Several of these resources represent valuable storehouses of knowledge. The software stores knowledge in the form of the firm's processes and procedures. Databases store knowledge in the form of the data and information that represent the firm's physical resources and operations. The users and information specialists store knowledge in the forms discussed previously—computer and information literacy, business fundamentals, and systems theory, development, and modeling.

Firms often regard *knowledge management (KM)* as another type of system to be developed. Such a system creates knowledge, manages it, and delivers it to appropriate users. Vendors such as KnowledgeBase.net sell knowledge management software to firms that wish to take advantage of prewritten software.

OFFICE AUTOMATION

When one traces the path that business computing has taken in the 50-or-so years of its history, one often comes upon the term *office automation*. As the term implies, office automation is the application of automation, such as computer technology, to office work. Office automation can be traced back to the early 1960s, when IBM coined the term **word processing** to express the concept that much office activity is centered on the processing of words. Subsequently, such other technologies as e-mail, electronic calendaring, videoconferencing, and desktop publishing were applied to office work, and together they were called office automation. **Office automation (OA)** includes all of the formal and informal electronic

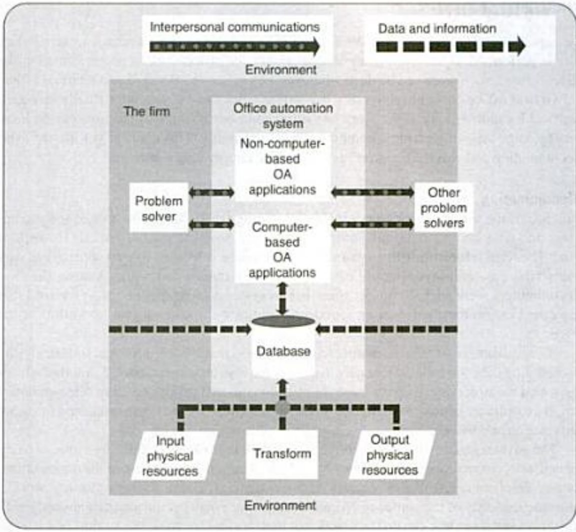


Figure 4.6 **An OA Model**

systems primarily concerned with the communication of information to and from persons both inside and outside the firm.

Some OA systems involve the use of a computer and some do not. Figure 4.6 is an OA model that shows how problem solvers use computer-based and non-computer-based applications. Some of the problem solvers reside within the firm; others are in the firm's environment. An advantage of OA is the fact that it provides a communications conduit for persons inside and outside the firm to communicate with each other. The model shows that the computer-based applications interface with a database that is populated by information gathered within the firm and from the environment.

A Shift from Clerical to Managerial Problem Solving

The first OA applications were intended to support secretarial and clerical personnel. Word processing, e-mail, fax, and electronic calendaring are examples. As managers and professionals became more computer literate, they recognized that they could use the applications to solve problems. They began using e-mail to communicate with other problem solvers, electronic calendaring to schedule meetings with other problem solvers, videoconferencing to link problem solvers over a wide geographical area, and so on.

Today, managers and professionals have as much claim on OA applications as do secretarial and clerical personnel.

THE VIRTUAL OFFICE

The capability of OA to link people electronically opened up new avenues in how office work is performed. It has even made it unnecessary for office work to be performed at the office. Instead, such work can be done wherever the employee is located—at a virtual office. The **virtual office** concept recognizes that office work can be done at virtually any geographical location as long as the work site is linked to one or more of the firm's fixed locations by some type of electronic communications capability. This concept got its start with telecommuting and was refined to achieve an office facility called *hoteling*.

Telecommuting

Evidence of the virtual office began to emerge during the 1970s as low-priced microcomputers and data communications equipment made it possible for individuals to work at home. The term **telecommuting** was introduced because it seemed like an appropriate way to describe how employees could electronically "commute" to work. Among the first telecommuters were such computer scientists as systems programmers, who realized that they could create their software products at home or on a sailboat just as well as at the office.

A big advantage of telecommuting to employees is that it provides them with flexibility in scheduling their job tasks so that personal tasks can also be accommodated. Another advantage is that the firm typically pays more attention to communications needs of telecommuters than in an ordinary office environment, where much information is communicated in casual conversation and by observation.

The advantages are offset, however, by some real disadvantages. First, by virtue of being isolated, telecommuting employees may feel like less important members of the organization. Another disadvantage is fear of job loss or career damage. Because the employees' work is done independently of the company operation, employees may get the idea that anybody with a computer and a modem can do their work and that they may become the victims of an "electronic layoff." Even if employees are not terminated, they can fear that not being a part of the physical organization can hurt their chances for career advancement. A third disadvantage is increased family tension. Spouses may view the job as a working arrangement that is being used to avoid family responsibilities. It is easy for the division between home and office responsibilities to become blurred.

Hoteling

The initial narrow focus of telecommuting on certain classes of office workers who could do all of their work at home has been broadened to include all kinds of employees who come to the office only when necessary. This concept has been given the name **hoteling**, and the idea is that the firm provides a central facility that can be shared by employees as the need for office space and support arises. Employees use the central facility in much the same way as they would use a hotel while on a trip. The employees make reservations for facilities with particular support resources, based on the work to be done. For this vision to be achieved, the central office facility must be staffed with appropriate support personnel and offer the needed technology.

The benefits of hoteling are a more effective utilization of resources and space and an improved focus on what is needed to support office personnel. The risks include perceived loss of "perks" by employees who no longer have private offices, a loss of community feeling, and a potential negative impact on corporate culture.

Advantages of the Virtual Office

Telecommuting and hoteling make the virtual office possible. The virtual office overcomes the physical constraints of the workplace with electronics and thereby makes possible several real advantages, including:

- **Reduced facility cost.** Because some employees are working elsewhere, the firm does not require as much office capacity, making possible reduced costs for office rent and expansion.
- **Reduced equipment cost.** Rather than provide a set of office equipment to everyone, employees can share equipment in much the same way that participants in a local area network share computing resources.
- **Reduced work stoppages.** When winter storms, floods, hurricanes, and the like make it impossible for employees to travel to the physical workplace, company activity can come to a screeching halt. In a virtual office setting, however, much of the work can continue.
- **Social contribution.** The virtual office makes it possible for the firm to employ persons who would not otherwise have an opportunity to work. People with disabilities, the elderly, and parents with young children can work at home. The virtual office, therefore, provides the firm with an opportunity to express its social conscience.

Disadvantages of the Virtual Office

When a firm commits to a virtual office strategy, it does so with the understanding that there can be some negative impacts, including:

- **Low morale.** A number of factors can produce low employee morale. One is the absence of positive feedback that comes from face-to-face interaction with superiors and peers.
- **Fear of security risks.** The security of data and information might be more difficult to control in a virtual office environment.

The virtual office demands cooperation by both the firm and the employees if it is to succeed. The virtual office may demand more dedication from employees than the fixed office. The virtual office is not for everyone. Unless employees can discipline themselves to do much of their work without supervision and motivation, the work will likely not get done. For employees who prefer to work alone and be their own boss, the virtual office can be the ideal setup.

THE VIRTUAL ORGANIZATION

The successes of the virtual office prompted visionaries to see how it could be expanded to apply to the entire firm—a virtual organization. In a **virtual organization**, operations throughout the firm are designed so that they that are not tied to physical locations.

The Societal Impact of the Virtual Organization

Although the virtual office and the virtual organization have been primarily identified as business strategies, the concept may eventually have dramatic implications for society as well.[2]

The industries that are the most attracted to the concept of the virtual office and the virtual organization are those that add value in the form of *information*, *ideas*, and *intelligence*. The term **Three I Economy** has been coined to describe such industries. Examples are education, health care, entertainment, travel, sports, and consulting. As these industries are attracted to the virtual office in increasing numbers, the movement may affect the way that practically everyone lives and works. This effect will be most obvious in the physical appearance and function of our cities. The virtual office and the virtual organization will decrease the demand for more skyscrapers and commuters, making our cities quieter, gentler, and more appealing as places to live.

For this to occur everyone must be able to participate. Workers on all levels will have to be attracted to jobs in the Three I Economy and have the necessary knowledge and skills to succeed. Such a high level of competence will require a dedication on the part of our educational institutions as well as governments at all levels to encourage and facilitate the change.

Today, almost all of the firm's activities encompass more information, ideas, and intelligence than in the past. Because of that, universities and high schools routinely include information literacy and computer literacy in their programs. Information technology and information systems are woven into the fabric of business processes.

Highlights in MIS

VIDEOCONFERENCING ALTERNATIVES

Videoconferencing is an office-automation application that involves the use of video equipment to link geographically dispersed conference participants. The equipment provides both sound and picture. Three videoconferencing configurations are possible:

- **One-way video and audio.** Video and audio signals are sent from a single transmitting site to one or more receiving sites. This is a good way for a project leader to disseminate information to team members at remote locations.
- **One-way video and two-way audio.** People at the receiving sites can talk to people at the transmitting site, while everyone views the same video images.
- **Two-way video and audio.** The video and audio communications between all sites are two-way. Although this is the most effective of the electronically aided conferencing approaches, it can be the most expensive. The first videoconferencing efforts used dedicated rooms that cost in the neighborhood of $30,000 or could be rented from a common carrier or hotel chain. Although those setups are still in use, another, lower-priced option is available—desktop videoconferencing.

DESKTOP VIDEOCONFERENCING With **desktop videoconferencing**, video and audio equipment are attached to each workstation in the network, enabling the two-way communication of picture and sound. The networked workstations each contain a camera mounted above the screen to view the user, a microphone, add-on boards, and software. The cost of such a setup continues to decrease, but additional costs must be considered. Desktop videoconferencing typically requires a dedicated server and a high-speed channel. One alternative, NetMeeting 3 from Microsoft, is included with Windows 2000 and later versions It uses the Internet to link users with multipoint data conferencing, text chat, whiteboard, and file transfer, in addition to point-to-point audio and video.

THE TELESUITE SOLUTION Telesuite, an Ohio-based firm, markets videoconferencing networks that utilize fiber-optic broadband channels and feature high-quality video.[3] The video image is much wider than the typical 4-by-3 aspect ratio, capable of providing an image that fills a 16 foot-wide wall. This wide view provides a much more natural setting, and participants frequently feel that they are communicating in person.

Videoconferencing has the inherent appeal of enabling managers to communicate in a way that most closely approximates the face-to-face meeting. The ability to span great geographic distances by means of videoconferencing enables more managers to get involved in decision making than otherwise would be the case—another example of the virtual organization.

PUTTING THE SYSTEM USERS AND INFORMATION SPECIALISTS IN PERSPECTIVE

The human element continues to be the most important ingredient in the development and use of information systems. The main players are the users and the information specialists. Both groups form the development team.

Early systems development was accomplished entirely by the information specialists, but over time users have played increasingly important roles. Carried to the extreme, users can do all of the development work.

Not only has the development work changed, but the setting in which the work is performed has changed as well. No longer is the organizational setting a physical one, requiring that the work and workers be located in a particular physical location. Electronic communication networks enable firms to achieve a virtual organization, where the work can be done virtually anywhere.

Highlights in MIS

A Successful KM Development Project at Nortel Networks[4]

Earlier, we recognized that a firm's knowledge can exist in its software. The software is used in information systems that perform various processes and support decision making. One such process is new-product development, and the key related decision is whether to develop a potential new product. Nortel Networks (using knowledge management software from Excalibur Technologies) applied KM to this area of its operations and credits the use of KM with its transformation from a technology-focused company to one that is more opportunity and customer focused. Their project involved the development of a new-product development (NPD) system that enabled Nortel to (1) leverage multidisciplinary NPD knowledge assets, (2) improve NPD decision making, and (3) facilitate learning and knowledge exchange.

The old NPD system, shown in Figure 4.7, was a five-phase process. The concept-development portion was ill-defined, causing the entire process to be ineffective. Management decided to use KM to redevelop the fuzzy front end. The new concept-development portion shown in Figure 4.8 illustrates the four phases with rectangles. The linkages that connect the phases (the arrows) take the form of more positive "why/why not" decisions rather than a hesitant "go/no go" attitude.

The project began in July 1995, and sufficient progress had been made by June 1996 to conduct a pilot test. The pilot involved the qualification of 112 ideas, yielding 7 product and service concepts for funding. In late 1997 and early 1998, Nortel began to implement the new NPD process, called "Time-to-Market." Two examples of successful projects have been a Privacy Manager^{SM} system that can ID 100 percent of incoming telephone calls and an Internet Call Waiting product that allows a user to use a single phone line to receive phone calls while connected to the Internet.

In successfully implementing KM, Nortel demonstrated its ability to use software to achieve a major improvement in the firm's focus. However, rather than establish a corporate knowledge officer, a new position—the *corporate learning officer (CLO)*—was created. The CLO and staff were given the task of implementing a corporate-wide KM strategy

Highlights in MIS [continued]

Figure 4.7 **The Original Nortel Networks New Product Development System**

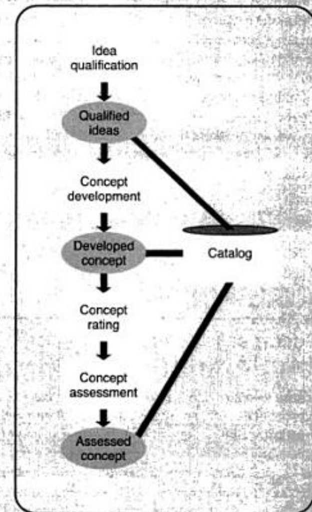


Figure 4.8 **The Nortel Networks New Product Concept Development System Utilizing Knowledge Management**

Summary

The classical business organization structure consisting of such areas as finance, human resources, information services, manufacturing, and marketing is a packaging of physical resources.

A firm's information specialists and users represent valuable information resources. The specialists include systems analysts, database administrators, Webmasters, and network specialists who work directly with users, as well as programmers and operators, who are charged with the responsibility of implementing systems to meet the users' needs. Initially, all information specialists were housed in a centralized information services unit. Over time, many of these resources were allocated to the business areas and led by divisional information officers. Several progressive structures for capturing the organizational relationships between information services and business areas have been proposed. These structures make use of networks—a *visioning network* that enables strategic information planning, an *innovation network* that ensures the achievement of innovative systems solutions in the business areas, and a *sourcing network* that makes maximum use of external resources. These structures portray IS working with business areas to achieve systems, providing business areas with the infrastructure so that the areas can develop their own systems, and enabling the firm to adjust the level of its information resources to fluctuating business levels.

Although users were restricted in their involvement in systems development during the early years of computing, they gradually gained more influence, which culminated in end-user computing (EUC). End-user computing requires that users be able to perform at least some part of the development effort for their systems.

Users vary in their degree of computer and information literacy, and these variations, plus others, result in varying degrees of support that are provided by information specialists. When a firm's users are capable of engaging in EUC, they are an especially valuable information resource. EUC enables the matching of capabilities and challenges and reduces the communications gap. Risks of EUC include poorly targeted systems, poorly designed and documented systems, inefficient use of information resources, and loss of data integrity, security, and control.

Anyone who develops systems—users and information specialists alike—must possess certain knowledge and skills. These are the educational criteria for careers in information systems. The knowledge includes computer and information literacy, business fundamentals, systems theory, the systems development process, and systems modeling. The skills include communications, analytical ability, creativity, and leadership. The degree to which knowledge and skills are important varies with the individual, the organization, and the system being developed.

The knowledge of the firm's information specialists and users is a valuable resource and should be managed. Formal knowledge management (KM) programs often consist of systems that gather, store, and disseminate knowledge. Some firms base their knowledge management systems on prewritten KM software.

Office automation has enabled certain office work to be performed at home—a phenomenon called *telecommuting*. Firms then realized that all employees did not have to do all of their work at the office; they could come to the office only when necessary. This concept, called *hoteling*, led to the broader concept of the *virtual office*, whereby all kinds of office work can be performed irrespective of physical location. This evolution, in turn, led to the concept of the *virtual organization*, whereby many of a firm's operations, not just office work, can be performed irrespective of physical location.

This chapter concludes the essential concepts relating to management information systems. The remainder of the book will be devoted to a discussion of the information resources and how information and technology can be managed.

Key Terms

visioning network
innovation network
sourcing network
office automation (OA)

Key Concepts

- end-user computing (EUC)
- virtual office
- telecommuting
- hoteling
- virtual organization

Questions

1. Differentiate between a physical organization and a virtual organization.
2. In the classical business organizational structure, which physical resources are allocated to the various units?
3. Identify the information resources.
4. Identify the information specialists. Which ones interface directly with the user?
5. What is a visioning network used for? An innovation network? A sourcing network?
6. In order for a person to engage in end-user computing, what must he or she do?
7. What are the main benefits of EUC? What are the main risks? How can the risks be minimized?
8. How do knowledge and skills differ?
9. Who were the original users of OA? Who were the later users?
10. What phenomenon started the movement toward the virtual office?
11. Is it possible for a single employee to engage in both telecommuting and hoteling at the same time? Explain.
12. What are the advantages of the virtual office? What are the disadvantages?

Topics for Discussion

1. What courses does your school offer to provide you with the different types of systems development knowledge? Address each type separately.
2. What courses does your school offer to provide you with the types of systems development skills? Address each skill separately.
3. Do you agree with the statement that "You are born with certain skills, you do not learn them?"

Problems

1. Go to the Bureau of Labor Statistics Web page at the U.S. Department of Labor—WWW.BLS.GOV/EMP. Look for employment projections for information systems professionals. How would you describe the employment opportunities of IS majors over the next 5 years?

Case Problem

Cyber U

In this exercise, you will apply the concepts of the virtual office to computer lab use on your campus. Most college campuses have computer labs for student use. These labs support course work, are located on campus, have various hours of operation, provide access to printers, offer access to help in using the computers and software, and provide other elements of education. However, the large majority of students today have access to computers and networks off-campus and in dorms. The question becomes, what economic advantages could be realized if your college campus applied virtual office concepts to student computing needs?

You may wish to make a spreadsheet for the comparison so that you can document your estimates and also make changes to gauge the economic effects of changes to your estimates. Make sure you include at least the following economic factors:

1. Cost of student purchasing a computer and printer
2. Cost of student gaining access to the Internet
3. Cost of a computer lab (multiplied by the number of labs the college supports)
    a. Computer hardware costs
    b. Computer software costs
    c. Cost of lab assistants
    d. Cost of printers, paper, and toner cartridges
    e. Cost of college support

Make one list for the costs in the current computing situation on your campus and a second for the costs based on the campus moving to virtual computing for students. In a virtual campus–computing scenario, the number of computer labs and computers in those labs and hours of lab operations would be greatly reduced. Students would use their own computing resources to access the software and files needed for course work. The college might then reduce the cost of fees, especially technology fees.

This exercise is simplistic, but it should stimulate you to consider if your college costs would actually be lowered if your college adopted more virtual office concepts.

Notes

[1]Material in this section is based on Ritu Agarwal and V. Sambamurthy, "Principles and Models for Organizing the IT Function," *MIS Quarterly Executive* 1(1) (March 2002), 1–16.

[2]Taken from Charles Handy, "Trust and the Virtual Organization," *Harvard Business Review* 73 (May–June, 1995), 40–50.

[3]Joe Sharkey, "When Having a Meeting Is Like Going to a Movie," *New York Times*, September 24, 2002, C-6.

[4]This section is based on Anne P. Massey, Mitzi M. Montoya-Weiss, and Tony M. O'Driscoll, "Knowledge Management in Pursuit of Performance: Insights from Nortel Networks," *MIS Quarterly* 26(3) (September 2002), 269–289.

PART 2

Information Resources

Decision making is information in action. Information systems provide support to staff members, professionals, managers, and anyone else who makes decisions in the organization. The large amount of data and short time frame for making decisions require almost everyone in an organization to use information technology resources. An organization that is unable to effectively use information systems cannot compete.

Managers need to know how to use current information technology and be aware of technology trends. Decisions are influenced by the data collected and the way they are processed. Understanding trends in information technology requires knowledge of the history of such technology and an awareness of how it may look in the next 5 to 10 years. Planning for changes in information technology is as important as planning for growth or a changing customer base.

Technological advances in information systems provide a strategic opportunity for an organization to surpass its competitors. Understanding the data resource and the development of information systems is the foundation for achieving those opportunities. Managers must be involved in the development of information systems. Data collected by the organization will be mined and processed to support business processes. Managerial insight into the decision-making process is crucial for designing effective information systems.

Chapter 5

Computing and Communications Resources

Learning Objectives

After studying this chapter, you should

- Know the various computer components.
- Know about personal computing devices.
- Understand the implications of the rapid advances in information and communication technologies.
- Be familiar with input and output resources.
- Recognize how different storage media differ and the advantages of each.
- Know the advantages of prewritten software.
- Understand the different computer networking strategies.
- Understand how communications over the public telephone system and networks differ.
- Know about network protocols.
- Distinguish between intranets, extranets, and the Internet.

Introduction

Your computer resources are not just those that sit on your desk; they also include the hardware and software and files that you access over a network. The computer resources you use are frequently connected to your computer via a network.

The speed and cost of communications and computer processors impact the use of these resources. Prices continue to drop; in fact, the power of computers doubles about every 18 months for the same price. Conversely, in 18 months you will be able to buy a computer with today's power for half the cost. Managers tend to use inexpensive resources, so the use of computer and communications resources can only continue to grow.

The incentive for connecting microcomputers via networks came from the desire for higher profits. Managers who could quickly and easily share computer-based information made better, faster decisions than their competitors. Sharing music and chatting online are fine as leisure pursuits, but they did not provide the momentum for the enormous amount of networking we see today. Businesses cannot effectively compete without being able to share their computer-based information, and that sharing requires networks.

As you study this chapter, put the changes in standards, speed, and costs into perspective. Don't be lulled into a view that it is simply history to be learned for an exam. Information technology standards are changing; firms that can look to the future and take advantage of change are the ones that will survive in today's economy.

HARDWARE

Computers come in varying speeds and prices, but they all have common features. The features of interest to us are the processor, memory, storage, and input and output devices (see Table 5.1). All general-purpose computers have the same types of components; larger computers have more and faster components than their microcomputer counterparts.

Large computers that perform the bulk of computer operations for centralized information systems are referred to as *mainframe computers*, or simply **mainframes**. Mainframes support hundreds or thousands of simultaneous users and operations. **Microcomputers** began as computers used by one person and were called *personal computers*, or **PCs**. Today, microcomputers have grown in power and are connected to other computers via the Internet. However, they are still frequently called PCs, because they are most often used by a single person who performs only a limited number of computing tasks.

Processors

The **processor** (also called the *central processing unit* or *CPU*) is where data processing is performed. Intel, Advanced Micro Devices (AMD), Cyrix, Motorola, and other firms manufacture the microprocessors in many popular microcomputers. A processor, such as the Intel Pentium Extreme Edition shown in Figure 5.1, controls the calculations and logical comparisons of data. It also directs and controls the movement of data from one location within the computer to another. Processor speed and word size combine to increase the power of computing.

Since their introduction, computers have become less and less expensive. As the cost of using information technology continues to plummet, firms use more of this inexpensive resource for decision making.

Table 5.1

Major Computer Components

Component	Description
Processor (central processing unit or CPU)	Controls calculations, controls logical comparisons of data, directs and controls movement of data from one location within the computer to another.
Memory (random access memory or primary storage)	Memory located on the computer's main circuit board called the motherboard. Data in memory is lost when the power to the computer is turned off.
Storage (disk space or secondary storage)	Memory located on a device that is not on the main circuit board. Many types of storage are removable and can be taken from one computer to another. Data in storage is not lost when the power to the computer is turned off. Common storage devices are floppy disks and CDs.
Input devices	A device that captures data by a manual or electronic method and transmits the data to storage or memory. Common input devices are keyboards, mice, and scanners.
Output device	A device that presents and/or transmits data from the computer to the user. Common output devices are computer monitors, printers, CDs, and speakers.
Input/Output devices	A device that can perform both input and output functions. Examples would be a touch-screen monitor and storage disks (such as floppies, Zip disks, and rewritable CDs).

PROCESSOR SPEED **Processor speed** is measured by the number of cycles that occur per second, and it has grown tremendously over the years since IBM introduced its first microcomputer. Speeds were initially expressed as megahertz (MHz), which stands for millions of cycles per second. Each cycle is an opportunity for an action, such as adding two numbers. The Intel 8088 chip used as the processor for IBM's first microprocessor ran at 4.77 MHz (4.77 million cycles per second). The Intel Pentium Extreme Edition runs at 3.2 gigahertz (GHz), or 3.2 billion cycles per second.

WORD SIZE The first processors were called "8-bit" machines, because 8 bits of data made up the size of one "word." A bit is a single value of zero or one. A **word** is the measure of how many bits may be moved with one cycle of the processor. Eight bits make up one byte, and each byte can store a single character. For example, the 8-bit string "01000001" represents the letter "A."

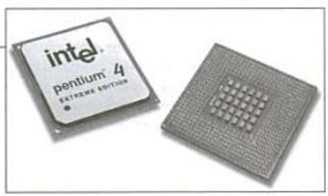


Figure 5.1 **Intel Pentium Extreme Edition**

Source: Photo courtesy of Intel Corporation.

Word size is important; it determines how many characters, such as the "A" just mentioned, can be moved in a single cycle of the processor. The first microcomputers had a word size of 8 bits, but most of today's microcomputers use a 32-bit word size. However, 64-bit compatible chips (such as the Intel Pentium Extreme Edition) are gaining popularity and should soon represent the majority of new sales. Early microcomputers could move only a single character with a single cycle; today's microcomputers move four characters with a single cycle and soon will move eight characters with a single cycle.

POWER The power of computers is affected by both word size and processor speed. Additionally, improvements in processor circuitry are making it possible for operations (such as addition, comparison of data values, and others) to be performed in fewer cycles. Moore's Law states that the power of a computer doubles about every 18 months. It is the combination of processor speed, word size, and circuitry improvement that results in this remarkable increase in power.

For many people, the growth in computer power is difficult to comprehend. Two examples will help you to understand how increased computer power has affected and will continue to affect your life. First, the power of the first personal computer introduced by IBM was greater than the power of most mainframe computers in 1973 when Neil Armstrong was the first man to walk on the moon. Second, computer power purchased by your company for $1 million the day you start work will cost less than $1 when you retire. As the price of information technology falls, managers use more information technology to aid in decision making, which changes the way they solve problems.

Memory

Data are stored in a computer in basically two ways—memory and storage. **Memory**, also called *primary storage* or *random access memory (RAM)*, refers to the storage area on the computer's circuit board. Figure 5.2 depicts a circuit board. Memory is volatile because its contents are lost when the computer's power is turned off. This fleeting characteristic reflects the fact that the value of bits can be changed as swiftly as processor cycles allow. Memory in a computer is extremely fast compared to accessing data on a storage device, such as a disk.

The amount of memory in a microcomputer can have significant impact on the user's perception of its speed. Microcomputers commonly have 128 to 256 megabytes (MB) of

Highlights in MIS

BLUE GENE

Microcomputer power is not the only computing power that is increasing; mainframe power is also making great leaps. IBM has announced it is creating two supercomputers for the Department of Energy[1] whose combined power will be greater than the combined power of the current 500 fastest supercomputers. The computers, finished in 2005, are being named Blue Gene/L.

These new computer architectures are moving toward petaflops—1,000 trillion cycles per second. Machines of this speed are expected to be constructed before 2010. These amazing speeds are to be achieved by harnessing the power of an array of high-speed microprocessors. The second Blue Gene/L will harnesses 12,000 of IBM's Power 5 microprocessor chips.

The Earth Simulator, formerly the fastest computer, was developed by NEC. It functions at about 35 trillion cycles per second. With the extreme power of these supercomputers, scientists hope to model world climate conditions and similarly difficult problems.

Figure 5.2
Microcomputer Circuit Board, also Known as a Motherboard

Source: Photo courtesy of Intel Corporation.

memory; 256 MB of memory is about 256 million bytes. Many microcomputers can accommodate 2 gigabytes (2 billion bytes) of memory. A table of byte, megabyte, gigabyte, terabyte, and petabyte conversions is presented in Table 5.2.

Memory can be thought of as the work space used by the processor. As an example, assume that, as you study, you are the processor. You read data from books and notes, perform mental analyses of the data, and write your conclusions on a piece of paper. You are manually performing the functions that a processor performs electronically. The memory available to the microcomputer is similar to the amount of desk space you can use when you study. If you had no room on your desk, you might have to keep your books in another place—on the floor or even in another room. Every time you need to read another paragraph, you would have to get up from your desk, go to where the books and notes were located, read from the books and notes only as much data as can fit into your memory, and then go back to your desk to process that data.

Having the data in an open book on your desk is much more efficient than having to get up and find the book in another room. In the same way, it is more efficient for the processor to access and utilize data in memory. Memory has become faster in order to keep up with the more powerful processors.

Storage

Storage for computers comes in the form of many different media, each having different characteristics that make it better suited for certain tasks. Although storage media vary from large computers to small, most share similar characteristics.

Table 5.2

Conversion from Bits to Bytes and Further

1 bit	=	a single value of 0 or 1
8 bits	=	1 byte = 1 character
2^{10} bytes	=	1,024 bytes = 1 kilobyte (1 KB)
2^{20} bytes	=	1 KB × 1 KB = 1,048,576 bytes = 1 megabyte (1 MB)
2^{30} bytes	=	1,073,741,824 bytes = 1 gigabyte (1 GB)
2^{40} bytes	=	1,099,511,627,776 bytes = 1 terabyte (1 TB)
2^{50} bytes	=	1,125,899,906,842,624 bytes = 1 petabyte (1 PB)

Storage is either fixed or removable. **Fixed storage** is permanently installed in the computer. An example is the hard drive of your microcomputer. **Removable storage** media usually take the form of a tape, disk (also known as a diskette), USB flash drive (sometimes called a "pen drive"), CD, or some other portable medium. The computer hardware that reads from and writes to the medium is a *drive*. Media and the drives that use them have become so closely associated that the words are used synonymously by many computer users.

FIXED STORAGE Microcomputers frequently come with 80 GB (80 gigabytes) of fixed storage, but up to 500 GB of hard drive storage can be purchased. Mainframes have terabytes and even petabytes of storage space—thousands of times the storage available on a microcomputer.

There is some debate as to whether microcomputer users need such large amounts of storage space, especially when so much storage capability can be accessed via a network. But audio files, video files, and images require large amounts of storage space, and these file types are increasingly popular. When the price difference between an 80-GB hard drive and a 500-GB hard drive is around $200, many people feel the larger amount of storage is too inexpensive to refuse.

REMOVABLE STORAGE Removable storage can be removed from one computer and inserted into another. Table 5.3 lists popular removable disks and their storage capacities.

Three types of high capacity media deserve attention: **USB flash drives, compact discs (CDs)**, and **digital versatile discs (DVDs)**. **Floppy disks** are becoming less popular as USB flash drives gain popularity. Floppy disks have a limited amount of storage space (1.44 MB), and some manufacturers have stopped offering them on standard microcomputer configurations. USB flash drives plug into a standard USB (universal serial bus) port, and some hold 2 GB of storage (see Figure 5.3).

CDs for microcomputers originally held data that could only be read; data could not be written to them. This was a very good format for distributing software. Later, a medium called CD-R (for "CD-recordable") became available. It allowed users to record CDs if they had a CD writer drive and used a CD-R disc. The problem is that a CD-R can be recorded once and only once. You cannot rewrite to a CD-R disc like you can with a floppy disk.

Then CD-RW for "CD rewritable" became available in 1997.[2] The technology allowed microcomputer users with a special write-capable CD drive to write data onto the CD multiple times. The CD-RW disc can take multiple recordings, just like a floppy disk. Files can be read from, deleted from, and added to a CD-RW disk.

CDs can hold up to 800 MB of data, and data transfer speeds from the CD to the processor can reach almost 5 million bits per second. The large amount of data that can be quickly transferred makes CDs popular for loading software and other large programs.

DVDs hold from 5 to 20 GB of data, and they also became available in 1997.[3] Their large storage capacity enables microcomputer users to view videos and movies on their computer. Computer users have shown an insatiable appetite for processor speed, memory, and storage space. Images require enormous amounts of storage space and are becoming increasingly important in communication. Such high-capacity DVDs hold much promise for the delivery of interactive video to microcomputer users for training and other communications purposes.

Table 5.3

Removable Disks and Their Storage Capacities
$3\frac{1}{2}$ inch floppy disk holds 1.44 MB of data
Zip disk (developed by Iomega Corp.) may hold 100 MB, 250 MB, or 750 MB of data depending on the model of Zip drive used
CD disks hold approximately 650 MB of data
DVD disks hold from 5 to 20 GB of data

Figure 5.3 **Memorex USB Flash Drive**

Source: © Memorex, Inc. TravelDrive™ is a registered trademark of Memorex, Inc. Used with permission.

Input Devices

Computers would not be very useful without input and output devices. Business operations require enormous amounts of data input and output, and devices were developed to meet those needs. Although many input and output devices are available, only a few have gained wide acceptance.

Human-captured data refers to input captured by a person typing on a keyboard, clicking a mouse, touching a monitor, speaking into a microphone, or a similar interaction. Figures 5.4, 5.5, and 5.6 show devices that capture human input. Human-captured input is very important, because it provides a direct mechanism for the user to control the computer. Most data are not originally in a machine-readable form, and human entry of the data is necessary.

There are two constraints to human-captured data. First, it is slow. Second, it generally does not achieve the very high level of accuracy of **machine-captured data**—data captured by an electronic or mechanical device.

A significant machine-readable event occurred when businesses were required to place a bar code on every product sold.[4] The bar code appears to a person as a sequence of vertical lines, some fatter and some thinner than others. By government decree, all items sold in the United States are required to display this code. The code encapsulates the industry, business, and product identity all the way down to whether the item is a can or plastic bottle. Each unique product has its own unique code. Scanners can read the bar code extremely quickly and pass the data to a computer. The error rate for scanners is extremely low.

Point-of-sale terminals are a type of scanner used in retail stores. They interact with a computer in the store that processes the product information to determine the product price,

Figure 5.4 **Computer Keyboard**

Source: Courtesy of Photolibrary. Com Royalty Free.

Figure 5.5 **Computer Mouse**

Source: © Corbis. All Rights Reserved.

change inventory levels to reflect the sale, and other actions. The computer can note when a minimum inventory level has been met and electronically order more of the product from a vendor. The real importance of point-of-sale terminals is not their technological sophistication, but rather their widespread use and impact on the retail sales industry.

It may seem that machine-captured data are better than human-captured data because computers capture data at less cost. This is true, but it is not the compelling reason. Businesses require large amounts of accurate data for their decision-making processes. The compelling reasons for machine-captured data are the speed and accuracy of the data-capture process. Lower cost is simply an added benefit.

Output Devices

Two of the most familiar output devices are the computer screen, sometimes called the *monitor,* and the printer. Although there has been much attention to the concept of a "paperless office," printed output is a fact of computing.[5]

Figure 5.6 **Touch Screen Monitor**

Source: © Bob Daemmrich/Stock, Boston.

The images on a computer screen are greatly affected by screen resolution. **Screen resolution** refers to the number of pixels, the individual dots of light on the monitor, that are presented. Today, resolutions of 1,600 × 1,200 and greater are common. That means there are 1,600 dots on each of 1,200 lines on the screen. The high resolution of computer screens allows the practical use of enough icons (symbols that represent an action to be performed by the computer) so that the *graphical user interface* (*GUI*, pronounced "gooey") has become the dominant interface.

Monitor sizes are measured along the diagonal of the screen. Monitors with 17- and 19-inch diagonals are common with most current popular computers. Flat-panel monitors take up much less space on a user's desk and use less energy, but cost about $150 more than the price of a traditional monitor (see Figure 5.7).

Printers have experienced advances similar to monitors. Key printer changes have been in the resolution for printing, the speed of printing, and color. Common printers today use either laser or ink-jet technologies. **Laser printers** are essentially copier machines, whereas **ink-jet printers** spray ink onto the surface of the paper.

The advantages of ink-jet printers are that they are mechanically small and generally lower in cost than laser printers. Ink-jet printers have a practical advantage over laser printers in that they can produce color output at a relatively low cost. Common, inexpensive ink-jet printers produce about 15 black and white pages per minute. Color printing is about half the speed of black and white printing. The resolution of ink-jet printing is generally 300 to 1,200 dots per inch.

The resolution of many laser printers is also generally 1,200 dots per inch. Color laser printers have speeds of about 20 pages per minute, whereas models that print only black-and-white copies may print 50 pages per minute. The speed and resolution of printing varies significantly among printer models. Cost is the main factor. Whereas fast, color laser printers may cost as much as $4,000, a color ink-jet printer may cost as little as $100.

Multimedia

The main evolution of input and output devices is in the direction of **multimedia**, the use of more than one medium at a time. For example, information in text form may be projected onto the computer screen accompanied by an image or video. Users don't just type commands; they use a pointing device such as a mouse or speak into a microphone to choose an icon that, in turn, causes the computer to operate on the screen's message. The touch of the keyboard or mouse, the spoken input, the sight of the screen images, and the sound from the speaker combine to provide a wealth of input and output possibilities.

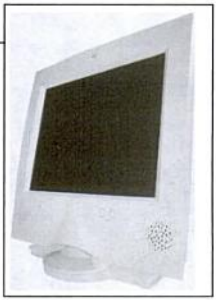


Figure 5.7 **Flat-Panel Computer Monitor**

Source: Ryan McVay/Getty Images, Inc.–Photodisc.

A significant portion of today's computer users would be denied access to computer-based information systems if multimedia were not available. A number of users are illiterate, function at a low level of literacy, or are physically impaired. Children and marginally literate adults need the multimedia capabilities of computers in order to effectively use the resource. Sounds, such as voice communications for instruction and user input, and video images are important for computer interaction with these groups of computer users. Animated images moving from one step to another, possibly with a voice in the background explaining the images, can provide education to this group of users. Multimedia capabilities expand the community capable of meaningful interaction with computing resources.

PERSONAL COMPUTING DEVICES

Personal computing has long been associated with microcomputers. In fact, microcomputers were initially called *personal computers*. Microcomputers were not networked together when they first appeared; each microcomputer user used the resource only for his or her personal computing. Now individual users of a microcomputer can share files, printers, and other resources when connected by a network.

Understanding more about these devices will help you see how they can change business decision making. Some features that make them especially desirable for personal computing are long battery life between recharging, wireless network access, the ability to synchronize data files with other computer resources, and a small, but functional, display screen.

Cell Phones with Interactive Messaging and Video

Popular cell phone manufacturers (Samsung, Nokia, Ericsson, and others) have built phones that display text messages and small images on the display screen. Some cell phones can store short videos. The phone's keypad becomes the input device, although some users find scrolling through the values on the phone's keypad to be tedious. However, the cell phone has rudimentary computing capacity, and its keypad and display screen act as input and output devices.

Cell phones have other features that assist business functions. Contact lists are maintained in the cell phone. The contact lists include not only phone numbers, but also names, addresses, e-mail addresses, notes, and more.

Scheduling and alarms are two additional features of phones that serve business purposes. Managers and professionals attend many meetings, and a cell phone alarm acts much like an alarm clock, ringing at a specified time. Scheduling is more involved. A calendar is displayed on the phone screen and the user selects a day, time of day, and a message concerning the nature of the scheduled appointment.

Smart Cell Phones

A cell phone is considered to be a **smart phone** when it performs tasks typically associated with microcomputers. The Treo 650 from Palm, Inc. (WWW.PALM.COM) fits this definition of a smart phone (see Figure 5.8). It includes scheduling features and contact lists. It also offers Web access and a keyboard. The feature that most distinguishes the Treo as a smart phone is that it can synchronize all of its information (schedule, phone numbers, and more) with a microcomputer.

The BlackBerry 7270 (Figure 5.9) can access your organization's wireless local area network and retrieve information from your databases when your organization installs the BlackBerry Enterprise Server to bridge from your standard server to the BlackBerry. One feature of the BlackBerry 7270 is that it has Voice over Internet Protocol (VoIP) capabilities allowing for lower calling costs through your corporate Private Branch Exchange (PBX). Devices like the BlackBerry help the virtual office concept (described in Chapter 4) become a reality.

Figure 5.8 **The Treo 650 is sold by Palm, Inc.**

Source: Courtesy of Palm, Inc.

Both the Treo and BlackBerry models use the **GSM (Global System for Mobile Communication)** digital cellular phone protocol. GSM is the most widely adopted protocol in Europe, Asia, Africa, and Australia. Its use in the United States started in 2002, and it is becoming the standard here as well. GSM phones create a truly global connection.

However, these added abilities come with a cost. Service plans for smart phones often start at $70 to $100 per month and can go much higher. The price does include both voice and data, so you can use a smart phone as both your phone and Web connection.

Home Networks

Home computer networks have become popular as cable TV companies and phone companies market modems for "broadband" Internet connections. If you have cable TV, you can

Figure 5.9 **BlackBerry 7270**

Source: Courtesy of Blackberry Research in Motion Ltd.

probably purchase a **cable modem** so that you can access the Internet via the cable that brings TV signals to your house. The phone company sells **DSL modems** (digital subscriber line modems). Both cable and DSL modems can bring high-speed Internet access into your home. A more complete network communications description comes later in this chapter.

MODEM SETUP Many households with more than one microcomputer have high-speed gateways to the Internet via a cable or DSL modem. The problem is how to share the single connection among multiple computers. The most common solution is to use a wireless router (see Figure 5.10). The modem connects to the router, and the router connects to computers via a wireless network.

Most new laptop computers have built-in wireless network access, eliminating the need to purchase a wireless access card. If you have a desktop computer without a wireless card, you can purchase a wireless adaptor that connects to a USB connection on your computer. You don't have to use a wireless network to connect multiple microcomputers to your modem, it is just an easy way to connect them at a fairly low cost. The technology between the wireless router and the wireless network card is conceptually similar to transmitting your voice from a cordless telephone to the base unit that plugs into the phone line.

Many electronics stores sell kits that include the wireless router as well as wireless network cards for the microcomputers. They also sell the cable and DSL modems if you prefer not to purchase these from your cable or phone company. Stores that sell the equipment frequently have fact sheets that explain the setup of the modems and network cards in simple terms.

WIRELESS SECURITY As you install your wireless network router, you will be asked certain questions. Understand that your wireless connection has a range of about 100 meters inside a building, because of walls and other obstructions. The range outside is roughly three times as far. This means that other users with wireless network cards can connect to your wireless router network if they live or work nearby. When setting up the router, you may wish to specify a password to limit access to your wireless network.

Another feature to switch on is the encryption of data transferred between the microcomputer and the wireless router. Encrypted data are encoded in such a way that it is very unlikely someone will be able to read information passed over your wireless network. When you set up the router, you may be asked "Do you want to enable WEP?" **Wired equivalent privacy**

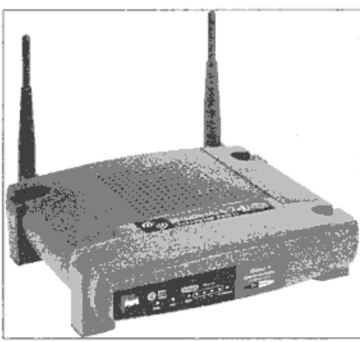


Figure 5.10 **Linksys Wireless Router**

Source: Courtesy of Cisco Systems, Inc.

(WEP) is a common standard, so it is possible that someone with the right equipment in the right place at the right time may be able to intercept and decode your messages, but it is unlikely.

Home Computing Security

Many people have used microcomputers for years and never thought about security. Three aspects of security are important for the microcomputers you use at home and at work: operating system updates, viruses, and spyware. Security for an organization's resources such as Web servers, databases, and networks should be the responsibility of information systems professionals. But you need to protect your computer.

Highlights in MIS

The Impact of Wireless Networks—Convenient but Vulnerable

Wireless networks are popular and their popularity is growing. One area of rapid growth has been wireless networks to distribute access to a single high-speed Internet connection. Many people with cable modems and more than one computer in their home use a wireless network so that the speed of the cable modem can be utilized by all the computers in the home.

"Kits" can be purchased from electronics stores and many microcomputer vendors to set up a home wireless network very easily and for a small amount of money. This is especially attractive to many college students. Assume you have an apartment and three other roommates and all four of you have your own computers. You have a cable modem, and you want to share its speed. The solution is simple; buy a wireless network access point (usually a router) and get a wireless network card for each microcomputer. Now everyone in your apartment can share the speed of the cable modem and the telephone line won't be tied up.

It sounds too good to be true. Actually, there are a few problems that you should know about. First, the "kits" sold by many electronics stores and microcomputer vendors are configured with standard settings so that they will be simple to install. This is good for the setup, but not so good for security. Imagine that everyone in a neighborhood has the same garage-door-opener code. The same analogy applies to the standard settings to let computers with wireless network cards link to the wireless network access point.

These access points are "self-detecting," which means that they are continuously searching for any new wireless network card, and when one is detected it is added to the network. Although you may think this is great when one roommate moves out and another moves in, what happens when someone moves into the apartment next door? The radio frequency signals pass through your apartment walls for about 100 meters. A neighbor with a wireless network card could detect and pick up your wireless access point. Without sharing the cost of the cable modem or the access point, the neighbor enjoys the high-speed access to the Internet at your expense.

This may merely annoy you, but the implications for a firm are far more serious. For example, a franchised pharmacy chain may have many stores. Each store may have a single high-speed communications line for the business transactions it must process. To share the high-speed communications line, the firm may use a wireless network within the store. At least the manager thinks it is shared only within the store. Actually, the wireless network spills out to the sidewalk, the parking lot, and even to adjoining buildings.

What happens if sensitive information from the network is captured by someone outside the store? What if the pharmacy records are accessed by someone outside the store? What responsibility—legal and moral—does the store have to safeguard the information? Business operations can be vulnerable to eavesdropping on wireless networks. It is the responsibility of the firm to take precautions to make wireless networks private to authorized users.

UPDATES Two types of updates are important for individual users: those for operating systems and those for applications software. Microsoft Windows is the most popular operating system for microcomputers. Apple Computer makes Mac OS X; Unix is another operating system. We will focus on the Windows operating system here because it is by far the most common operating system found on microcomputers. The lessons for Windows can be applied to Mac OS X and Unix.

Updating your operating system is important for security and efficiency. Security is the primary concern, but efficiency should not be overlooked. Almost every day a new type of computer hardware is created or improved. Software applications add new features. If you do not update your operating system, you may not be able to efficiently use these new products or features. In fact, without the updates you may not be able to use them at all.

Hackers are people who try to break into computer systems in order to gather information, deny the owner access to his or her computer resources, delete files, or otherwise disrupt the use of the microcomputer by its owner. Some hackers say the term is used incorrectly, that "crackers" are the people who intrude in others' computers for malicious acts, but hackers merely want to "look around." Anyone who breaks into your computer without your approval is a hacker, because they have no right to access your files or computer resources.

Operating systems are the computer programs that control the hardware and software resources of your computer, and for that reason they are the target of hackers. Hackers continually try new ways to break into your computer, so you need to continually update your operating system.

Always go to the Web site of your operating system vendor for updates. Microsoft Windows operating system updates are at WWW.MICROSOFT.COM. You will never receive an e-mail from a vendor with a link for an update; generally, these are scams to trick you into loading harmful software onto your computer. Update your operating system on a regular basis, such as once a week or month.

VIRUSES **Computer viruses** are small computer programs that replicate by inserting themselves into computer resources such as programs or files. Over time, viruses may take over computer resources because so many of the files and programs become infected and unusable. **Worms** are self-contained files or programs. It is common to refer to worms as viruses, but the distinction is that a worm does not have to attach itself to a program or file to replicate or cause harm. Worms can delete files, change files, send e-mail, and cause problems in a number of other ways. For most users, the term *virus* includes true viruses as well as worms. Antivirus software attacks both viruses and worms.

Viruses, and especially worms, are spread through networks. Because of this, some of the most notorious attacks are accomplished by worms that take over a computer and cause it to send large numbers of e-mails. By sending e-mails to the same address, that computer becomes overwhelmed from trying to process all of the incoming e-mail messages. The user is denied access to the services of the computer because it is overwhelmed with e-mail. That is why this type of attack is called a **denial-of-service attack**. A wider-reaching attack focuses on many computers on the same network in order to deny service to the network itself.

What can you do? Install antivirus software. A number of vendors sell antivirus software to organizations and individuals. Grisoft (WWW.GRISOFT.COM) takes an unusual market stand; its main market is the information systems professional who manages a Web server or other major information asset. Although Grisoft does sell its antivirus software (named AVG) for individual use, it provides a free version of its antivirus software for individual computers (not Web, file, or e-mail servers). The free version can be found by searching the Grisoft Web site for the phrase "free edition."

Update your antivirus software on a regular basis just as you update your operating system software.

SPYWARE **Spyware** is a small computer program that monitors what you are doing with your computer resources. Some spyware reports your computer activity, such as which Web sites you visit or which computer applications you use, to another entity. Some spyware actually hijacks your Web browser by taking you to a particular Web site each time you enter a phrase for a Web search. If you've ever experienced unexpected pop-up windows that appear after you type a phrase to be searched on the Web, then you've used a computer infected with spyware.

Most antivirus vendors' software also includes antispyware. Microsoft now includes Windows AntiSpyware with its operating systems. If you are using a Windows operating system, you can download this free antispyware program from the Microsoft Web site. Ad-Aware (from Lavasoft at WWW.LAVASOFT.COM) comes in both a free version and a commercial version. The only difference is in convenience of use. You should not use a microcomputer unless you run antispyware software on a regular basis, just like you run regular updates for your operating system.

How do you know if you have spyware on your computer? The only true way to know is to download antispyware and check your computer. If you have ever shared music or videos from a "free" service, downloaded a "free" game, played poker or the slot machines over the Internet with "free cash," or any other "free" service, then you probably have spyware on your computer.

SOFTWARE

There are two basic types of software: system and application software. System software is required to use the computer, whereas application software processes the user's data. Application software can be obtained in a prewritten form or produced in a custom fashion for a particular user.

System Software

System software (also called *operating system software*) performs certain fundamental tasks that all users of a particular computer require. These tasks relate to the hardware and not to the

Highlights in MIS

SLOW COMPUTERS AND SPYWARE

After class I was talking with one of my students. He wanted advice on the type of computer to purchase. As we talked, I found out that his computer was purchased just a year earlier, but was just too slow. Also, he was having trouble with his cable modem, and his Internet connection was becoming very slow.

Microcomputer technology changes quickly, but not so quickly that a user needs to buy a new computer each year. Also, it was an odd coincidence that his cable modem response became slow just as his computer became slow. It was time to ask about his computer use.

The student engaged in two risky computer use behaviors. First, he swapped music files with friends and with many people he did not know. He left his computer on and connected to his cable modem to increase the sharing of music files. Second, he liked computer games and frequently downloaded "free" games. Both of these activities are used by others to put spyware on computers.

The student loaded antispyware on his computer and ran the program. The software typically scans a computer within a minute or two, but his scan took almost an hour. Over 4,000 spyware programs were found on his computer. The computer took a long time to boot up after being turned on and a long time to run applications simply because most of the computer's resources were being hijacked by spyware. His Internet use was also hijacked; most of the communications were not his, but the communication of spyware reporting all of his computer activities. With the spyware removed, the computer and cable modem speed both returned to normal.

applications that the firm or user performs. It is impossible to use a modern computer without using some of its system software.The operating system manages the computer's processes, functioning as an interface connecting the user, the application software, and the hardware. Examples of operating systems for microcomputers are Windows XP and Mac OS X. Operating systems for smaller computers typically run on more than one manufacturer's processor, whereas the operating system for a large mainframe computer, such as IBM's OS/390, is proprietary and not shared with other computer manufacturers. UNIX is an unusual operating system in that versions run on both microcomputers and mainframes. UNIX is **freeware**; anyone can use it for free and change it to meet their particular needs.

UNIX also has versions that are proprietary (i.e., a vendor will charge a fee for the use or purchase of the operating system). Vendors make their versions of UNIX proprietary by adding features to the operating system that extend the basic features in the free version of UNIX. These vendors still distribute free versions of UNIX (sometimes called "open" versions) but they aggressively market their own proprietary versions for which they can charge customers.

All computers have operating systems, but the systems vary in the number of basic functions and in how those functions are performed. The operating system of a mainframe is much more complex than that of a single-user microcomputer, because the mainframe must coordinate the operations of multiple input and output devices, as well as handle simultaneous users.

Application Software

When the first computers were developed, there were no programming languages. Programmers would load a series of zeros and ones into the memory of the computer to control its operations. Today, we use prewritten application software and, less frequently, custom application software. Information systems professionals create prewritten software and custom application software. With the increase in sophistication of computer users has come an increase in the number of applications written by end users.

PREWRITTEN APPLICATION SOFTWARE Some information-processing tasks are so highly standardized that they function the same way from one business to the next. Software can be prewritten for these situations. Tax calculations, accounting for payroll, depreciation of fixed assets, and many other business transactions are standard. Because these and other such activities see widespread use, a great variety of prewritten software packages have been written for them.

Prewritten application software, sometimes called *off-the-shelf software*, is produced by suppliers and sold to users. Users can use software developed by experienced programmers without either hiring programmers or learning how to program. The users need only to install the software on their hardware, with little or no modification, in order to use it. The software generally allows users to make small adjustments to tailor it to their particular needs. Prewritten software has two very important benefits:

- Prewritten software is available now. The business does not have to wait 3 weeks or 6 months for programmers to develop it.
- Prewritten software is less expensive than custom software.

All businesses know that product development has both fixed and variable costs. Because the fixed costs of development are so high for most application software, compared to the variable costs of marketing and distributing it, the final cost to a business for using prewritten software is modest, because the development costs are spread among multiple users. Prewritten application software is very attractive for smaller businesses that have a limited number of employees available to write computer programs.

CUSTOM APPLICATION SOFTWARE Sometimes an organization has operations that are unique. In these cases, the business may have its own programmers or a consulting group of programmers write the application software to meet its needs. Such software is called **custom application software.**

Far less custom written software is created today than in the 1960s and 1970s when computers were first becoming popular in business. The cost of computing resources has fallen to the point where a very well-equipped microcomputer can be purchased for less than $700. However, in 2003 the Bureau of Labor Statistics found that basic programmers earn an average of $60,000 per year and systems analysts earn $70,000 per year.[6] Unless the firm has a unique business need, custom application software can be difficult to justify in economic terms.

USER-WRITTEN SOFTWARE End users are creating a significant amount of software applications they use in their job tasks. Chapter 4 has a section that addresses the benefits and costs of **end-user computing**. Factors that prompt end users to create their own applications are the speed in which the application is required, the complexity of the application, and the ease of using a software package.

Software packages such as Excel and Access from Microsoft are written in a manner that allows users to quickly perform simple programming steps. Macros, recorded scripts of the clicks required to perform a particular action, can be saved and run as if they were small computer programs. Applications in Access called "wizards" actually take the user through step-by-step instructions to make simple programs to access a database. As software packages have become easier to use, user-written applications have increased.

The Role of User-Friendly Software

Computer software that is simple and intuitive to use is frequently said to be **user friendly**. The term may elicit a negative connotation in that it implies that the application has been made so simplistic that anyone can use it. Actually, *user friendly* means that the application has been carefully engineered so that the varied talents and skills of a wide range of users can be accommodated. It is far more difficult to make software "user friendly" than to make it "programmer friendly."

Business users have expertise in their business area of purchasing, manufacturing, sales, finance, or another area. Widespread use of computer-based resources is achieved when the application software is designed so that these users can use computers to apply their business expertise without special training. Widespread use is the key.

Computer-based resources can play a role in the tasks of most office workers, from entry-level clerks to the chief executive officer. A friendly interface to tap into the computer-based resources means that more data will be used to make better decisions. A review of the characteristics of user-friendly applications follows.

USER-FRIENDLY APPLICATION CHARACTERISTICS

- Guided dialogue to direct the user concerning what data are needed, the data format required, and similar issues
- Menus, step-down lists of commands, and icons: Multiple ways to accomplish the same task provide guidance to novice users while at the same time allowing more proficient users to take shortcuts to task achievement
- Templates and fill-out forms
- Context-sensitive help: Helpful information should be provided to the specific spot where the user is having difficulty, which requires the computer program to keep track of where in the application the user's specific request is originating
- Graphical interface using standardized symbols: Users should not be expected to learn new icons as each application is written, but a standardization of the use of icons, their location on the interface, and their meaning must exist among a wide variety of applications

COMMUNICATIONS

The speed of data transmission between computers that takes place over public telephone systems is often slower than when computers are connected through their own networks. The wire making the connections is the same, yet most computer networks operate hundreds of times faster than connections routed through the public telephone system. The reason is that the protocols for public telephone system communications were established for voice-grade communication and the quality and speed of communication lines did not need to be high. A **protocol** is the specification for formatting data to be transferred between communications equipment.

Public Connections

People who use the telephone system can understand communications even when the line has static or a humming noise; however, computers require extremely reliable connections. Protocols for the public telephone system were established to meet the minimum criteria of voice transmissions—low-grade analog transmissions—and the quality required for voice communications is significantly lower than that needed for the transmission of computer data. The digital signals of computers and their high speeds are beyond the original intent of telephone protocols.

Telephone modems connect about half of home computers to the Internet at speeds of 56 Kbps (56,000 bits per second). **Integrated Services Digital Network (ISDN)** and **Digital Subscriber Line (DSL)** protocols provide standards for transmitting data at speeds from 1.5 to 32 Mbps (32 million bits per second) over standard telephone lines (see Table 5.4).

Table 5.4

Connecting to the Internet

CONNECTION	SPEED	DESCRIPTION
Telephone modem	56 Kbps	Device to connect computers over standard telephone lines.
Cable modem	2 Mbps (warning, see description)	Device that connects to the coaxial cable provided by a cable TV provider to a computer for Internet access. Speeds of these modems vary greatly with 2 Mbps being a frequently published speed advertised by the cable TV providers. However, 11 Mbps is the capability of most currently available cable modems, although providers usually limit the communications speed to the customer to 2 Mbps and sometimes to 512 Kbps.
Integrated Services Digital Network (ISDN)	128 Kbps to 1.5 Mbps	A connection using standard telephone lines as separate channels communicating at 64 Kbps each. The channels are bundled together so that the "basic" bundle of two channels results in the 128 Kbps communications rate. The most frequent bundling is 23 lines, which results in a communications rate of 1.5 Mbps.
Digital Subscriber Line (DSL)	32 Mbps	Technology similar to ISDN but more sophisticated in taking advantage of the communications speed capabilities of the telephone line. Newer versions, xDSL, can achieve speeds up to 52 Mbps.

Kbps = thousands of bits per second
Mbps = millions of bits per second

Digital protocols were introduced to the telephone system in the 1980s but did not become popular until the 1990s when the demand for computer connections from homes increased. Digital data communications, as opposed to voice communications, use packets. A **packet** is a piece of the total data to be communicated, combined with the address of the destination computer, the address of the sending computer, and other control information. Packets will be discussed in more detail later in the chapter.

Cable modems actually connect to the Internet via the coaxial cable that is common for receiving cable television. Cable modems generally reach a speed of 2 Mbps. However, actual speeds sometimes reach only 512 Kbps. Speed of transmission is not just dependent on the technical capability of the cable modem, but also on the speed limit that the cable company wishes to enforce. The maximum transmission capacity of most cable modems is 11 Mbps, but few cable companies allow that speed.

Once the reliability of fiber-optics was established, the need for slow protocols that tracked the sending and receiving of data from each piece of telephone equipment to the next was eliminated. **Asynchronous transfer mode (ATM)** technology offers two characteristics that improve data transmission rates. First, the size of the packet communicated is smaller than with earlier protocols for telephone systems, making it possible for packets from different users passing along the network at the same time to be more evenly intermixed. ATM's second characteristic is its increased speed, from 25 to 155 Mbps. In fact, ATM devices can bundle up to 16 channels together to achieve a transfer rate of almost 2.5 billion bits per second.

Private Lines

Communication requires a connection from one point to another. The possible paths across a network are numerous. Think of driving 20 people from one building to another building across town. If there are four people to a car then it would require five cars—five packets—to get the entire group across town. Each car has the address it needs to go to, and each car can take a different path across the network of roads to reach the building across town. As each car (or packet) travels the network, it has to stop for red lights at various points. The "red lights" on a network are all the network links that the packets must travel through from the origin to the destination.

What if there is an arrangement to keep an open path from the first building to the building across town? What if the arrangement keeps the path, the sequence of roads, open only to the cars traveling to the other building? The path that is always open—always connected—is called a **circuit**.

A **private line** is a circuit that is always open to your communication traffic. The terms **leased line** and **dedicated line** are also used. The private line dedicated to your use is provided by the common carrier, the telephone company. Your organization pays a fixed monthly fee for the use of the line; therefore, the more use the line receives, the smaller the per-unit data cost. Intuitively, it is as if the telephone company ran a wire directly from your firm to the destination.

Two types of private lines are popular—T-1 lines and T-3 lines. A **T-1 line**, sometimes called a *T-1 channel*, has a maximum transmission speed of just over 1.5 Mbps. A **T-3 line** can transfer data at 43 Mbps. The T-1 and T-3 lines are actually collections of 64-Kbps connections between the two pieces of telephone communications equipment. Because they are collections of 64-Kbps connections, the T-1 and T-3 lines can be **multiplexed**; that is, they can be broken into separate lanes of communication, like dividing a highway into multiple lanes. T-1 lines are frequently used by business organizations with a high amount of data communications traffic; T-3 lines are generally used by Internet service providers.

Virtual Private Networks

Private lines are expensive, at least in comparison to Internet connections. Private lines are more secure, because your organization's data are the only data on the communication line. They are also faster than secure Internet transmissions. The higher speed is due to the fact that the authentication of the message sent using the Internet is checked at multiple points as telephone equipment passes the message through multiple links of the network. What if you could achieve the security and speed of a private line but still use the low-cost Internet network?

Virtual private networks (VPNs)[7,8] are the answer to the question. To implement a VPN, an organization needs to contract with an Internet service provider that uses tunneling software. Microsoft and Cisco Systems, a major vendor of communications hardware and associated software, both support tunneling software.

Tunneling software simply establishes the set of intermediary locations of the telephone equipment that will host a given data communications transfer. Tunneling is conceptually similar to establishing a private circuit for the few milliseconds it takes to send the data.

Privacy is attained because the tunnel is not established unless the sending and receiving computers authenticate one another. Speed is attained because once the sending and receiving computers establish authenticity there is no reason for authenticity checks by each separate piece of telephone equipment as the network moves each packet of data along the communications medium. Low cost is achieved because the company is not paying for a dedicated, private communications line to each end point.

The cost savings of VPNs are particularly important when secure data transfers are required between multiple destinations. The traditional private line connects the same two end points (the same two computers) all the time. A virtual private network is established for each pair of computers, and the pair may change from one transmission to the next. VPNs offer a secure, fast, and inexpensive connection between organizations.

Communications—Networks

The International Organization for Standardization (WWW.ISO.ORG) was founded in 1946; it established the **Open Systems Interconnection (OSI)** standard architecture for network connections. OSI consists of a seven-layer model shown in Table 5.5. The levels are detailed so that the exact function for each layer of communication can be plainly defined. In current communications technology, two or more levels may be accomplished by a single piece of communications hardware.

In addition to the standard for the network architecture, a protocol is needed. As we stated earlier in the chapter, a *protocol* is a specification of the format for the data transmitted between communications devices. Once standards for communications networks have been established and protocols for data transfer are instituted, the rewards of information technology can be widely shared.

Protocols for Computer Communication

Computers were not initially designed to share data with other computers, only with terminals. A **terminal** is a device that has no storage or processor; it simply provides a means for

Table 5.5

Open Systems Interconnect (OSI) Reference Model

Layer	Name	Purpose
7	Application layer	Perform application-to-application communication
6	Presentation layer	Manage data-representation conversions
5	Session layer	Establish and maintain communication channel
4	Transport layer	Guarantee end-to-end integrity of data transmission
3	Network layer	Route data from one network address to another
2	Data link layer	Move data from one network address to another
1	Physical layer	Put data onto and off the network media

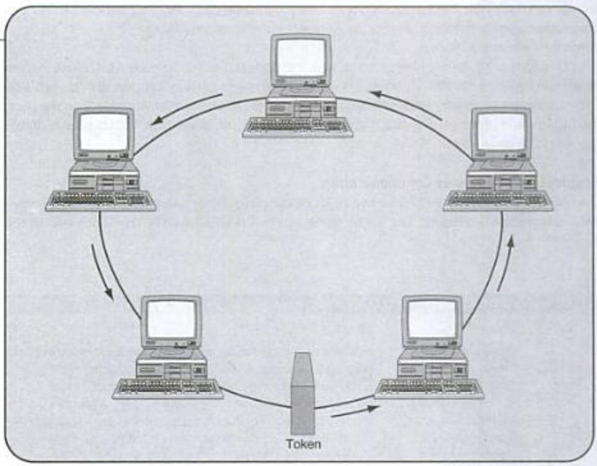
entering and displaying data for the computer. IBM recognized this communication limitation as a problem, especially because it wanted to sell multiple computers to a company. In response to the communications limitation, IBM and others began developing communications protocols.

SYSTEM NETWORK ARCHITECTURE IBM established the **System Network Architecture (SNA)**[9] as a proprietary protocol in 1974. The protocol is designed for large computers, not microcomputers. SNA requires a main, host computer that polls other computers connected by the network in a sequence, much like taking turns. If a polled computer has data to communicate, then the data are transferred, otherwise the next computer is polled. SNA requires firms to purchase additional hardware to control communications.

TOKEN RING IBM recognized that not all customers could or would pay the additional cost for control hardware. The company began to develop a proprietary protocol that did not rely on a host computer to control the communications to other computers but that would treat other computers as peers. The **peer-to-peer protocol** allows each computer to act as its own controller. IBM named its new peer-to-peer protocol Token Ring, because a logical token is passed among the peer computers. The computer with the token is the computer that is allowed to control communications. Figure 5.11 illustrates a Token Ring network.

ETHERNET Xerox developed a different peer-to-peer communications architecture in the early 1970s and, working in cooperation with Intel and Digital Equipment Corporation, released Ethernet. **Ethernet**[10] is an open protocol for peer-to-peer communications. The Ethernet standard is not proprietary and is presently overseen by a professional society, the Institute of Electrical and Electronics Engineers (IEEE). Unlike IBM's Token Ring, Ethernet works from a single transmission line. No token is passed to establish which peer computer controls the

***Figure 5.11* Token Ring Protocol Example**



communications medium. Instead, if a peer computer wishes to send data, it simply checks to see if data are being transmitted. If not, the computer sends the message.

If two peer computers try to send data at the same time, a **data transmission crash** occurs, with the data from one computer being mixed up with data communicated by the other computers. The data sent by each computer are lost in the crash, but the data loss on the communications line does not remove the data from each computer's storage. Each peer computer that sends data will wait for a signal from the receiving computer to verify that the data arrived safely. Lacking a proper reply, such as when data are lost in a data transmission crash, the sending computer merely resends the data. This strategy works well for most peer-to-peer connections, because the capacity of the network is typically far greater than the amount of data likely to be passed between computers on the network.

Packets

The volume of data being communicated can become large, and this becomes a problem when control is not enforced by a host computer. For large data transfers, the messages need to be broken into smaller pieces so that the message from one computer does not dominate the communications medium. This is accomplished with data packets. A **data packet** is a piece of the total data to be communicated, combined with the address of the destination computer, the sending computer, and other control information.

Networks may have one, ten, or even hundreds of possible routes through the communications media that connect the communicating computers. Just as there are many routes for someone to drive a car across town or across the country, individual packets may take different routes. The packets are collected at the destination, put into proper sequence, and checked to ensure that all packets in the message have arrived.

One of the more important packet switching protocols is **TCP/IP**, which stands for **Transmission Control Protocol/Internet Protocol**. The Transmission Control Protocol conducts communications over the network between two computers. The Internet Protocol handles the packets so that they can be routed between computers on the communications network.

Internet Network Addresses

To route packets through the network, each computer handling packets of data must have a unique address. When routing packets on the Internet, the IP address is used. The **IP address** is a four-part set of numbers (each from 0 to 255), separated by periods. The address parts designate the network, host, subnetwork, and computer being addressed. For example, the IP address for the University of North Carolina at Wilmington is 152.20.9.40.

Most users in a firm are linked to networks through a permanently assigned address. Users at home generally access networks using an Internet service provider (ISP). The user connects to the ISP using the public telephone system or through a cable or DSL modem. What remains to be done is to temporarily assign an Internet address to the home user so that communications from the network reach the correct user. That address is one of many owned by the ISP, and the home user simply uses the IP address only as long as the Internet connection is maintained.

NETWORK TYPES

Although many users feel as though there is only one network, the Internet, several types of networks are the building blocks that combine and make the Internet possible. The Internet itself is just a network of the other networks.

Understanding the different types of networks is important, because each can play a different role in the firm's communications strategy. Different types of networks can effectively compartmentalize communications. An analogy would be the layout of the building that houses a firm. An office suite is a collection of individual offices, perhaps in the same department. The suites connect to other suites, representing other departments. Each department suite would be its own local area; local areas would connect to other suites and eventually out of the building to other firms. The doors into a suite, a collection of suites, and the building itself each offer an opportunity to screen and possibly deny entrance. Networks need that same capability.

To be included on a network, each device—each computer, printer, or similar device—must be attached to the communications medium via a network interface card. The **network interface card (NIC)** acts as an intermediary between the data moving to and from the computer or other device and the network. The NIC is more than just a buffer between the computer and the network to allow temporary data storage. It also deciphers information from the packets to determine if the data are meant to be captured or if they should be allowed to pass down the communications line medium. Other network hardware is discussed in Table 5.6.

Local Area Networks

As managers and professional staff became dependent on personal computer resources to perform work tasks, they realized the limitations of passing computer-based information from one user to another by copying files to a disk. It was time consuming to copy the data, walk to coworkers, and have coworkers copy the data onto their computers. What if the coworkers were not at their desks? As important decision-making data became computer-based, computer-to-computer communication became important. Users needed a network.

A **local area network (LAN)**[11] is a group of computers and other devices (such as printers) that are connected together by a common medium. The medium is generally copper wire, but it can be wireless, fiber-optics, or other media. LANs typically join computers that are physically close together, such as in the same room or building. Only a limited number of computers and other devices can be connected on a single LAN.

As a general rule, a LAN will cover a total distance of less than one-half mile, with the distance between any two devices being no more than 60 feet. These distances are only guidelines, because the specifications imposed by the type of communications medium, the NIC used, and the LAN software dictate actual distances. The current transmission speed of data

Table 5.6

Communications Network Hardware

Name	Description
Hub	A device that receives a data packet from a computer at the end of one spoke of the star topology and copies the contents to all other devices. As vendors have tried to differentiate their products, the capabilities of hubs have increased. Some are "manageable" in that they monitor and control the flow of data among the spokes.
Router	A device to connect LANs together. Routers do not simply rebroadcast data; they process control information contained in communications packets in order to determine which LAN should receive the data. Because there may be many possible paths through a network to connect two computers, the router is key to determining which path will be efficient for data transfer.
Switch	A device that connects LANs together. Switches perform router tasks and more. Switches filter data from a network path when that path will not contain the destination computer. As a result of filtering, switches eliminate unnecessary data traffic and make communications more efficient.

along a LAN generally runs from 10 million to 1,000 million bits per second (10 Mbps to 1 Gigabit per second). LANs use only private network media; they do not transfer data over the public telephone system.

METROPOLITAN AREA NETWORKS AND WIDE AREA NETWORKS A **metropolitan area network (MAN)** is a network that has a physical-distance limit of roughly 30 miles. The distance covered differentiates MANs from LANs. Conceptually, a MAN may be the network that connects all of the suites in a building (all departments) together. Linking several buildings of an organization together, such as buildings on a university campus, is a common application of a MAN.

Like LANs, MANs do not use public telephone systems to transfer data. MANs transfer data at speeds similar to LANs.

Wide area networks (WANs) are used to connect computers and other devices when the distance exceeds the constraints of LANs and MANs. WANs use a common carrier, the public telephone system. As Internet connections became pervasive, interest in WANs declined. For practical purposes, WANs have been replaced by the Internet.

Internet

The Internet has had a greater impact on computer-based communications than any other development, and it has spawned such specialized applications as intranets and extranets. Simply put, an internet is just the collection of networks that can be joined together. If you have a LAN in one office suite and a LAN in a different office suite, you can join them, creating an internet.

Using everyday transportation as an analogy, you can travel two blocks to visit a friend using the road as the medium. This is an example of an internet. However, with an interconnecting set of roads, rivers, train tracks, and plane routes you can travel virtually anywhere in the world. This is an example of the **Internet**. The scale of interconnection is the difference between an *internet* and *the Internet*. That is why it is common to capitalize the "I" in Internet when referring to the global set of interconnecting networks.

The Internet is public. Anyone with a computer and access to the communication medium can travel the Internet. This openness has advantages and disadvantages. If your organization is seeking new customers, then you wish to have the widest possible audience for your products. However, the person using the Internet to retrieve data from your computer resources may retrieve data that you wish to keep private.

INTRANETS Organizations can restrict access to their networks to only members of their organization by using an intranet. An **intranet** uses the same network protocols as the Internet, but limits accessibility to computer resources to a select group of persons in the organization.

How is an intranet different from a LAN? Technically, a LAN has no physical connection to another network. It is important to note here that many people (incorrectly) refer to their local group of computers as their LAN, even though the local network bridges to other networks. The intranet has a connection to other networks within the firm but uses software, hardware, or a combination of both to prevent communications from devices outside the firm. Firewalls (discussed in Chapter 9) are commonly used to enforce intranet security.

EXTRANETS Some authorized users of a network may be outside the boundaries of the firm. For example, a firm's supplier may need access to computer-based inventory records. The connection to the outside user is most likely accomplished through the Internet. When an intranet is expanded to include users beyond the firm, it is called an **extranet**. Only trusted customers and business partners are afforded extranet access, because this access allows possible use of information systems and computer resources not directly related to the communication. Firewalls are also used with extranets in order to prevent unauthorized users from accessing computer resources.

THE CONVERGENCE OF COMPUTING AND COMMUNICATIONS

Computing devices and communications devices are now incorporating features of the other into themselves. The limits to the possibilities relate to battery life, communication speed and security, size of display and keyboard, and the user's imagination. In the office of the future, you may simply place your cell phone into a cradle on your desk. The cradle would attach to a monitor, keyboard, mouse, and any other input or output device you need. All computing would be performed by the computer processor within your phone. When you leave, your computer (inside your phone) goes with you. With cradles available for use in public areas (at a store, the library, or the gym), you could compute anywhere.

Voice over Internet Protocol (VoIP) is the routing of voice communications over the Internet as if they were digital communications. Any voice signal can be digitized and sent via the Internet and played back on speakers at its destination. If your computer has a microphone and speakers, then you can communicate with anyone else with similar equipment on their computer. Skype (WWW.SKYPE.COM) has provided free software for such connections since 2003.

Many users associate VoIP with an added feature that can be purchased if they use a cable modem. The added feature is connecting the computer to the public telephone system in order to make a computer-to-phone connection. Avaya, Vonage, and other companies sell this service, which makes voice communications possible over computer networks.

Summary

Summary

The basic computer system architecture includes a processor, memory, and storage. These components work together to input, manipulate, and output information. Microprocessors in microcomputers are tremendously fast, and their power doubles every 18 months.

Just as important as increases in computer power, interactions between users and computers have become more intuitive. Input and output choices have increased to provide managers with an array of possibilities for computer interaction. These advances, in part, are facilitated by the increased power and storage capabilities of current microcomputers. Images, sounds, videos, and other input and output choices are added to the standard keyboard, mouse, computer screen, and printer. The effect is far reaching and not always obvious. If a manager can use an icon to represent a computer action, then the user does not have to be able to read the same language or even be able to read at all. These multiple choices help bridge communication between users with different native languages and even to include young users who have not learned to read. The new choices have made computer-assisted decision making more inclusive to a wide range of demographic groups.

Software is evolving. This reflects the increasing belief that computer assistance is part and parcel to the decision-making processes of modern managers. Managers want software that controls hardware devices, maintains data security, enables multiple users to share common resources, and can be used without special training. It is inappropriate to say that software is becoming more "user friendly"; software is being better engineered to meet the needs and abilities of managers.

Computers can act as stand-alone resources, but their power as business tools is increased immensely when they share data. Data communications can take place from one computer to another either directly along a network connection or through the intervening network of the public telephone system. Computer hardware communicates much faster than telephone hardware. This means that transmission of computer data that travels across the public telephone system is slower than transmission that does not use the telephone system.

Networks started as connections from the computer to a terminal at some distance from the computer. The terminal has no processor and no storage; it simply acts to input and output data. Computer data transfer to another computer is more difficult because each computer has an operating system that controls access to its own resources. Networks are the hardware and software that act as intermediaries between computers to enable the sharing of computer resources.

Local area networks were the first type to network. They had limitations on the distance allowed between computer resources, but they made a big impression on management. Workers depend on computer-based data for decision making, and when workers can easily share computer-based data, the firm benefits.

Communication requires standards, because different manufacturers of computer and telephone hardware must have common, understandable representations of the data moving along communications media. Telephone systems standards were established for voice communications, and those communications can occur using low-grade, analog connections. However, the voice-grade medium for communication is not always reliable enough for data communications between computers, so new standards were required. The International Organization for Standardization established the Open Systems Interconnection standards for data communications that we use today.

Key Terms

mainframe
microcomputer (PC)
processor
word
memory
fixed storage
USB flash drive
compact disc (CD)
digital versatile disc (DVD)
floppy disk
human-captured data
machine-captured data
screen resolution
laser printer
ink-jet printer
multimedia
smart phone
Global System for Mobile Communication (GSM)
cable modem
digital subscriber line (DSL) modem
wired equivalent privacy (WEP)
hacker
computer virus
worm
denial-of-service attack
spyware
system software
prewritten application software
custom application software
user friendly
protocol
telephone modem
Integrated Services Digital Network (ISDN)
Digital Subscriber Line (DSL)
packet
cable modem
circuit
private line
virtual private network (VPN)
tunneling software
peer-to-peer protocol
Token Ring
Ethernet
data packet
Transmission Control Protocol/Internet Protocol (TCP/IP)
IP address
network interface card (NIC)
local area network (LAN)
metropolitan area network (MAN)
wide area network (WAN)
Internet
intranet
extranet
Voice over Internet Protocol (VoIP)

Key Concepts

- computer components
- personal computing devices
- networking
- communications and computing convergence

Questions

1. If you buy a computer today for $1,500, how many years would pass before the same amount of computer power could be purchased for $375? (Hint: Use Moore's Law.)
2. Assume that your friend's computer processor runs at 500 MHz and your computer's processor runs at 1 GHz. How fast is your computer processor speed compared to your friend's?
3. How does a CD-R differ from a CD-RW?
4. What are the most compelling reasons to capture data electronically instead of manually?
5. What does it mean if a monitor has a screen resolution of 1,600 × 1,200?
6. What makes a "smart" phone?
7. What is a hacker?
8. Why is custom software more expensive than prewritten software?
9. What does the phrase "user friendly" mean?
10. Why are networks that use the public telephone system slower in transmitting data than networks that communicate directly between computers?
11. What is a virtual private network?
12. What is a peer-to-peer network?
13. How does the Ethernet protocol deal with data transmission crashes?
14. What is the difference between a local area network and the Internet?
15. What is a disadvantage of connecting a wireless network access point to a cable modem?

Topics for Discussion

1. How will wireless communications and cell phones change computing?
2. Make an analogy between the rapid advances of information technology according to Moore's Law and what transportation (such as cars and planes) would look like if a similarly rapid advance in technology took place.
3. How would computing change managerial decision making if your cell phone could control your computer and display the results to the cell phone's display screen?

Problems

1. A firm can achieve competitive advantage by sharing computer-based information and systems with vendors. However, such sharing has risks related to making the firm's computing resources available via the Internet. Identify the risks and benefits of sharing computer-based information with vendors over the Internet. Do the benefits outweigh the risks?
2. Communications technologies and computing technologies are converging. How does a device such as the BlackBerry 7270 symbolize this convergence?

Case Problem

Special Salmon

You are the CIO of Special Salmon, one of the largest providers of fish to restaurant chains in North America. The information systems division is located in Miami at the company headquarters. Special Salmon occupies five separate office buildings in an industrial park; each building houses between 75 and 125 employees. Three seafood-processing plants are located in Georgia, Texas, and Virginia.

Special Salmon has a fleet of over 200 fishing boats that fish the Atlantic and Gulf coasts of the United States. Because competition is keen, it goes without saying that you have to know where the fish are located at any given time. You also have to know the types of fish that are processed and where they will be sold. Getting orders from your restaurant

Case Problem continued

customers requires some negotiation. Each restaurant requires certain amounts of specific items, but about half of their orders are based on what fresh seafood is available and its price. This is a true supply-and-demand business; demand and supply levels change daily as seafood is caught and sold. The product is perishable, so it needs to be sold quickly. At the same time, restaurants want what is fresh, and that means they must buy what is available.

Special Salmon has used proprietary communications with its customers for years. Dedicated phone lines, sometimes called private lines, were used, and they provided secure communications. But the cost was high. Now you are investigating the use of extranets to communicate with your customers. Your customers will gain access to your inventory information systems via the Internet to learn what seafood items you have, the inventory in your warehouses (as well as when the seafood was caught), and the amounts of seafood due to arrive at the warehouses within the next 24, 48, and 72 hours. Prices for seafood are also provided, but these are determined by the amount of each type of fish purchased and the total dollar amount of the purchase, coupled with recent purchases that lead to volume discounts.

You have already convinced the president and board of Special Salmon to switch from dedicated phone lines to an extranet. Now you need to make a plan to implement the extranet.

Make the following assumptions:

- The microcomputers in each office building and each seafood-processing plant are connected via a LAN.
- Each office building and each seafood-processing plant will connect to the Internet via a cable modem.

ASSIGNMENT

1. What are the benefits of using an extranet instead of dedicated/private phone lines in this situation?
2. What data communications speeds do you expect from the LANs and from the cable modems? Will this speed be sufficient for your business needs?
3. How do you expect your customers, the restaurants, to react to the change to extranets?

NOTES

[1]John Markoff, "IBM Plans a Computer that Will Set Power Record," *New York Times*, November 19, 2002, C-9.

[2]Carle Catalano, "CD-R and CD-RW," *Computerworld* 33(6) (February 8, 1999), 77.

[3]Terry Kuny, *Network Notes #39*, ISSN 1201-4338, Information Technology Services, National Library of Canada.

[4]Edward K. Yasaki, Sr., "Bar Codes for Data Entry," *Datamation* 21(5) (May 1975), 63.

[5]Jerome Nugent-Smith, "The Myth of the Paperless Office," *Modern Office* 24(9) (October 1985), 8–9.

[6]Bureau of Labor Statistics, July 2003, WWW.BLS.GOV.

[7]Joaquim Menezes, "Internet VPNs Ready to Grow," *Computer Dealer News* 15 (November 12, 1999), 43.

[8]Mike Hurwicz, "A Virtual Private Affair," *BYTE Magazine* 22 (July 1997), 79–84.

[9]Eric Krapf, "IBM-Cisco: End of an Era for Big Blue," *Business Communications Review* 29 (October 1999), 16–17.

[10]Alan Deikman, "Ethernet Maintains Its Lead with Flexibility and Compatibility," *Computer Technology Review* 10 (Fall 1990), 31–33.

[11]Sara Humphry, "The Complete Guide to NetWare LAN Analysis," *PC Week* 13 (November 4, 1996), N26–N31.

Chapter 6

Database Management Systems

Learning Objectives

After studying this chapter, you should

- Understand the hierarchy of data.
- Understand database structures and how they work.
- Know how to relate tables together in a database.
- Recognize the difference between a database and a database management system.
- Understand the database concept.
- Know two basic methods for determining data needs.
- Understand entity-relationship diagrams and class diagrams.
- Know the basics of reports and forms.
- Understand the basic differences between structured query language and query-by-example.
- Know about the important personnel who are associated with databases.
- Know the advantages and costs of database management systems.

Introduction

Database management systems organize the large volumes of data that firms use in their everyday transactions. Data must be organized so that managers can find specific data easily and quickly for decision making. Firms break the entire collection of data into a set of related tables of data. These smaller collections of related data reduce data redundancy. In turn, data consistency and accuracy are increased.

The structure of the firm's data has changed over the years. Currently, most firms use databases that conform to a relational structure. Two important reasons for this are that the relational database structure is easy to use and that relationships among tables in the structure are implicit. Ease of use has emboldened many managers to become direct users of database resources.

A database must be designed very carefully. Information systems professionals and business users work together to create database specifications. Approaches such as process-oriented modeling and enterprise modeling enable the database design to address existing problems as well as seize opportunities through synergy among business areas. Techniques such as entity-relationship diagrams and class diagrams clarify the communications between information specialists and users so that the database design meets the firm's needs.

The increased importance of databases as resources supporting decision making has required managers to learn more about database design and use. Forms and reports are the standard methods for access, but queries are becoming more important. All other things being equal, managers who can make the best direct use of database resources make the best decisions for the firm.

In this chapter, we present both examples and conceptualizations of databases. As topics are demonstrated, we occasionally repeat a concept. Bear with us. Database concepts are so important to managers that a second telling is justified.

DATA ORGANIZATION

Computers were initially used to solve problems requiring complex and tedious numerical calculations. Those problems required little input and little output. Today, firms require huge amounts of input and output. Firms often need the computer to solve the same problem, with different inputs, many times. Calculating the bill of a customer each time a sale is made is a simple process that may be repeated many times.

Firms store large amounts of data in their computer-based information systems simply because they conduct so many business transactions. So much data exists that it would be useless for business decision making without an effective and efficient manner for organizing it. In order to use the data and avoid chaos, the concept of "data" had to be broken down and reduced to smaller concepts. The smaller concepts of data make available building blocks that can be combined to reproduce the original data in an organized, accessible form.

The Data Hierarchy

Business data have traditionally been organized into a hierarchy of data fields that combine to form records, and records that combine to form files. A **data field** is the smallest unit of data; it represents the smallest amount of data that will be retrieved from a computer at a given time. An example of a data field might be a code for a course you are taking. A **record** is a collection of related data fields. Users logically think that the data fields in a record are related, such as a course code would be related to a course title. A **file** is a collection of related records, such as a file of all records containing course codes and title fields.

Files can be represented as tables; Table 6.1 is an example file that we can call COURSE. The records are the rows in the table. Values in the rows represent the values of the data fields—"MIS105" and "Information Systems Literacy" being the values of the course *Code* and *Description* fields for the first record. The simple hierarchy of fields comprising records that combine into a file establishes the fundamental organization of all data used in computer-aided decision making.

A **database** is a collection of files. The **general definition of a database** is that a database is the collection of all of a firm's computer-based data. A more **restrictive definition of a database** is that a database is the collection of data under the control of database management system software. Under the restrictive definition, the firm's data that are controlled and administered by a database management system would be considered to be the database; computer files in a manager's personal computer would be considered outside the database. In this text, we typically use the general definition of a database—that is, that a database is the collection of all computer-based data. However, in this chapter we explore the restrictive definition—data under the control of database management system software.

The Spreadsheet as a Simple Database

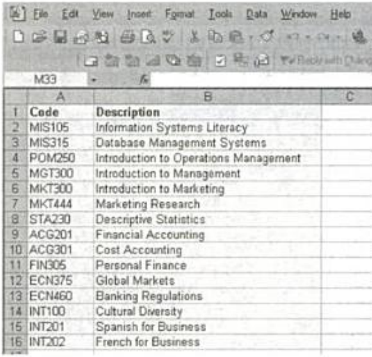
The table of rows and columns can be represented in a spreadsheet. Because so many users are familiar with spreadsheets, they are a useful way to introduce database concepts.[1] The columns of the spreadsheet represent the data fields, and column headings contain data field names. Rows of the table contain the field values.

Figure 6.1 illustrates an Excel spreadsheet containing the values from the COURSE table of Table 6.1. The table concept is important, because the most popular database structure for business organizations, the **relational database structure**, is conceptually similar to a collection of related tables. Most terms used by information specialists working with database management systems relate to terms used to describe tables, but some additional terms and concepts are required.

Table 6.1

The COURSE Table

Code	Description
MIS105	Information Systems Literacy
MIS315	Database Management Systems
POM250	Introduction to Operations Management
MGT300	Introduction to Management
MKT300	Introduction to Marketing
MKT444	Marketing Research
STA230	Descriptive Statistics
ACG201	Financial Accounting
ACG301	Cost Accounting
FIN305	Personal Finance
ECN375	Global Markets
ECN460	Banking Regulations
INT100	Cultural Diversity
INT201	Spanish for Business
INT202	French for Business



	A	B	C
1	Code	Description	
2	MIS105	Information Systems Literacy	
3	MIS315	Database Management Systems	
4	POM250	Introduction to Operations Management	
5	MGT300	Introduction to Management	
6	MKT300	Introduction to Marketing	
7	MKT444	Marketing Research	
8	STA230	Descriptive Statistics	
9	ACG201	Financial Accounting	
10	ACG301	Cost Accounting	
11	FIN305	Personal Finance	
12	ECN375	Global Markets	
13	ECN460	Banking Regulations	
14	INT100	Cultural Diversity	
15	INT201	Spanish for Business	
16	INT202	French for Business	

Figure 6.1
Spreadsheet Example of the COURSE Table

academic area have been stripped off and put into a separate column. The courses for the academic area are shown as columns on the same row. Columns for course codes and descriptions repeat; therefore, Table 6.2 is not a flat file.

Repeating columns violate the requirements for a flat file. The reason that a table must be a flat file is because computers read data fields from a record in sequence. When the sequence is not in a constant order, the computer cannot read the records correctly. In the first row of Table 6.2, the computer would read five values: "MIS," "105," "Information Systems Literacy," "315," and "Database Management Systems." The computer would expect to read five values in the next record: "POM," "250," "Introduction to Operations Mgt," "MKT," and "300." But notice that the computer has made a mistake; it confused the first two values of the third row as the fourth and fifth values on the second row. A flat file, one without repeating columns, provides the constant sequence of data fields that database management requires.

A second reason for flat files is that they allow relational database structures to be normalized. **Normalization** is a formal process for eliminating redundant data fields while preserving the ability of the database to add, modify, and delete records without causing errors. Normalization is beyond the scope of this text but is a primary focus of database management systems courses.

Table 6.2
The COURSE Table with Repeating Columns (Not a Flat File)

Area	Code	Description	Code	Description
MIS	105	Information Systems Literacy	315	Database Management Systems
POM	250	Introduction to Operations Mgt.		
MGT	300	Introduction to Management		
MKT	300	Introduction to Marketing	444	Marketing Research
STA	230	Descriptive Statistics		
ACG	201	Financial Accounting	301	Cost Accounting
FIN	305	Personal Finance		
ECN	375	Global Markets	460	Banking Regulations

Table 6.3

The BOOK Table

ISBN	TITLE
X125	Database Examples
C21	HTML for Beginners
P1963	Business Management
C123	Product, Promotion, Placement, and Price
W459	Personal Sales Techniques
R16	Introduction to Accounting
U523	Cost Accounting
H384	Operations Management Fundamentals
J384	Risk and Returns
K232	Personal Productivity Software
L921	Fundamentals of Hardware
K772	Stocks Versus Bonds
K127	Human Resources for Today
T881	Oracle Servers
T327	SQL Servers
A129	Business Management
N991	The Federal Reserve System
V67	Business French
X329	Spanish at Work
P88	Statistics for Business

Key Fields

Table 6.3 depicts values in the BOOK table and illustrates the concept of a key. The **key** in a table is a field (or combination of fields) that contains a value that uniquely identifies each record in the table. This means that each row in the table is uniquely identified. Many times a single field serves as a key for a table. Distinguishing between two or three rows is not enough; key values must be unique for the entire table. If you were told that the value of the *ISBN* field was "X125" you would know that the *Title* field value was "Database Examples." The *ISBN* field is the key.

At first glance it may seem that the values of the *Title* field will also uniquely identify each row. However, the title "Business Management" occurs twice, so the computer could not tell if the ISBN value "P1963" or "A129" should be used. Books occasionally have the same title, but an ISBN is always unique.

Some tables may have two fields that are candidates for being the key. A **candidate key** is a field that uniquely identifies each table row but that was not chosen to be the key. In the COURSE table described in Table 6.1, the *Description* field will uniquely identify each row. However, the *Code* field was chosen to be the key. Frequently, when confronted by a choice between two fields that could each be the key the field that is more compact is chosen. Field values that are longer (such as the *Description* field values versus those in *Code*) are avoided, because the longer field values present a higher risk of mistyping the key-field value.

Some tables require the values of two or more fields to uniquely identify each row in the table. A possible example might arise when courses have projects. Table 6.4 shows projects, but note that there is no single data field value that will uniquely identify each row. Values in the *Code* field column repeat between rows. So do field values in all other columns. However, when values in the *Code* and *Number* fields are taken in combination, the combined values become unique.

Table 6.4

The PROJECT Table

Code	Number	Title	Due	Points
MIS105	1	Home Page Development	9/15/2003	25
MIS105	2	Working With Windows	11/13/2003	50
MIS316	1	Alumni Database	12/5/2003	20
MKT444	1	Finding Customers	10/31/2003	50
MKT444	2	Segmenting Customers	11/21/2003	50
MKT444	3	Customer Service	12/12/2003	40
FIN305	1	Personal Portfolio	11/14/2003	35
INT201	1	Nouns	9/17/2003	15
INT201	2	Verbs	11/21/2003	25
INT202	1	Nouns	9/17/2003	15
INT202	2	Verbs	11/21/2003	25

Relating Tables

You can easily see the relationship between the COURSE and PROJECT tables (Tables 6.1 and 6.4). The tables share a common field, *Code*, and the value of the *Code* field determines which rows in the tables are logically joined. For example, if you are curious about the projects required for the course titled "Information Systems Literacy," you must find matching values in the data field shared by both tables. The *Code* field is in both tables and allows data in both tables to be brought together, or related. "MIS105" is the *Code* field value when "Information System Literacy" is the *Description* field value. This relates to the *Code* field value in the PROJECT table showing that the "Information Systems Literacy" course has projects for "Home Page Development" and "Working With Windows."

Sometimes tables that originally stand alone as independent may later be required to be joined. Consider Table 6.5, the DEPARTMENT table. It shows the six departments offering the courses in the COURSE table. The two tables do not share a common column. You might be able to guess which department offered each course based on the values in the *Abbreviation* field, but a computer needs an exact match, not a guess.

We will add the field *Abbreviation* to the COURSE table so that the two tables can be joined by a common field. Table 6.6 depicts the COURSE table with *Abbreviation* added. Now, a student having trouble in the "Introduction to Marketing" class can match the "MGTMKT" *Abbreviation* field value in the COURSE table to the "MGTMKT" *Abbreviation* field value in DEPARTMENT and know to call "910-4500" for help.

Table 6.5

The DEPARTMENT Table

Abbreviation	Name	Located	Phone
ISOM	Information Systems and Operations Management	Cameron Hall	910-3600
MGTMKT	Management and Marketing	Cameron Hall	910-4500
ACGFIN	Accounting and Finance	Dobo Hall	910-1800
ECN	Economics	Randall	910-0900
INT	International Business	Dobo Hall	910-0900

Table 6.6

The COURSE Table with *Abbreviation* Field Added

CODE	DESCRIPTION	ABBREVIATION
MIS105	Information Systems Literacy	ISOM
MIS315	Database Management Systems	ISOM
POM250	Introduction to Operations Management	ISOM
MGT300	Introduction to Management	MGTMKT
MKT300	Introduction to Marketing	MGTMKT
MKT444	Marketing Research	MGTMKT
STA230	Descriptive Statistics	ISOM
ACG201	Financial Accounting	ACGFIN
ACG301	Cost Accounting	ACGFIN
FIN305	Personal Finance	ACGFIN
ECN375	Global Markets	ECN
ECN460	Banking Regulations	ECN
INT100	Cultural Diversity	INT
INT201	Spanish for Business	INT
INT202	French for Business	INT

DATABASE STRUCTURES

Database structures are ways of organizing data in order to make data processing more efficient. The structure is then implemented via a database management system. We discuss three standard structures, but there is interest in developing new structures to more efficiently process very large amounts of data.[2]

A **database management system (DBMS)** is a software application that stores the structure of the database, the data itself, relationships among data in the database, and forms and reports pertaining to the database. The data field description is also included—field names, data types, number of decimal places, number of characters, default values, and all other field descriptions. This is why the database controlled by a database management system is called *a self-describing set of related data*.

Hierarchical Database Structures

The first database management system, IDS (Integrated Data Store),[3] was developed by GE in 1964. This database influenced the standardization work of the Committee on Data Systems Languages (CODASYL). The committee had members from government, industry, and academia so that the standard developed would be open to all. CODASYL formed a Data Base Task Group and charged the group with the responsibility to develop database standards.

The IDS database management system conformed to a **hierarchical database structure**. The hierarchical structure is formed by data groups, subgroups, and further subgroups; if you were to draw the structure, it would appear as the branches of a tree. Like branches on a tree, to get from a record on one branch to a record on a different branch required that the database management system navigate back to a common junction for the branches. Figure 6.2 shows navigation from the DEPARTMENT table to the COURSE table.

The hierarchical structure for databases was initially popular because it worked well with the transaction processing systems that performed such tasks as inventory control, order entry, accounts receivable, and accounts payable. Accounting tasks such as these were among the first business operations to be computerized.

Another reason for their initial popularity was that hierarchical structures utilize computer resources efficiently, especially when the large majority of records in the database are to

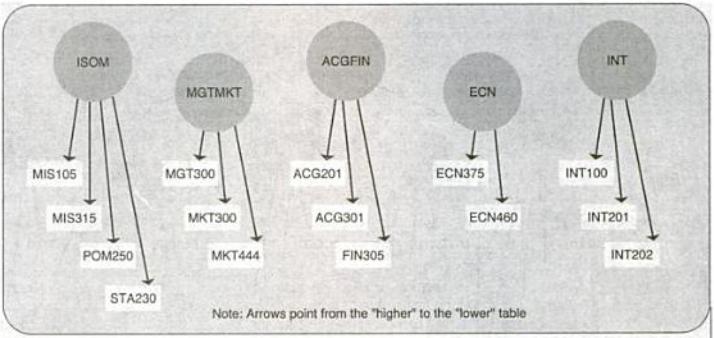


Figure 6.2 **The Hierarchical Structure Between the DEPARTMENT and COURSE Tables**

be used in an application. The organization wants all customers to get a bill, all vendors to be paid, and all orders to be processed. For these applications, hierarchical structures make very efficient use of database resources. In the 1960s, when the hierarchical structure was developed, computer resources were expensive.

However, when managers want only a few selected records from the very large number of records in the database the hierarchical structure is not efficient. This is because each hierarchical database record has a field that points to the storage address of the next logical record in the database. Records do not have to be stored physically one after the other on a storage device. A pointer locates the "logically next" record (the subsequent record), and the database management system retrieves the "logically next" record. However, managerial decisions may require a single, specific record to address a business problem. A manager wants a specific purchase order record to address a service complaint from a particular customer, not a list of the thousands of purchase orders placed that day.

Network Database Structures

The **network database structure** was developed to allow retrieval of specific records. It allows a given record to point to any other record in the database.[4] The Data Base Task Group subcommittee of CODASYL released its specification for the network database structures in 1971.[5]

Networks solved the problem of having to backtrack all the way to a joining "branch" of the database. Conceptually, any record in the database could point to any other record in the database, intuitively like leaping to any branch on the tree. However, this wide range of possible connections was the weakness of applying network structures to practical problems. It was just too chaotic to allow every record to point to every other record. Even experienced information systems professionals found it difficult to correctly develop and use databases using network structures.

Relational Database Structures

Business organizations never widely adopted database management systems built on the network structure. However, organizations still needed a way to address managerial problems using databases; that is, they needed a way to focus on small subgroups of data and link from

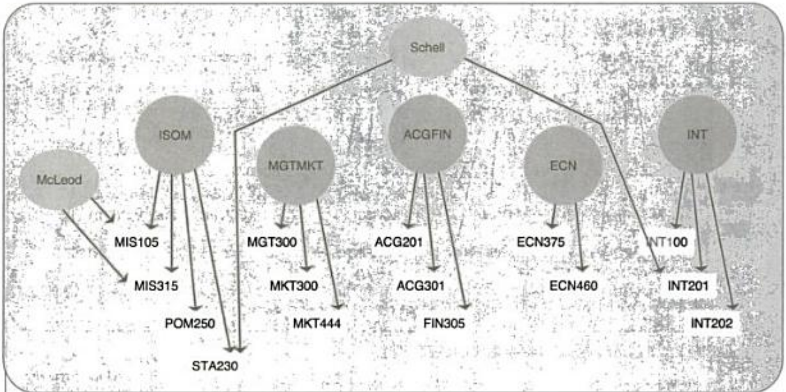


Figure 6.3 **Adding a Table for FACULTY Is Beyond the Ability of Hierarchical Database Structures**

one piece of data to another without having to navigate through a large number of intermediary data records.

Another problem was that tables farther down the branches could only be related to a single higher table. Like a leaf on a tree, a table is attached to only a single branch. If we wished to add a table for faculty (possibly have McLeod and Schell teach courses), the diagram would look like Figure 6.3. Conceptually, the COURSE table would have two higher tables pointing to it, FACULTY and DEPARTMENT. Such a relationship is not allowed by hierarchical database structures.

The breakthrough came from basic research using relational algebra conducted independently by C. J. Date[6] and E. F. Codd.[7] Their work is closely associated with the relational database structure that is the most commonly used today by business organizations. This database structure looks like a collection of tables similar to spreadsheet tables. Relationships between the tables are not stored as pointers or addresses; instead, the relationships between tables are implicit.

Whereas the hierarchical and network structures rely on **physical relationships** in the form of storage addresses, the relationships in relational database structures are implicit. **Implicit relationships** can be implied from the data. When a common data field (column) between two tables exists, the records (rows) from the two tables can be joined when the data field values are equal. This is how we joined the DEPARTMENT and COURSE tables together using values in the *Abbreviation* field.

The conceptualization of a database structure that consists of tables in which relationships are implicitly established by matching values in common data fields is easy to use and understand. Ease of use is very important. When organizations became "flatter" (when they reorganized to have fewer layers of management), fewer specialists were available to assemble data from computer-based systems and generate reports for managers. Today's managers and professional staff must access information directly from a database in order to support their decision making. The table-like structure of relational database management systems is a format that can be understood quickly by both managers and professional staff.

A RELATIONAL DATABASE EXAMPLE

An example of data fields, tables, and relationships between tables will set the stage for the database concepts presented later in the chapter. A database named ***Schedule*** has been created from tables used earlier in the chapter and some others. (We will use italics for the name of a database to distinguish it from a table.) Databases break information into multiple tables because if information were stored in a single table, many data field values would be duplicated; that is, data would be redundant. Databases reduce **data redundancy** in tables.

Databases increase **data consistency** and **data accuracy**. These are critical concerns. Managers make decisions critical to the firm's operations; accordingly, they need data that are both accurate and consistent with other data in the database. Reducing the amount of redundant data is good, but data consistency and accuracy are vital.

The *Schedule* Database

The example used here is implemented on Microsoft Access database management system software, but the implementation would be similar on any standard relational database product. IBM, Oracle, Microsoft, and many other companies provide relational database management system software. The implementations may be slightly different, but they all use the same structure.

The COURSE table in Access is shown in Figure 6.4. It is a list of data field values. The table itself had to be defined in Access before values were entered into the data fields. Figure 6.5 shows the definition of the *Code* field. The icon to the left of *Code* is a key, designating that *Code* is the key field of the COURSE table. *Code* is a text field, in that it can contain letters, digits, and/or symbols. By looking at the *Field Size* in Figure 6.5, you see that the field is limited to eight characters.

Note that other restrictions can be placed on *Code* values. An input mask can be used to force certain characters to be entered in a particular manner. For our *Code* values, a mask of "LLL000" in an Access DBMS definition would require that the first three characters be letters and the last three characters be digits. For other types of fields, such as phone numbers or zip codes, appropriate input masks can also be established. Default values can be specified as well as rules for validating (testing) the entered value. Any user-entered value that does not meet the requirements would be rejected and would not be recorded into the database.

The *Code* field is the key for the table, so duplicate values are not allowed. Key values must be unique. But other fields may allow duplicates if the designer chooses that option.

COURSE : Table

Code	Description	Abbreviation
+ ACG201	Financial Accounting	ACGFIN
+ ACG301	Cost Accounting	ACGFIN
+ ECN375	Global Markets	ECN
+ ECN460	Banking Regulations	ECN
+ FIN305	Personal Finance	ACGFIN
+ INT100	Cultural Diversity	INT
+ INT201	Spanish for Business	INT
+ INT202	French for Business	INT
+ MGT300	Introduction to Management	MGTMKT
+ MIS105	Information Systems Literacy	ISOM
+ MIS315	Database Management Systems	ISOM
+ MKT300	Introduction to Marketing	MGTMKT
+ MKT444	Marketing Research	MGTMKT
+ POM250	Introduction to Operations Management	ISOM
+ STA230	Descriptive Statistics	ISOM

Figure 6.4 **The COURSE Table in Access**

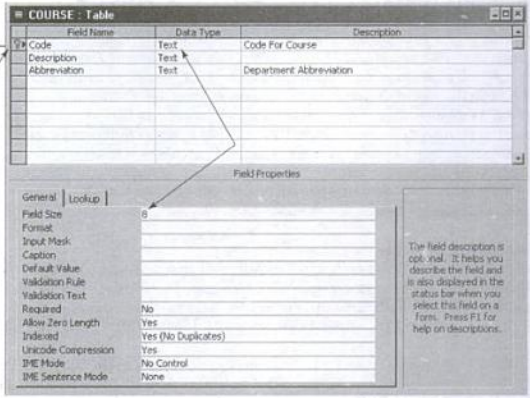


Figure 6.5 **Defining the *Code* Field in the COURSE Table**

Figure 6.6 illustrates that *Abbreviation* field values will be looked up from a list of values in the DEPARTMENT table. Remember from Table 6.6 that the *Abbreviation* field was added to the COURSE table so that records from COURSE and DEPARTMENT could be logically joined. Data values from the *Abbreviation* field in the DEPARTMENT table are presented to users in a drop-down menu when they try to enter values in the *Abbreviation* field of the COURSE table. This will ensure that a user entering data into the COURSE table does not make typographical errors when entering *Abbreviation* values.

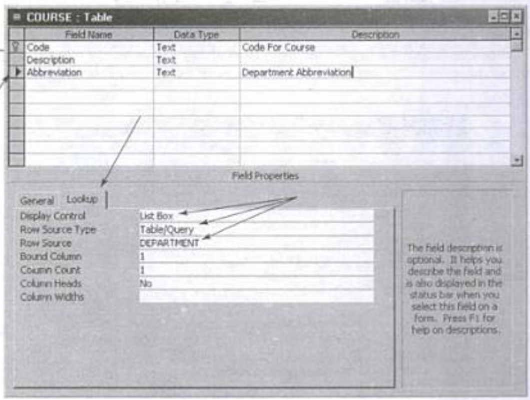


Figure 6.6 **Look-Up Values**

The design of the fields in the COURSE table enables the user to support data accuracy and consistency. Consistency between the COURSE and DEPARTMENT table is enforced because data values entered into the *Abbreviation* field in the COURSE table are selected from a list of values already existing in the *Abbreviation* field of the DEPARTMENT table. An input mask can ensure that *Code* values begin with three letters and end with three digits. Accuracy is enforced by validation rules. The field definitions are simple but quite powerful.

Redundancy is more difficult to conceptualize, especially after the tables have already been separated. Table 6.7 shows a single table of COURSE and DEPARTMENT fields before they were separated into different tables. Notice that the department name, location, and phone number is repeated. In Table 6.6, the COURSE table only has department abbreviations repeated—that repeated field allows COURSE to relate to DEPARTMENT. Redundant fields take up more storage space, slow record processing, and invite data inconsistency. Assume that the International Business department changes its name to "Global Business." If only two of the three affected records in Table 6.7 were changed, the database could not be sure which department name was correct.

Moving the *Name*, *Located*, and *Phone* data fields to a separate table means that a single change to any of these fields is the one and only change required; data inconsistency is avoided. It is necessary for the *Abbreviation* field values to be repeated in the COURSE

Table 6.7

Unseparated Table of Course and Department Data Fields

Code	Description	Abbreviation	Name	Located	Phone
MIS105	Information Systems Literacy	ISOM	Information Systems and Operations Management	Cameron Hall	910-3600
MIS315	Database Management Systems	ISOM	Information Systems and Operations Management	Cameron Hall	910-3600
POM250	Introduction to Operations Management	ISOM	Information Systems and Operations Management	Cameron Hall	910-3600
MGT300	Introduction to Management	MGTMKT	Management and Marketing	Cameron Hall	910-4500
MKT300	Introduction to Marketing	MGTMKT	Management and Marketing	Cameron Hall	910-4500
MKT444	Marketing Research	MGTMKT	Management and Marketing	Cameron Hall	910-4500
STA230	Descriptive Statistics	ISOM	Information Systems and Operations Management	Cameron Hall	910-3600
ACG201	Financial Accounting	ACGFIN	Accounting and Finance	Dobo Hall	910-1800
ACG301	Cost Accounting	ACGFIN	Accounting and Finance	Dobo Hall	910-1800
FIN305	Personal Finance	ACGFIN	Accounting and Finance	Dobo Hall	910-1800
ECN375	Global Markets	ECN	Economics	Randall	910-0900
ECN460	Banking Regulations	ECN	Economics	Randall	910-0900
INT100	Cultural Diversity	INT	International Business	Dobo Hall	910-0900
INT201	Spanish for Business	INT	International Business	Dobo Hall	910-0900
INT202	French for Business	INT	International Business	Dobo Hall	910-0900

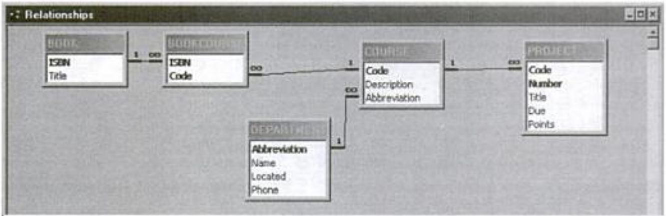


Figure 6.7 Access View of Tables, Fields, and Their Relationships

table. That redundancy enables us to join records from the separated DEPARTMENT and COURSE tables.

Figure 6.7 shows the ***Schedule*** database fields, tables, and relationships between tables. Fields within tables that represent the key are in bold font. Lines between tables delineate which fields are the common fields joining tables together in a relationship. Other features in Figure 6.7 will be discussed later in the chapter.

The Database Concept

When users think of records in a database, they intuitively feel that the sequence of records displayed in a report reflects the sequence in which the records are stored on the computer disk. A record that, to the user, appears before or after some other record may actually be stored at a completely separate part of the disk. A database management system can display the data in a logically, intuitively correct sequence even though individual records of the database may be dispersed across many files and located all over the computer's storage space. For example, in Figure 6.4 the *Code* values "ACG201" and "ACG301" appear to fall one after the other, but the two records may be at completely different places in storage. This logical integration of records across multiple physical locations is called the **database concept**. The physical location on the storage medium is not dependent on the user's perception of logical location.

Two primary goals of the database concept are to minimize data redundancy and to achieve data independence. Data redundancy—discussed earlier in the chapter—wastes storage space, slows record processing, and invites data inconsistency.

Data independence is the ability to make changes in the data structure without making changes to the application programs that process the data. For example, the computer program to process purchase orders is separate from the purchase order data stored in the database. Data independence is accomplished by the placing of data specifications in tables and dictionaries that are physically separate from the programs.

Refer back to Figure 6.5. The size of the *Code* field could be increased from 8 to 10 characters in the table definition without affecting any application using the *Code* field. When computer programs directly access data files to retrieve data, they must explicitly express the data format. That would require computer program code to be rewritten if the number of characters for *Code* were changed from 8 to 10. If there were 25 computer applications that needed access to the *Code* field, then all 25 would require modification. With data independence, no rewriting of computer code is required, because the one and only change would be in the definition of that field in the database.

A **data dictionary** includes the definitions of the data stored within the database and controlled by the database management system. Figure 6.5 depicts just one table in the ***Schedule*** database. The structure of the database encompassed by the data dictionary is the collection of all field definitions, table definitions, table relationships, and other issues. The data field name, type of data (such as text or number or date), valid values for the data, and other characteristics are kept in the data dictionary. Changes to data structure are made only once—in the data dictionary; application programs using the data are unaffected.

CREATING A DATABASE

Conceptually, the process of creating a database includes three main steps. First, you determine the data that you need. Second, you describe the data. Third, you enter the data into the database.

Determine Data Needs

Determining the data that need to be collected and stored is a key step to achieving a computer-based information system. Two basic approaches can be used to determine data needs: a process-oriented approach and enterprise modeling.

A PROCESS-ORIENTED APPROACH When firms take a **process-oriented approach** to determining their data needs, they complete the following sequence of steps. First, the *problem* is defined. Then the *decisions* required to solve the problem are identified, and for each decision the required *information* is described. Next, the *processing* necessary to produce the information is determined, and finally the *data* required by the processing are specified. The process-oriented approach is also called the **problem-oriented approach** and **process-oriented modeling**. To define data needs in a process-oriented approach:

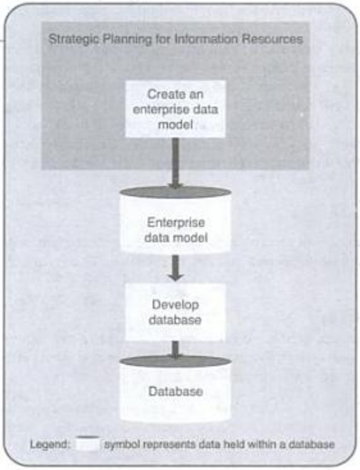
1. Define the problem.
2. Identify necessary decisions.
3. Describe information needs.
4. Determine the necessary processing.
5. Specify data needs.

The reason the process-oriented approach is sometimes called the *problem-oriented approach* is because it begins with a problem. A problem can be either good or bad; that is, it may be a threat to the firm or an opportunity to be exploited. Once problems are identified, the data and processes dealing with problem solutions can be determined. The strength of the process-oriented approach is that it addresses problems well.

AN ENTERPRISE MODELING APPROACH The strength of the enterprise modeling approach is that it takes advantage of a broad view of the firm's data resource.[8] All areas are considered, and synergy of data resources between business areas can be leveraged. Although the process-oriented approach enables the data needs of each system to be defined in a logical manner, its weakness is the difficulty of linking the data of one business problem to that of another. Information systems cannot easily share data if they are isolated from other information systems dealing with other business problems. This weakness is overcome by determining all of the firm's data needs and then storing that data in the database. This is the underlying logic of the **enterprise modeling approach**.

When a firm is engaged in enterprise data modeling, the description of all of the firm's data is called the **enterprise data model**. This top-down process, which begins during strategic planning for information resources, is illustrated in Figure 6.8.

Figure 6.8 **Creating an Enterprise Data Model**



Data Modeling Techniques

Modeling the firm's data needs is supported by techniques that describe the data, how the data aggregates into tables, and how tables relate to each other. A number of techniques are available, but we will focus on two: entity-relationship diagrams and class diagrams. *Entity-relationship diagrams* are used to describe relationships between conceptual collections of data so that their related records can be joined together. *Class diagrams* are used to describe both the data relationships and the actions that operate on the data in the relationships. These techniques provide tools to facilitate communications between users and information systems specialists concerning the structure of data used in an information system application.

Entity-Relationship Diagrams

Entity-relationship diagrams (ERDs),[9,10] like the name implies, deal with data in entities and the relationships between entities. When users and information specialists begin to communicate about the data needed for an information system, they speak in terms of collections of related data fields as opposed to individual data fields. These conceptual collections of related data fields are called **entities**. Although it is intuitively appealing to think of entities as tables, we cannot. Tables are the result of breaking entities into smaller units that conform to the rules for database structures. An entity may turn into a table, but frequently an entity is broken into several tables. ERDs are a higher level conceptualization of data than tables.

ERDs also express which entities should conceptually be related to others. The relationships between entities are not designated by common data fields in entities, because during this early stage of system development when the ERDs are first conceptualized the exact data fields for each table are not known. However, the user and information systems professional can conceptualize how records within entities might relate to records in other entities.

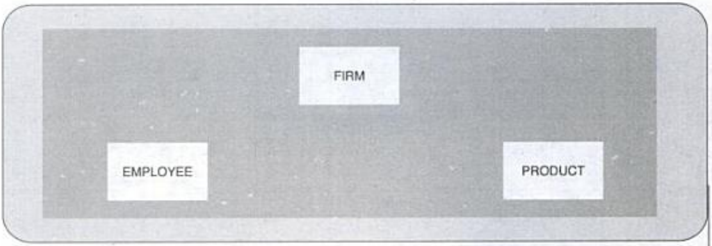


Figure 6.9 **Entities**

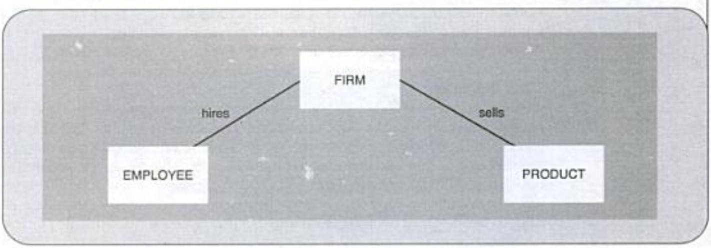
Entities in ERDs will have names, much like tables have names. Also, relationships link entities much like the lines joining tables via common fields between tables. ERD relationships will denote if a record in one entity will relate to one or more records in the other entity. In a similar fashion, you can see from Figure 6.7 that one record in the COURSE table may relate to many records (expressed by the infinity symbol) in the PROJECT table.

Let us assume that we need to describe the data needed for a new information system. The system will keep track of firms and their employees as well as their products. From this brief description, we can imagine that three separate data entities will exist: FIRM, EMPLOYEE, and PRODUCT. Entities are represented as boxes in an ERD, thus Figure 6.9 depicts the entities.

Before relationships among the entities are expressed, we must make some assumptions. First, a FIRM entity record contains information about the firm's name, address, and so forth. Second, a firm may have many employees, but an employee works for only one firm. This assumption is a bit simplistic, because some people work two or more jobs, but it will make the ERD explanation easier to follow. Last, we assume that records in the PRODUCT entity represent specific items and not a generic product such as "soft drink."

Because the firms sell the products, there is a relationship between the FIRM and PRODUCT entities. Similarly, firms hire employees, so there is a relationship between those two entities. The relationships are represented by named lines, as shown in Figure 6.10. Naming is important for documentation; it serves as an explanation as to why the designers have made a relationship between the entities.

Figure 6.10 **Entities and Relationships**



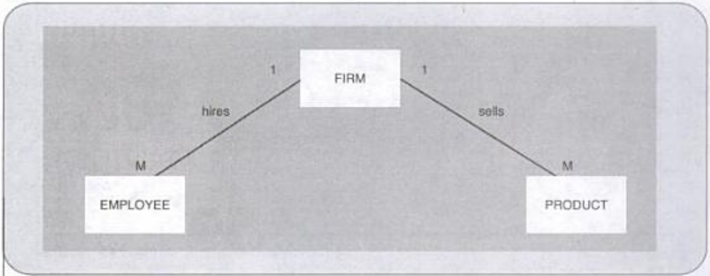


Figure 6.11 Entity-Relationship Diagram

The last part of creating the ERD is determining how many individual records in one entity will relate to individual records in the other. This is a key step in the conceptualization that impacts how the actual database tables are created. In our example, we assumed a given firm might hire a number of employees and that an employee could work for only one firm. The key words here are "could" and "might." A particular firm is allowed to hire more than one employee, but it is not required to hire more than one.

Figure 6.11 demonstrates how we specify that one record in the FIRM entity can be related to many records in the PRODUCT entity and also that one record in the FIRM entity can relate to many records in the EMPLOYEE entity. The relationship "hires" has a "1" next to the FIRM entity and an "M" next to the EMPLOYEE entity. The "M" stands for "many." The relationship would be read as "one firm record may relate to many employee records and one employee record may relate to only one firm record." The relationship between the FIRM and EMPLOYEE entities is called a "one-to-many" relationship. The relationship between the FIRM and PRODUCT entities is also a one-to-many relationship.

To complete our entity-relationship discussion, we need to provide a "many-to-many" relationship example. Suppose that another entity, PROJECT, was to be added to the application. A single project could have many employees, and a single employee could be on many projects. The PROJECT entity would have a relationship to the EMPLOYEE entity. This relationship, a many-to-many relationship, is shown in Figure 6.12.

In practice, the entity-relationship diagrams are developed early in the process, before specific data fields have been identified. Later, tables of data fields would be generated that lead to the creation of a database. ERDs are a powerful means of communication and documentation between information systems professionals and users. When ideas are clearly documented and communicated, the information systems specialists are better equipped to develop a database management system structure to support decision making.

Class Diagrams

An entity-relationship diagram is a graphical representation of only the data and relationships, not the actions taken on the data. A technique exists whereby both the data used in an application and the actions associated with the data can be represented graphically. These are called *class diagrams*, and they are one of several object-oriented design models. Objects are the conceptual chunks of an information system—the data, actions to be taken on the data, and relationships between objects. Objects have other characteristics that are useful in the analysis and design of information systems, but here we are only interested in their impact on describing data.

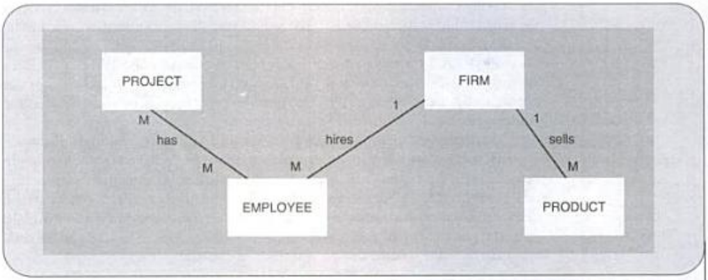


Figure 6.12 **Entity-Relationship Diagram with a Many-to-Many Relationship**

Class diagrams consist of the named class, fields in the class, and actions (sometimes referred to as *methods*) that act upon the class. The class diagram in Figure 6.13 illustrates the entity-relationship diagram we have just completed. Notice that class diagrams begin with the class name in the top segment of the rectangle. "clsFIRM" is the class name of the FIRM entity that we described earlier. (In class diagrams, it is customary, but not required, that the class name be preceded with the letters "cls.") Next, in the middle segment the diagram explicitly states fields in the class. Unlike tables for the database structures, redundant fields between two classes are not repeated. Also notice that an asterisk represents the "many" side of a one-to-many relationship.

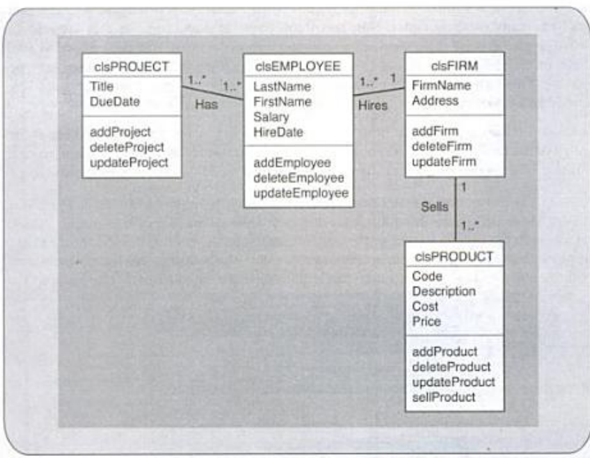


Figure 6.13 **Class Diagram**

Looking at the relationship between the clsFIRM and clsPRODUCT classes, note that the relationship is named "Sells." You would read the relationship as "one instance in the clsFIRM class sells one or more instances in the clsPRODUCT class." Also, "one instance in the clsPRODUCT class will be sold by only one instance in the clsFIRM class." Class diagrams appear intuitively similar to entity-relationship diagrams, yet the inclusion of actions that operate on the data (such as addProduct) provide deeper insights into how data and applications work together.

Although each class in Figure 6.13 has an add, delete, and update action, only the clsPRODUCT class has the "sellProduct" action. The "sellProduct" action might involve determining if the product is in stock, decreasing the number of units of the product in inventory based on the number ordered, and possibly initiating an order for more product from a vendor if inventory has fallen to a reorder point. The class diagram is still a high-level, conceptual representation of data, but the addition of the actions to be taken on the data can help bring clarity to the specific design of tables in a database.

USING THE DATABASE

We usually interact with a database from a personal computer even if the data are somewhere else on the network. Forms, reports, and queries are common methods for accessing the database held in a database management system.

Reports and Forms

The majority of users' interactions with databases are via reports and forms. GUIs are provided by most database management software vendors that make the development of forms and reports simple. Many of the reports and forms needed by users can be created without the assistance of information systems professionals.

The greatest difference between forms and reports is in their format. **Forms** typically show one record at a time and do not provide summary data and generally do not aggregate data from many database tables. Note that forms have these abilities, but they are seldom used. The greatest difference between a form and a report is that forms can be used to add, delete, or modify database records. Figure 6.14 shows a form for entering courses into the database. This form was developed in Access, but it is representative of those produced by most major DBMS software.

NAVIGATION Users can navigate from one record to the next using the navigation bar at the bottom of the form. The "*" icon on the navigation bar tells the form to create a new record. A form enables both the creation of new records and the modification of existing ones.

ACCURACY Forms enforce the data field definitions that were specified when the database was created. Those definitions can specify certain valid values, data ranges for numeric values, and other rules to support accuracy. They can also enforce rules beyond those in the data field definition. Forms provide an opportunity to tailor data values to the specific business area application, not just the general value rules applicable to the entire set of database users.

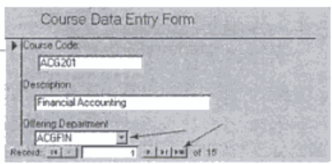


Figure 6.14 **A Data Entry Form for the Course Table**

CONSISTENCY Consistency is very important when field values in one table are used to join its records to another table. If a user mistyped a field value, it would mean that the record could not be joined to other tables. Notice in Figure 6.14 that a drop-down menu is presented to the user to enter a value. The field labeled *Offering Department* corresponds to the *Abbreviation* field in the COURSE table. That field ties a COURSE table record to a record in the DEPARTMENT table. The drop-down menu will only display values already entered in the *Abbreviation* field of the DEPARTMENT table, thus entries in the form are constrained to be consistent between the two tables.

FILTERING Databases may have enormous amounts of data. Users may wish to filter the records viewed using the form. Any field on the form could be used as a filter. For example, a filter could be established so that only junior-level courses (courses where the fourth character is a "3") would be displayed. Filtering helps combat information overload. It can also limit a user's access to data in the database in case certain records should be kept confidential.

SUBFORMS Figure 6.15 illustrates a form and subform combination. When users enter course information, they may also wish to enter information about projects at the same time. Notice that there are two navigation bars, one for the form and one for the subform. Entries into the subforms are automatically associated with the form record. Subforms help to enforce the accuracy and consistency that databases require.

Reports are aggregated data from the database that are formatted in a manner that aids decision making. For example, Figure 6.16 is a report that shows each department with a list of each course taught and the projects required for the course. Such aggregation seems almost trivial today, but before the age of databases such presentations could be difficult. The ease of use comes at a price, however; users must understand how databases work to produce reports.

Look at Figure 6.17 and notice that department names (such as *Economics*) appear in the report that do not appear in Figure 6.16. Why were they left off? They were left off because they had no projects. For example, neither ECN375 nor ECN460 had project records in the database, so the Economics department was not included in the Figure 6.16 report. Also, individual courses were left off, such as ACG201, even when the Accounting and Finance department was in the Figure 6.16 report.

An assumption was made by the report generator that if details at the lowest-level record do not exist, then higher-level records for the detail should not be displayed. Figure 6.7 illustrated that the DEPARTMENT table related down to the COURSE table, which, in turn, related down to the PROJECT table. Unless there was a related entry in the PROJECT table, no

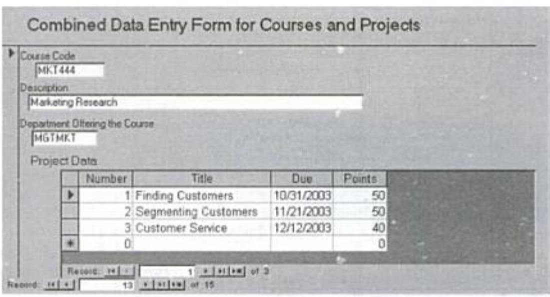


Figure 6.15
Combined Data Entry Form for the COURSE and PROJECT Tables

Figure 6.16 **Report of Departments Showing Courses Offered and Course Projects**

Courses by Department -- show projects

Department				
Accounting and Finance				
FIN305	*Personal Finance*			
		Project	*Due Date*	*MaximumPoints*
	1	Personal Portfolio	11/14/2003	35
International Business				
INT201	*Spanish for Business*			
		Project	*Due Date*	*MaximumPoints*
	1	Nouns	9/17/2003	15
	2	Verbs	11/21/2003	25
INT202	*French for Business*			
		Project	*Due Date*	*MaximumPoints*
	1	Nouns	9/17/2003	15
	2	Verbs	11/21/2003	25
Information Systems and Operations Management				
MIS10	*Information Systems Literacy*			
		Project	*Due Date*	*MaximumPoints*
	1	Home Page Development	9/15/2003	25
	2	Working With Windows	11/13/2003	50
MIS31	*Database Management Systems*			
		Project	*Due Date*	*MaximumPoints*
	1	Alumni Database	12/5/2003	20
Management and Marketing				
MKT44	*Marketing Research*			
		Project	*Due Date*	*MaximumPoints*
	1	Finding Customers	10/31/2003	50
	2	Segmenting Customers	11/21/2003	50
	3	Customer Service	12/12/2003	40

Figure 6.17 **Report of Departments and Courses Alone**

Courses by Department -- no projects

Department		
Accounting and Finance		
	ACO201	Financial Accounting
	ACO301	Cost Accounting
	FIN305	Personal Finance
Economics		
	ECN375	Global Markets
	ECN460	Banking Regulations
International Business		
	INT100	Cultural Diversity
	INT201	Spanish for Business
	INT202	French for Business
Information Systems and Operations Management		
	MIS105	Information Systems Literacy
	MIS315	Database Management Systems
	POM250	Introduction to Operations Management
	STA230	Descriptive Statistics
Management and Marketing		
	MGT300	Introduction to Management
	MKT300	Introduction to Marketing
	MKT444	Marketing Research

COURSE record was displayed. If no record from the COURSE table was used (for example, neither economics course had a project), then a DEPARTMENT record was not displayed.

It is a simple task to require the report to display records even when no matching record at a lower table is matched. But if users are unaware that reports created with default rules may exclude records, they may make ill-informed decisions.

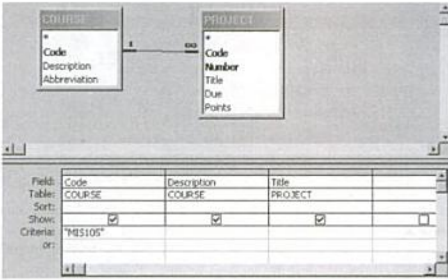


Figure 6.18 **Report of Departments and Courses Alone**

Queries

Some users wish to go beyond reports and forms to ask questions directly of the database. A **query** is a request for the database to display selected records. Database management systems typically provide an easy-to-use interface for the user.

A query generally selects a limited number of data fields and then constrains displayed records to a set of criteria. For example, suppose you wished to see only the course code, course description, and project title of the "MIS105" course. Figure 6.18 represents how that query could be represented.

This format is called **query-by-example (QBE)**, because the database management system software presents a standardized form that the user completes so that the system can generate a true query. The QBE form will display the tables involved in the query, in this case the COURSE and PROJECT tables. Next it will allow the user to choose the data fields from the tables that should be displayed. Also, criteria for limiting the search are added. In our case, the column containing course code values is limited only to values of "MIS105." If projects from either the MIS105 or MIS315 courses were desired, "MIS315" would have been entered in the cell directly below the "MIS105" entry. The result of the query is the table in Figure 6.19.

Query-by-example concepts are significant because of the importance of managers being able to directly access database values. Forms and reports may produce a volume of results that obscure what the manager is trying to find. Managers can utilize QBE to quickly find specific data to solve problems.

Structured Query Language

Structured query language (SQL) is the code that relational database management systems use to perform their database tasks. Although the user may see Figure 6.18 as the QBE, the database management system sees the structured query language in Figure 6.20. DBMS software contains GUIs and "wizard" programs to walk users through queries in a user-friendly manner.

Code	Description	Title
MIS105	Information Systems Literacy	Home Page Development
MIS105	Information Systems Literacy	Working With Windows

Figure 6.19 **Results of the Query-by-Example**

Figure 6.20
Structured Query Language Code to Find Projects for the MIS105 Course

```
SELECT COURSE.Code, COURSE. Description, PROJECT.Title
FROM COURSE, PROJECT
WHERE COURSE.Code = PROJECT.Code
    AND COURSE.Code = "MIS105"
```

SQL has become an important topic for two reasons. First, as more databases have become accessible via the Web, managers and other professionals need to know that SQL is the method of choice for interacting with Web-based databases. Second, managers need to know that writing SQL statements is not difficult for most of their data needs.

Advanced Database Processing

On-line analytical processing (OLAP) is becoming more common in database management system software.[11] Vendors are including this feature to allow data analysis similar to statistical cross-tabulation. For example, one of the fields in the PROJECTS table (Table 6.4) contains the number of points awarded for the project. If you wanted to know the sum of all points for projects in each course in each department, then OLAP would be beneficial.

Data mining, *data marts*, and *data warehousing* refer to the family of concepts that view the firm's data as a treasure box to be opened, examined, and conquered. They focus on methodologies that offer users quick access to aggregated data specific to their decision-making needs.

Knowledge discovery is another exciting concept. As databases grow and encompass larger and larger amounts of data, how can users recognize all of the relationships among the data? Which data fields are critical to decision making? Are there important data in the database that are not being used? Knowledge discovery attempts to answer these questions by analyzing data usage and data commonality among different tables. OLAP, data mining, data marts and warehouses, and knowledge discovery will be discussed in Chapter 8.

Highlights in MIS

It Can Be Healthy to Mine the Corporate Database[12]

Everyone talks about healthy corporate profits, but in the pharmaceutical industry better health does lead to healthy profits. An important part of making profits is getting the product to market rapidly. "Any improvement in getting an innovative drug to market will have a huge payoff," says Elliot Sigal, vice president for applied genomics at Bristol-Myers Squibb.

Twelve years and $300 million to $400 million are typically what it takes to discover a drug, bring it to market, and begin making profits. For some firms, the trial and error of test tubes can be aided by the search of enormous databases. Pharmaceutical companies and biotech firms, especially those involved with the genome project to map human DNA, are sharing database information to help determine which drugs have the greatest potential. Their intent is to put more resources into those drugs likely to succeed and to reduce the flow of resources to drugs that show low potential.

Will your database wear a white lab coat?

DATABASE PERSONNEL

Several key personnel are involved with databases. The database administrator has both technical and managerial responsibilities over the database resource. Database programmers are required to create efficient data-processing computer code. The database end users are the other key database personnel. By virtue of the decisions made and the amount of data retrieved, end users have a major impact on database design, use, and efficiency.

Database Administrator

The information specialist who is expert in developing, providing, and securing databases is the **database administrator (DBA)**. Database administrators oversee all database activities. They must have managerial skills as well as high technical skills. A firm typically has multiple database administrators, managed by a manager of database administration. Database administrators must understand the business operations of the firm, because the decisions in those operations drive much of the database content. They must also be masters of database technology, because hardware and DBMS software have a profound impact on the speed and ease of use of the database.

The duties of the DBA fall into four major areas: planning, implementation, operation, and security:

- **Database planning** involves working with business area managers to define the firm's data needs. The DBA should be a member of any team that is involved with a process-oriented or enterprise modeling approach to determining data needs. In addition, the DBA plays a key role in selecting the database management system software and hardware.
- **Database implementation** consists of creating the database to conform to the specifications of the selected database management system, as well as establishing and enforcing policies and procedures for database use.
- **Database operation** includes offering educational programs to database users and providing assistance when needed.
- **Database security** includes the monitoring of database activity using statistics provided by the database management system. In addition, the database management system ensures that the database remains secure. In a business environment where some vendors are allowed access to the organization's database or where the organization allows customers to access the order entry system to place their own orders, database security has become a very complex issue. It is important to remember that database security involves not only keeping unauthorized users out, but allowing authorized users easy access.

Database Programmer

Database programmers represent a high level of specialization and selection. They often have much more experience and training than do other programmers in the firm. One reason is that the database is the central repository of facts for the firm. If a programming error occurs in the database, then the consequences could be felt by a very large number of users. For this reason, firms want database programmers to be chosen from the most skilled personnel available.

Database programmers often write code to strip and/or aggregate data from the database. A single user can then download this efficiently gathered data from the firm's computer resources to her or his own personal computer. One benefit is that the firm's database is accessed only once, and further database processing occurs only on the user's computing resource, thereby achieving a higher efficiency level for database use. Another benefit is that the user does not need to access the totality of the firm's database, and because a user is more likely than a database programmer to make a mistake, the database is more secure.

End User

End users cannot be ignored as important personnel who interact with the database. They generate reports and forms, post queries to the database, and use results from their database inquiries to make decisions that affect the firm and its environmental constituents.

Database management system software has evolved to encourage interaction by decision makers. The user does not need to know how to code structured query language statements. Query-by-example forms let the user click a few choices and run the query. The increased ease of use has caused a large increase in end-user use, which in turn can lead to increased numbers of end-user errors.

Database management systems make assumptions about what users want as they click through the database interface. Unless the user understands what assumptions are made, the data displayed may not be what is needed for decision making. Users need training in database systems so that the database resource can be a true asset to decision making.

PUTTING DATABASE MANAGEMENT SYSTEMS IN PERSPECTIVE

The database management system makes it possible to create a database, maintain its contents, and disseminate the data to a wide audience of users without costly computer programming. Its ease of use allows managers and professional staff to access database contents with only modest training.

Every facet of information technology has its advantages and disadvantages; database management systems are no exception.

DBMS Advantages

The advantages of DBMSs have been stated earlier, but it is important to restate them. The DBMS enables both firms and individual users to:

- **Reduce data redundancy.** The amount of data is reduced, compared to when computer files are kept separately for each computer application. Duplicate data are limited to those fields necessary to join data from two tables. Common data among the files, in relational database management systems, are used to form implicit relationships among data.
- **Achieve data independence.** The specifications of the data are maintained in the database itself rather than in each application program. Changes may be made once, to the data structure, without requiring changes to the many application programs that access the data.
- **Retrieve data and information rapidly.** Logical relationships and structured query language enable users to retrieve data in seconds or minutes that otherwise might take hours or days to retrieve using such traditional programming languages as COBOL or Java. This is because a computer program in COBOL or Java does not need to be written to access the data. The database management system itself provides tools such as QBE and SQL to access data.
- **Improve security.** Both mainframe and microcomputer DBMSs can include multiple levels of security precautions such as passwords, user directories, and encryption. The data managed by DBMSs are more secure than most other data in the firm.

DBMS Disadvantages

A decision to use a DBMS commits a firm or user to:

- **Obtain expensive software.** Mainframe DBMSs are expensive. Microcomputer-based DBMSs, although costing only a few hundred dollars, can represent a substantial outlay for a small organization. Fortunately, Moore's Law still holds, and the cost of computer hardware and software continues to fall. This disadvantage becomes less important each year.
- **Obtain a large hardware configuration.** The ease with which the DBMS can retrieve information encourages more users to make use of the database. The increased number of users encouraged by the ease of use may lead to an increased amount of computer resources to access the database.

- **Hire and maintain a DBA staff.** The DBMS requires specialized knowledge in order to make full use of its capabilities. This specialized knowledge is best provided by database administrators.

A DBMS is not an absolute prerequisite to problem solving. However, information specialists and users find it to be one of the firm's greatest aids to decision making.

Summary

Computers are increasingly powerful, and the cost of computing resources continues to fall. At the same time, business organizations are capturing vast amounts of data and storing the data in databases. Database management system software is crucial for organizing the data into a structure that facilitates rapid retrieval.

Relational databases have become the dominant database structure in firms for two reasons. First, they are conceptually easy to understand. Second, relational database structures are easy to change because they use implicit relationships among data. Tables in a relational database are similar to spreadsheets; the table is the spreadsheet file, columns in the spreadsheet relate to fields, rows in the spreadsheet relate to records. Relationships between tables are formed when the data field values of common fields are equal. Relational database management systems are relatively easy for managers to understand and use.

Understanding database structure begins by understanding the role the data play in decision making. Firms can begin with the problems they face and construct required data from a process-oriented methodology. If the firm wants to take advantage of the commonality of problems across business areas, it can apply the enterprise modeling approach. Whichever method for specifying data is used, a technique must still be used to describe the required data. Entity-relationship diagrams and class diagrams are tools that enable users and information systems specialists to effectively communicate data requirements.

Data are typically retrieved via reports and forms. However, as managers need quicker direct access to data, they are writing their own database queries. This is a powerful tool for the manager, but like many power tools, there is a danger. If managers are not aware of the assumptions the database management system uses to process queries, reports, and forms, they may find that the data retrieved are not the intended data.

The enormity of the data associated with modern businesses and its critical impact on business operations have combined to cause the creation of a database administrator position in most large organizations. The duties of this person include working with management to plan the structure and organization of data held by the organization. Security issues are very important, especially because the Internet may enable individuals outside the organization to access information contained in the organization's database. Less publicized, but equally important, is the database administrator's role of training users who need to access the database. Security requires both keeping unauthorized individuals out and allowing easy access for authorized individuals.

All managers need to understand basic database structures and how to retrieve data from the database. This understanding is crucial to agile decision making.

Key Terms

data field	**file**	**flat file**
record	**database**	**key**

database management system (DBMS)
hierarchical database structure
network database structure
relational database structure
physical relationship
implicit relationship
data redundancy
data consistency
data accuracy
data independence
data dictionary
process-oriented modeling
enterprise modeling approach
entity-relationship diagram (ERD)
class diagram
form
report
query
query-by-example (QBE)
structured query language (SQL)
on-line analytical processing (OLAP)
database administrator (DBA)
database programmer

Key Concepts

- relational database structure
- database concept
- data modeling

Questions

1. How do the general and restrictive definitions of a database differ?
2. Assume you know there is a salary value of $45,000. Is $45,000 (a) a data field value, (b) a data field name, or (c) a record?
3. You open a file (such as a spreadsheet file) and see column headings of "StudentID," "StudentName," "Semester," "Course1," "Grade1," "Course2," "Grade2," "Course3," and "Grade3." Why is this not a flat file?
4. What is a key?
5. What is a candidate key?
6. How are relationships between tables established for relational databases?
7. Why has the relational database structure been so much more successful than the hierarchical or network structures?
8. What is data independence?
9. How does data redundancy lead to data inconsistency?
10. What is the difference between the process-oriented approach to determining data needs and the enterprise modeling approach?
11. When should a firm use a process-oriented approach to determine data needs as opposed to an enterprise modeling approach?
12. What is represented in a class diagram that is not represented in an entity-relationship diagram?
13. How are users more likely to obtain information from a database? Would they use query-by-example or structured query language?
14. Who in the firm is primarily responsible for database security?
15. The cost of database management software and hardware is an often-cited disadvantage. Why are those costs becoming less significant?

Topics for Discussion

1. Why are implicit relationships among data better suited for the changing data needs of firms than explicit relationships?
2. How do techniques such as entity-relationship diagrams and class diagrams help users and information systems professionals develop information systems?
3. How can database forms improve the accuracy and consistency of the database?
4. Assume that your firm maintains a duplicate copy of its database as a backup. So far, your firm has never had to use it. What is the danger of never having tested the backup system to ensure that a new database can be generated from the backup in an emergency?

Problems

1. Use a database management system software package of your choice and define the DEPARTMENT and COURSE tables shown in Tables 6.5 and 6.6. Then enter the records from Tables 6.5 and 6.6 into your newly created database.

2. Compare the database management software features of DB2 from IBM, SQL Server from Microsoft, and Oracle (from Oracle).
3. What difficulties would your firm have in using the enterprise modeling technique if it already has an existing database management system in place?

Case Problem

PETS TO PEOPLE

You have an internship with the local animal shelter. The shelter only provides a temporary home to cats and dogs. They know that you've taken an information systems course, so they want you to make a database. The database is needed for several reasons. First, the shelter wants to track those who adopt pets from the shelter so that "thank you" letters can be sent. Along with the "thank you" is a request for donations. Second, the shelter wants to track how many cats and dogs are adopted during any period of time, such as by month or year, so they can measure their success at encouraging pet adoption. Third, the shelter wants to determine how many animals have been adopted by the same person. The shelter only lets a person adopt an animal if they have not adopted an animal from the shelter in the last three months.

Adopters are identified by household. You have decided to use the phone number of the household as a way to uniquely identify each one. Pets are identified by a tag number, such as "D217" (for dog number 217) and "C142" (for cat 142). A pet can only be adopted by one household, but a household may adopt more than one pet. Now you need to describe the database.

ASSIGNMENT

1. This database can be built with only two tables: OWNER and PET. List each field that should be in each table. Some fields are expressly mentioned in the case, but you are free to add others that you believe are necessary to meet the decision needs of the case.
2. Determine which fields in the tables should be the key fields.
3. How do you relate the OWNER table to the PET table? Which field is chosen and why?

NOTES

[1]David C. Hayes and James E. Hunton, "What You Better Know About Databases," *Journal of Accountancy* 187(1) (January 1999), 61–63.
[2]Helen Hasan, Peter Hyland, David Dodds, and Raja Veeraraghavan, "Approaches to the Development of Multi-Dimensional Databases: Lessons from Four Case Studies," *Database for Advances in Information Systems* 31(3) (Summer 2000), 10–23.
[3]Robert W. Taylor and Randall L. Frank, "CODASYL Data-Base Management Systems," *ACM Computing Surveys* 8(1) (March 1976), 67.
[4]Andrew B. Whinston and Clyde W. Holsapple, "DBMS for Micros," *Datamation* 27(4) (April 1981), 165–166.
[5]"CODASYL: Introduction to Feature Analysis of Generalized Data Base Management Systems," *Communications of the ACM* 14(5) (May 1971), 308–318.
[6]C. J. Date, *An Introduction to Database Systems* (Addison-Wesley: Reading, MA, 1977).
[7]E. F. Codd, "A Relational Model of Data for Large Shared Databanks," *Communications of the ACM* (June 1970), 377–387.
[8]Guy Doumeingth, Yves Ducq, and Bruno Vallespir, "Production Management and Enterprise Modeling," *Computers in Industry* 42(2, 3), 245–263.
[9]Peter Chen, "The Entity-Relationship Model—Towards a Unified View of Data," *ACM Transactions on Database Systems* 1(1) (March 1976), 9–36.
[10]Peter Chen, originator of the Entity-Relationship (ER) model, was awarded the Harry M. Goode Memorial Award from the IEEE Computer Society in 2002.
[11]N. Colossi, W. Malloy, and B. Reinwald, "Relational Extensions for OLAP," *IBM Systems Journal* 41(4), 714–731.
[12]Adopted from Doug Levy, "Computing Cures Database May Put Drugs on Shelves Years Faster," *USA Today*, May 17, 1998, Feature—Money Section, 1-B.

Chapter 7

Systems Development

Learning Objectives

After studying this chapter, you should

- Recognize the systems approach as the basic framework for solving problems of all kinds.
- Know how to apply the systems approach to solving systems problems.
- Understand that the systems development life cycle (SDLC) is a methodology—a recommended way to develop systems.
- Be familiar with the main SDLC approaches—the traditional waterfall cycle, prototyping, rapid application development, phased development, and business process redesign.
- Know the basics of modeling processes with data flow diagrams and use cases.
- Understand how systems development projects are managed in a top-down fashion.
- Be familiar with the basic processes of estimating project cost.

Introduction

Both managers and systems developers can apply the systems approach when solving problems. The systems approach consists of three phases of effort: preparation, definition, and solution. Within each phase is a sequence of steps. Preparation effort *consists of viewing the firm as a system, recognizing the environmental system, and identifying the firm's subsystems.* Definition effort *involves proceeding from a system to a subsystem level and analyzing system parts in a certain sequence.* Solution effort *involves identifying the alternative solutions, evaluating them, and selecting the best one. The solution is then implemented, and follow-up action ensures that the problem is solved. When applied to the problem of systems development, the systems approach is called the* systems development life cycle (SDLC). *The traditional SDLC approach consists of five stages that occur one after the other.*

Prototyping *is a refinement of the traditional approach. It recognizes the advantage of repetitively soliciting user feedback and responding with system improvements and continuing the cycle until the system meets user needs. Some prototypes become production systems; others serve as blueprints for systems developed using another methodology. An application of the prototyping philosophy to the development of large-scale systems is rapid application development, or RAD. In addition to incorporating prototyping, RAD also encourages the use of other approaches, such as the use of computer-modeling tools and specialized teams, that are intended to speed the development process.*

An SDLC approach that is currently very popular is phased development. *It is based on the idea that a project is subdivided into modules, and that analysis, design, and preliminary construction efforts are directed at each module. The modules are then integrated in a final construction effort.*

When there is a need to take a completely new approach to improving an existing system, the business process redesign *methodology is often used. The term* reengineering *is also used, although that is only one aspect of business process redesign. Another aspect is* reverse engineering.

Data flow diagrams, or DFDs, have been the most popular modeling tool for the past 20 years or so. DFDs are a very natural way to document processes, and they can be prepared in a hierarchy to show varying degrees of detail. Although DFDs are good for depicting the processing overview, they fail to do a good job of showing processing detail. Other tools, such as use cases, can be used to show detail.

Systems development is very costly in terms of both money and time. As a result, the process should be well managed. The firm's executives provide the highest level of oversight, often with the executives participating in an MIS steering committee that oversees all ongoing projects. Each project is typically managed by a project leader. Project management tools such as Gantt charts, network diagrams, and reports enable executives, managers, and developers to keep projects on track.

A major objective of project management is to control cost. It is common practice to estimate the total costs of a project before work begins on it. This requires that considerable planning be directed at specifying what work will be done, by whom, and when. A number of techniques, some involving the computer and the Internet, are used in estimating project costs.

THE SYSTEMS APPROACH

A search for the origins of a systematic problem-solving process leads to John Dewey, a philosophy professor at Columbia University. In a 1910 book, Dewey identified three series of judgments involved in adequately resolving a controversy:[1]

1. Recognize the controversy.
2. Weigh alternative claims.
3. Form a judgment.

Dewey did not use the term *systems approach*, but he recognized the sequential nature of problem solving—identifying a problem, considering different ways to solve it, and finally selecting the solution that appears to be best.

Dewey's framework essentially lay dormant for many years, but during the late 1960s and early 1970s interest in systematic problem solving came on strong. Management scientists and information specialists were searching for efficient and effective ways to solve problems, and the recommended framework became known as the **systems approach**—a series of problem-solving steps that ensure that a problem is understood, alternative solutions are considered, and that the selected solution works.

A Series of Steps

Although the many descriptions of the systems approach follow the same basic pattern, the number of steps can vary. We use 10 steps, grouped into three phases, as illustrated in Figure 7.1. **Preparation effort** prepares the problem solver by providing a systems orientation. **Definition effort** consists of identifying the problem to be solved and then understanding it. **Solution effort** involves identifying alternative solutions, evaluating them, selecting the one that appears best, implementing that solution, and following up to ensure that the problem is solved.

Preparation Effort

The three preparatory steps do not have to be taken in order. In addition, the steps can occur over a long period of time—beginning now, in this course.

STEP 1—VIEW THE FIRM AS A SYSTEM You must be able to view your firm as a system. This can be accomplished by using the general systems model from Chapter 2 as a template. You must be able to see how your firm or organizational unit fits the model.

STEP 2—RECOGNIZE THE ENVIRONMENTAL SYSTEM The relationship of the firm or organization to its environment is also important. The eight environmental elements that we discussed in Chapter 2 provide an effective way of positioning the firm as a system in its environment.

Figure 7.1 **Phases and Steps of the Systems Approach**

Phase I: Preparation effort

Step 1. View the firm as a system
Step 2. Recognize the environmental system
Step 3. Identify the firm's subsystems

Phase II: Definition effort

Step 4. Proceed from a system to subsystem level
Step 5. Analyze system parts in a certain sequence

Phase III: Solution effort

Step 6. Identify alternative solutions
Step 7. Evaluate the alternative solutions
Step 8. Select the best solution
Step 9. Implement the solution
Step 10. Follow up to ensure that the solution is effective

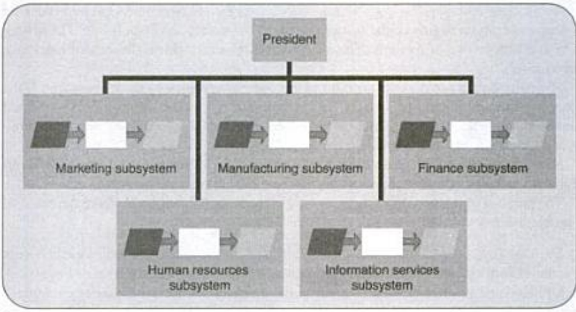


Figure 7.2 **Each Business Area Is a System**

Step 3—Identify the Firm's Subsystems The major subsystems of the firm can take several forms. The easiest for the manager to see are the *business areas*. Each can be regarded as a separate system, as shown in Figure 7.2.

The manager can also regard the *levels of management* as subsystems. The subsystems have a superior–subordinate relationship and are connected by both information and decision flows. When the manager sees the firm in this manner, the importance of information flows is clear. Without these flows, upper-level management is cut off from the lower levels.

The manager can also use *resource flows* as a basis for dividing the firm into subsystems. Finance, human resources, and information services all represent organization units dedicated to facilitate particular resource flows. Supply chain management is concerned with managing these resource flows.

When a manager can see the firm as a system of subsystems existing within an environment, a systems orientation has been achieved. The manager has completed the preparation effort and is now ready to use the systems approach in problem solving.

Definition Effort

Definition effort is usually stimulated by a **problem trigger**—a signal that things are going better or worse than planned. The signal can originate from within the firm or its environment, and it initiates a problem-solving process. In most cases, the trigger is a response to a symptom of a problem rather than a problem itself. A **symptom** is a condition that is produced by the problem and is usually more obvious than the root cause of the problem. For example, a symptom might be low sales that are reflected in a sales reporting system. Finding the root cause of the low sales may require digging through several layers of symptoms before identifying the root cause as poor sales training.

We define a **problem** as a condition or event that is harmful or potentially harmful or beneficial or potentially beneficial to the firm. This recognizes that managers react to things going better than expected just as well as to things going worse than expected. In the case of better performance, the manager wants to know why it occurred so that it can be continued. In the case of worse performance, the manager wants to bring performance back up to expectations.

The manager or someone in the manager's unit usually identifies the problem or a symptom. Once the problem is identified, the manager can call on a systems analyst to assist in understanding the problem. The definition effort consists of two steps: (1) proceed from a system to a subsystem level and (2) analyze system parts in a certain sequence.

STEP 4—PROCEED FROM A SYSTEM TO A SUBSYSTEM LEVEL As the manager seeks to understand the problem, the analysis begins on the system for which the manager is responsible. The system can be the firm or one of its units. The analysis then proceeds down the system hierarchy, level by level.

The manager first studies the position of the system in relation to its environment. Is the system in equilibrium with its environment? Are resources flowing between the system and its environment in the desired manner? Is the system meeting its objectives of providing products and services to the environment?

Next, the manager analyzes the system in terms of its *subsystems*. Are the subsystems integrated into a smoothly functioning unit, working toward the system objectives?

The purpose of this top-down analysis is to identify the system *level* where the cause of the problem exists.

STEP 5—ANALYZE SYSTEM PARTS IN A CERTAIN SEQUENCE As the manager studies each system level, the system elements are analyzed in sequence. This sequence is shown in Figure 7.3, which reflects the priority of each element in the problem-solving process. For example, a problem in Element 4 cannot be solved if there is a problem in Element 3.

ELEMENT 1—EVALUATE STANDARDS The performance standards for a system are usually stated in the form of plans, budgets, and quotas. Management sets the standards and must ensure that they are realistic, understandable, measurable, and valid (i.e., they must be a good measure of system performance).

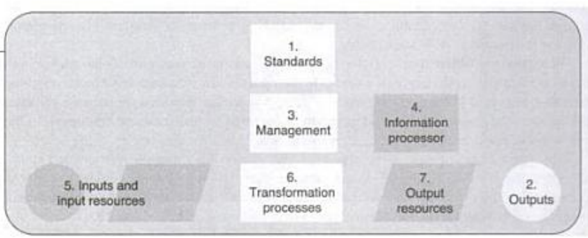
ELEMENT 2—COMPARE SYSTEM OUTPUTS WITH STANDARDS Once managers are satisfied with the standards, they next evaluate the outputs of the system by comparing them with the standards.

If the system is meeting its standards, there is no need to continue with the systems approach to problem solving *on this particular system level*. Rather, the manager should reevaluate the standards in light of the good current performance. Perhaps the standards should be raised. If the system is not meeting its standards, the manager must identify the cause, and the remaining system elements are possible locations.

ELEMENT 3—EVALUATE MANAGEMENT A critical appraisal is made of the system's management and *organizational structure*. Does a management team exist in terms of both the required quantity and quality? Are there enough managers, and do they have the right skills and abilities? In a similar fashion, does the organizational structure help or hinder the problem-solving process? In some cases, the establishment of a new unit is in order.

ELEMENT 4—EVALUATE THE INFORMATION PROCESSOR It is possible that a good management team is present, but that it is simply not getting the information that it needs. If this is the case, the needs must be identified and an adequate information system must be designed and implemented.

Figure 7.3 **Each Part of the System Is Analyzed in Sequence**



ELEMENT 5—EVALUATE THE INPUTS AND THE INPUT RESOURCES When this level of the systems analysis is reached, the conceptual system is no longer a concern, and the problem exists within the physical system. An analysis is made of both the physical resources in the input element of the system (such as the receiving dock, quality control section, and the raw materials stockroom) and the resources flowing through that element from the environment.

ELEMENT 6—EVALUATE THE TRANSFORMATION PROCESSES Inefficient procedures and practices may be causing difficulties in transforming inputs into outputs. Automation, robotics, computer-aided design and computer-aided manufacturing (CAD/CAM), and computer-integrated manufacturing (CIM) are examples of efforts to solve transformation problems.

ELEMENT 7—EVALUATE THE OUTPUT RESOURCES In analyzing Element 2, we paid attention to the outputs produced by the system. Here we consider the physical resources in the output element of the system. Examples of such resources are the finished goods storeroom, shipping dock personnel and machines, and the fleet of delivery trucks.

With the definition effort completed, the location of the problem in terms of system level and element is established. Now the problem can be solved.

Solution Effort

Solution effort involves a consideration of the feasible alternatives, a selection of the best one, and its implementation. Don't forget to follow up the implementation to ensure the solution is effective.

STEP 6—IDENTIFY ALTERNATIVE SOLUTIONS The manager identifies different ways to solve the same problem. For example, assume that the problem is a computer that cannot handle the firm's increasing volume of activity. Three alternative solutions are identified: (1) add more devices to the existing computer to increase its capacity and speed; (2) replace the existing computer with a larger computer; (3) replace the existing computer with a LAN of smaller computers.

STEP 7—EVALUATE THE ALTERNATIVE SOLUTIONS All of the alternatives must be evaluated using the same **evaluation criteria**, which are measures of how well an alternative would solve the problem. The evaluation produces advantages and disadvantages of implementing each alternative. However, the fundamental measure is the extent to which an alternative enables the system to meet its objectives.

STEP 8—SELECT THE BEST SOLUTION After evaluating the alternatives, the best one has to be selected. Henry Mintzberg, a management theorist, has identified three ways that managers go about selecting the best alternative:[2]

- **Analysis**—A systematic evaluation of options, considering their consequences on the organization's goals. An example is a presentation by the development team to the MIS steering committee, giving advantages and disadvantages of all options.
- **Judgment**—The mental process of a single manager. For example, a manufacturing manager applies experience and intuition in evaluating the layout of a new plant proposed by a mathematical model.
- **Bargaining**—Negotiations between several managers. An example is the give and take that goes on among members of the executive committee concerning which database management system to use.

The emphasis in this chapter is on analysis. However, judgment and bargaining should not be ignored. All three would probably be involved in the selection of the best of the three computer alternatives.

STEP 9—IMPLEMENT THE SOLUTION The problem is not solved simply by selecting the best solution. It is necessary to implement the solution. In our example, it would be necessary to install the required computing equipment.

STEP 10—FOLLOW UP TO ENSURE THAT THE SOLUTION IS EFFECTIVE The manager and developers should stay on top of the situation to make certain that the solution achieves the planned performance. When the solution falls short of expectations, it is necessary to retrace the problem-solving steps to determine what went wrong. Then another try is made. This process is repeated until the manager is satisfied that the problem has been solved.

THE SYSTEMS DEVELOPMENT LIFE CYCLE

The systems approach is a methodology. A **methodology** is a recommended way of doing something. The systems approach is the basic methodology for solving problems of all kinds. The **systems development life cycle (SDLC)** is an application of the systems approach to the development of an information system.

THE TRADITIONAL SDLC

It didn't take the first systems developers long to figure out that several stages of the development effort should be taken in a certain sequence if the project is to have the best chance of success. The stages are:

- Planning
- Analysis
- Design
- Implementation
- Use

The project is planned and the necessary resources to do the work are assembled. The existing system is analyzed to understand the problem and determine the functional requirements of the new system. The new system is then designed and implemented. After implementation, the system is used—ideally for a long period of time.

Because the tasks follow an orderly pattern and are performed in a top-down fashion, the traditional SDLC is often referred to as the **waterfall approach**. The flow of the activity is in one direction—toward project completion.

Figure 7.4 illustrates the circular nature of the life cycle. When a system outlives its usefulness and must be replaced, a new life cycle is initiated, beginning with the planning phase.

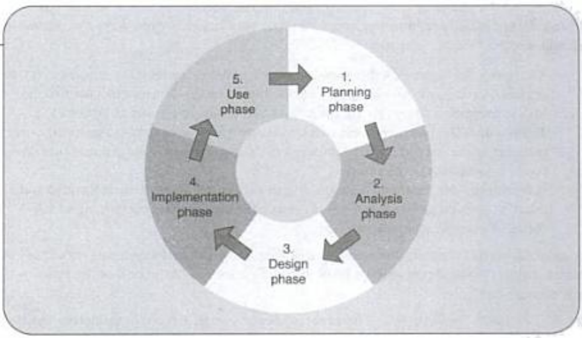


Figure 7.4 **The Circular Pattern of the System Life Cycle**

It is easy to see how the traditional SDLC is an application of the systems approach. The problem is defined in the planning and analysis stages. Alternative solutions are identified and evaluated in the design stage. Then, the best solution is implemented and used. During the use stage, feedback is gathered to see how well the system is solving the defined problem.

PROTOTYPING

Although it is difficult to argue with the logical unfolding of the stages of the traditional SDLC, it had its shortcomings. As systems grew in size and complexity, it became impossible to make a one-shot pass through the stages. Developers were always looping back and redoing things to come up with a system that satisfied the users. Also, projects tended to drag on for months and years, and almost always exceeded their budgets. In response to these limitations, systems developers decided to apply a technique that had proven effective in other pursuits, such as the design of automobiles—the use of prototypes. As applied to systems development, a **prototype** is a version of a potential system that provides the developers and future users with an idea of how the system in its completed form will function. The process of producing a prototype is called **prototyping**. The idea is to produce the prototype as quickly as possible, perhaps overnight, and obtain user feedback that will enable the prototype to be improved again very quickly.

Types of Prototypes[3]

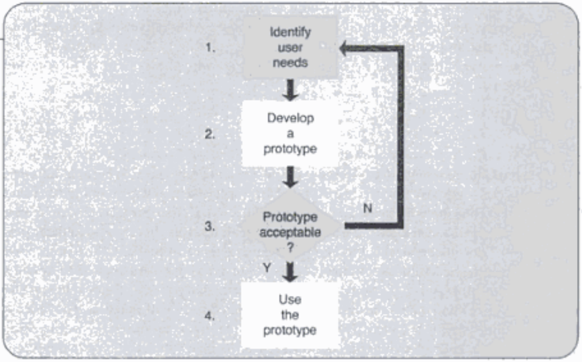
A common question that people often ask when first hearing about a computer prototype is, "Does the prototype become the actual system?" The answer is, "It depends."

Prototypes are of two types: evolutionary and requirements. An **evolutionary prototype** is continually refined until it contains all of the functionality that the users require of the new system. It is then put into production. Therefore, an evolutionary prototype becomes the actual system. A **requirements prototype**, however, is developed as a way to define the functional requirements of the new system when the users are unable to articulate exactly what they want. By reviewing the requirements prototype as features are added, users are able to define the processing required for the new system. When the requirements are defined, the requirements prototype has served its purpose and another project is initiated to develop the new system. Therefore, a requirements prototype does not become the actual system.

DEVELOPMENT OF AN EVOLUTIONARY PROTOTYPE Figure 7.5 shows the four steps involved in developing an evolutionary prototype. The four steps are as follows:

1. **Identify user needs.** The developer interviews users to obtain an idea of what is required from the system.
2. **Develop a prototype.** The developer uses one or more prototyping tools to develop a prototype. Examples of prototyping tools are integrated application generators and prototyping toolkits. An **integrated application generator** is a prewritten software system that is capable of producing *all* of the desired features in the new system—menus, reports, screens, a database, and so on. A **prototyping toolkit** includes separate software systems, such as electronic spreadsheets or database management systems, each capable of producing a *portion* of the desired system features.
3. **Determine if the prototype is acceptable.** The developer demonstrates the prototype to the users to determine whether it is satisfactory. If so, Step 4 is taken; if not, the prototype is revised by repeating Steps 1, 2, and 3 with a better understanding of the user needs.
4. **Use the prototype.** The prototype becomes the production system.

Figure 7.5
Development of an Evolutionary Prototype



This approach is possible only when the prototyping tools enable the prototype to contain all of the essential elements of the new system.

DEVELOPMENT OF A REQUIREMENTS PROTOTYPE Figure 7.6 shows the steps involved in developing a requirements prototype. The first three are the same as those taken to develop an evolutionary prototype. The next steps are as follows:

4. **Code the new system.** The developer uses the prototype as the basis for coding the new system.
5. **Test the new system.** The developer tests the system.
6. **Determine if the new system is acceptable.** The user advises the developer whether the system is acceptable. If so, Step 7 is taken; if not, Steps 4 and 5 are repeated.
7. **Put the new system into production.**

This approach is followed when the prototype is intended only to have the appearance of a production system, but not when it is to contain all of the essential elements.

The Attraction of Prototyping[4]

Both users and developers like prototyping for the following reasons:

- Communications between the developer and user are improved.
- The developer can do a better job of determining the user's needs.
- The user plays a more active role in system development.
- The developers and the user spend less time and effort in developing the system.
- Implementation is much easier because the user knows what to expect.

These advantages enable prototyping to cut developmental costs and increase user satisfaction with the delivered system.

Potential Pitfalls of Prototyping

Prototyping is not without its potential pitfalls. They include:

- The haste to deliver the prototype may produce shortcuts in problem definition, alternative evaluation, and documentation. The shortcuts produce a "quick and dirty" effort.
- The user may get overly excited about the prototype, leading to unrealistic expectations regarding the production system.

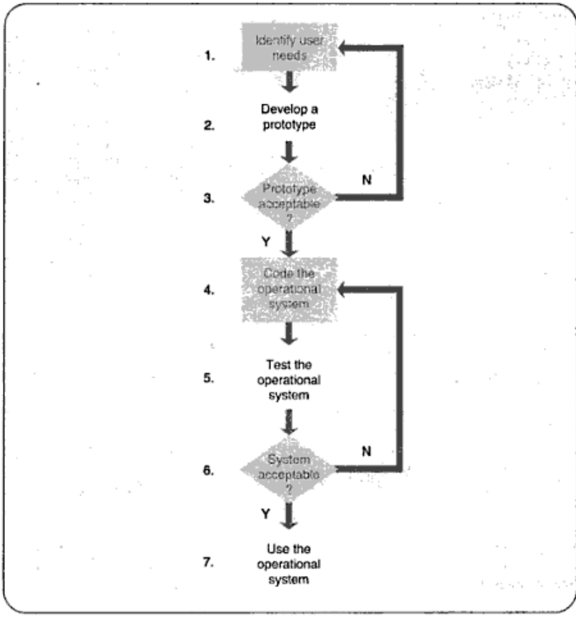


Figure 7.6
Development of a Requirements Prototype

- Evolutionary prototypes may not be very efficient.
- The computer–human interface provided by certain prototyping tools may not reflect good design techniques.

Both users and developers should be aware of these potential pitfalls when they elect to pursue the prototyping approach. However, on balance, prototyping has proven to be one of the most successful SDLC methodologies. It would be difficult to find a development project that did not incorporate prototyping to some degree.

RAPID APPLICATION DEVELOPMENT

A methodology that has the same objective of speedy response to user needs as does prototyping but is broader in scope is RAD. The term **RAD**, for **rapid application development**, was coined by computer consultant and author James Martin, and it refers to a development life cycle that is intended to produce systems quickly without sacrificing quality.[5]

RAD is an integrated set of strategies, methodologies, and tools that exists within a framework called information engineering. **Information engineering (IE)** is the name that Martin gives to his overall approach to system development, which he treats as a firmwide activity. The term **enterprise** is used to describe the entire firm.

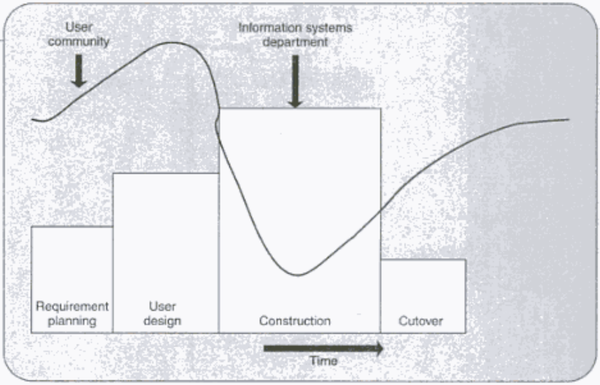


Figure 7.7 **Rapid Application Development Is an Integral Part of Information Engineering**

Source: James Martin, *Rapid Application Development,* 1st ed., © 1991, p. 127. Adapted by permission of Pearson Education, Inc., Upper Saddle River, NJ 07458.

Figure 7.7 illustrates the RAD life cycle according to Martin, showing the amount of effort expended by both users and information specialists. The names of Martin's life cycle stages differ somewhat from those we have used for the traditional SDLC, but the same sequence of work is involved. In the traditional life cycle, representatives from the information systems department do the majority of the work, with users only gaining momentum during cutover. The opposite is true in the RAD life cycle illustrated in Figure 7.7 where users play the major role except during construction. Martin's underlying logic was that greater user involvement, especially during early stages, would enable systems to be developed more quickly. Cutover occurs sooner during RAD than in the traditional life cycle.

The Essential Ingredients of RAD

RAD requires four essential ingredients: management, people, methodologies, and tools:

- **Management.** Management, especially top management, should be *experimenters* who like to do things a new way or *early adapters* who quickly learn how to use new methodologies.
- **People.** Rather than utilize a single team to perform all of the SDLC activities, RAD recognizes the efficiencies that can be achieved through the use of specialized teams. Members of these teams are masters of the methodologies and tools that are required to perform their specialized tasks. Martin uses the term **SWAT team**, with SWAT standing for "skilled with advanced tools."
- **Methodologies.** The basic RAD methodology is the RAD life cycle.
- **Tools.** RAD tools consist mainly of fourth-generation languages and computer-aided software engineering (CASE) tools that facilitate prototyping and code generation. CASE tools use the computer to prepare documentation that can be transformed into operational software and databases.

Of all the components of information engineering, RAD has probably enjoyed the greatest support. Although it may not be applied exactly as Martin envisioned, its emphasis on user involvement and speed make it very appealing. If you ask CIOs which SDLC they use, they are likely to say, "Oh, we use RAD."

PHASED DEVELOPMENT

One systems development methodology used by many firms today is a combination of the traditional SDLC, prototyping, and RAD—taking the best features of each. The traditional SDLC contributed the logical sequence of stages, prototyping contributed the iterative solicitation of user feedback, and RAD contributed the notion that user involvement includes participation in development. The name that we give this contemporary methodology is *phased development*. **Phased development** is an approach for developing information systems that consists of six stages—preliminary investigation, analysis, design, preliminary construction, final construction, and system test and installation. The analysis, design, and preliminary construction stages are taken for each system module.

The Phased Development Stages

The six phased development stages are illustrated in Figure 7.8.

PRELIMINARY INVESTIGATION The developers, including users as well as information specialists, conduct an enterprise analysis for the purpose of learning about the organization with the systems

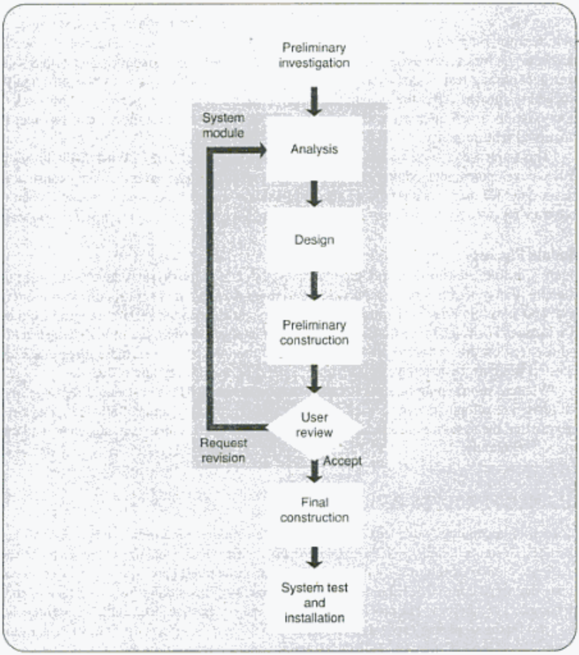


Figure 7.8 **The Stages of the Phased Development Methodology**

problem; define the new system objectives, constraints, risks, and scope; evaluate both project and system feasibility; subdivide the system into major components; and obtain user feedback.

ANALYSIS The developers analyze the users' functional requirements for each system module using a variety of information gathering techniques and then document the findings in the form of process, data, and object models.

DESIGN The developers design the components and interfaces with other systems for each new system module and then document the design using the various modeling techniques.

PRELIMINARY CONSTRUCTION The developers construct and test the software and data for each system module and obtain user feedback. For any modules that do not receive user approval, the analysis, design, and preliminary construction stages are repeated.

FINAL CONSTRUCTION The module software is integrated to form the complete system, which is tested along with the data. In addition, any needed hardware is obtained and tested, facilities are constructed, and users are trained. The training covers the procedure that users are to follow in using the system and often the procedure to follow in installing the system on their workstations.

SYSTEM TEST AND INSTALLATION The developers design and perform a system test that includes not only software and data, but the other information resources as well—hardware, facilities, personnel, and procedures. The system components are installed, and a user acceptance test is conducted. Acceptance by the users serves as the go-ahead to proceed to cutover. After the system has been in use for some time, perhaps a few weeks or months, a postimplementation review is conducted to ensure that the system has met the functional requirements.

This sequence of stages is not unlike those of the traditional SDLC. What distinguishes the phased development methodology is the way that analysis, design, and preliminary construction are repeated for each system module separately, rather than for the overall system. When the stages are repeated for the modules, they are called phases; hence the name *phased development*.

Module Phases

Figure 7.9 illustrates how the module phases are integrated into system development. In this example, the system has been subdivided into three major modules: a report writer, a database, and a Web interface. The number of modules varies with the system, ranging from one to a dozen or so. You can see that, in the figure, the analysis, design, preliminary construction, and user review are performed separately for each module. Moreover, these three phases are repeated when necessitated by user review—reflecting the prototyping influence.

Whereas prototyping is best suited for small systems, RAD is best suited for large ones, and phased development can be used for the development of systems of all sizes. The key is the way that the system is subdivided into modules and each is analyzed, designed, and constructed separately.

BUSINESS PROCESS REDESIGN

Information technology advances quickly, and organizations need to take advantage of these advances. Systems include both those that process the firm's data and those that perform basic functions, such as drilling for oil or fabricating a manufactured part. Management often concludes that fresh approaches should be taken to these systems, taking full advantage of modern computer technology. The process of reworking the systems has been called **reengineering**. The term **business process redesign (BPR)** is also used. BPR affects the firm's IT operations in two ways. First, IT can apply BPR to the redesign of information systems that can no

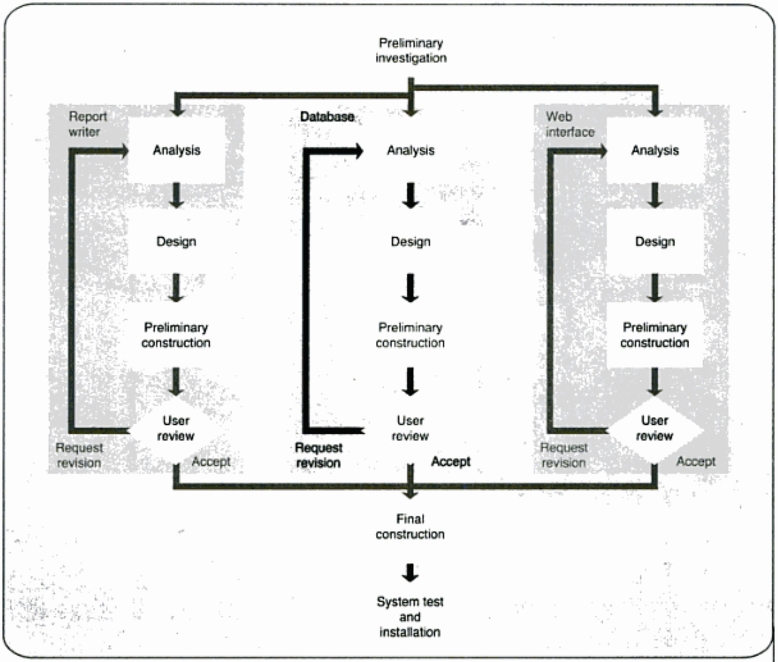


Figure 7.9 **Analysis, Design, and Preliminary Construction are Performed on Each System Module**

longer be kept alive by ordinary maintenance. Such systems are called **legacy systems**, because they are too valuable to discard but represent a drain on IS resources. Second, when a firm applies BPR to its major operations, the effort invariably has a ripple effect that results in the redesign of information systems.

Strategic Initiation of BPR Projects

BPR has such a potentially dramatic effect on the firm and its operations that such projects are usually initiated at the strategic management level. Figure 7.10 shows that such projects are triggered by a problem or opportunity. Strategic management determines that BPR is appropriate and authorizes that physical processes (Circle 1 in the figure) be redesigned. Such physical processes include inbound logistics of physical resources, operations that create the firm's products or services, and outbound logistics. BPR can also be aimed at the activities that support the physical processes—human resources, purchasing, marketing, and the like.

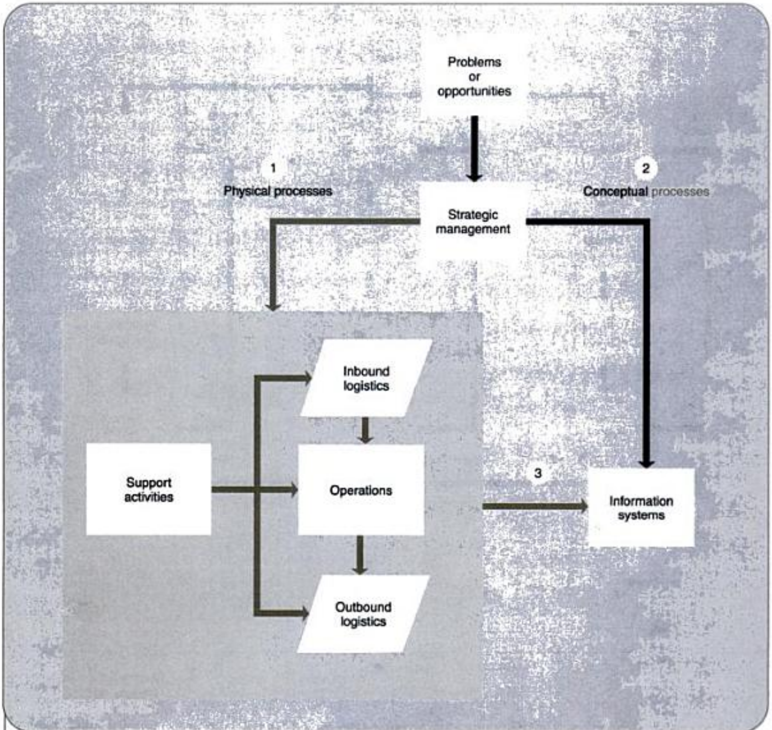


Figure 7.10 **Top-Down Initiation of BPR Projects**

Strategic management can also authorize that information systems be redesigned to take advantage of modern technology (Circle 2 in the figure). For example, systems can be redesigned so that they are Web-based.

When physical processes are redesigned, a domino effect often occurs that results in the redesign of corresponding information systems (Circle 3 in the figure). For this reason, BPR invariably involves information services.

IS has devised two techniques for applying BPR—reverse engineering and reengineering. These components can be applied separately or in combination.

Reverse Engineering

Reverse engineering had its origin in business intelligence. Firms have long kept current on their competitors' products by purchasing samples and taking them apart to see what makes

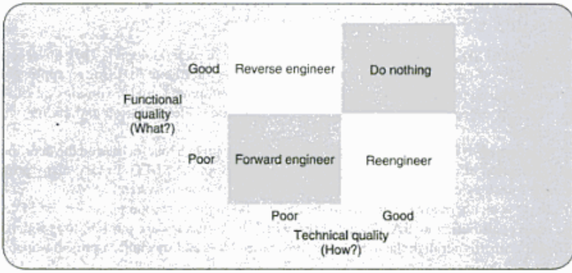


Figure 7.11 **BPR Component Selection Is Based on Both Functional and Technical Quality**

them tick. The design specifications of the competitors' products are derived from the products themselves, reversing the normal pattern in which the design comes first.

As used in computing, **reverse engineering** is the process of analyzing an existing system to identify its elements and their interrelationships as well as to create documentation at a higher level of abstraction than currently exists.[6] This need arises when the firm wants to redevelop an existing system for which little or no documentation exists.

The starting point in reverse engineering a system is the computer code, which is transformed into documentation. This documentation can, in turn, be transformed into more abstract descriptions, such as data flow diagrams, use cases, and entity-relationship diagrams. The transformation can be accomplished manually or by BPR software.

Reverse engineering, therefore, follows a backward path through the system life cycle, reconstructing the system design and planning that went into the original development effort. The result is a thoroughly documented system. However, the system still does exactly what it was originally designed to do. Reverse engineering does not change the **functionality** of a system—the job that it performs. Rather, the objective is to better understand a system in order to make changes by other means, such as reengineering.

Reengineering

Reengineering is the complete redesign of a system with the objective of changing its functionality. However, it is not a "clean slate" approach, because the knowledge of the current system is not completely ignored. That knowledge is gained by first engaging in reverse engineering. Then the new system is developed in the normal manner. The name **forward engineering** is given to the process of following the SDLC in the normal manner while engaging in BPR.

Selection of the BPR Components

The BPR components can be applied separately or in combination, depending on the degree of change sought. The proper mix depends on the current state of the system in terms of its functional and technical quality. Figure 7.11 shows these two influences. **Functional quality** is a measure of what the system does. **Technical quality** is a measure of how well it does it.

When both functional and technical quality are poor, a forward-engineering project is in order. Things are so bad that it is best to start over, taking the steps of the system life cycle in the normal manner. When the functionality is good but the technical quality is poor, reverse engineering should be pursued. When functionality is poor but technical quality is good, reengineering is called for. In this case, the system reflects modern techniques but is simply not doing the job. When both functionality and technical quality are good, it is best to leave things alone.

PUTTING THE TRADITIONAL SDLC, PROTOTYPING, RAD, PHASED DEVELOPMENT, AND BPR IN PERSPECTIVE

The traditional SDLC, prototyping, RAD, and BPR are all methodologies. They are recommended ways of developing an information system. The traditional SDLC is an application of the systems approach to the problem of system development, and it contains all of the basic system approach elements, beginning with problem identification and ending with system use.

Prototyping is an abbreviated form of the systems approach that focuses on the definition and satisfaction of user needs. Prototyping can exist within the SDLC. In fact, many prototyping efforts may be required during the development of a single system.

RAD is an alternative approach to the design and implementation phases of the SDLC. The main contribution of RAD is the speed with which systems are put into use, which is achieved primarily through the use of computer-based tools and specialized project teams.

Phased development uses the traditional SDLC as a basic framework and applies it to a project in a modular fashion using the same tools and concept of specialized teams as does RAD.

Currently, firms are revamping many systems that were implemented with computer technology that is obsolete by today's standards. Because of Moore's Law, information technology can quickly become obsolete. The term *BPR* is used for this approach of using technology to its fullest. Prototyping, RAD, and phased development can be used in a BPR project to meet users' needs in a responsive way.

SYSTEMS DEVELOPMENT TOOLS

The systems approach and the various systems development life cycles are methodologies—recommended ways of solving systems problems. The methodologies are like the blueprints that architects draw to guide contractors, carpenters, plumbers, electricians, and the like when they construct the houses. Similarly, the methodologies guide systems developers as they construct systems.

When the carpenters, plumbers, and electricians do their work, they make use of various tools—hammers, saws, wrenches, and so on. Carrying the analogy to systems work still further, the system developers also use tools. In Chapter 6, we described two data modeling tools—entity-relationship diagrams and class diagrams. These tools have enjoyed widespread popularity and use for many years, but work continues to improve their use. For example, research has concluded that modeling the processes and data of object models can be enhanced by the use of patterns that typically exist between objects.[7] Recognizing that certain patterns occur frequently enhances the developers' ability to establish a complete set of system requirements as a way to eliminate or reduce the opportunity for system failures.

Data-Driven Versus Process-Driven Approaches

During the early years of computer system development, practically all of the attention was given to the processes that the computers would perform, as opposed to the data that would be used. The emergence of database management systems in the 1970s drew attention to the importance of data design. Such data modeling tools as entity-relationship diagrams and class diagrams are evidence of this attention.

Now we turn our attention to modeling the processes that systems perform.

PROCESS MODELING

Process modeling was first accomplished with flowcharts. These diagrams illustrated the flow of data through systems and programs. The International Organization for Standardization

(ISO) established standards for the shapes of the flowchart symbols, ensuring their use on a worldwide basis. Their popularity was short-lived, however, as simpler and more effective modeling tools were devised. The ISO flowcharting standards specified the use of more than 20 symbols, and their proper use challenged even the most expert information specialists. When data flow diagrams with their four symbols came along in the late 1980s, interest in their adoption was immediate.

Data flow diagrams are excellent for modeling processes at a summary level. However, they suffer in capturing processing details. For this reason, data flow diagrams are typically supplemented by other, more detail-oriented tools, such as use case diagrams.

Data Flow Diagrams

A **data flow diagram (DFD)** is a graphic representation of a system that uses four symbol shapes to illustrate how data flows through interconnected processes. The symbols represent (1) environmental elements with which the system interfaces, (2) processes, (3) data flows, and (4) data storage.

ENVIRONMENTAL ELEMENTS Environmental elements exist outside the boundary of the system. These elements provide the system with data input and receive the system's data output. In a DFD, no distinction is made between data and information. All of the virtual flows are regarded as data.

The name **terminator** is often used to describe the environmental elements, because they mark the points where the system terminates. A terminator is represented in a DFD with a square or a rectangle, labeled with the name of the environmental element.

A terminator can be:

- A *person*, such as a manager, who receives a report from the system
- An *organization*, such as another department within the company or another company
- Another *system* with which the system interfaces

An important task in systems analysis and design is the definition of the system boundary. Terminators serve this purpose. The developer works within the boundary and establishes linkages with the system's environment in the form of data flows.

PROCESSES A **process** is something that transforms input into output. It can be illustrated with a circle, a horizontal rectangle, or an upright rectangle with rounded corners. Each process symbol is identified with a label. The most common labeling technique is to use a *verb and an object*, but you can also use the name of a *system* or a *computer program*.

DATA FLOWS A **data flow** consists of a group of logically related data elements (ranging from a single data element to one or more files) that travel from one point or process to another. The arrow symbol is used to illustrate the flow and can be drawn with either a straight or curved line.

Data flows can *diverge* when the same data travels to multiple locations in the system. Data flows can also *converge* to show several identical data flows that travel to a single location. Sometimes the system design will call for a two-way flow. This can be illustrated with a single two-headed arrow, or two arrows can be used.

A data flow must involve a process. Data can flow between an external entity and a process, between a data store and a process, and between two or more processes.

The phrase "data in motion" is a good way to think of a data flow, because the data move from one point in the system to another.

DATA STORAGE When it becomes necessary to hold data for some reason, a data store is used. In DFD terminology, a **data store** is a repository of data. Think of a data store as "data at rest." A data store can be represented by a set of parallel lines, an open-ended rectangle, or an oval.

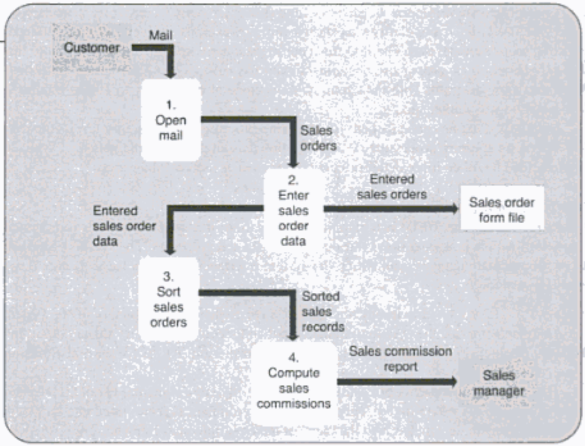


Figure 7.12 **A Data Flow Diagram of a Sales Commission System**

The process of drawing a DFD is simply one of identifying the processes, linking them with data flows, identifying the terminators that provide input and receive output, and adding data stores where needed.

The DFD in Figure 7.12 illustrates a system that a firm might use to compute commissions for its sales representatives. Here, the terminators are illustrated with rectangles, the processes with upright rectangles with rounded corners, the data flows with straight lines, and the data stores with open-ended rectangles.

A customer fills out a sales order and mails it to the company. In Process 1, the mail is opened and the sales order is removed. The data from the sales order are entered into the information system in Process 2. After the data have been entered, the sales order forms are filed away for safekeeping in the Sales Order Form file. In Process 3, the sales order data are sorted into a particular sequence. The sorted records are then used in Process 4 to prepare a sales commission report for the sales manager.

LEVELED DATA FLOW DIAGRAMS Figure 7.12 identifies the major processes of the system. It is called a **Figure 0 diagram**. We will explain how that name is derived later. It is possible to use additional DFDs to achieve documentation at both a more summarized and a more detailed level. A diagram that documents the system at a more summarized level is called a *context diagram;* a diagram that provides more detail is called a *Figure n diagram.*

THE CONTEXT DIAGRAM The **context diagram** positions the system in an environmental context. The diagram consists of a single process symbol that represents the entire system. It shows the data flows leading to and from the terminators. Figure 7.13 is a context diagram of the sales commission system.

When drawing a context diagram, you:

1. Use only a single process symbol.
2. Label the process symbol to represent the entire system. You can use a verb plus object such as "Process sales commissions" or you can use the system name as in the figure.

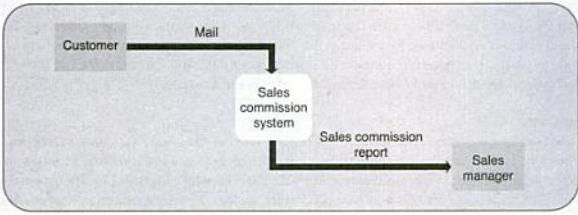


Figure 7.13 **A Context Diagram of a Sales Commission System**

3. Do not number the single process symbol.
4. Include all of the terminators for the system.
5. Show all of the data flows between the terminators and the system.

Although the context diagram documents a system at the highest level, it is usually easier to begin documentation at a lower level—say, the Figure 0 level.

FIGURE N DIAGRAMS When it is necessary to document the system in greater detail than the Figure 0 diagram, you use one or more Figure n diagrams. A **Figure n diagram** documents a single process of a DFD in a greater amount of detail. The *n* represents the number of the process on the next higher level that is being documented. Take the sales commission system in Figure 7.12, for example. Processes 1, 2, and 3 are documented in sufficient detail; however, Process 4 represents two processes—compute the commission amounts and accumulate the totals.

Figure 7.14 shows a **Figure 4 diagram.** It explodes Process 4 of the Figure 0 diagram, making it a Figure 4 diagram. If you document Process 4.1 in still more detail, you draw another Figure n diagram, called a Figure 4.1 diagram. As you continue to document lower levels, you use such names as Figure 4.1.1, Figure 4.1.1.1, and so on.

Now you can understand why the DFD in Figure 7.12 is called a Figure 0 diagram. It is because the process on the next higher level in the context diagram is unnumbered.

Notice that the data flow into Process 4.1 in Figure 7.14 has a small circle at one end. The circle, called a **connector**, contains the number of the process that provides the data flow. A connector can also be used in the same way to show the destination process of data leaving a system. This is the way that the processes of one DFD are linked to the processes of another.

The term **leveled DFDs** is used to describe the hierarchy of diagrams, ranging from the context diagram to the lowest-level Figure n diagram, that are used to document a system.

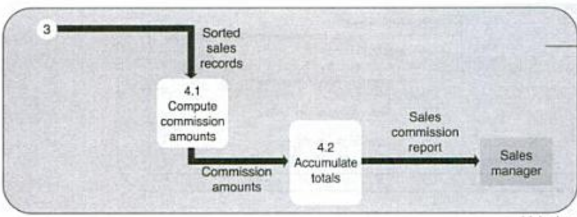


Figure 7.14 **A Figure 4 Diagram of a Sales Commission System**

HOW MUCH DETAIL TO SHOW Two general rules guide developers in deciding how many levels of DFDs to use. The first is to restrict a single DFD to no more than six to eight processes. The second is to use another tool to document the lowest level of detail, but to use no more than a single page. If more space is required, you stopped using data flow diagramming too soon.[8] A good process modeling tool to use for greater detail is the *use case*.

Use Cases

A **use case** is a narrative description in an outline form of the dialog that occurs between a primary and secondary system. In most cases, the primary system is a computer program and the secondary system is a person interacting with the computer program. The dialog usually consists of actions that are taken by the participants, such as those by a data entry operator and the computer system.

There are two use case formats. One is a continuous narrative with each action numbered sequentially. The other is called the **ping-pong format**, because it consists of two narratives and the numbering indicates how the tasks alternate between the primary and secondary systems. The ping-pong format, illustrated in Figure 7.15, is the most popular format. The example in Figure 7.15 illustrates the following actions:

A data entry operator logs on with a password.

The system verifies the password or denies entry.

The data entry operator enters sales order data into the workstation. The order data include:

- Customer number
- Item number
- Item quantity

Figure 7.15 A Use Case

Use case name:	**Enter sales order data**
Description:	**Data entry operation for order entry system**
Prerequisites:	**Create customer, create item**
Associations:	**Main menu**
Principle Actor:	**Data entry operator**

Data Entry Operator	System
1.0 Operator logs on with a password 1.0-A Return to main menu 1.1-A Go to 7.0-A	2.0 System verifies operator and prompts operator to enter additional information 2.0-A System does not verify operator and prompts to reenter 2.1-A Go to 1.0
3.0 Operator enters customer number, item number, and item quantity 3.0-A Return to main menu 3.1-A Go to 7.0-A	4.0 System verifies customer number and item number 4.0-A System does not verify customer number and item number 4.1-A System displays an error message and prompts operator to reenter 4.2-A Go to 3.0 5.0 System saves order data
6.0 Go to 3.0 6.0-A Return to main menu 6.0-A Log off	7.0 System logs employee off 7.0-A System displays main menu

The order entry program accesses master files to verify the accuracy of:

- Customer number
- Item number

When a number is not verified as being correct, the program displays an error message and asks the operator to reenter the information.
When the operator wishes to conclude the order entry process, he or she logs off.

In this example, the actions involve the data entry operator (the left-hand column) and the system (the right-hand column). You begin on the left with Step 1.0—the operator logging on. Then, you take the next higher-numbered Step (2.0) where the system verifies the operator and prompts for more information.

If the system does not verify the operator, Steps 2.0-A and 2.1-A are taken. Alphabetic letters are appended to step numbers for **alternative events**—actions that are not normally expected to occur.

If the system verifies the operator, he or she executes Step 3.0, entering the data. If the system does not verify the operator, he or she is directed to the main menu (Step 3.0-A), and Step 3.1-A specifies that Step 7.0-A next be executed, with the system displaying the main menu.

In Steps 4.0 and 4.0-A through 4.2-A, the system either verifies or does not verify the entered data, and the verified data are saved in Step 5.0.

After the data are saved in 5.0, Step 6.0 transfers the logic back to 3.0, where the operator can enter more data or the operator can indicate a desire to return to the main menu (Step 6.0-A).

Use Case Guidelines

A set of guidelines for preparing a use case in the ping-pong format is shown in Figure 7.16.

When to Use Data Flow Diagrams and Use Cases

Data flow diagrams and use cases are most often prepared during the preliminary investigation and analysis stages of the phased development methodology. The DFDs illustrate an overview of the processing, and the use cases provide the detail. Normally, several use cases are required to support a single Figure 0 diagram.

PROJECT MANAGEMENT

The first systems development projects were managed by the manager of the IT unit, assisted by the managers of systems analysis, programming, and operations. Through trial and error, the management responsibility has gradually encompassed higher management levels—the strategic level in many cases. Today, it is possible for life cycle management to span several organizational levels and to involve managers outside of IT. Figure 7.17 shows the hierarchical nature of project management. In this example, there are five development projects ongoing at the same time, all managed by the MIS steering committee.

When the system has strategic value or affects the entire organization, the president or the firm's executive committee may decide to oversee the development project. Many firms establish a special committee below the level of the executive committee that assumes responsibility for overseeing all of the systems projects. When the purpose of a committee is to provide ongoing guidance, direction, and control, it is called a **steering committee.**

The MIS Steering Committee

When a firm establishes a steering committee for the purpose of directing the use of the firm's computing resources, the name **MIS steering committee** is used. Permanent members of the MIS steering committee invariably include top executives. Temporary members include lower-level managers and consultants who participate during the time that their expertise is needed.

Use Case Guidelines

1. Begin numbering with 1.0 on the left-hand side to represent the first user action.
   Example: 1.0 Employee logs on with a password.
2. The first entry in the right-hand side should be 2.0, for the first system action.
3. Use decimal numbers to indicate steps taken in a sequence that are all part of a particular action. Otherwise, use ascending whole numbers (3, 4, 5, etc.).
   Example: 2.0 System verifies user
   2.1 System prompts user to enter additional information
4. Append an alphabetical letter to a sequence number for an alternate event.
   Example: 2.0-A System does not verify user
   2.1-A System prompts user to reenter password
5. When there are mutually exclusive alternate events, use multiple alphabetical letters.
6. For subsidiary actions, use a whole number for the basic action, followed by decimal numbers for the subsidiary actions.
   Example: 3.0 User creates report
   3.1 User specifies starting and ending dates
   3.2 User specifies report type
7. For optional actions, use a whole number for the basic action, followed by decimal numbers and alphabetical letters for the optional actions.
   Example: 3.2 User specifies report type
   3.3-A User specifies summary tabular report
   3.4-A User specifies detailed tabular report
   3.5-A User specifies graphical report
8. At the end of the process, the user should choose to repeat the process or log off.
   Example: 10.0 User returns to the main menu
   10.0-A User logs off
9. When the user logs off, the system should respond by logging the user off.
   Example: 11.0-A System logs user off.

Figure 7.16 Use Case Guidelines

The MIS steering committee performs three main functions:[9]

- It **establishes policies** that ensure computer support for achieving the strategic objectives of the firm.
- It **provides fiscal control** by serving as the approval authority for all requests for computer-related funds.
- It **resolves conflicts** that arise concerning priorities for computer use.

In effect, the task of the MIS steering committee is to carry out both the overall strategy that is established by the executive committee and the strategic plan for information resources.

By centralizing the management of system life cycles within the steering committee, two main advantages accrue.[10] The likelihood is increased that:

- The computer will be used to support users throughout the firm
- Computer projects will be characterized by good planning and control

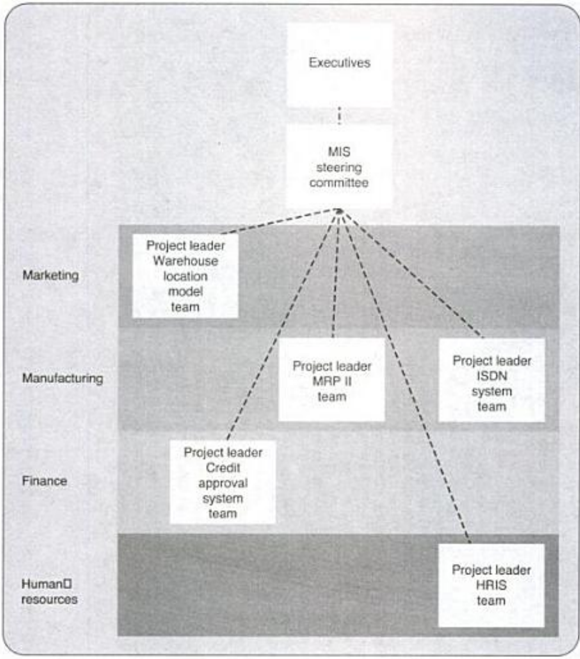


Figure 7.17 **Managers of a System Life Cycle Are Arranged in a Hierarchy**

The MIS steering committee is the most visible evidence that the firm intends to make information resources available to all users who have a genuine need.

Project Leadership

The MIS steering committee seldom gets directly involved with the details of the work. That responsibility goes to project teams. A **project team** includes all of the persons who participate in the development of an information system. A team may have as many as a dozen members, consisting of some combination of users, information specialists, and perhaps an internal auditor. The auditor ensures that the system design satisfies certain requirements in terms of accuracy, controls, security, and auditability. The team activity is directed by a **team leader** or **project leader** who provides direction throughout the life of the project. Unlike the MIS steering committee, the project team is not ongoing; it is usually disbanded when implementation is completed.

ID	Task Name	Duration	Start	Finish	Resource Names
1	**Phase 1: Preliminary Investigation**	21 days	Mon 9/30/02	Mon 10/28/02	
2	**Analysis**	9 days	Mon 9/30/02	Thu 10/10/02	Team
3	A-1 Initiate Contact with ECI	2 days	Mon 9/30/02	Tue 10/1/02	Team
4	A-2 Hold Group Meeting to Prepare for Initial Contact	1 day	Wed 10/2/02	Wed 10/2/02	Team
5	A-3 Conduct Initial Group Meeting in JAD	1 day	Wed 10/2/02	Wed 10/2/02	Team
6	A-4 Document Organization Background	6 days	Thu 10/3/02	Thu 10/10/02	Umang
7	A-5 Document Organization Chart	6 days	Thu 10/3/02	Thu 10/10/02	Umang
8	A-6 Document Project Definition	6 days	Thu 10/3/02	Thu 10/10/02	Umang
9	A-7 Document Problem Chain	6 days	Thu 10/3/02	Thu 10/10/02	Deborah
10	A-8 Document Goal Analysis	6 days	Thu 10/3/02	Thu 10/10/02	Phil
11	A-9 Document Risk Evaluation	6 days	Thu 10/3/02	Thu 10/10/02	Phil
12	A-10 Document Existing/Proposed System	6 days	Thu 10/3/02	Thu 10/10/02	Phil
13	A-11 Document System	6 days	Thu 10/3/02	Thu 10/10/02	Kyle, Philip
14	A-12 Document Requirements	6 days	Thu 10/3/02	Thu 10/10/02	Deborah
15	A-13 Prepare Evaluation of System Solutions	6 days	Thu 10/3/02	Thu 10/10/02	Deborah
16	**Design**	4 days	Fri 10/11/02	Wed 10/16/02	
17	D-1 Design Documentation Part of Delivery 1	2 days	Fri 10/11/02	Mon 10/14/02	Team
18	D-2 Define Actions to Achieve Goals	2 days	Fri 10/11/02	Mon 10/14/02	Team
19	D-3 Put a Project Control Mechanism in Place	2 days	Fri 10/11/02	Mon 10/14/02	Team
20	D-4 Get Initial Approval for Documents	2 days	Tue 10/15/02	Wed 10/16/02	Team
21	**Construction**	6 days	Thu 10/17/02	Thu 10/24/02	
22	C-1 Construct Documentation Part of Delivery 1	6 days	Thu 10/17/02	Thu 10/24/02	Team
23	C-2 Construct Existing System Functions/Components Matrix	1 day	Thu 10/17/02	Thu 10/17/02	Kyle
24	C-3 Construct Existing System Data Flow Diagrams	1 day	Thu 10/17/02	Thu 10/17/02	Kyle
25	C-4 Construct Proposed System Functions/Components Matrix	1 day	Fri 10/18/02	Fri 10/18/02	Kyle
26	C-5 Construct Proposed System Data Flow Diagrams	1 day	Fri 10/18/02	Fri 10/18/02	Kyle
27	C-6 Construct Gantt Chart	6 days	Thu 10/17/02	Thu 10/24/02	Philip, Kyle
28	**Review**	2 days	Fri 10/25/02	Mon 10/28/02	
29	R-1 Review Gantt Chart	1 day	Fri 10/25/02	Fri 10/25/02	Team
30	R-2 Review Next Steps for Project with ECI	1 day	Fri 10/25/02	Fri 10/25/02	Team
31	R-3 Attend Team Meeting Regarding Phase 1	1 day	Mon 10/28/02	Mon 10/28/02	Team
32	**Phase 2: Build Template**	18 days	Tue 10/29/02	Thu 11/21/02	
33	**Analysis**	2 days	Tue 10/29/02	Wed 10/30/02	
34	A-1 Analyze Website Requirements	2 days	Tue 10/29/02	Wed 10/30/02	Phil, Deborah
35	A-2 Analyze Website Design Alternatives	2 days	Tue 10/29/02	Wed 10/30/02	Deborah, Phil
36	A-3 Analyze Search Functionality Priorities	1 day	Tue 10/29/02	Tue 10/29/02	Deborah, Phil
37	**Design**	3 days	Thu 10/31/02	Mon 11/4/02	
38	D-1 Design Basic Website Templates	3 days	Thu 10/31/02	Mon 11/4/02	Deborah, Phil
39	D-2 Design Serach Interface Templates	2 days	Thu 10/31/02	Fri 11/1/02	Deborah, Phil
40	**Construction**	6 days	Tue 11/5/02	Mon 11/11/02	

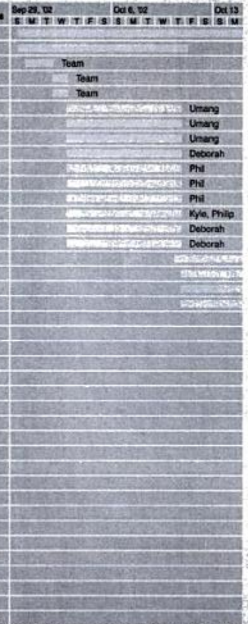


Figure 7.18 **A Gantt Chart**

The Project Management Mechanism

The basis for project management is the project plan, which is prepared during the preliminary investigation stage when the phased development methodology is followed. Once the project objectives, constraints, and scope have been defined, it is possible to identify the tasks that must be performed. The plan is first sketched out in a general form and is then made more specific. A popular format for a detailed plan is a Gantt chart, which identifies the tasks, who will perform them, and when they will be performed. A **Gantt chart** is a horizontal bar chart that includes a bar for each task to be performed. The bars are arranged in a time sequence. Figure 7.18 is the first part of a Gantt chart, prepared using a Microsoft Excel spreadsheet. The number of tasks increases as the project becomes more complex. Even simple projects can involve a hundred or more tasks.

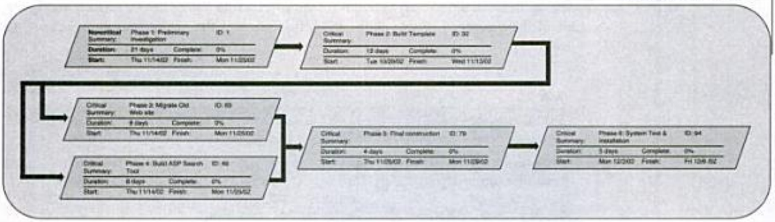
A complement to the Gantt chart is the network diagram. A **network diagram**, also called a *CPM* (for *Critical Path Method*) diagram or *PERT* (for *Program Evaluation and Review Technique*) chart, is a drawing that identifies activities and links them with arrows to show the sequence in which they are to be performed. Figure 7.19 is an example of a high-level network diagram that identifies the phases of a project. Microsoft Project, the project management software system from Microsoft, will prepare the network diagram automatically from the Gantt chart data.

Gantt charts and network diagrams are examples of graphic reports. Narrative reports, in the form of weekly written reports prepared by the project leader, provide another way to communicate project information to the MIS steering committee. The committee meets periodically, and the project leaders supplement their written reports with oral reports that review progress, identify challenges, and specify future actions. In this way, the committee is able to remain current on each project and make decisions intended to ensure that the project is successfully completed, within both time constraints and budgets.

Web Support for Project Management

In addition to software-based project management systems, such as Microsoft Project, support can also be obtained from the Internet. For example, Logic Software, a Toronto-based firm, offers a project management system called EasyProjects.net. The firm also offers an online project management course as an aid to firms wishing to increase the project management knowledge of its employees.

Figure 7.19 **A Network Diagram**



PROJECT COST ESTIMATING[11]

Estimating the time and money required to develop a system has always been a daunting task. However, over time many methods have been devised to estimate project costs and schedules. All of these methods rely in one way or another on three components:

1. Information about the specific system being built and the people who will do the developing
2. Historical experience
3. Knowledge of software development processes and estimating tools and techniques

The cost-estimating process consists of a set of inputs, tools and techniques, and outputs. Table 7.1 lists some of the components.

Cost-Estimating Inputs

A *work breakdown structure (WBS)* identifies the project activities that will require resources. Examples of WBSs are Gantt charts and network diagrams. *Resource requirements* specify the particular resources that will be required and in what quantities. *Resource rates* are the unit costs for each type of resource. *Activity duration estimates* specify the work period required to complete the activity. *Historical information* consists of files of past project data, commercial cost-estimating databases, and project team knowledge.

Cost-Estimating Tools and Techniques

Analogous estimating uses actual costs of similar projects that have been performed in the past as a basis for projecting the cost of the project under consideration. This technique is used when little other information is available. It is less costly than other techniques, but generally less accurate.

Bottom-up estimating begins with details, such as activities in a Gantt chart, and applies cost data, such as hourly rates for employees, to produce an estimated project cost. The greater the beginning detail, the more accurate the anticipated results.

Computerized tools are available for use in a stand-alone fashion or to simplify the tools just described. A source of computerized tools is WWW.CONSTRUX.COM.

Mathematical models can use quantified project characteristics and simulate different scenarios. Outputs are the most accurate when the historical data are accurate, the characteristics are easily quantifiable, and the model is scalable in that it can handle a wide range of project sizes.

Cost-Estimating Outputs

Cost estimates are made for all resources charged to the project and are usually expressed in applicable financial units, such as dollars or Euros. Such estimates can be refined during the course of the project to reflect additional information as the project unfolds. *Supporting*

Table 7.1

Components of the Cost-Estimating Process

INPUTS	TOOLS AND TECHNIQUES	OUTPUTS
Work breakdown structure	Analogous estimating	Cost estimates
Resource requirements	Bottom-up estimating	Supporting details
Resource rates	Computerized tools	Cost-management plan
Activity duration estimates	Mathematical modeling	
Historical information		

Table 7.2

Example of Project Cost

Team	Plan	Analysis	Design	Implement	Maintain	Total hours	Hourly Costs	Total Cost
Warehouse	80	240	160	120	160	760	$35.50	$26,980.00
Logistics	80	160	240	40	809	600	$75.00	$45,000.00
Inventory	80	160	400	80	160	880	$75.00	$66,000.00
Totals						*2,240*		*$137,980.00*

details document how the estimate was developed and any assumptions that were made. The *cost-management plan* describes how cost variances will be managed.

Table 7.2 is an example of a cost estimate for a project that will require three teams (warehouse, logistics, and inventory) and will span five project stages. The stage estimates are for person-hours, which are converted to dollars.

Highlights in MIS

A Quick Fix for IT at the FBI? Think Again[12]

On May 7, 2001, the FBI selected DynCorp to spearhead its 3-year, $400 million Trilogy IT infrastructure project. Then September 11 happened. All of a sudden, 3 years seemed way too long; immediate action was needed. The FBI began to pressure DynCorp to complete the project by the end of 2002.

On July 16, 2002, the Bush administration announced the details of the National Strategy for Homeland Security. On that same day, the FBI informed a Congressional panel that it would be impossible to speed up the Trilogy project—even with increased funding. The reason? The FBI determined that it was more important to do the project right than do it quick. Sometimes pouring more money into a developmental project to speed things up won't work—regardless of how important the project is.

Summary

The systems approach consists of three phases of effort: preparation, definition, and solution. Preparation effort involves viewing the firm as a system, recognizing the environmental system, and identifying the firm's subsystems. Definition effort consists of two steps: proceeding from a system to subsystem level and analyzing system parts in sequence. Solution effort includes identifying alternative solutions, evaluating them, selecting the best one, implementing it, and following up to ensure that it is effective.

When the systems approach is applied to systems development, the result is the systems development life cycle (SDLC). Numerous SDLC methodologies have evolved, with the traditional cycle, prototyping, RAD, and phased development drawing the most attention. The traditional SDLC approach, also called the waterfall approach, consists of five stages: planning, analysis, design, implementation, and use. In prototyping, a trial system is developed quickly and presented to the user for review. Refinements are made based on the review, and this process is repeated until the prototype is approved by the user. When the prototype becomes the production system, it is called an evolutionary prototype. When the prototype is used as a blueprint for another development project, it is a requirements prototype. Rapid application development (RAD) emphasizes a high level of user involvement and use of computer-based development tools. Phased development takes the best features of the other methodologies and repeats the analysis, design, and preliminary construction stages for each major module of the system being developed.

After the system has been in use and there is a need to redevelop it using modern technology, a methodology called *business process redesign* can be followed. Reverse engineering can be applied to legacy systems to generate needed documentation. Reengineering consists of reverse engineering, followed by taking the SDLC stages in the normal sequence—a process called *forward engineering*.

As systems are developed, the processes, data, and objects are modeled. A popular process-modeling tool is data flow diagramming, which uses symbols for processes and environmental elements linked by arrows to show data flow. Data storage is illustrated with data store symbols. Leveled diagrams consist of data flow diagrams (DFDs) in a hierarchy that shows varying levels of detail. The highest-level DFD is the context diagram, the one on the next lower level is the Figure 0 diagram, and lower-level diagrams are called Figure n diagrams. DFDs are not as effective for showing details and are usually supplemented by another process modeling tool, such as use cases.

As a firm goes about developing its information systems, the projects are managed by a hierarchy of managers that can include the executive committee, an MIS steering committee, and a project manger for each development team. Project management begins with a plan, specified in detail by a Gantt chart and perhaps in a summary format by a network diagram. On a periodic basis throughout the project, the project leader makes written and oral reports to the MIS steering committee, informing the members of progress, problems, and plans.

Before management gives the go-ahead to a systems project, it usually requires that the project's costs be estimated. Input data are used in a variety of ways to produce not only cost estimates, but also such supporting details as how the estimates were made, assumptions, and how cost variances will be managed once the project gets underway.

Key Terms

problem
evaluation criteria
methodology
prototype
evolutionary prototype
requirements prototype
SWAT team
reverse engineering
functionality
forward engineering
data flow diagram (DFD)
data store
Figure 0 diagram
context diagram
Figure n diagram
leveled DFDs
use case
MIS steering committee
Gantt chart
network diagram

Key Concepts

- systems approach
- systems development life cycle (SDLC)
- prototyping
- reengineering
- rapid application development (RAD)
- phased development
- business process redesign (BPR)

Questions

1. What name did Dewey use for a problem? For a decision?
2. What are the three phases of effort in applying the systems approach?
3. What is the reasoning for first evaluating a system's standards and outputs?
4. What are the three ways of selecting the best alternative, according to Mintzberg?
5. Identify the five stages of the traditional systems development life cycle.
6. What is the difference between an evolutionary and a requirements prototype?
7. What name does James Martin use for his overall system methodology?
8. What are the four essential ingredients of RAD?
9. What feature(s) does phased development take from the traditional SDLC? From prototyping? From RAD?
10. Which of the phased development stages are repeated for each system module?
11. When does a firm get involved with business process redesign?
12. When is reverse engineering performed?
13. The BPR approach that is taken depends on two kinds of quality. What are they?
14. What DFD symbols define the system boundary?
15. What is the difference between a data flow and a data store?
16. How many process symbols are on a context diagram?
17. When do DFDs become ineffective as process models?
18. In a use case, what does the primary system usually represent? The secondary system?
19. What is the name of the committee that oversees a firm's system development projects and hears reports from project leaders?
20. Identify two graphical reporting tools that contribute to the project management mechanism.
21. Give two examples of work breakdown structure.

Topics for Discussion

1. In defining the problem, why proceed from a system to subsystem level?
2. Which of Mintzberg's three means of selecting the best solution is most susceptible to company politics?
3. How could a developer guard against the pitfalls of prototyping?
4. Would members of the MIS steering committee have to be knowledgeable in computer processing in order to do their job?
5. In assigning personnel resources to a project, which should you determine first—who will be assigned or what tasks are to be performed?

Problems

1. In describing phased development, the chapter describes the tasks that are performed in each stage. Use Figure 7.9 as a basis and prepare a Gantt chart that lists the tasks (using a verb and object) for each phase (the rectangles). Assume that you and four of your classmates will perform the work and enter the names for each task, along with estimated times for doing the work. Assume that the project must last no longer than 6 months. Your instructor will advise you about which software package to use.
2. For your Gantt chart in Problem 1, draw a network diagram similar to the one in Figure 7.19. Your instructor will advise you whether you can deviate from the sample format.

Case Problem

Saint James Hospital

You have just been hired as the new administrator of Saint James Hospital. A hospital administrator has the same responsibilities as a company president. As you take time to get your feet on the ground, you go through the files that were maintained by your predecessor. One of the files is labeled "MIS Committee." You are aware of the committee and the hospital's plan to upgrade the computer applications from transaction processing to include information systems for the business areas. The development activity was to have begun last week.

You open the folder and shuffle through the papers, just to get an idea of the contents. You notice a letter from Ron Harper, the CIO. It is a description of steps that information services plans to take as a part of the new system activity.

> Information services would like to develop the new systems free from any initial constraints. By doing so, we will have a better chance of designing the systems that are best for SJH. If, after development, the MIS committee wishes to scale down the systems in any manner, that activity can be accomplished.
>
> We believe that we should proceed with systems development and accomplish everything up through program testing before involving the MIS committee. Such a prototyping approach best conserves the valuable time of the committee members and provides the committee with an example of how the new system will function.
>
> All of the project control will be performed by information services. We have obtained a project management package from the Web and are presently creating a network diagram.
>
> Information services will coordinate the analysis and design with the various departments. The systems analysts will explain the study to the department heads, and if the analysts request my help, I will gladly give it.
>
> According to our preliminary calculations, it will take about 5 months to develop the prototype information systems. One reason for the short time period is the approach that we will use to identify the managers' and physicians needs. Our systems people have designed a questionnaire that will be mailed to each potential user. We are quite pleased with the questionnaire and anticipate that it will be more effective than time-consuming interviews, which the physicians especially dislike.
>
> I will keep the MIS committee informed of our progress, and when we approach the completion date we can schedule a presentation. If we encounter any problems that we cannot handle, we will call them to the attention of the committee and ask for assistance.

Assignment

1. You are aware of the three main functions that an MIS steering committee performs. If Ron excludes the committee from the initial portion of the development, will it be able to discharge those functions? Explain.
2. If it cannot perform its functions, what are the likely consequences? Explain.
3. Ron states that prototyping will be used. Does it sound like that was a wise choice? Explain.

Notes

[1]John Dewey, *How We Think* (New York: D.C. Heath & Company, 1910), 101–107.
[2]Henry Mintzberg, "Planning on the Left Side and Managing on the Right," *Harvard Business Review* 54 (July–August 1976), 55.
[3]This discussion is based on Jane M. Carey, "Prototyping Alternative Systems Development Methodology," *Information and Software Technology* 32 (March 1990), 120–121.
[4]This section and the next are from Carey, "Prototyping," 121–122.
[5]This section is based on James Martin, *Rapid Application Development* (New York: Macmillan, 1991).
[6]The definitions used in this section are based on Elliott J. Chikofsky and James H. Cross II, "Reverse Engineering and Design Recovery: A Taxonomy," *IEEE Software* 7 (January 1990), 13–17.
[7]Narasimha Bolloju, "Improving the Quality of Business Object Models Using Collaboration Patterns," *Communications of the ACM* 47 (July 2004), 81–86.
[8]One approach to incorporating more detail into DFDs is the use of fish-eye views, which "magnify" the detail of selected components. See Ozgur Turetken, David Schuff, Ramesh Sharda, and Terence T. Ow, "Supporting Systems Analysis and Design Through Fisheye Views," *Communications of the ACM* 47 (September 2004), 72–77.
[9]From D. H. Drury, "An Evaluation of Data Processing Steering Committees," *MIS Quarterly* 8 (December 1984), 259.
[10]*Ibid.*, 260.
[11]This example is based on material presented by Donna Thomas, Dell Computer Corporation, at the McCombs School of Business, The University of Texas at Austin, August 13, 2001.
[12]"Take a Lesson from Trilogy," *Federal Computer Week*, July 29, 2002, WWW.FCW.COM.

Chapter 8

Information in Action

Learning Objectives

After studying this chapter, you should

- Know that a firm's ability to develop effective information systems can be a key factor in its success.
- Recognize that the transaction processing system processes describe the firm's basic daily operations.
- Be familiar with the processes performed by a transaction processing system for a distribution firm.
- Recognize that organizational information systems have been developed for business areas and organizational levels.
- Be familiar with architectures of marketing, human resources, manufacturing, and financial information systems.
- Know the architecture of an executive information system.
- Understand what customer relationship management is and why it requires a large computer storage capability.
- Recognize how a data warehouse differs from a database.
- Understand the architecture of a data warehouse system.
- Know how data are stored in a data warehouse data repository.
- Know how a user navigates through the data repository.
- Know what on-line analytical processing (OLAP) is.
- Know the two basic ways to engage in data mining.

Introduction

Managers often focus on only a few key activities, called critical success factors (CSFs), *that greatly influence the firm's success or failure. By focusing on CSFs, management ensures that it spends its time on the things that really count. The ability of a firm to develop effective information systems is a CSF.*

The transaction processing system processes data that describe the firm's daily operations. This processing produces a database that is used by other systems within the firm. The transaction processing system of a firm that is in the distribution business (i.e., a manufacturer, wholesaler, or retailer) processes customer sales orders, orders replenishment stock, and maintains a general ledger.

Other information systems in the firm are intended to support organizational units. For example, the marketing information system, human resources information system, manufacturing information system, and financial information system are tailored to the information needs of those business areas, and the executive information system recognizes the unique information needs of users on the top organizational level.

*Although the databases of the transaction processing system and the organizational systems have great value, they fall short when users want an extended history of a certain activity. This need has produced an application that is currently very popular—*customer relationship management, *or* CRM. *The data needs of CRM are so great that an innovative type of storage is required—a* data warehouse. *Warehouse data accumulate over time, and the data can be retrieved quickly for use in decision making. A special type of software, called* OLAP *(for* on-line analytical processing*) has been developed to provide information to data warehouse users in a multidimensional form. An interesting feature of data warehousing is that software can recognize patterns in the data that are unknown to the users. This type of data mining is called* knowledge discovery.

INFORMATION AS A CRITICAL SUCCESS FACTOR

In 1961, D. Ronald Daniel of McKinsey & Company, one of the nation's largest consulting companies, coined the term **critical success factor (CSF)**. He determined that a few key activities spell success or failure for any type of organization. The key activities are the CSFs, and they can vary from one type of organization to another. For example, in the automobile industry the CSFs are believed to be styling, an efficient dealer network, and tight control of manufacturing costs. In the insurance industry, the CSFs are identified as development of agency management personnel, control of clerical personnel, and innovation in creating new insurance products. At least, in the early 1960s these were believed to be the CSFs.[1]

When a firm's management embraces the CSF concept, they focus their attention on identifying the CSFs and then monitoring how well the firm achieves them.

In this text, we have recognized that information resources are a good way to achieve competitive advantage. Firms that pursue this strategy accept that information is a valuable resource and that a good information system is a CSF. In this chapter, we describe various types of information systems and explain how they are used.

THE TRANSACTION PROCESSING SYSTEM

The term **transaction processing system** is used to describe the information system that gathers data describing the firm's activities, transforms the data into information, and makes the information available to users both inside and outside the firm. This was the first business application to be installed on computers when they were introduced in the 1950s. The terms

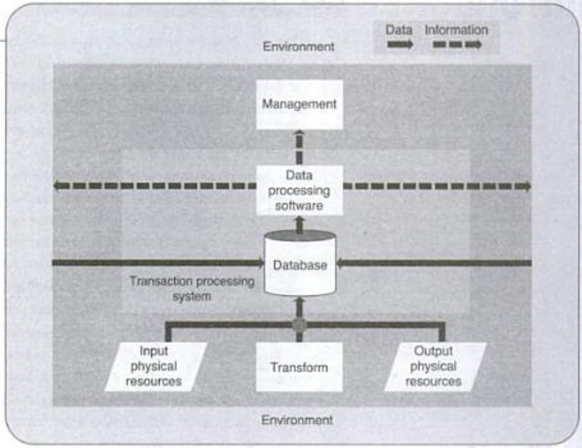


Figure 8.1 **A Model of a Transaction Processing System**

electronic data processing (EDP) system and **accounting** information system have also been used, but they are not as popular today.

Figure 8.1 is a model of a transaction processing system. The model is a derivation of the general systems model of the firm that we described in Chapter 2. The input, transformation, and output elements of the physical system of the firm are at the bottom. Data are gathered from throughout the physical system and the environment and entered into the database. Data processing software transforms the data into information for the firm's management and for individuals and organizations in the firm's environment.

The information flow to the environment is especially important. The transaction processing system is the only information system that has the responsibility to meet information needs outside of the firm. The transaction processing system has a responsibility to furnish information to each environmental element except competitors. For example, the transaction processing system provides customers with invoices and statements, suppliers with purchase orders, and stockholders and owners with data in annual reports.

A good example of a transaction processing system is one used by distribution firms—firms that distribute products or services to their customers. We call such a system a **distribution system**. As you study this system, it will help to think of a product-oriented firm such as a manufacturer, wholesaler, or retailer. In addition, the distribution system can also be found in such service organizations as the United Way and hospitals and in such governmental agencies as the military and the IRS. All organizations are in the distribution business in one form or another. Also keep in mind that you probably cannot find a firm that processes its data exactly the same way as described here. Our model is a general one, fitting most firms in a general way.

System Overview

We will use data flow diagrams, or DFDs, to document the system. We described DFDs in Chapter 7. They document a system in a hierarchical manner, and the diagram in Figure 8.2

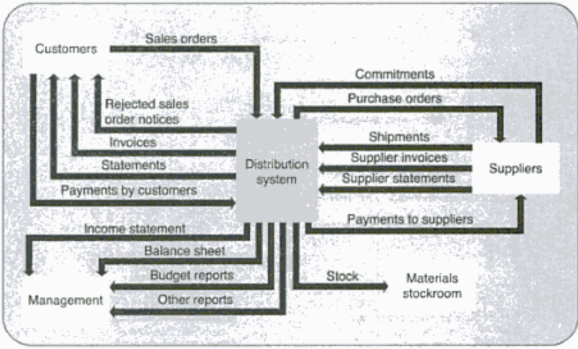


Figure 8.2 **A Context Diagram of the Distribution System**

represents the highest level. The diagram is called a *context diagram* because it presents the system in the context of its environment.

The entire system is represented by the rectangle labeled "Distribution system" in the center. The environmental elements that interface with the system are represented by rectangles and are connected to the system by arrows called *data flows*.

The environmental elements of the distribution system include customers, suppliers, the materials stockroom, and management. The data flows that connect the firm with its customers are quite similar to the flows that connect the firm with its suppliers. That is because the firm is a customer of its supplier. The orders that the firm receives from its customers are called *sales orders*, whereas the orders that the firm places to its suppliers are called *purchase orders*. In some cases, the firm will first obtain commitments from its suppliers before the purchase orders are prepared. The firm may send *rejected sales order notices* to its customers—perhaps their credit rating is bad. Although suppliers also send *rejected purchase order notices* to the firm, we have omitted that flow for the sake of simplicity. Both the firm and its suppliers use *invoices* to advise customers how much money they owe and *statements* to collect unpaid bills. Finally, both the firm and its customers must make *payments* for their purchases.

The data flows from the distribution system to management consist of the standard accounting reports.

All but two of the data flows in Figure 8.2 consist of virtual resources. The two exceptions include the one from the suppliers to the system, labeled *shipments*, and the one from the system to the materials stockroom, labeled *stock*. Data flows can reflect both virtual and physical resources.

The Major Subsystems of the Distribution System

The context diagram is fine for defining the boundary of the system—the environmental elements and the interfaces. However, we need to learn more about the processes that are performed. We accomplish this by identifying the three major subsystems in Figure 8.3 in a Figure 0 diagram. An explanation of the term *Figure 0 diagram* follows.

The subsystems are identified by the numbered upright rectangles in Figure 8.3. The first subsystem is concerned with filling customer orders, the second with ordering replenishment stock from suppliers, and the third with maintaining the firm's general ledger.

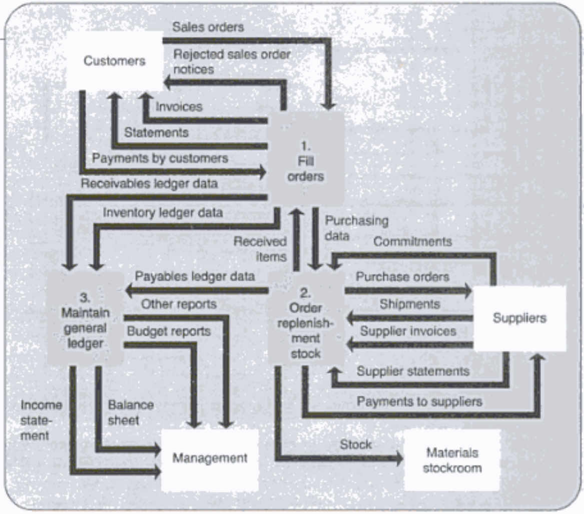


Figure 8.3 **A Figure 0 Diagram of the Distribution System**

Systems that Fill Customer Orders

Figure 8.4 shows the four main systems that are involved in filling customer orders: order entry, inventory, billing, and accounts receivable. The **order entry system** enters customer orders into the system, the **inventory system** maintains the inventory records, the **billing system** prepares the customer invoices, and the **accounts receivable system** collects the money from the customers.

Figure 8.4 is an explosion of Process 1 in the Figure 0 diagram. For this reason, it is called a Figure 1 diagram. The figure number refers to the corresponding process number on the next higher level DFD. Now we can explain how the name *Figure 0 diagram* was derived. Because the context diagram consists of only a single, unnumbered process symbol, there is no figure number to reference and the next lower level DFD is called a *Figure 0 diagram.*

You will notice that some of the arrows are connected to small circles with numbers in them. The circles are **connectors** that establish flows to other DFDs. The numbers identify the *system numbers* of the other DFDs. For example, the data flow labeled *receivables ledger data* is connected to Process 3, which is the process that maintains the general ledger.

Systems that Order Replenishment Stock

In a similar manner, we identify the subsystems that are concerned with ordering replenishment stock from suppliers. This detail is shown in Figure 8.5, and it is called a *Figure 2 diagram*. The **purchasing system** issues purchase orders to suppliers for the needed stock, the **receiving system** receives the stock, and the **accounts payable system** makes payments.

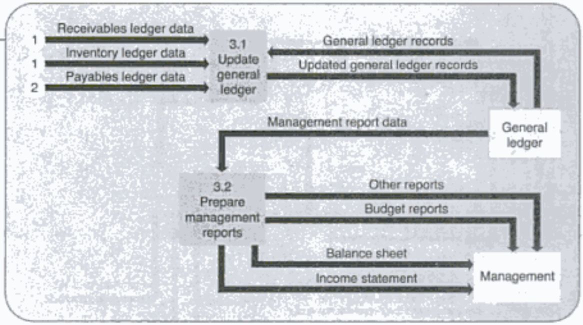


Figure 8.6 **A Figure 3 Diagram of the Systems that Perform General Ledger Processes**

Two subsystems are involved. The **update general ledger system** posts the records that describe the various actions and transactions to the general ledger. The **prepare management reports system** uses the contents of the general ledger to prepare the balance sheet and income statement and other reports.

Unlike previous DFDs, Figure 8.6 includes a *data store*—the DFD term for a relatively permanent data storage repository, such as a master file or a history file. The store is illustrated by an open-ended rectangle and labeled with the name *general ledger.*

Putting the Transaction Processing System in Perspective

It was no accident that the transaction processing system was the first information system to be computerized. In addition to being the best understood application area, it serves as the foundation for all other applications. The foundation exists in the form of the database, which documents everything of importance that the firm does in performing its operations and interfacing with its environment.

ORGANIZATIONAL INFORMATION SYSTEMS

The business areas of the firm—finance, human resources, information services, manufacturing, and marketing—use the database produced by the transaction processing system, plus data from other sources, to produce information that managers use in making decisions and solving problems. Information systems have been developed for each of these business areas. Another type of information system that has been implemented in many firms—the executive information system (EIS)—is intended for an organizational level rather than a business area. The EIS is used by managers on the upper organizational levels.

All of these information systems are examples of **organizational information systems**. They are developed to meet the needs for information relating to those particular parts of the organization.

In the following sections, we will describe information systems for four major business areas of the firm and one for the executive organizational level.

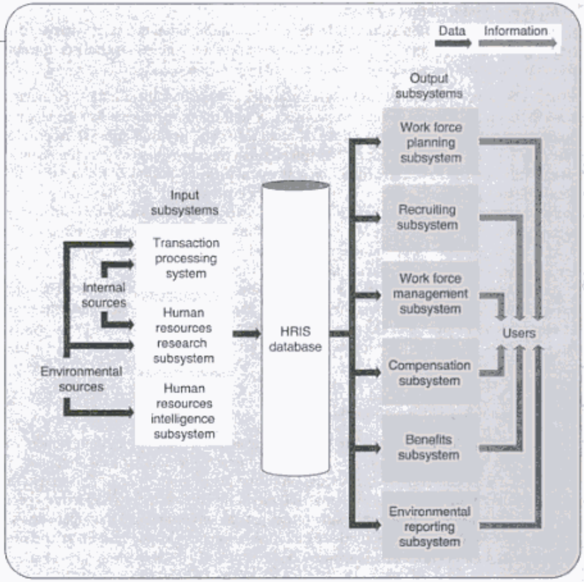


Figure 8.8 **A Model of a Human Resources Information System**

The Human Resources Information System

The **human resources information system (HRIS)** provides information to managers throughout the firm concerning the firm's human resources. Figure 8.8 illustrates the HRIS, using the same format as the MKIS. The transaction processing system provides input data, as does a human resources research subsystem that conducts special studies and a human resources intelligence subsystem that gathers environmental data that bear on HR issues.

The output subsystems of the HRIS each address a particular aspect of HR management: planning, recruiting, and managing the workforce; compensating the employees; providing employee benefits; and preparing the many HR reports that are required by the environment, primarily government agencies. This is the way that output subsystems are determined—they represent the major areas of interest to the users.

The Manufacturing Information System

The **manufacturing information system** provides information to managers throughout the firm concerning the firm's manufacturing operations. Figure 8.9 illustrates the manufacturing information system, using the same format as the MKIS and HRIS. The industrial engineering subsystem consists of activity by industrial engineers (IEs) who conduct studies of the manufacturing operation to ensure its efficiency. The four output subsystems report on subjects that are of greatest interest concerning manufacturing—production, inventory, quality, and cost.

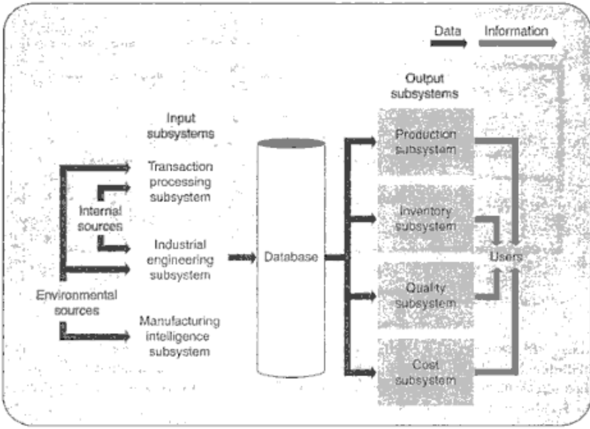


Figure 8.9 **A Model of a Manufacturing Information System**

The Financial Information System

The **financial information system** provides information to managers throughout the firm concerning the firm's financial activities. Figure 8.10 uses the same format as the information systems for the other business areas. The internal audit subsystem consists of activities by the firm's internal auditors to maintain the integrity of the firm's systems. Key output activities include forecasting future economic trends, managing the flow of funds through the firm, and controlling the firm's finances.

The Executive Information System

The **executive information system (EIS)** is a system that provides information to upper-level managers on the overall performance of the firm. The term **executive support system (ESS)** has also been used.

The firm's EIS usually consists of executive workstations that are networked to the central computer. This arrangement is shown in Figure 8.11. The workstation configuration includes a personal computer with a secondary storage unit housing the executive database. This database contains data and information that has been preprocessed by the firm's central computer. The executive enters information requests to produce preformatted information displays or to perform a minimum amount of processing. These preformatted reports act as a "dashboard" for executives to monitor the critical success factors of the organization.

The EIS model also shows the composition of the central computer that relates to the EIS. Data and information can be entered into the corporate database from external sources, and current news and explanations of events can be entered by staff members using their workstations. In addition to the corporate database, the EIS includes the executives' electronic mailboxes and a software library that produces the executives' information.

Although it is generally accepted that executives prefer summary information, there are exceptions. Some executives prefer the detail. Designers of EISs build in flexibility so that the

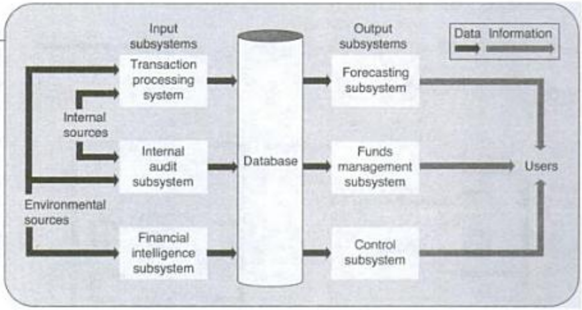


Figure 8.10 **A Model of a Financial Information System**

systems fit the preferences of all executives, whatever they are. One approach is to provide a **drill-down capability**. With this approach, the executive can bring up a summary display and then successively display lower levels of detail. This drilling down continues until executives are satisfied that they have obtained as much detail as is necessary.

Figure 8.12 shows a series of screen displays that illustrate the drill-down process. In this example, an executive is reviewing profit data for the firm's product categories to see how actual performance compares to the budget. The actual and budget figures represent thousands of dollars. The display in Figure 8.12A indicates a high negative variance for radio profit when

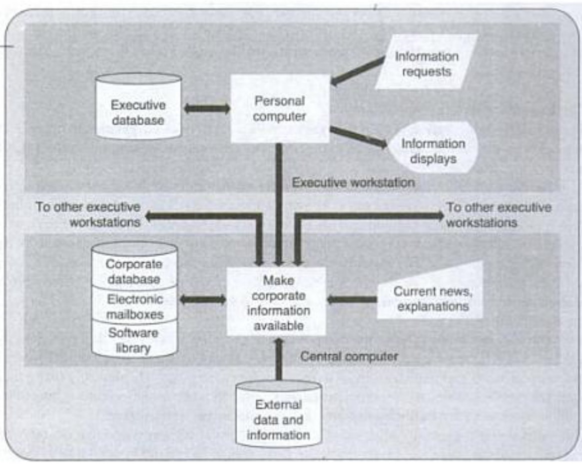


Figure 8.11 **An EIS Model**

AMERICAN ELECTRONICS

STANDARD FINANCIAL REPORTS

Consumer

Current Month	Actual	% Total	Budget	% Total	Variance	% Var.
Profit Before Tax						
Radio ♦	1,771	24.83%	2,084	28.71%	-313	-15.0%
Stereo	2,256	31.63%	2,193	30.21%	63	2.9%
Tape Recorder	569	7.98%	504	6.94%	65	12.9%
Television	2,537	35.57%	2,478	34.14%	59	2.4%
Total	7,133	100.00%	7,259	100.00%	-126	- 1.7%

A. Summary display

AMERICAN ELECTRONICS

STANDARD FINANCIAL REPORTS

Consumer Radio

B. Display one level down

Current Month	Actual	% Total	Budget	% Total	Variance	% Var.
Net Sales	12,986	100.00%	12,741	100.00%	245	1.9%
Cost of Sales	- 7,488	- 57.66%	- 7,213	- 56.61%	-275	3.8%
Gross Margin	5,498	42.34%	5,528	43.39%	- 30	- .5%
Research & Devel. ♦	1,694	13.04%	1,412	11.08%	282	20.0%
Selling & Mktg.	1,505	11.59%	1,498	11.76%	7	.5%
General & Admin.	511	3.94%	522	4.10%	- 11	- 2.1%
Interest Income	60	.46%	62	.49%	- 2	- 3.2%
Interest Expense	- 77	- .59%	- 74	- .58%	- 3	4.1%
Before Tax Profit	1,771	13.64%	2,084	16.36%	-313	-15.0%

AMERICAN ELECTRONICS

STANDARD FINANCIAL REPORTS

Consumer Radio Research & Devel.

Current Month	Actual	% Total	Budget	% Total	Variance	% Var.
Project RA100 ♦	517	30.52%	303	21.46%	214	70.6%
Project RA200	179	10.57%	176	12.46%	3	1.7%
Project RA300	115	6.79%	80	5.67%	35	43.8%
Project RA400	315	18.60%	288	20.40%	27	9.4%
Project RA500	231	13.64%	225	15.93%	6	2.7%
Project RA600	337	19.89%	340	24.08%	- 3	- .9%
Total R&D Expense	1,694	100.00%	1,412	100.00%	282	20.0%

C. Display two levels down

Figure 8.12 **The Drill-Down Technique**

Source: Courtesy of Pilot Executive Software compared to the budget. The executive requests more detailed information on the radio product and receives the display in Figure 8.12B. It is now clear that research and development expenses are out of line, being 20 percent over budget. The executive drills down to another level and retrieves the display in Figure 8.12C, which shows the problem to be primarily with Project RA100. Now the executive knows where to concentrate problem-solving efforts.

CUSTOMER RELATIONSHIP MANAGEMENT

The databases that we included in the model of the transaction processing system and in the models of the marketing, human resources, manufacturing, and financial information systems are intended to support the users in performing their day-to-day activities. The data in these databases must be kept current so that users have the best basis for making decisions and solving problems. For example, if a sales manager is concerned about a particular sales region meeting its sales quota, the manager wants to see sales data that are current as of that day, or perhaps even that hour or minute.

In designing these databases, effort is made to provide some, although limited, historical data. For example, an HR manager reviewing the overtime work for a particular employee would want to know that employee's year-to-date overtime earnings. In this case, the total figure represents the overtime earnings from the beginning of the fiscal year to the current date.

Even though some historical data are included, the database seldom contains more than one year of historical data. In some instances, however, users may want a richer historical record in order to study behavior over time or to assemble as much information as possible to address an especially complex problem. This need for historical data has been especially strong in the marketing area, where managers want to be able to track the purchase behavior of customers over an extended period. This need has stimulated a popular marketing strategy called *customer relationship management*. **Customer relationship management**, or **CRM**, is the management of the relationships between the firm and its customers so that both the firm and its customers receive maximum value from the relationship. It recognizes that cultivation of long-term customer relationships is a good strategy, because it usually costs less to keep an existing customer than to obtain a new one. Therefore, efforts are made to understand the customers so that their needs can be met and they will remain loyal to the firm.

When a firm seeks to practice CRM, it implements a CRM system. The **CRM system** accumulates customer data over a long term—5 years, 10 years, or more—and uses that data to produce information for users. The central element in a CRM system is the data warehouse. CRM is only one application that may use a data warehouse, but it is a good example for explaining the concept.

DATA WAREHOUSING

As you can imagine, as transaction data accumulate over the years the volume of data becomes enormous. Only recently has computer technology been capable of supporting a system with such large-scale data demands. Now it is possible to build a system with almost unlimited data capacity.

Data Warehouse Characteristics

The term **data warehouse** has been coined to describe data storage that has the following characteristics:

- The storage capacity is very large.
- The data are accumulated by adding new records, as opposed to being kept current by updating existing records with new information.

- The data are easily retrievable.
- The data are used solely for decision making, not for use in the firm's daily operations.

Achieving a data warehouse sounds like a big challenge—and it is. In fact, it is so big that some experts recommend taking a more modest approach—implementing the data warehouse in a piecemeal way. When this approach is followed, the term *data mart* is used to describe the subsets. A **data mart** is a database that contains data describing only a segment of the firm's operations. For example, a firm may have a marketing data mart, a human resources data mart, and so on.

The creation and use of a data warehouse or data mart is called **data warehousing** and is performed by a system.

The Data Warehousing System

The data warehouse is the central portion of a data warehousing system that enters data into the warehouse, transforms the contents into information, and makes the information available to users. Figure 8.13 is a diagram of a data warehousing system. Data are gathered from the data sources and sent through a staging area before being entered in the warehouse data repository. An information delivery system obtains data from the warehouse data repository and transforms it into information for the users.

The primary data sources are the transaction processing systems, but additional data are obtained from other sources, both internal and environmental. When data are identified as having potential value in decision making, they are added to the data warehouse.

The staging area is where the data undergoes extraction, transformation, and loading, a process often abbreviated to **ETL**. The **extraction** process combines data from the various sources; the **transformation** process cleans the data, puts it into a standardized format, and prepares summaries. The data will be stored in both a detailed and summary form to provide

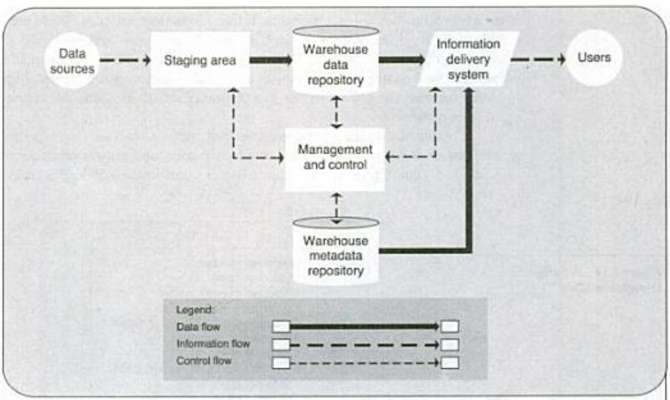


Figure 8.13 **A Model of a Data Warehousing System**

for maximum flexibility in meeting the varying information needs of the users. The **loading** process involves the entry of the data into the warehouse data repository.

You will notice in Figure 8.13 that there are two repositories: one for warehouse data and one for warehouse metadata. The term **metadata** means "data about data." It is data that describes the data in the data repository. It is similar to the data dictionary of a database, only much more detailed. In addition to describing the data, the metadata tracks the data as it flows through the data warehousing system.

The data warehousing system also includes a management and control component. This is similar to a database management system, controlling the movement of data through the system.

How Data Are Stored in the Warehouse Data Repository

In a database, all of the data about a particular subject are stored together in one location, usually a table. The data includes identifying data (such as customer number), descriptive data (such as customer name), and quantitative data (such as current month sales). In the warehouse data repository, two types of data are stored in separate tables. The table data are combined to produce an information package.

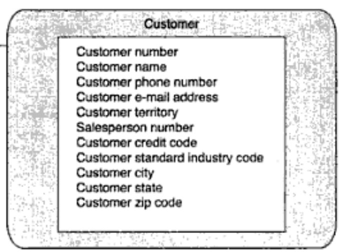
DIMENSION TABLES Identifying and descriptive data are stored in **dimension tables.** The term **dimension** captures the idea that this data can provide the basis for viewing the data from various perspectives, or various dimensions. Figure 8.14 illustrates a dimension table for the customer entity or object. The entries give you an idea of the typical makeup of the identification and descriptive data. In this example, customer number can be used to identify a customer, and the remaining data elements describe various details about a customer.

With the sample dimensions in the figure, users can produce analyses by customer, by customer territory, by standard industry code, by zip code, and so on.

FACT TABLES Separate tables called **fact tables** contain the quantitative measures of an entity, object, or activity. A sample fact table is provided in Figure 8.15. In this example, the fact table contains data about a particular activity—commercial sales. These are all measures of that activity. Some are units, such as actual sales units and budgeted sales units. The remainder are in dollars. With these types of facts available for commercial sales, users can produce such quantitative analyses as actual sales units versus budgeted units, average sales dollar per unit, sales commissions as a percent of actual sales, and sales bonuses as a percent of sales commissions.

Combined with the dimension table data, various analyses can be prepared, such as net sales by customer territory, sales taxes by zip code, and sales commissions by credit code. Users can request information that involves any combination of the dimensions and facts.

Figure 8.14 **A Sample Dimension Table**



Commercial Sales Facts

Actual sales units
Budgeted sales units
Actual sales amount
Budgeted sales amount
Sales discount amount
Net sales amount
Sales commission amount
Sales bonus amount
Sales tax amount

Figure 8.15 **A Sample Fact Table**

INFORMATION PACKAGES How does the data warehousing system know to associate a particular dimension table with a particular fact table? The two types of data are combined to form an information package. An **information package** identifies all of the dimensions that will be used in analyzing a particular activity. Figure 8.16 shows the format, and Figure 8.17 includes some sample data.

In the Figure 8.16 format, four dimensions (the vertical columns) are linked to the facts (the row at the bottom). There can be any number of dimensions. In the Figure 8.17 example, the package includes four dimensions that can be used to analyze commercial sales by time, salesperson, customer, and product.

Each dimension in the information package has a key and one or more additional dimensions. For example, the customer key is the customer number. Think of dimensions as attributes, or descriptor variables. Each attribute is arrayed in a hierarchy ranging from the smallest increment at the top to the largest at the bottom. For example, the smallest measure of time is hour and the largest is year. For the salesperson, the hierarchy shows how salespersons can be grouped into branches, into larger regions, and into subsidiaries of the firm.

Figure 8.16 **Information Package Format**

Subject: Name of Business Activity Being Measured

Dimension name	Dimension name	Dimension name	Dimension name
Dimension key	Dimension key	Dimension key	Dimension key
Attribute 1	Attribute 1	Attribute 1	Attribute 1
Attribute 2	Attribute 2	Attribute 2	Attribute 2
Attribute 3	Attribute 3	Attribute *n*	Attribute 3
Attribute 4	Attribute *n*		Attribute 4
Attribute *n*			Attribute *n*
Facts: Numeric measures of the business activity.			

Subject: Commercial Sales

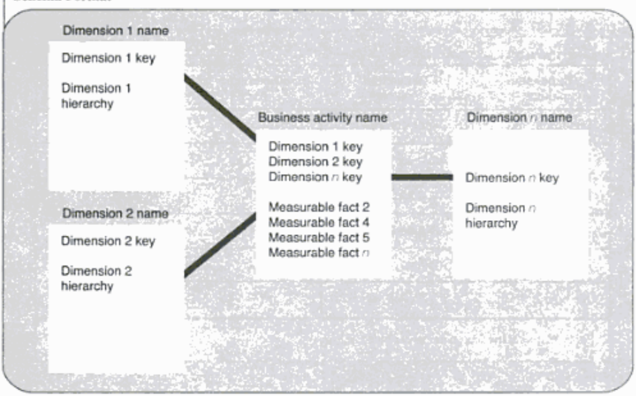
Time	Salesperson	Customer	Product
Time key	Salesperson key	Customer key	Product key
Hour	Salesperson name	Customer name	Product name
Day	Sales branch	Customer territory	Product model
Month	Sales region	Customer credit code	Product brand
Quarter	Subsidary		Product line
Year			

Facts: Actual sales units, budgeted sales units, actual sales amount, bugeted sales amount, sales discount amount, net sales amount, sales commission amount, sales bonus amount, sales tax amount

Figure 8.17 **A Sample Information Package**

THE STAR SCHEMA For each dimension, a key identifies the dimension and provides the link to the information package. Figure 8.18 shows how the keys in the three dimension tables are related to keys in the information package in the center. Figure 8.19 provides an example using four dimension tables—customer, time, salesperson, and product. Because of the

Figure 8.18 **Star Schema Format**



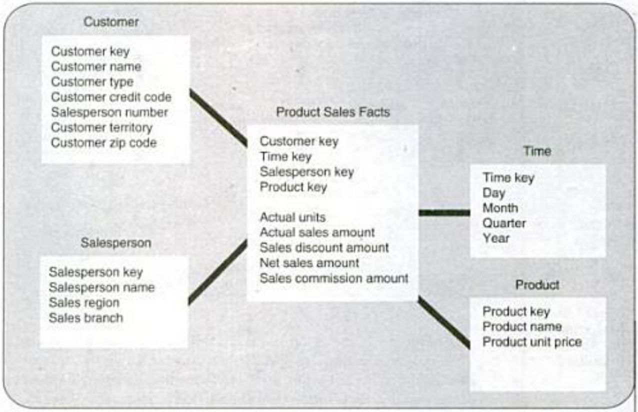


Figure 8.19 **A Sample Star Schema**

similarity of the pattern to a star, this structure is called a **star schema**. This particular star schema would permit preparation of such information as:

- Actual sales units by zip code for a particular month
- A comparison of sales commission amounts by sales region for the two previous quarters
- Product sales by customer for the year to date

This star schema is focused on commercial sales in terms of customers, salespersons, products, and time. The warehouse data repository contains multiple star schemas, one for each type of activity to be analyzed.

INFORMATION DELIVERY

The final element in the data warehousing system is the information delivery system, which obtains data from the data repository, transforms it into information, and makes the information available to users.

The information can be provided in a detailed form or in various summary levels. Figure 8.20 illustrates how the user can navigate through the data repository to produce summary information (such as net sales for the Midwestern sales region), detailed information (net sales for salesperson 383), and detailed data (sales units for salesperson 383).

The process of navigating down through the levels of detail is called **drill down**, a process that originated with EISs. The process of navigating upwards is called **roll up**, enabling the user to begin with a detail display and then summarize the details into increasingly higher summary levels. The user can also **drill across**, quickly moving from one data hierarchy to another, and **drill through**, going from a summary level to the lowest level of detailed data.

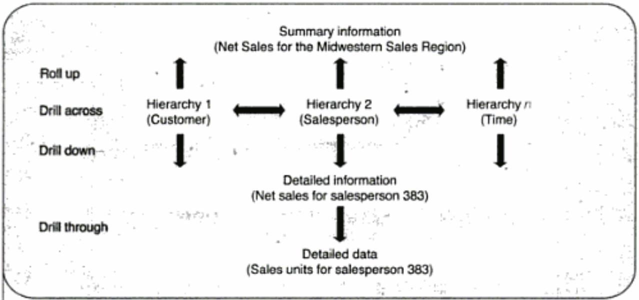


Figure 8.20 **Navigating Through the Warehouse Data Repository**

Figure 8.21 shows the results of a drill-across navigation, producing outputs in different hierarchies. The user can specify the customer hierarchy for customer *Bill Marlowe* and obtain the output at the top, then specify the time hierarchy for *January 2003* and obtain the information in the center, and then specify the product class *Shoes* and obtain the output at the bottom. The information delivery software accomplishes the navigation quickly.

CUSTOMER: Bill Marlowe

Month	Shoes	Coats	Sweaters	Skirts/Slacks
January 2003	145.00	279.95	118.29	.00
February 2003	.00	.00	79.95	.00
March 2003	239.50	.00	.00	391.50
April 2003	49.95	.00	.00	129.95

A Sales by Customer by Product Class by Month

Month: January 2003

Product	Paul Murray	Bill Marlowe	Armondo No	Kelly Pope
Shoes	.00	145.00	89.95	234.68
Coats	234.68	279.95	.00	434.50
Sweaters	112.19	118.29	.00	.00
Skirts/Slacks	141.12	.00	217.92	.00

B Sales by Month by Product Class by Customer

Product Class: Shoes

Customer	January 2003	February 2003	March 2003	April 2003
Paul Murray	.00	.00	.00	238.92
Bill Marlowe	145.00	.00	239.50	49.95
Armondo No	89.95	122.34	89.95	119.35
Kelly Pope	234.68	.00	112.92	.00

C Sales by Product Class by Customer by Month

Figure 8.21 **Drilling Across Hierarchies Produces Multiple Views**

OLAP

Any type of software can be used to extract data from the data repository and transform it into information. Report writers, database query packages, and mathematical models can all be used. In addition, there is a type of software that has been developed especially for the data warehouse. It is called **OLAP**, for **on-line analytical processing**. OLAP enables the user to communicate with the data warehouse either through a GUI or a Web interface and quickly produce the information in a variety of forms, including graphics.

There are two approaches to OLAP: ROLAP and MOLAP. **ROLAP** (for **relational on-line analytical processing**) uses a standard relational database management system. **MOLAP** (for **multidimensional on-line analytical processing**) uses a special multidimensional database management system. ROLAP data typically exist in a detailed form, and analyses must be performed to produce summaries. MOLAP data are typically preprocessed to produce summaries at the various levels of detail and arranged by the various dimensions.

Figure 8.22 illustrates the two architectures. Both include a data warehouse server and a second server that contains the OLAP software. A major difference is that the workstation of the MOLAP user includes a downloaded multidimensional database. The data in this database have already been formatted in various dimensions so that data may be made available quickly rather than force users to go through time-consuming analyses.

ROLAP can easily produce outputs at detailed levels and at a few summary levels but must execute processes to achieve summary levels that have not been previously prepared. This means that ROLAP analysis is constrained to a limited number of dimensions. Figure 8.23 illustrates a report that ROLAP can easily prepare. This report shows sales data in three dimensions: for a particular product (DVD), in a particular region (West), and by quarter.

In addition to a faster summary ability, MOLAP can produce information in many dimensions—10 or more. Figure 8.24 illustrates a summary report in four dimensions: store type, product, age, and gender.

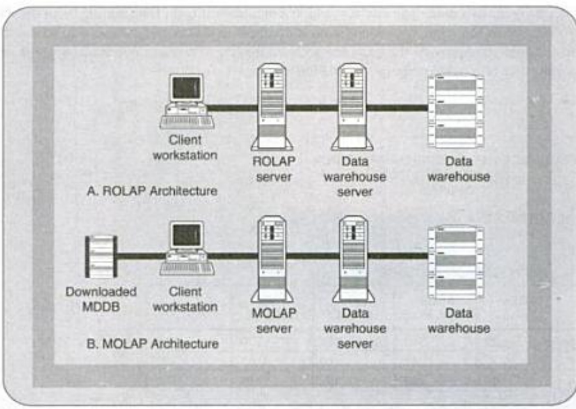


Figure 8.22 **ROLAP and MOLAP Architectures**

ANALYSIS OF RETAIL PRICE DISCOUNTS
PRODUCT CLASS BY STORE REGION BY QUARTER
2001 THROUGH 2003
IN DOLLARS

STORE REGION: WEST

PRODUCT CLASS: DVD

QUARTER	RETAIL SALES	SALES DISCOUNTS	NET SALES
1/2001	7,525	610	6,915
2/2001	7,280	0	7,280
3/2001	11,310	1,108	10,202
4/2001	12,445	1,829	10,616
1/2002	16,418	2,314	14,104
2/2002	1,320	725	595
3/2002	6,694	890	5,804
4/2002	12,310	2,555	9,755
1/2003	11,927	3,719	8,208
2/2003	5,423	1,429	3,994
3/2003	2,764	960	1,804
4/2003	15,329	4,230	11,009
TOTAL	110,745	20,459	90,286

Figure 8.23 **An Example of a Report that Could Be Produced with ROLAP**

DATA MINING

A term that is often used in conjunction with data warehousing and the data mart is *data mining*. **Data mining** is the process of finding relationships in data that are unknown to the user. It is analogous to a miner panning for gold in a mountain stream. Data mining helps the user by discovering the relationships and presenting them in an understandable way so that the relationships may provide the basis for decision making. There are two basic ways of performing data mining: hypothesis verification and knowledge discovery.

Figure 8.24 **An Example of a Report that Could Be Produced with MOLAP**

PRODUCT SALES BY CUSTOMER GENDER
YEAR-TO-DATE 2003
IN UNITS

STORE TYPE: DEPARTMENT

PRODUCT NUMBER: 23184

PRODUCT NAME: ROLLING CARRY-ON LUGGAGE

GENDER	AGE= 15–20	AGE= 21–30	AGE= 31–40	AGE= 41–50	AGE= OVER 50	TOTAL
FEMALE	8	23	144	124	79	378
MALE	6	17	85	63	51	222
TOTAL	14	40	229	187	130	600

Hypothesis Verification

Assume that a bank has decided to offer mutual funds to its customers. Bank management wants to target promotional materials at the customer segment that offers the greatest potential business. One approach is for the managers to identify the characteristics that they believe members of the target market will have. Assume that the managers believe that the target market consists of young, married, two-income, and high net-worth customers. This multidimensional query could be entered into the DBMS, and the appropriate customer records retrieved. Such an approach, which begins with the user's hypothesis of how the data are related, is called **hypothesis verification**. The shortcoming of this approach is that the retrieval process is guided entirely by the user. The selected information can be no better than the user's understanding of the data. This is the traditional way to query a database.

Knowledge Discovery

In **knowledge discovery**, the data warehousing system analyzes the warehouse data repository, looking for groups with common characteristics. In the bank example, the system might identify not only the young married group, but also retired married couples who rely on Social Security and pensions.

The big contribution of knowledge discovery is that it gives the data warehousing system a data analysis ability that exceeds that of the users. In order to accomplish this, the data mining software must be capable of identifying patterns in the data that are not obvious to users. Such an ability is obtained by employing artificial intelligence tools such as neural networks, decision trees, genetic algorithms, and memory-based reasoning.[2]

Putting Data Warehousing in Perspective

There has always been a need for data warehousing, but the information technology needed to support it only became available and affordable at a later time. When technology caught up to demand, some dramatic accomplishments were made. Some were new innovations, such as a new way of storing data in information packages, which made it possible to analyze the data in practically unlimited ways, and OLAP, which made it possible to retrieve the data quickly. Existing methodologies and technologies were also applied, such as the drill-down concept and the use of artificial intelligence to discover new relationships in data.

The ability to store practically unlimited quantities of data and retrieve it quickly opens up new doors to data processing.

Highlights in MIS

Casinos Lead the Way in Data Mining[3]

Although data mining is being done by firms of all kinds, the gambling industry is leading the way if the reports out of MGM Mirage, Harrah's, and Foxwoods are any indication. These resorts are able to keep track of their customers' gambling behavior and award prizes to keep them coming back. Prizes include such incentives as free hotel rooms, show tickets, and meals. The key ingredient is the loyalty card, a special bar-coded card that the casino gives to its best customers. Then, when the customer engages in gambling, the card is scanned, gathering data that identifies the type of gambling, when it begins and ends, the amount of money wagered, and the amount

Highlights in MIS [continued]

of money won or lost. The data are stored in a data warehouse. The MGM Mirage data warehouse maintains 6 terabytes of customer information. Harrah's accumulates data on 23 million customers, 8 million of whom have the loyalty cards. The Native American-owned Foxwoods data warehouse has a smaller capacity—200 gigabytes—but this data can be matched with third-party databases that provide demographic data to learn such details as whether the customer has children and how much he or she earns. At Foxwoods, when customers spend $100 or more a day, they receive red-carpet treatment. Harrah's knows a lot about its customers as well, such as whether someone likes thick steaks, oceanfront views, or Elvis slots.

All of these applications are examples of customer relationship management. The casinos believe that by knowing their customers they can offer incentives that will cause customers to keep coming back. John Boushy, Harrah's CIO, said, "We decided we would never be able to anticipate the questions that marketing might ask, so we keep all the data." Harrah's began populating its data warehouse in 1995 and has never deleted any data—it just keeps on accumulating.

Summary

Performance in a few areas of a firm's operations can spell success or failure. These areas, called *critical success factors (CSFs)*, vary from one firm to another, but tend to follow certain patterns based on industry. The ability of a firm to develop good information systems is a CSF. Such systems are those that process accounting data and provide information to organizational units.

The system that processes the firm's accounting data is called the *transaction processing system*. Data are gathered from the physical system of the firm and entered into a database, along with data from the environment. Data processing software transforms the data into information for management and the environment.

A distribution system consists of three main processes: fill customer orders, order replenishment stock from suppliers, and maintain the general ledger. Order processing involves an order entry system, an inventory system, a billing system, and an accounts receivable system. The stock replenishment system consists of a purchasing system, a receiving system, and an accounts payable system. The general ledger system consists of two main subsystems: update the general ledger system and prepare management reports system.

Organizational information systems are tailored to business areas and organizational levels. The systems for business areas consist of input subsystems that gather data and information for entry into a database and output subsystems that transform the data into information. The three input subsystems include the transaction processing system, a system that conducts special research projects, and a system that gathers intelligence data from the environment. The output systems produce information relating to the most important activities of the organizational unit. For example, for the marketing information system, the output subsystems report on the four ingredients of the marketing mix.

The executive information system (EIS) has a different architecture, consisting of executive workstations networked to the central computer. Preformatted information displays are downloaded from the central computer and stored in an executive database.

A computer application that is currently drawing much attention is *customer relationship management (CRM)*. It demands a supersized data storage area called a *data warehouse*, which accumulates data rather than keeping it current, makes the data easily retrievable, and is dedicated to supporting decision making rather than supporting daily operations. Subsets of the data warehouse are called *data marts*.

A data warehousing system includes a staging area where ETL (extraction, transformation, and loading) are performed, a warehouse data repository where the data are stored, and an information delivery system that transforms the data into information and delivers it to users. A management and control unit controls the data flow from sources to users, and a warehouse metadata repository houses data that describe the data in the warehouse data repository and keeps track of the data as it flows through the system.

Data are stored in the warehouse data repository in dimension tables and fact tables, which are integrated in an information package. A graphical view of the information package and its dimension tables is called a *star schema*.

Users navigate through the warehouse data repository by performing such operations as drill down, roll up, drill across, and drill through. A special type of information delivery software has been developed especially for the data warehouse. It is called *OLAP*, for *on-line analytical processing*. OLAP enables data to be analyzed in multiple dimensions, a capability that is more easily performed by MOLAP (multidimensional on-line analytical processing) than ROLAP (relational on-line analytical processing) due to the fact that MOLAP provides users with downloaded multidimensional databases.

The process of looking through the data warehouse for data is called *data mining*, and it can be performed two ways. In hypothesis verification, the user believes that certain patterns exist in the data, and the system either confirms or rejects this assumption. In knowledge discovery, the user leaves it up to the system to find the patterns, which it does by using artificial intelligence logic.

In addition to the technological innovations of data warehousing, it represents a breakthrough in another way—it offers a new way of thinking about data. Rather than trying to keep data current, the idea is to just accumulate data over time. The data warehouse provides users with a new approach for obtaining information for decision making.

Key Terms

transaction processing system
dimension table
fact table
information package
star schema
drill down
roll up
drill across
drill through
on-line analytical processing (OLAP)
relational on-line analytical processing (ROLAP)
multidimensional on-line analytical processing (MOLAP)
data mining
hypothesis verification
knowledge discovery

Key Concepts

- critical success factor (CSF)
- information systems for organizational areas and levels
- input subsystems for data entry
- output subsystems for information transformation
- customer relationship management (CRM)
- data warehouse

Questions

1. Who uses the output of the transaction processing system?
2. What are the contents of the transaction processing system database? Where do they come from?
3. What types of firms would use a distribution system?
4. What are the four environmental elements of the distribution system? Which exist inside the firm? Which exist outside?

5. Are the data flows in the distribution system physical, conceptual, or both? Explain.
6. What are the three types of input subsystems that exist in an information system for a business area?
7. Where are the data stored in an executive information system? How are the data stored—in a detail or summary form or both?
8. How do EIS designers address the needs of executives who prefer both detail and summary data?
9. Why gather voluminous quantities of customer data?
10. What is the difference between a data warehouse and a database?
11. What is a data mart?
12. What do the letters ETL stand for? Where do these tasks fit in the data warehousing system?
13. What kind of data are stored in dimension tables? Fact tables?
14. Why store detailed data in the data warehouse? Why store summary data?
15. What does an information package do?
16. What forms the connections between the information package and the multiple dimension tables in a star schema?
17. What distinguishes drill down from drill through?
18. Would a manager who prefers summaries use ROLAP or MOLAP? Explain.
19. How does hypothesis verification tell users something that they did not previously know?
20. What has enabled casinos to have such successful data warehousing systems?

Topics for Discussion

1. What are some areas of business other than marketing that would require data warehouses?
2. The chapter suggests that data marts can be developed for business areas. What are some other possible subsets of the data warehouse?
3. What would be an example of multidimensional analysis involving five dimensions?

Problems

1. Draw a diagram of an information system for your college or university. Use the format of input subsystems, databases, and output subsystems. Hint: In specifying the output subsystems, identify information that would be of interest to the users—members of the university or college administration.
2. Assume that the manager doing the drill down in Figure 8.12 is looking for evidence of good performance related to the radio product line. Are there any? If so, what are they?

Case Problem

Great Lakes Boat and Marine

Your career is progressing nicely—3 successful years in the management services division of a large accounting firm. Your performance as a computer consultant was so outstanding that you got a job offer from one of your clients—Great Lakes Boat and Marine. You had managed the information technology upgrade and deployment so well that Sue Rankin, the president, offered you the position of CIO. The previous CIO decided to retire after the IT upgrade project was completed. Sue told you that the next step was to reengineer the MIS so that it consisted of a strong set of information systems for the business areas. She wants the synergy that occurs when all areas work together.

During your first day on the job, you meet with Rankin to learn more about her expectations. She tells you that she has formed an MIS committee consisting of Ric Guenther

Case Problem continued

(vice president of manufacturing), Don Lehnert (vice president of marketing), Ling Huang (vice president of finance), and you. Rankin wants you to get to know each member and then make arrangements for the first planning meeting. You already know Huang, having worked with her on the IT project. You know that she is extremely computer literate and anxious to expand the scope of the computer applications. You have met Guenther and Lehnert, but you don't know them very well. As you leave Rankin's office, you ask, "Aren't you going to be on the MIS committee?" "No," Rankin replies, "I'm too busy planning our entry into the New England market. I just don't have time." Smiling, she says, "That's why I hired you," and then she waves you on your way.

Your first stop is Guenther's office. You find him extremely likable—a warm handshake, boundless energy, contagious optimism, and a great sense of humor. You spend 2 hours in his office, learning about him and his area and talking about computers. Guenther wants to get started immediately. "We've just been waiting for someone like you," he says. "We've known about MIS and how it can help us in manufacturing but haven't had anyone to get things moving. I want data collection terminals in every work area. I need good data to establish production standards. I want all manufacturing managers to become expert in MIS. I'm willing to give them time off from work to take MIS courses at Great Lakes State, just down the road. I've seen what a good MIS can do in manufacturing and I can't wait to get started."

Neither can you. You are so excited after talking with Guenther that you almost run down the hall to Lehnert's office. When his secretary ushers you into his office and his greeting is "Well, what do you want?" you expect that you might be in for some rough sailing. You introduce yourself and explain Rankin's charge of developing an information system for marketing, which you describe as an MKIS. You feel uncomfortable when Lehnert nervously jingles coins in his pocket as you talk. When you pause to catch your breath, he says, "Listen, I don't have time to get involved with Sue's project. We're planning on expanding into New England, and I have to find eight new distributors. If I can't get my marketing job done, there won't be any company to put an MKIS in. Now I have to go. Why don't you talk with my manager of marketing administration, John Herndon. The MIS would really be in John's area. He'll get you fixed up. Just a minute and I'll have my secretary take you to his office. I've appreciated meeting you, and I wish you all the luck in the world. I'm sure you will give us a good MKIS."

Assignment

1. Do we have a problem here? If so, what is it?
2. What is this synergy that Sue talks about? What will be the effect if marketing does not cooperate with the finance and manufacturing areas?
3. Assume that Rankin remains strongly committed to information systems for each business area. What would you suggest to her as a strategy for ensuring that she gets her wish? Give some thought to the MIS steering committee; who would be the best person to be the chair of that committee?

Notes

[1]The CSFs identified here are from John D. Rockart, "Chief Executives Define Their Own Data Needs," *Harvard Business Review* 57 (March–April 1979), 85.
[2]For descriptions of these knowledge discovery methodologies, see William G. Zikmund, Raymond McLeod, Jr., and Faye Gilbert, *Customer Relationship Management: Integrating Marketing Strategy and Information Technology* (New York: John Wiley & Sons, 2003).
[3]This section is based on Kim S. Nash, "Casinos Hit Jackpot with Customer Data," *Computerworld*, July 2, 2001, 16.

PART 3

Managing Information and Technology

Computer applications in business have usually been tailored to the firm's organizational structure. The first applications were aimed at the accounting area and then systems were developed to provide information to business areas and to the firm's executive level. Some of these organizational information systems demand special innovations in computer technology. For example, in the marketing area increasing interest in customer relationship management (CRM) has demanded innovations in data warehousing and data mining.

Security and ethics events of the past few years have imposed increased responsibilities on those who manage the firm's information resources. Because the firm and its organizational units rely so completely on computer technology, it is important that the information resources be kept secure. Contingency plans that are intended to ensure the continued availability of the firm's information resources address threats and risks that were unimaginable just a few years ago. By the same token, everyone connected to the firm must ensure that information systems are used in an ethical way, protecting and respecting the rights of those both inside and outside the firm.

As the firm's managers draft the strategic information plan, they must insist on a strong security component and a basis of ethical computer use. By being vigilant to the importance of the computer to their organization, managers put a powerful decision support tool into the hands of the firm's problem solvers.

Chapter 9

Information Security

Learning Objectives

After studying this chapter, you should

- Understand the organizational needs for information security and control.
- Know that information security is concerned with securing all information resources, not just hardware and data.
- Know the three main objectives of information security.
- Know that management of information security consists of two areas: information security management (ISM) and business continuity management (BCM).
- See the logical relationship among threats, risks, and controls.
- Know what the main security threats are.
- Know what the main security risks are.
- Recognize the security concerns of e-commerce and how credit card companies are dealing with them.
- Be familiar with a formal way to engage in risk management.
- Know the process for implementing an information security policy.
- Be familiar with the more popular security controls.
- Be familiar with actions of government and industry that influence information security.
- Know how to obtain professional certification in security and control.
- Know the types of plans that are included in contingency planning.

Introduction

All organizations have a need to keep their information resources secure. Industry has long recognized the need for safeguards from computer criminals, and now government is ratcheting up security levels as a means to combat terrorism. When these organizations implement security controls, the key issues of security versus availability and security versus privacy rights must be addressed.

Information security is intended to achieve confidentiality, availability, and integrity in all of the firm's information resources—not just hardware and data. The management of information security consists of both the day-to-day protection, which is called information security management (ISM), and the preparations for operating after a disaster, which is called business continuity management (BCM).

Two approaches can be taken to developing ISM strategies: risk management and benchmark compliance. Paying attention to threats and risks is integral to the risk management approach. Threats can be internal or external, accidental or deliberate. Risks include unauthorized incidents of disclosure, use, and modification as well as theft, destruction, and denial of service. The most notorious threat is computer viruses. E-commerce produces a special risk, but some unique responses have come from such organizations as American Express and Visa.

Three types of controls are available. Technical controls consist of restrictions on access, firewalls, cryptography, and physical controls. Formal controls are in writing and have a long-term life expectancy. Informal controls are intended to ensure that the firm's employees both understand and support the security policies.

A number of governments have established standards and passed legislation that affect information security. Industry associations have also provided standards and professional certifications.

Business continuity management consists of a set of subplans to (1) provide for safety of employees, (2) enable continued operation by means of backup computing facilities, and (3) protect the firm's vital records. Firms wanting to develop a new contingency plan need not start from scratch; several software-based templates are available, as are outlines and hints from state governments.

ORGANIZATIONAL NEEDS FOR SECURITY AND CONTROL

In today's world, organizations are becoming more aware of the importance of keeping all of their resources, virtual as well as physical, secure from both inside and outside threats. The first computer systems had little security protection, but that changed during the Vietnam War when a number of computer installations suffered damage by protesters. This experience inspired industry to put in place security precautions aimed at eliminating or reducing the opportunity of damage or destruction and also at providing the organization with an ability to continue operation after disruption.

The U.S. federal government is now implementing similar precautions and controls, under the authority of the Patriot Act and the Office of Homeland Security. Approaches pioneered by industry are being copied and expanded. As these federal precautions are implemented, two critical issues must be addressed. The first issue is security versus individual rights. The challenge is to implement adequate security and control measures that do not infringe on the individual rights guaranteed by the Constitution. The second issue is security versus availability. This issue is prominent in the medical area, where concerns over the privacy of individuals' medical records are receiving attention. The security of medical records is being expanded to include microchips embedded in patients, in addition to medical data stored in computers.

Security issues are extremely difficult to resolve and will receive increasing attention in the future.

INFORMATION SECURITY

When government and industry first became aware of the need to secure their information resources, attention was focused almost exclusively on protecting hardware and data, and the term **systems security** was used. This narrow focus was subsequently broadened to include not only hardware and data, but also software, computer facilities, and personnel as well. Today, the scope has broadened to include all types of data—not just data within computers. The term **information security** is used to describe the protection of both computer and non-computer equipment, facilities, data, and information from misuse by unauthorized parties. This broad definition includes such equipment as copiers and fax machines and all types of media, including paper documents.

Objectives of Information Security

Information security is intended to achieve three main objectives: confidentiality, availability, and integrity.

- **Confidentiality.** The firm seeks to protect its data and information from disclosure to unauthorized persons. Executive information systems, human resource information systems, and such transaction processing systems as payroll, accounts receivable, purchasing, and accounts payable are especially critical in this regard.
- **Availability.** The purpose of the firm's information infrastructure is to make its data and information available to those who are authorized to use it. This objective is especially important to information-oriented systems such as human resources information systems and executive information systems.
- **Integrity.** All of the information systems should provide an accurate representation of the physical systems that they represent.

The firm's information systems must protect the data and information from misuse, but ensure its availability to authorized users who can have confidence in its accuracy.

Management of Information Security

Just as the scope of information security has broadened, so has the view of the management responsibility. Management is not only expected to keep the information resources secure, it is also expected to keep the firm functioning after a disaster or security breach. The activity of keeping the information resources secure is **information security management (ISM)**; the activity of keeping the firm and its information resources functioning after a catastrophe is **business continuity management (BCM)**.

The CIO is the logical person to have responsibility for information security, but organizations are beginning to designate persons who can devote full-time attention to the activity. The title **corporate information systems security officer (CISSO)** has been used for the person in the organization, typically a member of the information systems unit, who is responsible for the firm's information systems security. Currently, however, a movement is underway to achieve an even higher level of security in the firm by designating a **corporate information assurance officer (CIAO)** who will report to the CEO and manage an information assurance unit. As envisioned, the CIAO should possess the full range of security certifications and have a minimum of 10 years experience in managing an information security facility.[1]

INFORMATION SECURITY MANAGEMENT

In its most basic form, information security management consists of four steps: identifying the *threats* that can attack the firm's information resources; defining the *risks* that the threats can impose; establishing an *information security policy*; and implementing *controls* that address the risks. Threats impose risks, which must be controlled. The term **risk management** has

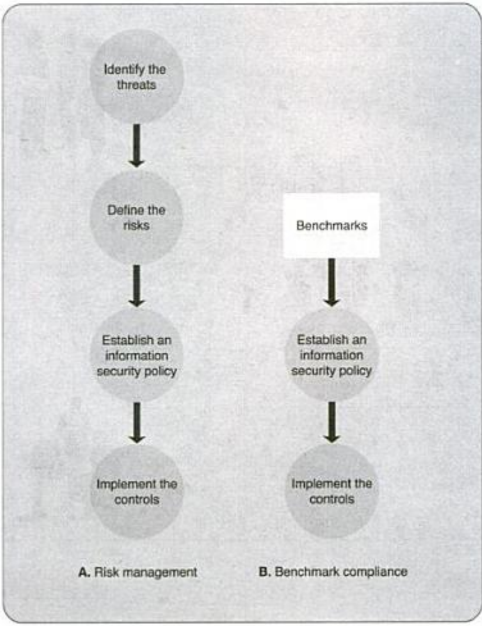


Figure 9.1
Information Security Management (ISM) Strategies

been coined to describe this approach of basing the security of the firm's information resources on the risks that it faces. Figure 9.1A illustrates the risk management approach.

Another option exists for formulating the firm's information security policy. It has become popular in recent years with the emergence of information security standards or benchmarks. A *benchmark* is a recommended level of performance. The **information security benchmark** is a recommended level of security that in normal circumstances should offer reasonable protection against unauthorized intrusion. Such standards and benchmarks are defined by governments and industry associations and reflect what those authorities believe to be the components of a good information security program. When a firm follows this approach, which we call **benchmark compliance**, it is assumed that government and industry authorities have done a good job of considering the threats and risks and that the benchmarks offer good protection. Figure 9.1B shows the benchmark compliance approach.

THREATS

An **information security threat** is a person, organization, mechanism, or event that has potential to inflict harm on the firm's information resources. When one thinks of information security threats, it is only natural to think of groups or individuals outside the firm carrying

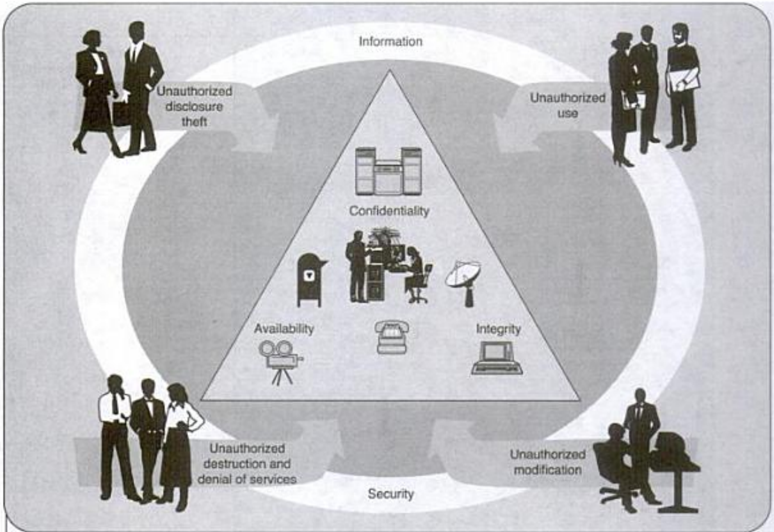


Figure 9.2
Unauthorized Acts Threaten System Security Objectives

out intentional acts. Actually, threats can be internal as well as external, and they can be accidental as well as intentional.

Figure 9.2 shows the information security objectives and how they are subjected to the four types of risks.

Internal and External Threats

Internal threats include not only the firm's employees, but also temporary workers, consultants, contractors, and even the firm's business partners. A survey by the Computer Security Institute found that 49 percent of the respondents faced security incidents brought on by actions of legitimate users;[2] the proportion of computer crimes committed by employees has been estimated to be as high as 81 percent.[3] Internal threats are considered to present potentially more serious damage than external threats due to the more intimate knowledge of the system by the internal threats.

Accidental and Deliberate Acts

Not all threats are deliberate acts carried out with the intent of inflicting harm. Some are accidental, caused by persons inside or outside the firm. Just as information security should be aimed at preventing deliberate threats, it should also eliminate or reduce the opportunity for accidental damage.

TYPES OF THREATS

Everyone has heard of computer viruses. Actually, a virus is only one example of a type of software that bears the name *malicious software*. **Malicious software**, or **malware**, consists of complete programs or segments of code that can invade a system and perform functions not intended by the system owners. The functions can erase files or cause the system to come to a halt. There are several types of malicious software; in addition to viruses, there are worms, Trojan horses, adware, and spyware.

A **virus** is a computer program that can replicate itself without being observable to the user and embed copies of itself in other programs and boot sectors. Unlike a virus, a **worm** cannot replicate itself within a system, but it can transmit its copies by means of e-mail. A **Trojan horse** can neither replicate nor distribute itself; users distribute it as a utility. When the utility is used, it produces unwanted changes in the system's functionality. **Adware** generates intrusive advertising messages, and **spyware** gathers data from the user's machine. Of these malware types, adware and spyware are the most recent. It was not until early 2005, after becoming aware of the extent of the problem, that Microsoft decided to enter the antispyware battle. The South Korea MSN Web site was hacked into in June 2005, and the attack was not discovered for days.

Antispyware programs often attack cookies, the small text files that businesses put on customers' hard drives to keep track of their customers' shopping interests. The removal of cookies by antispyware programs is causing concern for some marketers.[4] The most effective solution might be for the antispyware to not delete the first-party cookies stored by businesses for their customers, but to only delete third-party cookies put there by other organizations.

RISKS

We define an **information security risk** as a potential undesirable outcome of a breach of information security by an information security threat. All risks represent unauthorized acts. Such risks are of four types: unauthorized disclosure and theft, unauthorized use, unauthorized destruction and denial of service, and unauthorized modification.

Unauthorized Disclosure and Theft

When the database and software library are made available to persons not entitled to have access, the result can be the loss of information or money. For example, industrial spies may gain valuable competitive information, and computer criminals may embezzle the firm's funds.

Unauthorized Use

Unauthorized use occurs when persons who are not ordinarily entitled to use the firm's resources are able to do so. Typical of this type of computer criminal is the hacker who views a firm's information security as a challenge to be overcome. A hacker, for example, can break into a firm's computer network, gain access to the telephone system, and make unauthorized long-distance calls.

Unauthorized Destruction and Denial of Service

Individuals can damage or destroy hardware or software, causing the firm's computer operations to shut down. It is not even necessary for computer criminals be on the premises. They can log onto the firm's computer network and use the firm's resources (such as e-mail) to such an extent that normal business operations break down.

Unauthorized Modification

Changes can be made to the firm's data, information, and software. Some changes go unnoticed and cause the users of the system outputs to make the wrong decisions. One example is to modify grades in a student's academic record.

RISK MANAGEMENT

Earlier, we identified risk management as one of two strategies for achieving information security. Risks can be managed by applying controls to either remove the risks or to reduce their impact. Defining risks consists of four substeps:[8]

1. Identify business assets to be protected from risks.
2. Recognize the risks.
3. Determine the level of impact on the firm should the risks materialize.
4. Analyze the firm's vulnerabilities.

A systematic approach can be taken to Substeps 3 and 4—determining the impact and analyzing the vulnerabilities.[9] Table 9.1 illustrates the options.

Impact severity can be classified as **severe impact** (puts the firm out of business or severely limits its ability to function), **significant impact** (causes significant damage and cost, but the firm will survive), or **minor impact** (causes breakdowns that are typical of day-to-day operations). For both severe and significant risks, a vulnerability analysis is conducted. When the analysis indicates high vulnerability (substantial weaknesses exist in the systems), controls *must* be implemented to eliminate or reduce the vulnerability. When vulnerability is medium (some weaknesses exist), controls *should* be implemented. When vulnerability is low (the system is well constructed and is operating correctly), the existing controls should be kept intact.

At the completion of the risk analysis, the findings should be documented in a risk analysis report. The contents of this report should include information, such as the following, about each risk:[10]

1. A description of the risk
2. Source of the risk
3. Severity of the risk
4. Controls that are being applied to the risk
5. The owner(s) of the risk
6. Recommended action to address the risk
7. Recommended time frame for addressing the risk

Table 9.1

Degree of Impact and Vulnerability Determine Controls

	Severe Impact	Significant Impact	Minor Impact
High Vulnerability	Conduct vulnerability analysis. Must improve controls.	Conduct vulnerability analysis. Must improve controls.	Vulnerability analysis unnecessary.
Medium Vulnerability	Conduct vulnerability analysis. Should Improve controls.	Conduct vulnerability analysis. Should Improve controls.	Vulnerability analysis unnecessary.
Low Vulnerability	Conduct vulnerability analysis. Keep controls intact.	Conduct vulnerability analysis. Keep controls intact.	Vulnerability analysis unnecessary.

When the firm has responded to the risk, the report should be completed by adding a final section:

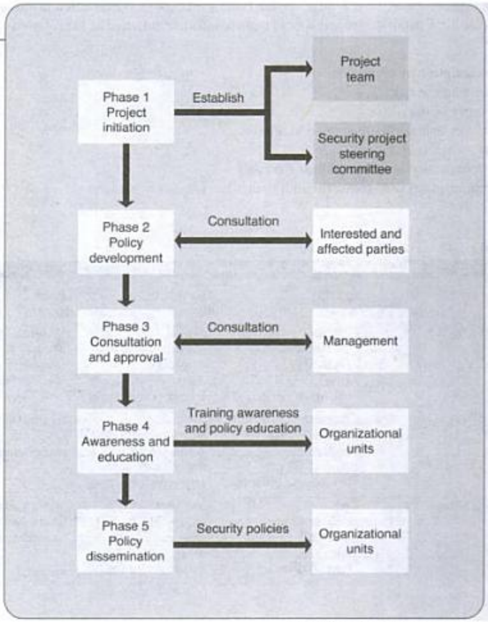
8. What was done to mitigate the risk.

INFORMATION SECURITY POLICY

Regardless of whether the firm follows a risk management or benchmark compliance strategy, a security policy should be implemented to guide the overall program. The firm can implement its security policy by following a phased approach. Figure 9.3 illustrates the five phases of implementing a security policy.[11]

- **Phase 1—Project initiation.** The team that is to develop the security policy is formed. If the corporate MIS steering committee is unable to assume responsibility for overseeing the security policy project, a special steering committee can be formed. If a special committee is formed, it will include managers from the areas where the policy will apply.
- **Phase 2—Policy development.** The project team consults with all interested and affected parties to determine the requirements of the new policy.
- **Phase 3—Consultation and approval.** The project team consults with management to inform them of findings to date and to obtain their views on policy requirements.

Figure 9.3
Development of Security Policy



- **Phase 4—Awareness and education.** Training awareness and policy education programs are conducted in the organizational units. The trainees may consist of the project members, other internal representatives such as persons from IT and HR, or outside consultants. This is an example of knowledge management. Management puts in place formal programs to increase the security knowledge of the appropriate employees.
- **Phase 5—Policy dissemination.** The security policies are disseminated throughout the organizational units where the policies apply. Ideally, the unit managers will hold meetings with employees to ensure that they understand the policies and are committed to following them.

Separate policies are developed for:

- Information systems security
- System access control
- Personnel security
- Physical and environmental security
- Data communications security
- Information classification
- Business continuity planning
- Management accountability

The policies are made known to employees, preferably in writing, and through educational and training programs. With the policies established, controls can be implemented.

CONTROLS

A **control** is a mechanism that is implemented to either protect the firm from risks or to minimize the impact of the risks on the firm should they occur. Controls fall into three categories: technical, formal, and informal.[12]

TECHNICAL CONTROLS

Technical controls are those that are built into systems by the system developers during the systems development life cycle. Including an internal auditor on the project team is an excellent way to ensure that such controls are included as a part of system design. Most of the security controls are based on the hardware and software technology. The more popular ones are described in the following sections.

Access Controls

The basis for security against threats by unauthorized persons is access control. The reasoning is simple: If unauthorized persons are denied access to the information resources, then harm cannot be done.

Access control is achieved by means of a three-step process that includes user identification, user authentication, and user authorization. The incorporation of these steps into a security system is shown in Figure 9.4.

1. **User identification.** Users first identify themselves by providing something that they *know*, such as a password. The identification may also include the user's *location*, such as a telephone number or network entry point.
2. **User authentication.** Once initial identification has been accomplished, users verify their right to access by providing something that they *have*, such as a smart card or token or an identification chip. User authentication can also be accomplished by providing something that they *are*, such as a signature or a voice or speech pattern.
3. **User authorization.** With the identification and authentication checks passed, a person can then be authorized to access certain levels or degrees of use. For example, one user might be authorized only to read records from a file, whereas another might be authorized to make changes in the file records.

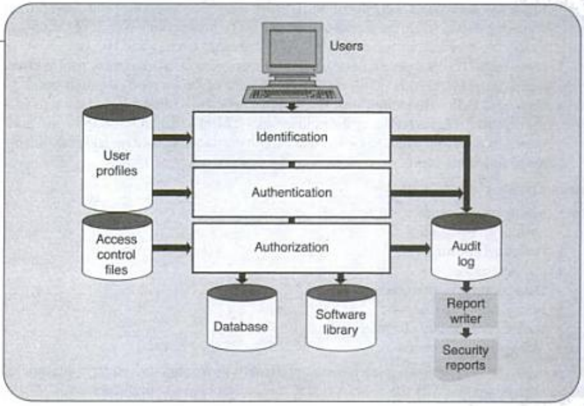


Figure 9.4 **Access Control Functions**

Source: Ken Cutler, "Hackers, Viruses, Thieves, and Other Threats to Your Information Assets," in *Computer Security Seminar Course Material* (New York: ACM, 1991). Copyright © 1991 Association of Computing Machinery. Used by permission.

Identification and authentication make use of **user profiles**, or descriptions of authorized users. Authorization makes use of **access control files** that specify the levels of access available to each user.

Once users have satisfied the three access control functions, they can use the information resources within the constraints of the access control files. A computer-based audit log is maintained of all access control activity, such as date and time of day and terminal identification, and it is used to prepare security reports.

Intrusion Detection Systems

The underlying logic of intrusion detection systems is to recognize an attempt to breach the security *before* it has the opportunity to inflict damage. A good example is **virus protection software** that has proven to be effective against viruses transported in e-mail. The software identifies the virus-carrying messages and warns the user.

Another example of intrusion detection is the software aimed at identifying potential intruders before they have an opportunity to inflict harm. **Insider threat prediction tools** have been developed that consider such characteristics as the person's position in the firm, access to sensitive data, ability to alter hardware components, the types of applications used, the files owned, and the usage of certain network protocols. The output of such profilers, some of which are quantitative, can classify the internal threats in such categories as possible *intentional threat*, *potential accidental threat*, *suspicious*, and *harmless*.[13]

Firewalls

Computer resources are at risk whenever they are connected to a network. One approach to security is to physically separate a firm's Web site from the firm's internal network that contains sensitive data and information systems. Another is to provide trading partners with passwords that enable them to enter the internal network from the Internet. A third approach is to build a protective wall, a firewall.

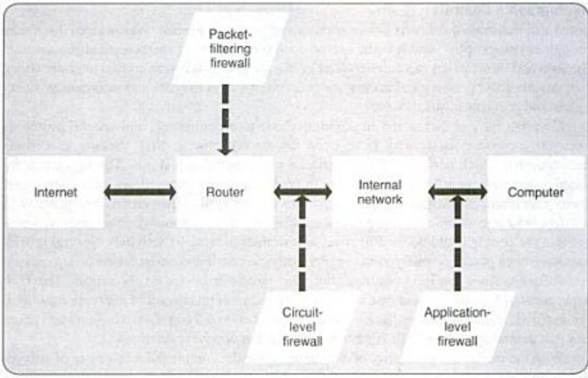


Figure 9.5 **Location of Firewalls in the Network**

The **firewall** acts as a filter and barrier that restricts the flow of data to and from the firm and the Internet. The concept behind the firewall is that it establishes one safeguard for all computers on the firm's network rather than separate safeguards for each computer. Some companies that offer antivirus software (such as McAfee at WWW.MCAFEE.COM and Norton at WWW.NORTON.COM) now include firewall software at no extra charge with the purchase of their antivirus products.

Three types of firewalls are *packet filtering*, *circuit level*, and *application level*. Figure 9.5 illustrates the location of these firewalls in the network.

PACKET-FILTERING FIREWALL A router is a network device that directs the flow of network traffic. When the router is positioned between the Internet and the internal network, it can serve as a firewall. The router is equipped with data tables of IP addresses that reflect the filtering policy. For each transmission, the router accesses its tables and enables only certain types of messages from certain Internet locations (IP addresses) to pass through. An **IP address** is a set of four numbers (each from 0 to 255) that uniquely identify each computer connected to the Internet. A limitation of the router is that it is a single point of security, so if a hacker gets through then the firm can be in trouble. "IP spoofing," fooling the router's access tables, is one method hackers use to foil routers.

CIRCUIT-LEVEL FIREWALL A step up in security over the router is a circuit-level firewall that is installed between the Internet and the firm's network but closer to the communications medium (the circuit) than a router. This approach allows a high amount of authentication and filtering, much higher than a router. However, the limitation of a single point of security still applies.

APPLICATION-LEVEL FIREWALL This firewall is located between the router and the computer performing the application. The full power of additional security checks can be performed. After the request has been authenticated as coming from an authorized network (circuit level) and from an authorized computer (packet filtering), the application can request further authentication information such as asking for a secondary password, confirming an identity, or even checking to see if the request is during normal business hours. Although this is the most effective type of firewall, it tends to degrade access to the resource. Another issue is that a network programmer must write specific program code for each application and change the code as applications are added, deleted, or modified.

Cryptographic Controls

Stored and transmitted data and information can be protected against unauthorized disclosure through **cryptography**, which is the use of coding by means of mathematical processes.[14] The data and information can be encrypted in storage and as it is transmitted over networks. If an unauthorized person gains access, the encryption makes the data and information meaningless and prevents misuse.

Cryptography is increasing in popularity due to e-commerce, and special protocols aimed at e-commerce security have been developed. One is SET (Secure Electronic Transactions), which performs security checks using digital signatures. The signatures are issued to the persons who can participate in an e-commerce transaction—customers, merchants, and financial institutions. Dual signatures are used rather than credit card numbers.

Considerable attention is currently being directed at encryption by governments, which fear that the coding could be used to cover up criminal or terrorist activities. Several restrictions have been placed on encryption use. Presently, no restrictions exist on importing encryption software from foreign countries, but there are restrictions on its export. The U.S. Department of Commerce administers U.S. policy and prohibits export of encryption technology to Cuba, Iran, Iraq, Libya, North Korea, the Sudan, and Syria. Organizations and countries that defend the individual's right to use encryption oppose restrictions.

With the increasing popularity of e-commerce and the continual development of encryption technology, its use is expected to increase within the bounds of government restrictions.

Physical Controls

The first precaution against unauthorized intrusions was to lock the computer room door. Subsequent refinements led to more sophisticated locks, opened by palm prints and voice prints, and to surveillance cameras and security guards. Firms can carry physical controls to the limit by locating their computer centers in remote areas far from cities and far from areas especially sensitive to such natural disasters as earthquakes, floods, and hurricanes.

Putting the Technical Controls in Perspective

You can see from this long list of technical controls (and we did not list them all), that much attention has been directed at using technology to safeguard information. The technical controls are recognized as being the best bet for security. Firms typically select from the list and implement a combination that is considered to offer the most realistic safeguard.

FORMAL CONTROLS

Formal controls include the establishment of codes of conduct, documentation of expected procedures and practices, and monitoring and preventing behavior that varies from the established guidelines. The controls are formal in that management devotes considerable time to devising them, they are documented in writing, and they are expected to be in force for the long term.

There is universal agreement that if formal controls are to be effective, top management must participate actively in their establishment and enforcement.

INFORMAL CONTROLS

Informal controls include education and training programs and management development programs. These controls are intended to ensure that the firm's employees both understand and support the security program.

ACHIEVING THE PROPER LEVEL OF CONTROLS

All three types of controls—technical, formal, and informal—cost money. Because it is not a good business practice to spend more for a control than the expected cost of the risk that it addresses, the idea is to establish controls at the proper level. Thus, the control decision boils down to cost versus return, but in some industries other considerations must be addressed. In banking, for example, when engaging in risk management for ATMs, controls must keep the system secure but not at the cost of diminishing customer convenience. Also, in health care, the questions of patient health and right to privacy must be considered. The system should not be made so secure as to reduce the amount of patient information that can be made available to hospitals and physicians who are responsible for the patient's health.

GOVERNMENT AND INDUSTRY ASSISTANCE[15]

Several governments and international organizations have established standards that are intended to serve as guidelines for organizations seeking to achieve information security. Some of the standards are in the form of benchmarks, which we identified earlier as providing an alternate strategy to risk management. Some of the standard-setting entities use the term *baseline* rather than *benchmark*. Organizations are not required to adhere to the standards. Rather, the standards are intended to provide the firm with assistance in establishing a target level of security. The following are some examples:

- **United Kingdom's BS7799.** The UK standards establish a set of baseline controls. They were first published by the British Standards Institute in 1995, then published by the International Standards Organization as ISO 17799 in 2000, and made available to potential adopters online in 2003.
- **BSI IT Baseline Protection Manual.** The baseline approach is also followed by the German Bundesamt fur Sicherheit in der Informationstechnik (BSI). The baselines are intended to provide reasonable security when normal protection requirements are intended. The baselines can also serve as the basis for higher degrees of protection when those are desired.
- **COBIT.** COBIT, from the Information Systems Audit and Control Association & Foundation (ISACAF), focuses on the process that a firm can follow in developing standards, paying special attention to the writing and maintaining of the documentation.
- **GASSP.** Generally Accepted System Security Principles (GASSP) is a product of the U.S. National Research Council. Emphasis is on the rationale for establishing a security policy.
- **ISF Standard of Good Practice.** The Information Security Forum Standard of Good Practice takes a baseline approach, devoting considerable attention to the user behavior that is expected if the program is to be successful. The 2005 edition addresses such topics as secure instant messaging, Web server security, and virus protection.

None of the standards offer complete coverage of the subject, but, when taken together, they form a good basis for the firm to follow in establishing its own information security policy that supports its organizational culture.

GOVERNMENT LEGISLATION

Governments in both the United States and the United Kingdom have established standards and passed legislation aimed at addressing the increasing importance of information security, especially in light of 9/11 and the pervasive nature of the Internet and the opportunities it provides for computer crime. Among these are:

- **U.S. Government Computer Security Standards.** A study by the Gartner research firm predicted that through 2005, 90 percent of all computer security attacks would be aimed at weaknesses for which there is a known protection.[16] The U.S. government responded with a program aimed at applying these known protections. The program includes a set of security standards that participating organizations should meet, plus the availability of a software program that grades users' systems and assists them in configuring their systems to meet the standards. The National Institute of Standards and Technology (NIST) makes available a questionnaire that organizations can complete to evaluate the security of their information systems. Two software systems, ASSET-System and ASSET-Manager, provide help in completing the questionnaire and assessing the status of the firm's security plan.

- **The U.K. Anti-Terrorism, Crime and Security Act (ATCSA) 2001.** In the United Kingdom, Parliament enacted the Anti-Terrorism, Crime and Security Act (ATCSA) 2001.[17] This act has three provisions: (1) ISPs are required to maintain data about all communications events for 1 year, (2) government taxing authorities are empowered to disclose information about an individual's or organization's financial affairs to authorities investigating crime or terrorism, and (3) the obligation of confidence is removed for public bodies even if there is only suspicion of an impending terrorist act. Since its implementation, the act has been criticized by such human rights groups as Amnesty International. It will be interesting to see if such criticism continues in light of the 2005 London train bombings.

INDUSTRY STANDARDS

The Center for Internet Security (CIS) is a nonprofit organization dedicated to assisting computer users to make their systems more secure. Assistance is provided by two products—CIS Benchmarks and CIS Scoring tools. CIS Benchmarks helps users secure their information systems by implementing technology-specific controls. CIS Scoring Tools enables users to calculate their security level, compare it to benchmarks, and prepare reports that guide users and system administrators to secure systems.

PROFESSIONAL CERTIFICATION

Beginning in the 1960s, the IT profession began offering certification programs. The three following examples illustrate the breadth of the subject matter covered by such programs.

Information Systems Audit and Control Association

The first security certification program was the Certified Information System Auditor, offered by the Information Systems Audit and Control Association (ISACA). Subsequently, ISACA developed the Certified Information Security Manager designation. In order to earn this certification, the applicant must complete an exam (offered for the first time in June 2003), adhere to a code of ethics, and verify work experience in information security. Information on ISACA can be found at WWW.ISACA.ORG.

International Information System Security Certification Consortium[18]

The Certification Information System Security Professional (CISSP) is offered by the International Information System Security Certification Consortium (ISC). The CISSP certification verifies that the holder has a general expertise in information security that encompasses such topics as access control, cryptography, security architecture, Internet security, and security management practices. Certification is based on performance on an exam of 250 multiple-choice questions. More information can be found at WWW.ISC2.ORG.

SANS Institute

SANS (SysAdmin, Audit, Network, Security) Institute offers certifications through its Global Information Assurance Certification Program, which includes courses such as IT Security Audit and Control Essentials, and Writing and Assessing Security Policy. Information on SANS can be obtained from WWW.SANS.ORG.

PUTTING INFORMATION SECURITY MANAGEMENT IN PERSPECTIVE

Firms should put in place an information security management policy before putting controls in place. The policy can be based on an identification of threats and their risks or on guidelines provided by governments and industry associations. Firms implement a combination of technical, formal, and informal controls that are expected to offer the desired level of security within cost parameters and in accordance with other considerations that enable the firm and its systems to function effectively.

BUSINESS CONTINUITY MANAGEMENT

The activities aimed at continuing operations after an information system disruption are called **business continuity management (BCM)**. During the early years of computing, this activity was called **disaster planning**, but a more positive term, **contingency planning**, became popular. The key element in contingency planning is a **contingency plan**, which is a formal written document that spells out in detail the actions to be taken in the event that there is a disruption, or threat of disruption, in any part of the firm's computing operations.

Firms have found that, rather than relying on a single, large contingency plan, the best approach is to develop several subplans that address specific contingencies.[19] Typical subplans include the emergency plan, the backup plan, and the vital records plan.

The Emergency Plan

The **emergency plan** specifies those measures that ensure the safety of *employees* when disaster strikes. The measures include alarm systems, evacuation procedures, and fire-suppression systems.

The Backup Plan

The firm should make arrangements for backup computing *facilities* in the event that the regular facilities are destroyed or damaged beyond use. These arrangements constitute the **backup plan**. Backup can be achieved by means of some combination of redundancy, diversity, and mobility:[20]

- **Redundancy.** Hardware, software, and data are duplicated so that when one set is inoperable, the backup set can continue the processing.
- **Diversity.** Information resources are not all installed at the same location. Large firms typically establish separate computing centers for different areas of their operations.
- **Mobility.** Firms can enter into a reciprocal agreement with other users of the same type of equipment so that each firm can provide backup to the other in the event of a catastrophe. A more elaborate approach is to contract for backup service at hot or cold sites. A **hot site** is a complete computing facility that is made available by a supplier to its customers for use in the event of emergencies. A **cold site** includes only the building facilities, but not the computing resources. The firm can obtain a cold site from a supplier or construct its own facilities. For either approach, the firm must provide the computing resources. The largest suppliers of hot and cold sites are IBM and SunGard.

The Vital Records Plan

A firm's **vital records** are those paper documents, microforms, and magnetic and optical storage media that are necessary for carrying on the firm's business. The **vital records plan** specifies how the vital records will be protected. In addition to safeguarding the records at the computer site, backup copies should be stored at a remote location. All types of records can be physically transported to the remote location, but computer records can be transmitted electronically.

PUTTING BUSINESS CONTINUITY MANAGEMENT IN PERSPECTIVE

Business continuity management is one area of computer use where it is easy to see major improvements. During the late 1980s, only a handful of firms had such plans, and firms seldom put them to test. Since then, much effort has gone into contingency planning, and a great deal of information and assistance are available. Packaged plans are available that firms can adapt to their specific needs. TAMP Computer Systems markets a Disaster Recovery System (DRS) that includes a database management system, instructions, and tools that can be used in preparing a recovery plan. Guidelines and outlines are available that firms can use as starting points or benchmarks. A guideline for contingency planning prepared by the Texas Department of Information Resources can be obtained at WWW.DIR.STATE.TX.US/SECURITY/CONTINUITY/INDEX.HTM.

Highlights in MIS

THE NEWEST THREAT TO THE CORPORATION: CYBEREXTORTION

He cruised Virginia and Maryland neighborhoods in his old, blue Pontiac with an antenna mounted on the dashboard. As he did so, he tapped into wireless connections to Yahoo! and American Online to lift accounts and passwords. He was a new brand of computer criminal—a cyberstalker, engaged in cyberextortion.

He was also an entrepreneur who owned a patent business, and he used the computer in an effort to extort $17 million from MicroPatent, a patent and trademarking firm. He had previously applied for a job with MicroPatent and was turned down. He directed more than a dozen e-mail threats at Daniel I. Videtto, the MicroPatent president. The cyberstalker claimed that he had thousands of proprietary MicroPatent documents, confidential customer data, computer passwords, and e-mail addresses, and he warned that if Mr. Videtto ignored his demands, the information would "end up in e-mail boxes worldwide."[21]

Unlike many firms that take the easy way out by giving in to the extortionist's demands, MicroPatent decided to fight back. The company hired private investigators and also a former psychological profiler for the CIA. The task of the profiler was to create a psychological profile of the stalker. Eventually, this work paid off. In March of 2004, authorities arrested the cyberstalker as he sat in his car composing e-mails that he planned to send wirelessly to Mr. Videtto. Later that same year the cybercriminal pleaded guilty to a criminal extortion charge and was sentenced to 5 years in prison.

Gregory M. Bednarski, a Carnegie Mellon University researcher, has studied cybercrime, and regards cyberextortion to be the type of security breach that is most often overlooked by firms. However, it is difficult to measure the real extent of damage, because many corporations go out of their way to avoid negative publicity related to security intrusions.

Summary

Today, business organizations are seeking information system security without impeding information availability to those who are authorized to receive it. Governments are seeking system security without invading personal rights to privacy. These are difficult balances to achieve.

The original focus of systems security on the computer and database has been broadened to include not only all types of information resources, but also such noncomputer media as paper documents, and the activity is named *information security*. The three objectives of information security are confidentiality, availability, and integrity. These objectives are met by following programs of information security management (ISM) on a daily basis and business continuity management (BCM) to remain operational after a disruption from a disaster or a security breach. Current thinking is that this security activity should be managed by a corporate information assurance officer (CIAO) who directs a separate security facility and reports directly to the CEO.

Two approaches can be taken to implement ISM. Risk management involves identifying threats, defining risks, establishing an information security policy, and implementing controls. Benchmark compliance replaces the threat and risk considerations with benchmarks of good information security, which are usually made available by governments or industry associations.

Threats can be internal or external, accidental or deliberate. Much attention has been directed at both internal and external threats, with the internal controls usually taking the form of intrusion detection tools and prediction of intrusions before they occur. The most notorious threat is the virus, which is only one example of malicious software, along with worms, Trojan horses, spyware, and adware. Risks are the unauthorized acts performed by the threats. The acts can result in unauthorized (1) disclosure and theft, (2) use, (3) destruction and denial of service, and (4) modification. E-commerce increases the threat of credit card fraud, which can be minimized when participants use numbers randomly generated for transactions rather than traditional credit card numbers.

When engaging in risk management, the level of impact and the degree of vulnerability can be defined in a systematic way. Severe or significant impact demands a vulnerability analysis. Controls must be implemented for severe impacts and should be implemented for significant ones.

Information security policy can be implemented by following a five-phase plan. The project includes a project team and perhaps a special steering committee. The team works with management and interested parties in developing the policy, which is then disseminated to organizational units after providing training and educational programs. Separate policies can be developed to secure the information system, personnel, data communications, and the physical environment.

There are three types of controls: technical, formal, and informal. Technical controls employ hardware and software. Access controls grant access only after users pass screens of user identification, authentication, and authorization. Intrusion detection systems include antivirus packages and models that can identify insider threats. Firewalls are aimed at protecting the firm's network from intrusion via the Internet. Cryptographic controls are considered to be especially effective because they do not hinge on preventing access; rather, they make data and information unusable when it is surreptitiously obtained. Physical controls secure the computing facility by restricting or discouraging unauthorized access. Formal controls take the form of top-down efforts, such as codes of conduct, procedures, and practices. Informal controls are concerned primarily with giving employees the information that they need to carry out the controls.

Much has been accomplished in the area of security standards. Both national governments and industry associations have issued standards or provided assistance in determining what should be included in security programs. Governments have also passed legislation that requires certain standards to be followed or that enables organizations to provide information about potential terrorist or organized crime threats without fear of prosecution. Going hand-in-hand with industry support are the various security certification programs, which address such broad subjects as management practices and such narrow ones as cryptography.

Business continuity management is achieved by means of a contingency plan, which is usually divided into subplans. An emergency plan protects the employees; a backup plan enables the organization to continue even after loss of a computing capability; the vital records plan ensures that valuable data is not lost.

So much is available today to firms that want to improve information security. This is one area of computer activity where the correct path is well-lit.

Key Terms

information security
information security management (ISM)
business continuity management (BCM)
risk management
information security benchmark
information security threat
malicious software, malware
virus
worm
Trojan horse
adware
spyware
information security risk
control
user profile
access control file
virus protection software
insider threat prediction tool
firewall
cryptography
contingency plan
emergency plan
backup plan
vital records plan

Key Concepts

- layers of access control
- risk management
- benchmark compliance

Questions

1. What is included in information security that is not included in systems security?
2. Identify the three objectives of information security.
3. Information security is subdivided into two separate efforts. What are they?
4. How does risk management differ from benchmark compliance?
5. Explain why an internal threat is to be more feared than an external one.
6. Identify five examples of malware.
7. What special type of risk must be addressed by e-commerce systems?
8. What are the four steps leading to risk management?
9. Distinguish between a severe impact and a significant impact from a threat.
10. What is the final section in a risk analysis report? When is that section prepared?
11. Name the five phases of information security policy.
12. What are the three basic types of controls?
13. How does a user pass the user identification check? The user authentication check? The user authorization check?
14. What type of threat is addressed by a firewall?
15. What is the most effective type of firewall? What is the disadvantage of this type of firewall?
16. What is so great about cryptography?
17. What is the difference between formal and informal controls?
18. What types of plans are included in contingency planning?
19. What physical resource does the emergency plan protect?
20. List three approaches to system backup.
21. How does a hot site differ from a cold site?

Topics for Discussion

1. Figure 9.1A shows the security policy being established after threats and risks have been defined. Explain why the policy should be established first.
2. What are the characteristics of an employee who would represent an insider threat?
3. The outline of the report to be prepared at the end of risk analysis refers to the "owner(s) of the risk." What is meant by "owning" a risk? Who would be an example of an owner?
4. Why not just rely on cryptography, and not worry about restricting access?

Problems

1. Go to WWW.SUNGARD.COM and obtain information about the business continuity services offered by SunGard. Write a paper describing your findings. Your instructor will provide the specifics in terms of format, paper length, and so on.
2. Assume that you are the newly hired corporate information systems security officer for a small Midwest

Chapter 10

Ethical Implications of Information Technology

Learning Objectives

After studying this chapter, you should

- Understand how morals, ethics, and laws differ.
- Be familiar with computer legislation that has been passed in the United States and know how legislation in one country can influence computer use in others as well.
- Know how a firm creates an ethics culture by first establishing a corporate credo, then establishing ethics programs, and lastly establishing a corporate ethics code.
- Know why society demands that computers be used ethically.
- Know the four basic rights that society has concerning the computer.
- Know how the firm's internal auditors can play a positive role in achieving information systems that are designed to meet ethical performance criteria.
- Be aware of computer industry codes of ethics, and the wide variety of educational programs that can help firms and employees use computers ethically.
- Know what the chief information officer (CIO) can do to be a power center as the firm follows ethical practices.
- Be acquainted with the most profound piece of legislation to be levied on business in recent history—The Sarbanes-Oxley Act.

systems. However, we will continue to describe how the computer ought to be applied in an ethical manner. Our mission is to recognize that businesspeople in general and information specialists in particular have definite responsibilities in terms of performing within ethical, moral, and legal constraints.

MORALS, ETHICS, AND LAWS

As we go about our everyday lives, we are guided by many influences. As socially conscionable citizens, we want to do what is morally right, be ethical, and obey the law.

Morals

Morals are traditions of belief about right and wrong conduct.[1] Morals are a social institution with a history and a list of rules. We begin to learn the rules of moral behavior as children: "Treat others as you wish to be treated." "Always say, 'Thank you.'" As we grow and mature physically and mentally, we learn the rules that our society expects us to follow. These rules of conduct are our morals.

Although societies around the world do not all subscribe to the same set of morals, there is a strong underlying commonality. "Doing what is morally right" is the bedrock of our social behavior.

Ethics

We are also guided in our actions by ethics. The word *ethics* is derived from the Greek root *ethos*, meaning "character." **Ethics** is a collection of guiding beliefs, standards, or ideals that pervades an individual or a group or community of people.[2] All individuals are accountable to their community for their behavior. The community can exist in such forms as a neighborhood, city, state, nation, or profession.

Unlike morals, ethics can vary considerably from one community to another. We see this variability in the computer field in the form of **pirated software**—software that is illegally copied and then used or sold. In some countries the practice is more prevalent than in others. In 2004, it was estimated that 21 percent of the software in use in the United States had been pirated; the figure jumps to 32 percent in Australia and 90 percent in China.[3]

Some might say that these figures show that Chinese computer users are less ethical than those in the United States. This is not necessarily so. Some cultures, especially those of Asian countries, encourage sharing. In the words of a Chinese proverb, "He that shares is to be rewarded; he that does not, condemned."[4] Even so, software piracy is a problem, because there is no incentive to create and distribute new software unless those who use it recognize its economic value.

Laws

Laws are formal rules of conduct that a sovereign authority, such as a government, imposes on its subjects or citizens. For the first 10 years or so of computer use in government and business, there were no computer-related laws. This was because the computer was a new innovation, and the legal system needed time to get up to speed.

In 1966, the first case of computer crime made the news when a programmer for a bank altered a computer program so that it would not flag his account as being overdrawn. He could continue writing checks even though there was no money in the account. The ruse worked until the computer went down, and manual processing revealed the unflagged, overdrawn balance. The programmer was not charged with committing a computer crime, because no laws were on the books. Rather, he was charged with making false entries in bank records.[5]

Computer Legislation in the United States

Once U.S. computer legislation began to be enacted, it focused on rights and restrictions related to data access, especially credit data and data held by the government. Privacy, computer crime, and software patents were the primary focus.

DATA ACCESS RIGHTS AND RESTRICTIONS The Freedom of Information Act of 1966 gave U.S. citizens and organizations the right to access data held by the federal government, with a few exceptions. The 1970s brought additional laws in the form of the Fair Credit Reporting Act of 1970, which dealt with the handling of credit data, and the Right to Federal Privacy Act of 1978, which limited the federal government's ability to conduct searches of bank records. Later, another law aimed at restricting the federal government, the Computer Matching and Privacy Act of 1988, restricted the federal government's right to match computer files for the purpose of determining eligibility for government programs or identifying debtors.

PRIVACY Shortly after the Freedom of Information Act went into effect, the federal government put into law the Electronic Communications Privacy Act of 1968. However, the act covered only voice communications. It was rewritten in 1986 to include digital data, video communications, and electronic mail.[6]

COMPUTER CRIME In 1984, the U.S. Congress strengthened the computer legislation by passing federal statutes that applied specifically to computer crime:[7]

- The Small Business Computer Security and Education Act established the Small Business Computer Security and Education Advisory Council. The council was assigned the responsibility to advise Congress concerning matters relating to computer crime against small businesses and to evaluate the effectiveness of federal and state crime laws in deterring and prosecuting computer crime.
- The Counterfeit Access Device and Computer Fraud and Abuse Act made it a federal felony for someone to gain unauthorized access to information pertaining to national defense or foreign relations. The act also made it a misdemeanor to gain unauthorized access to a computer protected by the Right to Financial Privacy Act or the Fair Credit Reporting Act and to misuse information in a computer owned by the federal government.

Software Patents

In July 1998, the U.S. Court of Appeals for the Federal Circuit affirmed that a business process could be patented. The case became known as the **State Street Decision**.[8] At issue was a software package used for managing mutual funds. Up until that time, the court's position had been that software could not be patented for two reasons: (1) a mathematical algorithm was not patentable and (2) business methods could not be patented.

Apparently feeling that software patents should have some restrictions, the U.S. Congress in April 2001 introduced a bill requiring a determination of the significance of a patent and whether it is appropriate for use with computer technology. Further, after 18 months all business-related patents would be published to provide an opportunity for holders of prior art to make their case.[9]

In this fashion, the U.S. federal government has gradually established a legal framework for computer use. As with ethics, however, the computer laws can vary considerably from one country to the next.

Software Patent Legislation in the European Union

In early 2002, responding to the State Street Decision, which stimulated a flurry of software patent activity in the United States that affected European firms, the European Union (EU) Parliament made proposals that standards for software patents be established that would be much stricter than those in the United States. The proposals generated much discussion and disagreement, and the Directive on the Patentability of Computer-Implemented Inventions was eventually rejected by the EU Parliament in July 2005.[10]

Personal Privacy Legislation in the People's Republic of China[11]

Both government and citizens of the People's Republic of China (PRC) are becoming aware of the need to define personal privacy. One problem is that the term *privacy* often has a negative connotation, being associated with someone who has something to hide. Chinese personal privacy activists are pressing for regulations that would protect such personal data as income level, occupation, marital status, physical attributes, and even address and phone number.

Currently, the Chinese government is focusing on imposing regulations on the use of computers and the Internet. These regulations stipulate that such use cannot damage "state security," "social interest," "citizens' lawful interest," and "privacy." However, no definitions of these terms have been provided.

In making their arguments, activists identify both the European Union and the United States as models for the type of legislation needed.

PUTTING MORALS, ETHICS, AND LAWS IN PERSPECTIVE

Computer use in business is guided by the moral and ethical values of managers, information specialists, and users, as well as by the applicable laws. Laws are the easiest to interpret because they exist in writing. Ethics, however, are not so precisely defined, and are not even agreed upon by all members of a society. It is this complex area of computer ethics that is receiving much current attention. In the remainder of the chapter, we focus on ethical use of information technology.

NEED FOR AN ETHICS CULTURE

A widely held opinion in business is that a firm reflects the personality of its leader. For example, the influence of James Cash Penney on JCPenney Colonel John Patterson on National Cash Register (NCR), or Thomas J. Watson, Sr., on IBM established the personalities of those corporations. Today, the CEOs of such firms as FedEx, Southwest Airlines, and Microsoft have such an influence on their organizations that the public tends to view the firm as the CEO.

This linkage of the CEO with the firm is the basis for the ethics culture. If the firm is to be ethical, then top-level management must be ethical in everything that it does and says. Top-level management leads by example. This behavior is the **ethics culture**.

How the Ethical Culture Is Imposed

The task of top-level management is to see to it that its concept of ethics permeates the organization, filtering down through the ranks to touch every employee. The executives achieve this implementation in a three-tiered fashion, in the form of a corporate credo, ethics programs, and tailored corporate codes.[12] Figure 10.1 shows the different tiers and their relationships.

CORPORATE CREDO A **corporate credo** is a succinct statement of the values that the firm seeks to uphold. The purpose of the credo is to inform persons and organizations, both inside and outside the firm, of the firm's set of ethical values. Figure 10.2 shows an example of a corporate credo from Security Pacific Corporation, a Los Angeles–based bank. Security Pacific management recognized that its business was built on commitments, both internal and external.

ETHICS PROGRAMS An **ethics program** is an effort consisting of multiple activities designed to provide employees with direction in carrying out the corporate credo. A typical activity is the orientation session that is held for new employees. During this session considerable attention is paid to the subject of ethics.

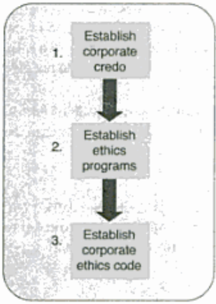


Figure 10.1 **Top-Level Management Imposes the Ethics Culture in a Top-Down Manner**

Figure 10.2 **Example of a Corporate Credo**

Source: Reprinted from "Creating Ethical Corporate Structures" by Patrick Murphy, ***MIT Sloan Management Review*** 30 (Winter 1989), p. 82, by permission of publisher. Copyright © 1989 Massachusetts Institute of Technology. All rights reserved.

Commitment to customer

The first commitment is to provide our customers with quality products and services that are innovative and technologically responsive to their current requirements, at appropriate prices. To perform these tasks with integrity requires that we maintain confidentiality and protect customer privacy, promote customer satisfaction, and serve customer needs. We strive to serve qualified customers and industries that are socially responsible according to broadly accepted community and company standards.

Commitment to employee

The second commitment is to establish an environment for our employees that promotes professional growth, encourages each person to achieve his or her highest potential, and promotes individual creativity and responsibility. Security Pacific acknowledges our responsibility to employees, including providing for open and honest communication, stated expectations, fair and timely assessment of performance, and equitable compensation that rewards employee contributions to company objectives within a framework of equal opportunity and affirmative action.

Commitment of employee to Security Pacific

The third commitment is that of the employee to Security Pacific. As employees, we strive to understand and adhere to the Corporation's policies and objectives, act in a professional manner, and give our best effort to improve Security Pacific. We recognize the trust and confidence placed in us by our customers and community and act with integrity and honesty in all situations to preserve that trust and confidence. We act responsibly to avoid conflicts of interest and other situations that are potentially harmful to the Corporation.

Commitment of employee to employee

The fourth commitment is that of employees to their fellow employees. We must be committed to promote a climate of mutual respect, integrity, and professional relationships, characterized by open and honest communication within and across all levels of the organization. Such a climate will promote attainment of the Corporation's goals and objectives, while leaving room for individual initiative within a competitive environment.

Commitment to communities

The fifth commitment is that of Security Pacific to the communities that we serve. We must constantly strive to improve the quality of life through our support of community organizations and projects, through encouraging service to the community by employees, and by promoting participation in community services. By the appropriate use of our resources, we work to support or further advance the interests of the community, particularly in times of crisis or social need. The Corporation and its employees are committed to complying fully with each community's laws and regulations.

Commitment to stockholder

The sixth commitment of Security Pacific is to its stockholders. We will strive to provide consistent growth and a superior rate of return on their investments, to maintain a position and reputation as a leading financial institution, to protect stockholder investments, and to provide full and timely information. Achievement of these goals for Security Pacific is dependent upon the successful development of the five previous sets of relationships.

Another example of an ethics program is the ethics audit. In an **ethics audit**, an internal auditor meets with a manager in a several-hour session for the purpose of learning how the manager's unit is carrying out the corporate credo. For example, an auditor might ask a sales manager, "Have there been any instances where we have lost business because we do not give gifts to purchasing agents?"

TAILORED CORPORATE CODES Many firms have devised their own corporate code of ethics. Sometimes these are adaptations of codes for a particular industry or profession. Later in the chapter we will study the codes of ethics for the information systems profession.

Putting the Credos, Programs, and Codes in Perspective

The corporate credo provides the setting in which the firm's ethics programs are carried out. The ethics codes describe the specific behaviors that the firm's employees are expected to carry out in their dealings with each other and the elements in the firm's environment.

REASONS FOR A COMPUTER ETHIC

James H. Moor has defined **computer ethics** as the analysis of the nature and social impact of computer technology as well as the corresponding formulation and justification of policies for the ethical use of such technology.[13]

Computer ethics, therefore, consists of two main activities. The person in the firm who is the logical choice for implementing the ethics programs is the CIO. The CIO must (1) be alert to the effects that the computer is having on society and (2) formulate policies to ensure that the technology is used throughout the firm in an ethical manner.

One point is very important: *The CIO does not bear this managerial responsibility for computer ethics alone*. The other executives contribute as well. This firmwide involvement is an absolute necessity in today's world of end-user computing, in which managers in all areas are responsible for the ethical use of computers in their areas. Beyond the managers, all employees are responsible for their computer-related actions.

Reasons for the Importance of Computer Ethics

James Moor identifies three main reasons for society's high level of interest in computer ethics: logical malleability, the transformation factor, and the invisibility factor.

LOGICAL MALLEABILITY By **logical malleability**, Moor means the ability to program the computer to do practically anything you want it to do. The computer performs exactly as it is instructed by the programmer, and this can be a frightening thought. However, when a computer is used for an unethical activity it is not the computer that is the culprit. Rather, it is the person or persons behind the computer who are at fault. So, rather than fear that the computer is sometimes used in an unethical way, society should fear the persons who are directing the computer.

THE TRANSFORMATION FACTOR This reason for concern over computer ethics is based on the fact that computers can drastically change the way we do things. A good example is e-mail. E-mail did not simply replace regular mail or telephone calls; it has provided an entirely new means of communication. Similar transformations can be seen in how managers conduct meetings. Whereas managers once had to physically assemble in the same location, they can now meet in the form of a videoconference.

THE INVISIBILITY FACTOR The third reason for society's interest in computer ethics is that society views the computer as a black box. All of the computer's internal operations are hidden from view. Invisibility of internal operations provides the opportunity for invisible programming values, invisible complex calculations, and invisible abuse:

- **Invisible programming values** are those routines that the programmer codes into the program that may or may not produce the processing that the user desires. During the course of writing a program, the programmer must make a series of value judgments as to how the program should accomplish its purpose. This is not a malicious act on the part of the programmer, but rather a lack of understanding. A good example of the impact that invisible programming values can have is the Three Mile Island nuclear disaster. The plant operators had been trained in handling emergencies by using a mathematical model. The model was designed to simulate single malfunctions occurring alone. What happened, however, was that multiple malfunctions occurred simultaneously. The inability of the computer to give the users what they needed was due to this invisibility factor.

- **Invisible complex calculations** take the form of programs that are so complex that users do not understand them. A manager uses such a program with no idea of how it is performing its calculations.
- **Invisible abuse** includes intentional acts that cross legal as well as ethical boundaries. All acts of computer crime fall into this category, as do such unethical acts as invasion of individuals' right to privacy and surveillance.

Society is, therefore, very concerned about the computer—how it can be programmed to do practically anything, how it is changing many of the ways that we do things, and the fact that what it does is basically invisible. Society expects business to be guided by computer ethics in order to put these concerns to rest.

Social Rights and the Computer

Society not only expects government and business to use computers in an ethical way, it also demands certain computer-related rights. The most widely publicized classification of human rights in the computer area is Richard O. Mason's PAPA.[14] Mason coined the acronym **PAPA** to represent society's four basic rights in terms of information: *privacy, accuracy, property,* and *accessibility*.

Right to Privacy

Supreme Court Justice Louis Brandeis is credited with recognizing "the right to be left alone."[15] Mason feels that this right is being threatened because of two forces. The first is the increasing ability of the computer to be used for surveillance. The second is the increasing value of information in decision making. The federal government addressed a portion of this problem in the Privacy Act of 1974. However, that act only covers violations by the government.

According to Mason, decision makers place such a high value on information that they will often invade someone's privacy to get it. Marketing researchers have been known to go through people's garbage to learn what products they buy, and government officials have stationed monitors in restrooms to gather traffic statistics to be used in justifying expansion of the facilities.

These are examples of snooping that do not use the computer. The general public is aware that the computer can be used for this purpose, but it is probably not aware of the ease with which personal data can be accessed, especially using the Internet. If you know how to go about the search process and are willing to pay some fees along the way, you can obtain practically any type of personal and financial information about private citizens.

Right to Accuracy

The computer is given credit for making possible a level of accuracy that is unachievable with noncomputerized systems. The potential is certainly there, but it is not always reached. Some computer-based systems contain more errors than would be tolerated in manual systems.

Right to Property

Here we are talking about intellectual property, usually in the form of computer programs. Software vendors can guard against theft of their intellectual property by means of copyrights, patents, and license agreements. Until the 1980s, software was covered by neither copyright nor patent laws. Now, both can be used to provide some degree of protection. Patents provide especially strong protection in the countries where they are enforced, because it is not necessary that a clone match the original version exactly in order for copyright protection to be obtained.

Software vendors try to plug loopholes in the laws by means of the license agreements that their customers accept when they use the software. Violation of the agreements can put the customers in court.

Right to Access

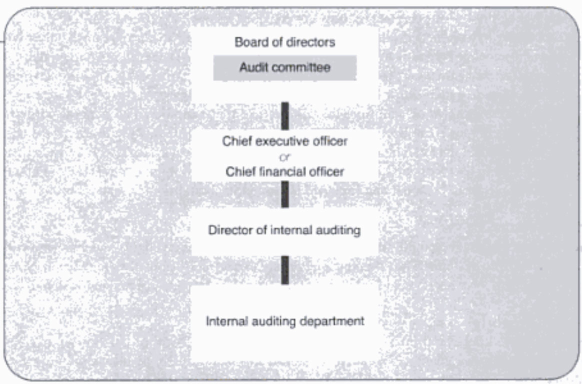
Prior to the introduction of computerized databases, much information was available to the general public in the form of printed documents or microform images stored in libraries. The information consisted of news stories, results of scientific research, government statistics, and so on. Today, much of this information has been converted to commercial databases, making it less accessible to the public. To have access to the information, one must possess the required computer hardware and software and pay the access fees. In light of the fact that a computer can access data from storage much more quickly and easily than any other technology, it is ironic that a right to access is a modern-day ethical issue.

INFORMATION AUDITING

As we build the case for ethical computer use, one group can serve as a key building block. They are the internal auditors. Firms of all sizes rely on **external auditors** from outside the organization to verify the accuracy of accounting records. Larger firms have their own staff of **internal auditors**, who perform the same analyses as external auditors but have a broader range of responsibilities. Some external auditors have been doing some internal auditing and overseeing the work of the internal auditors, but, after Enron, this practice has come to a halt. This was one of the many downfalls of Arthur Andersen with Enron. The Securities and Exchange Commission has placed restrictions on the amount of internal auditing that external auditors can perform.[16] That was one of the many downfalls of Arthur Andersen with Enron.

Figure 10.3 shows a popular way to position internal auditing in the organization. The board of directors includes an **audit committee**, which defines the responsibilities of the

Figure 10.3 **The Position of Internal Auditing in the Organization**



internal auditing department and receives many of the audit reports. The **director of internal auditing** manages the internal auditing department and usually reports to the CEO or the chief financial officer (CFO). This top-level positioning of internal auditing within the organization ensures that it is recognized as an important activity and receives the cooperation of managers on all levels.

The Importance of Objectivity

A unique ingredient that internal auditors offer is objectivity. They operate independently of the firm's business units and have no ties with any individuals or groups within the firm. Their only allegiance is to the board of directors, the CEO, and the CFO.

In order for the auditors to retain their objectivity, they make it clear that they do not want operational responsibility for the systems that they help to develop. They work strictly in an advisory capacity. They make recommendations to management, and management decides whether to implement those recommendations.

Types of Auditing Activity

There are four basic types of internal auditing activity: financial, operational, concurrent, and internal control systems design.

FINANCIAL AUDITING A **financial audit** verifies the accuracy of the firm's records and is the type of activity performed by external auditors. On some assignments, the internal auditors work jointly with external auditors. On other assignments, the internal auditors do all of the auditing work themselves.

OPERATIONAL AUDITING An **operational audit** is not conducted to verify the accuracy of records, but rather to validate the effectiveness of procedures. This is the type of work done by the systems analyst during the analysis stage of the systems development life cycle. The systems that are studied are almost invariably virtual rather than physical, but they do not necessarily involve the computer.

When internal auditors conduct operational audits, they look for [illegible] basic system features:

- **Adequacy of controls.** Is the system designed to prevent, detect, or correct errors?
- **Efficiency.** Are the operations of the system carried out so as to achieve the greatest productivity from the available resources?
- **Compliance with company policy.** Does the system enable the firm to meet its objectives or solve its problems in the prescribed way?

When information specialists develop systems, they look for these same features.

CONCURRENT AUDITING A **concurrent audit** is the same as an operational audit except that the concurrent audit is ongoing. For example, internal auditors may randomly select employees and personally hand them their paychecks rather than use the company mail. This procedure ensures that the names on the payroll represent real employees and not fictitious entries made by an unscrupulous supervisor who wants to receive some extra paychecks.

INTERNAL CONTROL SYSTEMS DESIGN In operational and concurrent auditing, the internal auditors study existing systems. However, an auditor should not wait until a system is implemented to exert an influence on it. Internal auditors should actively participate in systems development for two reasons. First, the cost of correcting a system flaw increases dramatically as the system life cycle progresses. According to Figure 10.4, it costs 4,000 times as much to correct a design error during the operation and maintenance of a system than when the design is being conceptualized. The second reason for involving the internal auditors in systems development is that they offer expertise that can improve the quality of the system.

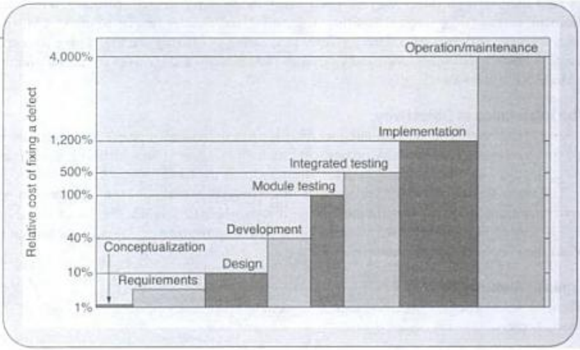


Figure 10.4 **The Escalating Cost of Correcting Design Errors as the System Life Cycle Progresses**

Source: Frederick Gallegos, "Audit Contributions to Systems Development," *EDP Auditing* 9 (Boston: Auerbach Publishers, 1991), section 72-01-70. Copyright © 1991. Reprinted by permission.

The Internal Audit Subsystem

In Chapter 8, we presented an architecture for information systems tailored to different business areas. The general architecture includes input subsystems that enter data into the database. In the financial information system illustrated in Chapter 8 (Figure 8.10), the internal audit subsystem is one of the input subsystems.

Including internal auditors on systems development teams is a good step toward having well-controlled information systems, and the systems are a good step toward giving management the information it needs to achieve and maintain ethical business operations.

ACHIEVING ETHICS IN INFORMATION TECHNOLOGY

How is an ethics culture achieved in a firm? The firm need not attempt to do all of the work alone. There is assistance in the form of ethics codes and ethics educational programs that can provide the foundation for the culture. The educational programs can assist in developing a corporate credo and in putting ethics programs in place. The ethics codes can be used as is or can be tailored to the firm.

Codes of Ethics

The Association for Computing Machinery (ACM), founded in 1947, is the oldest professional computer organization in the world. ACM has developed a *Code of Ethics and Professional Conduct* that its 80,000 members are expected to follow. In addition, a *Software Engineering Code of Ethics and Professional Practice* is intended to serve as a guide for teaching and practicing software engineering, which is the use of engineering principles in software development.

ACM CODE OF ETHICS AND PROFESSIONAL CONDUCT The current form of the ACM code of ethics was adopted in 1992 and consists of "imperatives," which are statements of personal responsibility. The code is subdivided into four parts. Figure 10.5 is an outline that includes the imperatives for each section. Each imperative is documented with a brief narrative.

1. **General Moral Imperatives.** These deal with moral behavior (contributing to society; avoiding harm; being honest, trustworthy, and fair) and issues that are currently receiving legal attention (property rights, intellectual property, privacy, and confidentiality).

Outline of the ACM Code of Ethics and Professional Conduct

1. General Moral Imperatives

1.1 Contribute to society and human well-being.
1.2 Avoid harm to others.
1.3 Be honest and trustworthy.
1.4 Be fair and take action not to discriminate.
1.5 Honor property rights including copyrights and patents.
1.6 Give proper credit for intellectual property.
1.7 Respect the privacy of others.
1.8 Honor confidentiality.

2. More Specific Professional Responsibilities

2.1 Strive to achieve the highest quality, effectiveness, and dignity in both the process and products of professional work.
2.2 Acquire and maintain professional competence.
2.3 Know and respect existing laws pertaining to professional work.
2.4 Accept and provide appropriate professional review.
2.5 Give comprehensive and thorough evaluations of computer systems and their impacts, including analysis of possible risks.
2.6 Honor contracts, agreements, and assigned responsibilities.
2.7 Improve public understanding of computing and its consequences.
2.8 Access computing and communication resources only when authorized to do so.

3. Organizational Leadership Imperatives

3.1 Articulate social responsibilities of members of an organizational unit and encourage full acceptance of those responsibilities.
3.2 Manage personnel and resources to design and build information systems that enhance the quality of working life.
3.3 Acknowledge and support proper and authorized uses of an organization's computing and communication resources.
3.4 Ensure that users and those who will be affected by a system have their needs clearly articulated during the assessment and design of requirements; later the system must be validated to meet requirements.
3.5 Articulate and support policies that protect the dignity of users and others affected by a computing system.
3.6 Create opportunities for members of the organization to learn the principles and limitations of computer systems.

4. Compliance with the Code

4.1 Uphold and promote the principles of this code.
4.2 Treat violations of this code as inconsistent with membership in the ACM.

Figure 10.5 **Outline of the ACM Code of Ethics and Professional Conduct**

Source: Copyright © Association for Computing Machinery. Used with permission.

2. **More Specific Professional Responsibilities.** These address dimensions of professional performance. Moral issues of being honest in making evaluations and honoring commitments are addressed. Legal issues and the social responsibility of contributing to public understanding of computers are addressed.
3. **Organizational Leadership Imperatives.** As a leader, the ACM member has a responsibility to support only the legal use of computing resources, to stimulate others in the organization to meet their social responsibilities, to enable others in the organization to benefit from the computer, and to protect the interests of users.
4. **Compliance with the Code.** Here, the ACM member indicates support for the code.

The ACM code addresses five main dimensions of computer work—moral, legal, professional performance, social responsibility, and internal support. Table 10.1 illustrates how

Table 10.1

Topics Covered by the ACM Code of Ethics and Professional Conduct

	Moral Behavior	Legal Responsibility	Professional Performance	Social Responsibility	Internal Support
General Moral Imperatives	X	X			
More Specific Professional Responsibilities	X	X	X	X	
Organizational Leadership Imperatives		X			X

these five areas are addressed by the three main sections. Although the ACM code is intended for direction of ACM members, it provides a good guideline for all computer professionals.

ACM Software Engineering Code of Ethics and Professional Practice

This code recognizes the significant influence that software engineers can have on information systems and consists of expectations in eight major areas:

1. Public
2. Client and Employer
3. Product
4. Judgment
5. Management
6. Profession
7. Colleagues
8. Self

Five of these deal with responsibilities that the engineer has to constituents (Public, Client and Employer, Management, Profession, and Colleagues). Two (Product and Judgment) deal with professional performance, and one (Self) addresses self improvement. Table 10.2 shows the focus of the sections on these three main responsibilities.

The ACM codes are available at WWW.ACM.ORG.

Table 10.2

Topics Covered by the ACM Software Engineering Code of Ethics and Professional Practice

	Responsibility to Constituents	Professional Performance	Self-Improvement
Public	X		
Client and Employer	X		
Product		X	
Judgment		X	
Management	X		
Profession	X		
Colleagues	X		
Self			X

Computer Ethics Education

Formal educational programs in computer ethics are available from a variety of sources—college courses, professional programs, and private educational programs.

COLLEGE COURSES Early in its existence, ACM developed a model computing curriculum that specified the computer courses that should be offered by an educational institution.

Colleges and universities have been teaching computer ethics for some time. Business schools typically offer an ethics course or integrate the subject into such business core courses as marketing and accounting. Some online courses are also available. The University of Phoenix offers an online interdisciplinary capstone course in ethics for undergraduate information technology majors (WWW.PHOENIX.EDU), and the American College of Computer & Information Sciences offers a computer ethics course in its undergraduate MIS curriculum (WWW.ACCIS.EDU).

PROFESSIONAL PROGRAMS The American Management Association offers special programs that address subjects of current importance, such as ethics. An AMA 2002 Corporate Values Survey found that 23 percent of the respondents' firms adhered to ethical and integrity guidelines only part of the time, and 33 percent frequently issued statements that conflicted with internal realities.[17] An AMA Special Issues Forum was convened in New York City in November 2002 to address these issues. One of the presenters was Frank Ashen, the New York Stock Exchange Chief Ethics Officer.

PRIVATE EDUCATIONAL PROGRAMS LRN®, the Legal Knowledge Company, offers Web-based course modules that address a wide range of ethical and legal issues.[18] The courses are intended for use by firms that seek to increase the ethical awareness of their workforce. You can learn more about LRN at WWW.LRN.COM.

The college courses enable students to prepare to address ethical issues when they enter industry, and the professional and private programs enable managers and employees on all levels to maintain their ethical awareness and commitment as technology and social imperatives change.

ETHICS AND THE CIO[19]

The need to restore integrity to American business has never been greater. Since 2002, CEOs and CFOs have been required by law to sign off on the accuracy of their financial statements. This requirement puts responsibility on the executives as well as on the corporate information services unit and the information services units of the business areas to provide the executives with the financial information that they need.

Information services is only one unit in the organizational structure, but it is in a key position to have the most influence on satisfying the demands of both government and society for accurate financial reporting. Moreover, as the executive with a full-time information responsibility, the CIO is the logical person to lead efforts to meet these reporting objectives. The CIO can bring financial reporting up to expectations by following a program that includes the following:

- **Achieving a higher level of understanding of accounting principles.** The CIO has long been expected to understand the principles of business and business operations. The CIO now is expected to be especially knowledgeable about accounting systems.
- **Reviewing the information systems that accomplish financial reporting and taking remedial action.** The CIO should initiate projects to review transaction processing systems and business area information systems to ensure that they are operating at maximum effectiveness. The project leaders should submit reports of findings to the CIO, the MIS steering committee, and the executive committee.

When weaknesses are identified, system development projects should be initiated to address them.

- **Educating the firm's executives on financial systems.** Formal sessions should be scheduled with the firm's executives, especially the CEO and CFO and other members of the executive committee, to review the financial systems—transaction processing, financial information, and executive information. One way to accomplish continuing education is to make sure that financial managers are liberally represented on the MIS steering committee. That way, they will actively participate in all systems projects that deal with financial information.
- **Integrating alarms into information systems that alert executives to activities that require attention.** The executive information system and financial information system should be reviewed for the purpose of evaluating capabilities for alerting executives to indicators that certain activities are getting out of line. Many firms have identified critical success factors that are key to the firm meeting its objectives, and these are excellent measures for the systems to monitor on a daily basis.
- **Actively participating in the release of financial information to environmental elements.** The CIO should work with the stockholder relations department to identify the information to be included in stockholder reports and to be presented at stockholder meetings. Systems should be put in place to produce this information, and the CIO should be included on the stockholder meeting program to explain the firm's financial reporting systems and to answer questions.
- **Keeping tight control on money spent for information resources.** The CIO should be especially diligent in monitoring spending on information resources. Reporting systems should involve all levels of information services management and all business units in (1) justifying expenditures on hardware and software and other information resources for inclusion in the operating budget and (2) managing the funds once they have been approved.

By following such a program, the CIO can be the beacon for information integrity in the firm.

LIFE UNDER SARBANES-OXLEY

If there wasn't a strong argument prior to 2002 that the CIO should be a beacon for information integrity in the firm, there is now. In response to the corporate financial scandals at Enron, WorldCom (now MCI), HealthSouth, and Tyco, the U.S. Congress passed the Sarbanes-Oxley Act (officially named the Public Company Accounting Reform and Investor Protection Act of 2002). The bill was approved by the House 423-3 and the Senate 99-0, and signed into law by President Bush on July 30, 2002. The objective of Sarbanes-Oxley, known as SOX, is to protect investors by making the firm's executives personally accountable for the financial information that is provided to the firm's environment, primarily stockholders and the financial community.

SOX consists of 10 major provisions, 2 of which directly affect the firm's information services unit:

- CEOs and CFOs must certify the financial reports.
- U.S. companies are required to have internal audit units.

If the CEOs and CFOs must certify the firm's finances, then the CIO and information services must provide financial information that possesses the four dimensions of information that we identified in Chapter 2—relevance, accuracy, timeliness, and completeness. And, if all firms must have internal auditor staffs, they should be represented in the development of all information systems, not just financial systems.

SOX 404

The SOX provision that has the greatest impact on IT is Section 404, which deals with management assessment of internal controls. This requires that a good set of internal controls over financial reporting be in place. We addressed security controls in Chapter 9; here, we are talking about financial controls. We recognized the need for such controls in the model of the financial information system in Chapter 8 by including the control subsystem as one of the output subsystems.

In meeting the control requirements imposed by SOX, the CIO must ensure that such controls are built into systems during systems development. Development activities should include:

1. Identifying systems that play a role in financial reporting
2. Identifying the risks faced by these systems
3. Designing controls that address the risks
4. Documenting and testing the controls
5. Monitoring the effectiveness of the controls over time
6. Updating the controls as needed

The CIO should make sure that the CEO, CFO, and other executives understand the controls and keep them current on their development through the use of the MIS steering committee reporting mechanisms.

SOX 409

Another SOX provision that affects information services is Section 409, which addresses real-time issuer disclosures. This means that the firm must be able to report changes in its financial condition in *real time*—as the changes occur. To do this, the information systems should feature online inputs, and output subsystems should be capable of immediately reporting changes in the firm's financial condition. Another provision of 409 is that the firm is required to retain copies of its audit review work papers for 5 years. This includes electronic records.

SOX and COBIT

In Chapter 9, we identified COBIT as an industry organization that can provide security standards for the firm's information resources. This same organization can provide assistance to the firm in addressing its SOX responsibilities. The COBIT standards align very well with the SOX expectations. Because COBIT has more than 47,000 members worldwide, its financial reporting standards can have a global effect.

Putting Sarbanes-Oxley in Perspective

At the beginning of this chapter, we recognized that we take a prescriptive approach to describing MIS—we describe it as it ought to be practiced. Sarbanes-Oxley is a good argument for such an approach. Firms, and CIOs, that practice MIS the way we have described it should have little or no trouble operating under the SOX requirements. Put another way, SOX expects executives, financial systems, and IT to perform the way they should perform—in an ethical way.

Highlights in MIS

SOX Lose Season Opener[20]

You might expect to see this headline in a Chicago or Boston newspaper during baseball season. Actually, the SOX we are talking about here is the Sarbanes-Oxley Act, and the season opener is the court case that was the first prosecution of an executive under the Act. The executive was Richard Scrushy, the former CEO of HealthSouth.

The game was played in a Birmingham, Alabama, courtroom and took longer than an afternoon or evening to play. It lasted for 4 months and 28 days and ended on June 28, 2005 with acquittal on all 36 charges relating to a multibillion-dollar fraud.

In trying to explain the acquittal, the prosecution recognized the length and complexity of the trial, the local setting of Scrushy's home town, and the fact that the jury evidently did not buy the stories of the five financial officers who had served under Scrushy and had admitted to involvement in the fraud along with Scrushy. The jurors apparently felt the five were trying to reduce their own sentences.

The prosecutors were hoping for a guilty verdict, like the one rendered against Bernie Ebbers of WorldCom, who was found guilty of fraud in March 2005. The Scrushy verdict should provide some hope for other executives slated for trial and provide insight to the government as to how Sarbanes-Oxley violations should be tried in the future.

Summary

Morals are informal traditions of good conduct, which remain fairly constant from one society to another. Ethics are beliefs, standards, and ideals that are intended to serve as guidelines for individuals and communities. Ethics vary from one society to another. Laws are formal rules that are enacted by governments and carry penalties for noncompliance.

U.S. computer laws have been enacted to address such subjects as data rights and restrictions, privacy, computer crime, and software patents. Court decisions, such as the State Street Decision, also contribute to the body of legislation. The EU considered tightening the software patenting requirements of the State Street Decision. In China, attention is being given to such computer-use concerns as state security, social interest, citizens' lawful interest, and privacy.

A firm imposes an ethics culture in a top-down manner, establishing a corporate credo, ethics programs, and ethics codes, in that order.

Society expects computers to be used in an ethical way for three reasons. Logical malleability means that the computer can be programmed to do practically anything. The transformation factor recognizes that the computer can affect dramatic changes in our everyday lives. The invisibility factor recognizes that internal computer processing is hidden from view. The internal processing can include programming values, complex calculations, and acts of computer crime.

Richard Mason's PAPA identifies four computer rights of society: rights to privacy, accuracy, property, and access.

Large firms include a staff of internal auditors that reports to the board of directors or a high-level executive and offers the advantage of objectivity. The internal auditors engage in four types of activity. In operational auditing, they verify that the firm's systems have adequate controls, operate efficiently, and comply with company policy. In financial auditing, they verify the accuracy of records. In concurrent auditing, they conduct ongoing operational audits. In internal control systems design, they ensure that systems perform as intended. The financial information system includes an internal audit subsystem that enters the results of audits into the database.

The ACM has developed a code of ethics and professional conduct for its members, which can be used by anyone in the computer industry. The code consists of imperatives in three categories: general moral imperatives, more specific professional responsibilities, and organizational leadership imperatives. ACM has also developed a code for software engineering that consists of expectations in eight areas: public, client and employer, product, judgment, management, profession, colleagues, and self.

Computer ethics education can be accomplished in formal courses offered by colleges, professional programs such as those of the American Management Association, and private educational programs that can deliver the material using the Web.

The CIO can make a big contribution to the ethical operation of a firm by understanding accounting principles, ensuring that financial reporting systems are effective, educating the firm's executives on financial systems, making sure that alarms are built into financial systems to notify management when the firm is varying from its course, being an active participant in communicating information to the environment on the firm's financial systems, and keeping tight control over IT expenditures.

Although Sarbanes-Oxley is targeted at CEOs and CFOs, the CIO can play a key role in the firm meeting its SOX expectations. The CIO can ensure that the CEO and CFO understand the financial information systems and the controls built into them. This information can be relayed through the MIS steering committee. All executives can be kept informed of the progress in incorporating controls into the systems as they are developed. The firm's internal auditors can play active roles in systems development.

KEY TERMS

morals
ethics
laws
corporate credo
ethics program
ethics audit
computer ethics
logical malleability
transformation factor
invisibility factor
internal auditor
financial audit
operational audit
concurrent audit

KEY CONCEPTS

- The combination of morals, ethics, and laws as guidelines of socially expected behavior
- An ethical culture as the setting for achieving ethical behavior in an organization
- The invisibility of computer processes
- PAPA
- Ethical guidelines in the form of imperatives
- The requirement for controls built into systems that must deliver accurate financial information

QUESTIONS

1. Which is least likely to vary from one society to another—morals, ethics, or laws?
2. What is an ethics audit?
3. At which organization was the Freedom of Information Act, the Right to Federal Privacy Act, and the Computer Matching and Privacy Act aimed?
4. What type of organization was selected by the U.S. Congress in 1984 for protection against computer crime?
5. Has the United States taken a tight or loose view of the requirements to obtain a software patent? Explain.

6. In imposing an ethical culture, three actions are taken. What are they?
7. Which manager has the responsibility for computer ethics in the firm?
8. What are the three components of the invisibility factor?
9. The chapter describes certain U.S. laws that address one or more of the PAPA components. Name each law and identify the component or components that it addresses.
10. Internal and external auditors frequently work together on one type of audit. What is it?
11. When an operational audit is conducted in an ongoing manner, what is it called?
12. Who is expected to conform to the ACM Code of Ethics and Professional Conduct?
13. Is the ACM Code of Ethics and Professional Conduct concerned only with ethics? Explain.
14. Who are the software engineer's constituents that are identified in the ACM Software Engineering Code of Ethics?
15. Which information systems should have alarms built into them to notify executives when activities are not going as planned?
16. How is the CIO affected by Sarbanes-Oxley?
17. What are the two SOX provisions that have the greatest effect on information services?

Topics for Discussion

1. The chapter mentioned that an internal auditor conducts the firm's ethics audit. Is there anyone else in the firm who could do that? Should they?
2. Why would a firm want to go to the trouble of devising its own corporate code of ethics when many standard ones are available?
3. How can a firm ensure that logical malleability does not lead to ethics violations?

Problems

1. Assume that you are a world-famous computer ethics consultant and that the People's Republic of China has asked you to define "state security," "social interest," "citizens' lawful interest," and "privacy" in relation to computer use. Provide a definition and an example for each.
2. The corporate credo of the Security Pacific Corporation includes responsibilities to three elements in the firm's environment: customers, communities, and stockholders. We know that the firm's environment contains eight elements. Which of the five remaining elements should be included in a firm's corporate credo? For each one, include a statement of an ethical responsibility of the firm to that element.

Case Problem: National Foods

National Foods is a leading manufacturer of food products, competing with such firms as General Mills and General Foods. Each of the firm's sales representatives is equipped with a notebook computer with wireless capabilities. At the end of the day, the sales representatives transmit sales data to headquarters. The data identify the number of units of each product that were sold, plus status reports on special promotions such as cooperative ads, coupons, and contests.

It's Friday afternoon before Memorial Day, and Dan Kennerly, the CIO, is on his way out of his office when the telephone rings. It's Fred Ennen, the vice president of marketing. Fred congratulates Dan on the new sales tracking system that has just been installed. The system uses the notebook data that the sales reps transmit. Fred raves on and on about it for

Chapter 11

Decision Support Systems

Learning Objectives

After studying this chapter, you should

- Understand the fundamentals of decision making and problem solving.
- Know how the decision support system (DSS) concept originated.
- Know the fundamentals of mathematical modeling.
- Know how to use an electronic spreadsheet as a mathematical model.
- Be familiar with how artificial intelligence emerged as a computer application and know its main areas.
- Know the four basic parts of an expert system.
- Know what a group decision support system (GDSS) is and the different environmental settings that can be used.

Introduction

Managers make decisions to solve problems. Problem solving is accomplished in four basic phases and makes use of such frameworks as the general systems model of the firm and the environmental model. By following the systems approach to solve problems, the manager takes a systems view.

The problem-solving process consists of four basic elements: standards, information, constraints, and alternative solutions. As the process is followed, selection of the best alternative is not always accomplished by a logical analysis alone, and it is important to distinguish between problems and symptoms.

Problems can vary in structure, and the decisions to solve them can be programmed or nonprogrammed. The decision support system (DSS) concept was originally aimed at semistructured problems. The first DSS outputs consisted of reports and outputs from mathematical models. Subsequently, a group problem-solving capability was added, followed by artificial intelligence and on-line analytical processing (OLAP).

Mathematical models can be classified in various ways, and their use is called simulation. The electronic spreadsheet is a good vehicle for mathematical modeling. It can be used for both static and dynamic models and can enable the manager to play the "what-if" game.

Artificial intelligence can be a component of a DSS. By adding a knowledge base and an inference engine, the DSS can suggest problem solutions to the manager.

When groupware is added to the DSS, it becomes a group decision support system (GDSS). A GDSS can exist in several different settings that are conducive to group problem solving.

WHAT IT'S ALL ABOUT—DECISION MAKING

Thus far, we have devoted almost an entire book to management information systems (MIS). However, stripped of all its frills and extras an MIS is simply *a system that provides users with information for use in making decisions to solve problems.*

Although it may not have been obvious, we have used decision making and problem solving as an integrating theme throughout the text. We have distinguished between problem solving and decision making, provided a list of problem-solving steps, described two frameworks that are useful in problem solving, and presented the systems approach as the basis for solving problems of all kinds.

Problem Solving and Decision Making

In Chapter 1, we described the role of information in management problem solving, distinguishing between problem solving and decision making.

We recognized that **problem solving** consists of a response to things going well and also to things going badly by defining a **problem** as a condition or event that is harmful or potentially harmful to a firm or that is beneficial or potentially beneficial. We also recognized that during the process of solving problems managers engage in **decision making**, the act of selecting from alternative problem solutions. We defined a **decision** as a selected course of action and recognized that it is often necessary to make multiple decisions in the process of solving a single problem.

Problem-Solving Phases

In Chapter 1, we also addressed the problem-solving process by describing Herbert A. Simon's four basic phases. According to Simon, problem solvers engage in:[1]

- **Intelligence activity.** Searching the environment for conditions calling for a solution.
- **Design activity.** Inventing, developing, and analyzing possible courses of action.

- **Choice activity.** Selecting a particular course of action from those available.
- **Review activity.** Assessing past choices.

We also recognized that in performing these activities, the problem solver must have information, and we illustrated that fact with Figure 1.13.

Problem-Solving Frameworks

In Chapter 2, we presented two frameworks that are useful in problem solving, the general systems model of the firm and the eight-element environmental model. We illustrated the general systems model in Figure 2.1 and presented it as a framework of a firm as a system, identifying the important elements that should be present and the flows of data, information, and decisions that connect the elements. We illustrated the environmental model in Figure 2.2 and recommended its use in understanding the environment of the firm and the interactions between the firm and each element in the form of resource flows.

The Systems Approach

Our most elaborate treatment of problem solving came in Chapter 7 when we presented the systems approach, a series of steps grouped into three phases—preparation effort, definition effort, and solution effort. We illustrated the approach in Figure 7.1 and recommended that the general systems model be used in viewing the firm as a system and that the environmental model be used in recognizing the environmental system. We also recommended that the system elements be analyzed in a certain sequence and illustrated that sequence in Figure 7.3.

The Importance of a Systems View

In using the general systems model and the environmental model as a basis for problem solving, we are taking a **systems view**, which regards business operations as systems embedded within a larger environmental setting. This is an abstract way of thinking, but it has potential value to the manager. The systems view:

1. Prevents the manager from getting lost in the complexity of the organizational structure and details of the job
2. Recognizes the necessity of having good objectives
3. Emphasizes the importance of all of the parts of the organization working together
4. Acknowledges the interconnections of the organization with its environment
5. Places a high value on feedback information that can only be achieved by means of a closed-loop system

If you ask managers whether they have a systems view, you may get a negative answer or "I don't know. I never thought much about it." However, they most likely recognize the definition and solution effort of the systems approach as things that they do and recognize the five points of the systems view as objectives that they try to achieve.

BUILDING ON THE CONCEPTS

With this understanding of the fundamental problem-solving concepts, we can now describe how they are applied in decision support systems.

Elements of a Problem-Solving Process

Several elements must be present if a manager is to successfully engage in problem solving. These elements are shown in Figure 11.1.

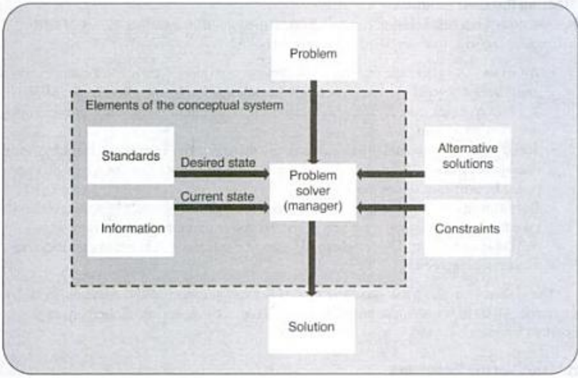


Figure 11.1 **Elements of the Problem-Solving Process**

Most problems that managers solve can be regarded as systems problems. For example, the firm as a system is not functioning as intended. Or, there is a problem with the inventory system, the sales commission system, and so on. The solution to a systems problem is one that best enables the system to meet its objectives, as reflected in the system's performance standards. These *standards* describe the **desired state**—what the system should achieve. In addition, the manager must have available *information* that describes the **current state**—what the system is now achieving. If the two states are different, some problem is the cause and must be solved.

The difference between the current state and the desired state represents the **solution criterion**, or what it will take to bring the current state to the desired state. Of course, if the current state happens to represent a *higher* level of performance than the desired state, the task is not to bring the current state in line. Rather, the task is to keep the current state at the higher level. If higher-level performance can be maintained, then the desired state should be raised.

It is the manager's responsibility to identify *alternative solutions*, which always exist. This is one step of the problem-solving process where computers have been of little help. Managers typically rely on their own experience or obtain help from the noncomputer portion of the information processor, such as input from others both inside and outside the organization.

Once the alternatives have been identified, the information system can be used to evaluate each one. This evaluation should consider any possible **constraints**, which are either internal or environmental. **Internal constraints** take the form of limited resources that exist within the firm. For example, the IT unit cannot develop a CRM system due to a lack of expertise in OLAP. **Environmental constraints** take the form of pressures from various environmental elements that restrict the flow of resources into and out of the firm. An example would be an increase in interest rates by the Federal Reserve Board that puts the cost of plant expansion out of reach.

When all of these elements exist and the manager understands them, a solution to the problem is possible.

Selecting the Best Solution

The selection of the best solution can be accomplished in different ways. Henry Mintzberg, a management theorist, has identified three approaches:[2]

- **Analysis**—A systematic evaluation of options, considering their consequences on the organization's goals. An example might be deliberation by members of the MIS steering committee to decide which approach to take in implementing an executive information system.
- **Judgment**—The mental process of a single manager. For example, a manufacturing manager applies experience and intuition in evaluating the layout of a new plant proposed by a mathematical model.
- **Bargaining**—Negotiations between several managers. An example is the give and take that goes on among members of the executive committee concerning which market to enter next. This is where the very real influence of company politics can most easily be seen.

The emphasis in this book is on analysis. However, judgment and bargaining should not be ignored. All three ways would probably be involved in the selection of alternatives to solve important problems.

Problems Versus Symptoms

It is important to recognize the distinction between problems and symptoms. Otherwise, you might spend much time and money chasing the wrong problem or something that is not actually a problem. A **symptom** is a condition produced by the problem. Often the manager sees symptoms rather than the problem.

A medical doctor follows this process of sorting through symptoms to find the cause of an ailment ("What's causing your lack of energy?"). A manager faces the same task when confronted with a symptom such as low profits. Something is causing the low profits. The problem is the cause of the low profits. In fact, it is good to think of a problem as the *cause of the trouble* or the *cause of the opportunity*.

Problem Structure

A manager may understand some problems better than others. The problem of how much replenishment stock to reorder is an example of a problem that a manager may understand very well. In fact, a mathematical model called the *EOQ (economic order quantity)* formula prescribes how the problem is to be solved. Such a problem is called a **structured problem** because it consists of elements and relationships among elements, all of which are understood by the problem solver.

However, the manager may not understand other problems at all. These problems are called *unstructured problems*. An **unstructured problem** is one that contains no elements or relationships between elements that are understood by the problem solver. An example of an unstructured problem is deciding what movie made you feel the best. The business manager is often ill-equipped to define such problems in a structured way.

Actually, few problems in an organization are completely structured or completely unstructured. Most problems are those where the manager has a less than perfect understanding of the elements and their relationships. A **semistructured problem** is one that contains *some* elements or relationships that are understood by the problem solver and some that are not. An example is the selection of a location to build a new manufacturing plant. Some of the elements, such as land cost, taxes, and the costs of shipping in raw materials, can be measured with a high degree of precision. Other elements, however, such as natural hazards and local community attitudes, are difficult to identify and measure.

Once procedures have been devised, computers can solve structured problems without manager involvement. However, the manager often has to do all of the work in solving unstructured problems. In the vast middle ground of semistructured problems, the manager and the computer can jointly work toward a solution.

Types of Decisions

In addition to giving us problem-solving steps, Herbert A. Simon devised a method for classifying decisions. He believed that decisions exist on a continuum, with programmed decisions at one end and nonprogrammed decisions at the other. **Programmed decisions** are "repetitive and routine, to the extent that a definite procedure has been worked out for handling them so that they don't have to be treated de novo (as new) each time they occur."[3] **Nonprogrammed decisions** are "novel, unstructured, and unusually consequential. There is no cut-and-dried method for handling the problem because it hasn't arisen before, or because its precise nature and structure are elusive or complex, or because it is so important that it deserves a custom-tailored treatment."[4]

Simon explained that the two decision types are only the black and white ends of the continuum and that the world is mostly gray. However, the concept of programmed and nonprogrammed decisions is important, because each calls for a different technique.

DECISION SUPPORT SYSTEMS

The first 10 years or so of computer use in business was limited to transaction processing. In the mid-1960s, the MIS concept emerged in recognition of the need to provide information to managers. The MIS approach was as broad as possible, seeking to provide information to *all managers* in the firm for use in solving *all types of problems*. This proved to be an extremely ambitious undertaking, and many systems failed to live up to expectations.

Two MIT professors, G. Anthony Gorry and Michael S. Scott-Morton, believed that an information system that focused on single problems faced by single managers would provide better support. They described their concept in an article titled "A Framework for Management Information Systems," published in 1971 in the *Sloan Management Review*.[5] Central to their concept was a table, called the Gorry and Scott-Morton grid. The grid, illustrated in Figure 11.2, classifies problems in terms of problem structure and management level. Gorry and Scott-Morton used names for the levels that had been coined by management theorist

Degree of problem structure		Management levels	
	Operational control	Management control	Strategic planning
Structured	Accounts receivable Order entry Inventory control	Budget analysis—engineered costs Short-term forecasting	Tanker fleet mix Warehouse and factory location
Semistructured	Production scheduling Cash management	Variance analysis—overall budget Budget preparation	Mergers and acquisitions New product planning
Unstructured	PERT/COST systems	Sales and production	R&D planning

Figure 11.2 **The Gorry and Scott-Morton Grid**

Source: Reprinted from "A Framework for Management Information Systems" by Gorry and Scot Morton, *MIT Sloan Management Review* (Fall 1971), p. 55-71., by permission of publisher. Copyright © 1971 Massachusetts Institute of Technology. All rights reserved.

Robert N. Anthony. Anthony called the top level the *strategic planning level*, the middle level the *management control level*, and the lower level the *operational control level*.

The cells of the grid contain examples of problems that are typical of the corresponding management levels and problem structures. At that time, the problems above the horizontal dashed line had been well supported by computer processing. The name *structured decision system (SDS)* was used to describe the systems that were able to solve the identified problems. The problems below the line had eluded computer processing, and Gorry and Scott-Morton used the term *decision support system (DSS)* to describe the systems that could provide the needed support.

The name **decision support system (DSS)** stuck and became used to describe a system designed to help a specific manager solve a specific problem. Emphasis was on the word *help*. The DSS was never intended to solve the problem without the help of the manager. The idea was that the manager and the computer would work together to solve the problem. The type of problem that would be solved was the semistructured problem. The computer would address the structured portion, and the manager would address the unstructured portion.

Gorry and Scott-Morton achieved more than they set out to do. As evidenced by the title of their article, they sought to add to the MIS concept. Instead, they identified a new type of information system.

Since 1971, the DSS has been the most successful type of information system and today represents the most productive application of the computer to problem solving.

A DSS Model

Figure 11.3 is a model of a DSS. The figure shows, in a left-to-right manner, how the concept developed over time. As the DSS was originally conceived, it produced periodic and special reports and outputs from mathematical models. The special reports consisted of responses to database queries. With the DSS firmly established, an ability was added to permit problem solvers to work in groups. The addition of groupware software enabled the system to function as a *group decision support system (GDSS)*. More recently, an artificial intelligence capability has been added, along with an ability to engage in OLAP.

We described OLAP in Chapter 8 when we discussed data warehousing, and we will not repeat that material here. In the remainder of the chapter, we will address mathematical modeling and artificial intelligence.

MATHEMATICAL MODELING

A **model** is an abstraction of something. It represents some object or activity, which is called an **entity**. Managers use models to represent problems to be solved. The objects or activities that cause problems are the entities.

Types of Models

There are four basic types of models: physical, narrative, graphic, mathematical.

PHYSICAL MODELS **A physical model** is a three-dimensional representation of its entity. Physical models used in the business world include scale models of shopping centers and prototypes of new automobiles.

The physical model serves a purpose that cannot be fulfilled by the real thing. For example, the physical model enables designers to evaluate the design of an object, such as an airplane, and make changes prior to the object's actual construction. This saves time and money.

NARRATIVE MODELS One type of model that managers use daily is the **narrative model**, which describes an entity with spoken or written words. The listener or reader can understand the entity from the narrative. All business communications are narrative models, which makes the narrative model the most popular type of model.

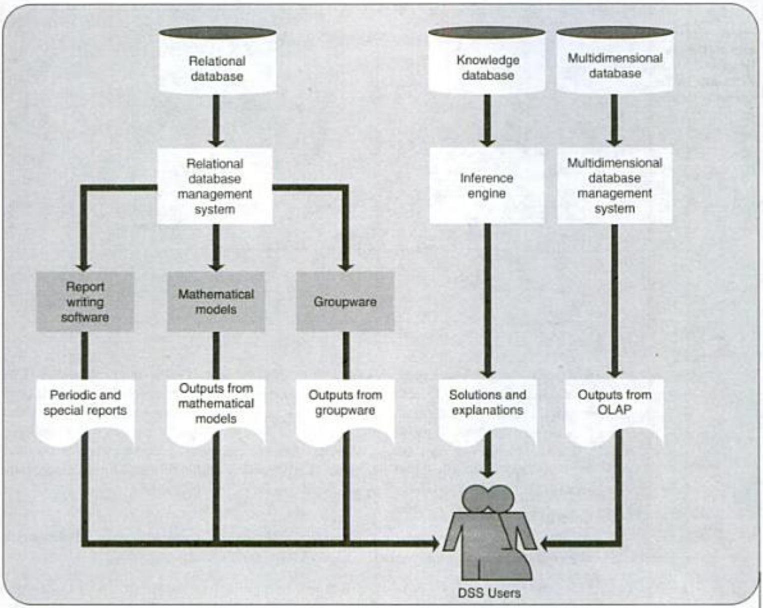


Figure 11.3 **A DSS Model that Incorporates Group Decision Suppo**[illegible]**, OLAP, and Artificial Intelligence**

Source: Reprinted by permission, Gerardine DeSanctis and R. Brent Gallupe, "A Foundation for the Study of Group Decision Support Systems", *Management Science*, (May 1987), Copyright 1987, the Institute for Operations Research and the Management Sciences (INFORMS), 7240 Parkway Drive, Suite 310, Hanover, MD 21076 USA.

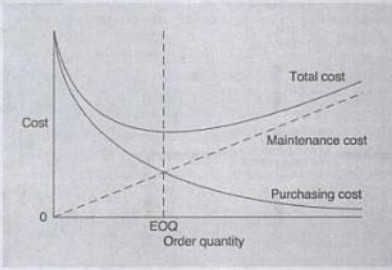
GRAPHIC MODEL Another type of model in constant use is the graphic model. A **graphic model** represents its entity with an abstraction of lines, symbols, or shapes. The graphic model in Figure 11.4 illustrates one of the most popular concepts in business—economic order quantity. The **economic order quantity (EOQ)** is the optimum quantity of replenishment stock to order from a supplier. The EOQ balances the costs of purchasing the stock and the costs of maintaining it until it is used or sold. The line that slopes down from the left in the figure represents the unit purchasing cost, which decreases as the order quantity increases. The line that moves up from left to right represents how the maintenance cost increases in a linear fashion as the order quantity increases. Both costs are added together to yield the total cost curve. The low point on the total cost curve represents the EOQ.

Graphic models are also used in the design of information systems. Many of the tools used by systems developers are graphic in nature. Entity-relationship diagrams, class diagrams, and data flow diagrams are examples.

MATHEMATICAL MODEL Any mathematical formula or equation is a **mathematical model**. Many of the mathematical models that business managers use are no more complex than the one used to compute the EOQ:

$$EOQ = \sqrt{\frac{2PS}{M}}$$

Figure 11.4 A Graphical Model of the Economic Order Quantity Concept



where P is the unit purchasing cost (in dollars), S is the annual sales (in units), and M is the annual maintenance cost per unit (in dollars). The maintenance cost includes all of the costs incurred in storing the item, such as insurance, spoilage, and loss due to theft.

Some mathematical models use hundreds or even thousands of equations. For example, a financial planning model developed by the Sun Oil Company during the early years of its MIS used approximately 2,000 equations.[6] Large models of this sort tend to be cumbersome and difficult to use. The trend today is toward the use of smaller models.

Uses of Models

All four types of models facilitate both understanding and communication. Mathematical models have, in addition, a predictive capability.

FACILITATE UNDERSTANDING A model is typically simpler than its entity—an entity is an object or process. The entity is more easily understood when its elements and their relationships are presented in a simplified way. Once a simple model is understood, it can gradually be made more complex so as to more accurately represent its entity. However, the model still only *represents* its entity; *it never matches it exactly*.

FACILITATE COMMUNICATION All four types of models can communicate information quickly and accurately to people who understand the meaning of the shapes, words, graphics, and mathematics.

PREDICT THE FUTURE The precision with which the mathematical model can represent its entity endows it with a special capability that is not available with the other model types. The mathematical model can predict what might happen in the future, but it is not 100 percent accurate. No model is that good. Because assumptions usually must be made concerning much of the data that are fed into the model, the manager must use judgment and intuition in evaluating the output.

Classes of Mathematical Models

A mathematical model can be classified in terms of three dimensions: the influence of time, the degree of certainty, and the ability to achieve optimization.

STATIC OR DYNAMIC MODELS A **static model** does not include time as a variable. It deals with a situation at a particular point in time. It is like a snapshot. A model that includes time as a variable is a **dynamic model**. This model represents the behavior of the entity over time, like a motion picture.

PROBABILISTIC OR DETERMINISTIC MODELS Another way to classify models is based on whether the formulas include probabilities. A **probability** is the chance that something will happen. Probabilities range from 0.00 (for something with no chance) to 1.00 (for something that is a sure thing). A model that includes probabilities is called a **probabilistic model**. Otherwise, it is a **deterministic model**.

OPTIMIZING OR SUBOPTIMIZING MODELS An **optimizing model** is one that selects the best solution among the alternatives presented. For a model to be able to do this, the problem must be very well structured. A **suboptimizing model**, often called a **satisficing model**, permits a manager to enter a set of decisions; once this step is completed, the model will project an outcome. The model does not identify the decisions that will produce the best outcome, but leaves that task to the manager.

Any model can be classified in terms of the three dimensions. For example, the EOQ formula is a static, deterministic, optimizing model.

Simulation

The act of using a model is called **simulation**. The simulation takes place in a particular scenario and predicts the effect of the problem solver's decision or decisions.

THE MODELING SCENARIO The term **scenario** is used to describe the conditions that influence a simulation. For example, if you are simulating an inventory system, as shown in Figure 11.5, the scenario specifies the beginning balance and the daily sales units. The data elements that establish the scenario are called **scenario data elements**. Models can be designed so that the scenario data elements are variables, thus enabling different values to be assigned.

DECISION VARIABLES The input values that the manager enters to gauge their impact on the entity are known as **decision variables**. In the Figure 11.5 example, the decision variables include the order quantity, reorder point, and lead time (the time required for the supplier to furnish replenishment stock).

Simulation Technique

The manager usually executes an optimizing model only once; the model produces the best solution using the particular scenario and the decision variables. However, it is necessary to execute a suboptimizing model over and over, searching for the combination of decision variables that produces a satisfying outcome. This iterative process of trying out decision alternatives is known as playing the **what-if game**.

Each time the model is executed, only one of the decision variables should be changed so that its influence can be seen. In this way, the problem solver systematically discovers the combination of decisions that will lead to problem solution.

Format of Simulation Output

It is a good practice to include the scenario elements and decision variables on the same screen or page as the output, as shown in Figure 11.5. With such a layout, it is always clear which inputs produced the output.

A Modeling Example

A firm's executives might use a mathematical model to make several key decisions. Perhaps the executives want to simulate the effect of:

- The *price* of the product
- The amount of *plant investment* that will be necessary to provide the capacity for producing the product

Figure 11.5 **Scenario Data and Decision Variables from a Simulation**

INVENTORY PLANNING MODEL
OCTOBER 11

SCENARIO:

BEGINNING BALANCE: 200

DAILY SALES UNITS: 20

DECISIONS:

ORDER QUANTITY: 100

REORDER POINT: 175

LEAD TIME: 3

RESULTS:

DAY	BEGINNING BALANCE	RECEIPTS	SALES	ENDING BALANCE	ORDER QUANTITY	RECEIPT DUE DAY
1	200		20	180		
2	180		20	160	100	5
3	160		20	140		
4	140		20	120		
5	120	100	20	200		
6	200		20	180		
7	180		20	160	100	10
8	160		20	140		
9	140		20	120		
10	120	100	20	200		
11	200		20	180		
12	180		20	160	100	15
13	160		20	140		
224	120	100	20	200		
225	200		20	180		

- The amount to be invested in *marketing* activity, such as advertising and personal selling
- The amount to be invested in *R&D (research and development)*.

Furthermore, the executives want to be able to simulate four quarters of activity and produce two reports—(1) an operating statement that includes such key nonmonetary values as market potential (demand) and plant capacity and (2) an income statement that reflects the results in monetary terms.

Model Input

Figure 11.6 shows the input screen that is used to enter the scenario data elements for the *prior quarter*. Some of the elements relate to the firm—its plant capacity, the number of units that were produced, the dollar value of raw materials, and so forth. The other elements relate to the influence of the firm's environment—the economic index, seasonal index, competitor price, and competitor marketing.

Figure 11.7 shows the scenario elements for the *next quarter*. The executives indicate how many quarters they want to simulate. Then they enter estimates for the economic and seasonal indexes and for the competitor's price and marketing.

In the lower portion of the screen, the executives enter the four decisions (Price \$12.00; Plant investment \$100,000; Marketing \$1,000; R&D \$0), with space at the right where the

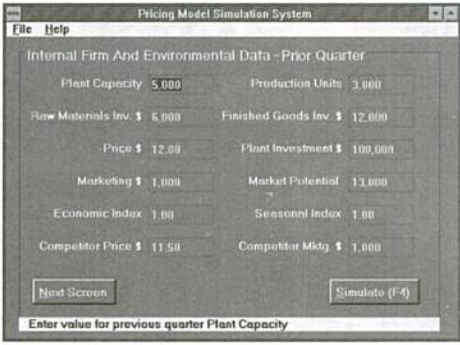


Figure 11.6 **A Model Input Screen for Entering Scenario Data for the Prior Quarter**

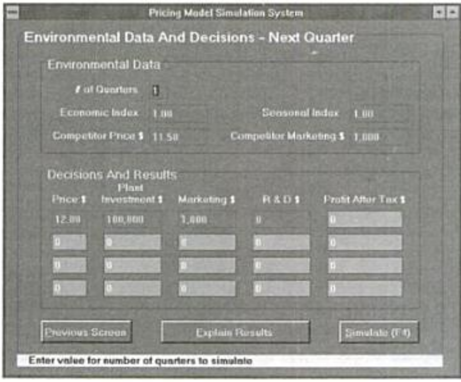


Figure 11.7 **A Model Input Screen for Entering Scenario Data for the Next Quarter**

resulting after-tax profits will be displayed. The screen can accommodate decisions for four quarters. The screen shows default values for unsimulated quarters.

Model Output

The next quarter's activity (Quarter 1) is simulated, and the after-tax profit is displayed on the screen. The executives study the figure and decide on the set of decisions to be used in Quarter 2. These decisions are entered, and the simulation is repeated. This process continues until all four quarters have been simulated. At this point the screen appears as shown in Figure 11.8.

The executives can obtain more detailed output in displayed or printed form. The operating statement in Figure 11.9 and the income statement in Figure 11.10 are displayed on separate screens.

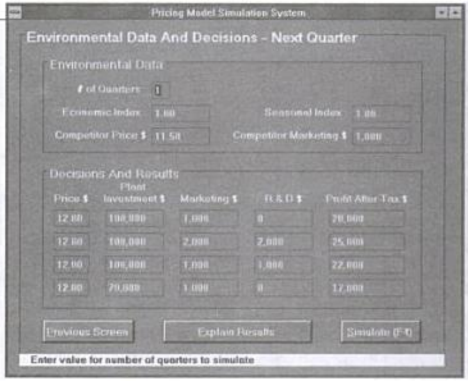


Figure 11.8 **Summary Output from the Model**

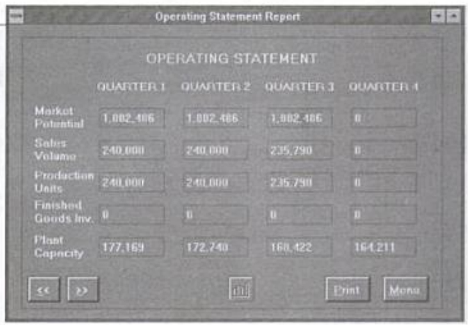


Figure 11.9 **The Operating Statement Shows Nonmonetary Results of the Simulation**

Advantages and Disadvantages of Modeling

Managers who use mathematical models can expect to benefit in the following ways:

- The modeling process can be a *learning experience*. Invariably, managers learn something new about the physical system with each modeling project.
- The speed of the simulation process enables the *consideration of a larger number of alternatives* by providing the ability to evaluate the impact of decisions in a short period of time. In a matter of minutes, it is possible to simulate several months, quarters, or years of company operations.
- As we have already recognized, models provide a *predictive power*—a look into the future—that no other information-producing method offers.

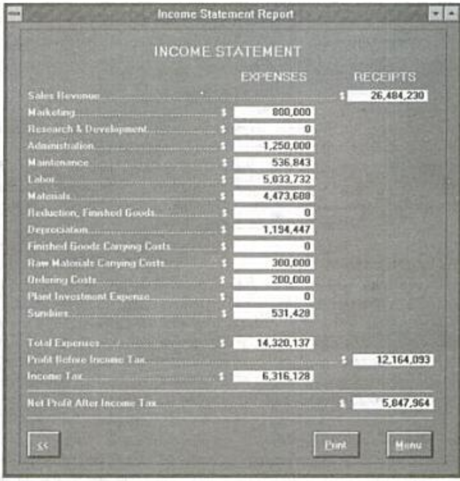


Figure 11.10 **The Income Statement Shows Monetary Results of the Simulation**

- Models are *less expensive* than trial and error. The modeling process is costly in terms of development time and the software and hardware required for the simulations, but the cost is not nearly as high as that of bad decisions that are implemented in the real world.

These modeling advantages can be offset to some degree by two basic disadvantages:

- The *difficulty of modeling a business system* will produce a model that does not capture all of the influences on the entity. For example, in the model just described, someone in the firm must estimate the values for the scenario data elements. Also, the mathematical formulas usually only approximate the behavior of the entity. This means that considerable judgment must be applied in implementing the decisions that are based on the simulation results.
- A *high degree of mathematical skill* is required to personally develop more complex models. Also, such skill is necessary to properly interpret the output.

For a long time, many managers believed that the disadvantages of modeling outweighed the advantages. That situation has changed, owing to a combination of more user-friendly modeling tools and more computer-literate and information-literate managers.

MATHEMATICAL MODELING USING ELECTRONIC SPREADSHEETS

The technological breakthrough that enabled problem solvers to develop their own mathematical models instead of relying completely on information specialists or management scientists was the electronic spreadsheet. Prior to the spreadsheet, mathematical models were programmed in such scientific programming languages as Fortran or APL, which were beyond the competency of problem solvers who did not have computer backgrounds. When the spreadsheet came on the scene, it immediately became apparent that it would be a good vehicle for mathematical modeling.

Static Modeling Capability

The rows and columns of an electronic spreadsheet make it ideal for use as a static model. Figure 11.11 shows an operating budget in the form of a tabular report with columns for the budgeted expenses, actual expenses, and variance. The rows are used for the various expense items. This is a very simple model, where the only math is the subtraction of the actual from the budgeted expenses to produce the variance. This model reports the status of the operating budget at a specific point in time—the week ending June 25.

Dynamic Modeling Capability

A spreadsheet is especially well-suited for use as a dynamic model. The columns are excellent for the time periods, as illustrated in Figure 11.12. Here, the columns represent months. This is also a very simple model, with ending cash calculated by adding beginning cash and cash in and subtracting cash out. The monthly simulations are cumulative, with the ending balance of one month becoming the beginning balance of the next. Models such as the cash-flow model are of special interest to financial managers or members of the financial staff and can be quite complex. This model reports how the cash flows in and out during the 6 months shown.

Playing the "What-if" Game

The spreadsheet also lends itself to playing the "what-if" game, where the problem solver manipulates one or more variables to see the effect on the outcome of the simulation. For example, in the operating budget in Figure 11.11 the problem solver could make changes to the

Figure 11.11
Spreadsheet Rows and Columns Provide the Format for a Columnar Report

Source: Raymond McLeod, Jr., *Decision Support Software for the IBM Personal Computer* (Chicago: Science Research Associates, 1988), 235.

OPERATING BUDGET

DEPARTMENT 210 – WELDING SHOP

WEEK ENDING JUNE 25

ACCOUNT	BUDGET	ACTUAL	VARIANCE
SALARIES	$9,715.00	$10,317.50	$602.50-
EQUIPMENT	$750.00	$517.50	$232.50
SUPPLIES	$1,400.00	$1,255.59	$144.41
OVERHEAD	$250.00	$250.00	$0.00
TOTAL	$12,115.00	$12,340.59	$225.59-

CASH FLOW MODEL

MONTH	1	2	3	4	5	6
BEGINNING CASH	5000	5480	6005	6087	5975	6861
CASH IN	1800	2100	1932	1813	2987	2800
CASH OUT	1320	1575	1850	1925	2101	2495
ENDING CASH	5480	6005	6087	5975	6861	7166

Figure 11.12 **Spreadsheet Columns Are Excellent for Time Periods in a Dynamic Model**

Source: Raymond McLeod, Jr., *Decision Support Software for the IBM Personal Computer* (Chicago: Science Research Associates, 1988), 234.

actual salaries (maybe increasing them by 10 percent to simulate the effect of a pay raise) and see the effect on salary variance and overall variance. In the cash-flow model in Figure 11.12, the financial manager could manipulate the cash in and cash out figures to see the effect.

The Spreadsheet Model Interface

When using a spreadsheet as a mathematical model, the user can enter data or make changes directly to the spreadsheet cells or can use a graphical user interface. The pricing model described earlier and illustrated in Figures 11.6 through 11.10 could have been developed using a spreadsheet and a graphical user interface. Such an interface can be prepared using a programming language such as Visual Basic and most likely would require the expertise of an information specialist. A development approach would be for the user to develop the spreadsheet and then have the interface added by an information specialist.

ARTIFICIAL INTELLIGENCE

In its original form, DSS emphasized mathematical modeling and database querying. Before long, DSS developers began to recognize the need to incorporate artificial intelligence. **Artificial intelligence (AI)** is the activity of providing such machines as computers with the ability to display behavior that would be regarded as intelligent if it were observed in humans.[7] AI represents the most sophisticated computer application in that it seeks to duplicate some types of human reasoning.

History of AI

The seeds of AI were sown only 2 years after General Electric installed the first computer for business use. The year was 1956, and the term *artificial intelligence* was coined by John McCarthy as the theme of a conference held at Dartmouth College. That same year, the first AI computer program, called Logic Theorist, was announced. Logic Theorist's limited ability to reason (proving calculus theorems) encouraged researchers to develop another program called the General Problem Solver (GPS), which was intended for use in solving problems of all kinds. The task turned out to be more than the early pioneers could handle, and AI research took a back seat to the less ambitious computer applications such as MIS and DSS. Over time, however, persistent research paid off, and AI became established as a solid computer application area.

Areas of AI

AI is being applied in business in the form of expert systems, neural networks, genetic algorithms, and intelligent agents.[8]

EXPERT SYSTEMS The **expert system** is a computer program that attempts to represent the knowledge of human experts in the form of heuristics. The term *heuristic* is derived from the same Greek root as the word *eureka*, which means "to discover." A **heuristic** is a rule of thumb or a rule of good guessing.

Heuristics do not guarantee results as absolutely as do the conventional algorithms that are incorporated into mathematical models, but they offer results that are specific enough most of the time to be useful. Heuristics allow the expert system to function in a manner consistent with a human expert, advising the user on how to solve a problem. Because the expert system functions as a consultant, the act of using it is called a **consultation**—the user consults the expert system for advice.

Expert systems are developed by an information specialist (frequently called a **knowledge engineer**) who has special expertise in artificial intelligence. The knowledge engineer is adept in obtaining knowledge from the expert.

NEURAL NETWORKS **Neural networks** mimic the physiology of the human brain. They are capable of finding and differentiating between patterns, making them especially useful in business in the areas of speech recognition and optical character recognition.

GENETIC ALGORITHMS **Genetic algorithms** apply the "survival of the fittest" process to enable problem solvers to produce increasingly better problem solutions. For example, investment bankers can use them to select the best investment portfolios for their clients.

INTELLIGENT AGENTS **Intelligent agents** are used to perform repetitive computer-related tasks. An example is data mining, where knowledge discovery enables the data warehouse system to identify previously unknown data relationships.

The Appeal of Expert Systems

An expert system offers unique capabilities as a decision support system. First, an expert system offers the opportunity to make decisions that exceed the manager's capabilities. For example, a new investments officer for a bank can use an expert system designed by a leading financial expert and, in doing so, incorporate the expert's knowledge into his or her investment decisions. Second, the expert system can explain its line of reasoning in reaching a particular solution. Very often, the explanation of how a solution was reached is more valuable than the solution itself.

The Expert System Configuration

An expert system consists of four main parts: the user interface, the knowledge base, the inference engine, and the development engine. This architecture is illustrated in Figure 11.13.

THE USER INTERFACE The user interface enables the manager to enter instructions and information into the expert system and to receive information from it. The instructions specify the parameters that guide the expert system through its reasoning process. The input information is in the form of values assigned to certain variables.

Expert systems are designed to recommend solutions. These solutions are supplemented by explanations. There are two types of explanations: explanations of questions that the manager asks and explanations of the problem solution.

THE KNOWLEDGE BASE The **knowledge base** contains both facts that describe the problem area and knowledge representation techniques that describe how the facts fit together in a logical manner. The term **problem domain** is used to describe the problem area.

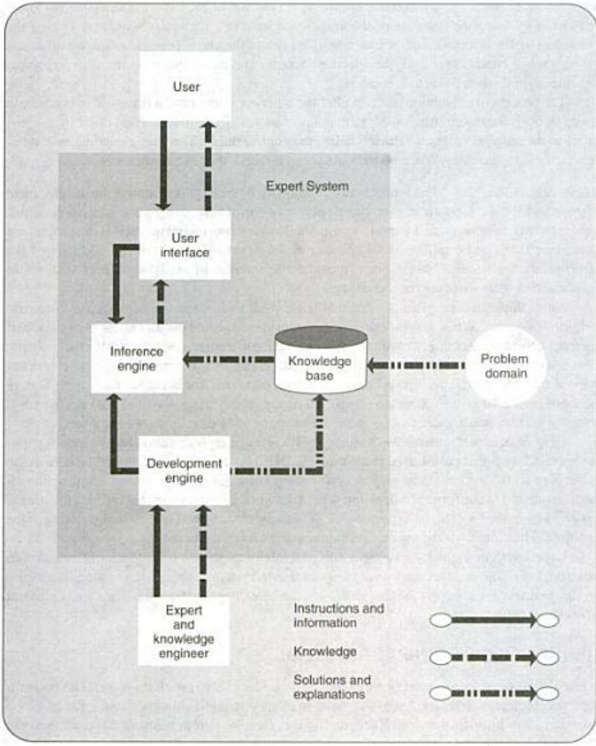


Figure 11.13 **An Expert System Model**

A popular knowledge representation technique is the use of rules. A **rule** specifies what to do in a given situation and consists of two parts: a *condition* that may or may not be true and an *action* to be taken when the condition is true. An example of a rule is:

If Economic.Index > 1.20 and Seasonal.Index > 1.30 Then Sales.Outlook = 'EXCELLENT'

All of the rules contained in an expert system are called the **rule set**. The rule set can vary from a dozen or so rules for a simple expert system to 10,000 rules for a complex one.

THE INFERENCE ENGINE The **inference engine** is the portion of the expert system that performs reasoning by using the contents of the knowledge base in a particular sequence. During the consultation, the inference engine examines the rules of the knowledge base one at a time, and when a rule's condition is true, the specified action is taken. In expert systems terminology, the rule is *fired* when the action is taken.

The process of examining one rule after the other continues until a complete pass has been made through the entire rule set. More than one pass usually is necessary in order to assign a value to the problem solution, which is called the **goal variable.** The passes continue as long as it is possible to fire rules. When no more rules can be fired, the reasoning process ceases.

THE DEVELOPMENT ENGINE The fourth major component of the expert system is the development engine, which is used to create the expert system. There are two basic approaches: programming languages and expert system shells. An **expert system shell** is a ready-made processor that can be tailored to a specific problem domain through the addition of the appropriate knowledge base. Today, most of the interest in applying expert systems to business problems involves the use of shells.

An example of a problem domain that lends itself to an expert system shell is computer help-desk support.[9] When a help-desk expert system is used, either the user or the help-desk staff member communicates directly with the system, and the system attempts to resolve the problem. One test of the degree of sophistication of artificial intelligence is whether the users can determine if they are interfacing with a human or a computer. This test is named the Turing Test, in honor of one of the great pioneers in computer science, Alan Turing. A sign of a good expert system is if the user is not aware that he or she is communicating directly with a computer.

Help-desk expert systems use a variety of knowledge representation techniques. A popular approach is called **case-based reasoning (CBR).** This approach uses historical data as the basis for identifying problems and recommending solutions. Some systems employ knowledge expressed in the form of a **decision tree**, a network-like structure that enables the user to progress from the root through the network of branches by answering questions relating to the problem. The path leads the user to a solution at the end of the branch.

Expert system shells have brought artificial intelligence within the reach of firms that do not have the resources necessary to develop their own systems using programming languages. In the business area, expert system shells are the most popular way for firms to implement knowledge-based systems.

GROUP DECISION SUPPORT SYSTEMS

It has always been an accepted fact that managers seldom solve problems alone. The committees, project teams, and task forces that exist in many companies are good examples of group approaches to problem solving. Recognizing this fact, system developers have adapted the DSS to group problem solving.

The GDSS Concept

A **group decision support system (GDSS)** is "a computer-based system that supports groups of people engaged in a common task (or goal) and that provides an interface to a shared environment."[10] Other terms have also been coined to describe the application of information technology to group settings. These terms include **group support system (GSS), computer-supported cooperative work (CSCW), computerized collaborative work support,** and **electronic meeting system (EMS).**[11] The software that is used in these settings has been given the name **groupware.**

How the GDSS Contributes to Problem Solving

The underlying assumption of the GDSS is that improved communications make possible improved decisions. Improved communications are achieved by keeping the group discussion

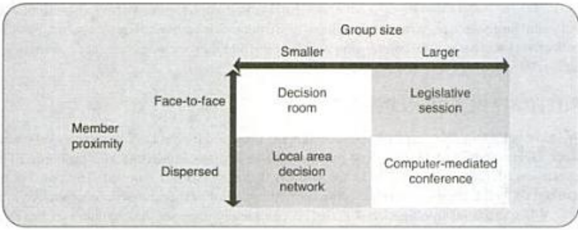


Figure 11.14 **Group Size and Location Determine DSS Environmental Settings**

Source: Reprinted by permission, Gerardine DeSanctis and R. Brent Gallupe, "A Foundation for the Study of Group Decision Support Systems", *Management Science*, (May 1987), Copyright 1987, the Institute for Operations Research and the Management Sciences (INFORMS), 7240 Parkway Drive, Suite 310, Hanover, MD 21076 USA.

focused on the problem, resulting in less wasted time. The time gained can be devoted to a more thorough discussion of the problem, thus contributing to a better problem definition. Or, the time gained can be used in identifying more alternatives than would otherwise be possible. The evaluation of more alternatives increases the likelihood of a good solution.

GDSS Environmental Settings

The GDSS contributes to problem solving by providing a setting that is conducive to communications. Figure 11.14 shows four possible GDSS settings based on the size of the group and where the members are located. In each setting, group members may meet at the same time or at different times. When members meet at the same time, it is called a **synchronous exchange**. An example is a committee meeting. When members meet at different times, it is called an **asynchronous exchange**. An example is communication back and forth using e-mail.

DECISION ROOM **A decision room** is the setting for small groups of people meeting face-to-face. The room contributes to communication through a combination of furnishings, equipment, and layout. The equipment can include a combination of workstations, audio pick-up microphones, video cameras, and large display screens. In the center of the room is a facilitator's console. The **facilitator** is the person whose chief task is to keep the discussion on track.

Based on the arrangements that are established for each session, one group member's keyed-in messages to another member can be displayed on the large screen for the entire group to see. Other material pertinent to the discussion can also be displayed from such media as PowerPoint images, videotapes, color slides, and transparencies.

Two unique GDSS features are parallel communication and anonymity. **Parallel communication** is when all participants enter comments at the same time, and **anonymity** is when nobody is able to tell who entered a particular comment. Anonymity enables participants to enter what they really think without fear of ridicule from other group members. Also, it allows each idea to be evaluated on its merits rather than on who offered it.

LOCAL AREA DECISION NETWORK When it is impossible for small groups of people to meet face-to-face, the members can interact by means of a LAN. A member enters comments in a workstation and views the comments of the other members on the screen.

LEGISLATIVE SESSION When the group is too large for a decision room, a legislative session is required. The large size imposes certain constraints on communications. Either the opportunity for equal participation by each member is removed or less time is available. Another approach is for the facilitator to decide which material is displayed on the screen for the group to view.

COMPUTER-MEDIATED CONFERENCE Several virtual office applications permit communication between large groups with geographically dispersed members. These applications are collectively known as *teleconferencing applications*, and they include computer conferencing, audio conferencing, and videoconferencing.

PUTTING THE DSS IN PERSPECTIVE

We have seen how the scope of decision support provided by the DSS has expanded greatly since Gorry and Scott-Morton first got the idea to address semistructured problems. This expansion of scope is testimony to the success that the DSS has enjoyed. The concept has worked so well that developers are continually thinking of new features to incorporate.

When artificial intelligence is added, it completely changes the character of the DSS. Someone once addressed the difference between a DSS and an expert system by explaining that when a manager uses a DSS, he or she is sitting at the workstation and is deciding how to use the information display to solve the problem. When the manager uses an expert system, the manager is sitting at the workstation, but a consultant is sitting next to the manager, giving suggestions on how to solve the problem. Artificial intelligence enables the DSS to provide a level of decision support that was not originally intended by the early DSS visionaries.

The GDSS capability is firmly established. In fact, there may be more GDSS applications today than DSS ones. As far as OLAP goes, it is new to the scene, and it will be interesting to follow its progress.

Highlights in MIS

FIX IT BEFORE IT BREAKS[12]

Predictive maintenance is the name given to the activity of predicting when a machine will fail and performing maintenance on it just prior to that time to prevent the failure. This is a good idea, but one that is not easy to accomplish. However, SKF in Sweden has developed a DSS with a knowledge-based capability to do just that.

SKF manufactures bearings, which are used in many types of machines, and the company has captured about 20 percent of the world market. SKF became interested in predictive maintenance as a way to generate intelligence that could be used across the entire design process. After devoting 2 years to the development process, the result was a decision support system named @ptitude.

@ptitude uses data from a database that contains nearly 100 years of operating data gathered from hundreds of thousands of machines in use around the world. In addition, data are provided from real-time machine condition reporting. The availability of such a rich data source enables the system to relate failure data to how the parts are assembled and how they may fail in the future. Heinz Bloch, a consulting engineer, described early versions of DSS use in predictive maintenance as requiring an engineer to input all of the data that was available for a particular machine problem (say, a leaking seal). But, the engineer didn't have all the data necessary to answer all of the questions from the system. As a result, the system would come to some enlightening solution such as "You have a seal problem."

The robust data sources of @ptitude are expected to enable it to pinpoint when components have failed in service. This will enable SKF design engineers to focus on key elements that have the greatest impact on life-cycle costs and create designs that increase machine reliability.

In addition to making @ptitude available internally, SKF has established a Web site that offers @ptitude to engineers around the world on a subscription basis. To learn more, go to WWW.SKF.COM/PORTAL/SKF/HOME/APTITUDEEXCHANGE.

Summary

Managers make multiple decisions in the process of solving a problem. In solving a problem, managers go through a series of four activities: intelligence, design, choice, and review. In taking a systems view and following the systems approach, managers can use the general systems model of the firm and the environmental model. The purpose of taking a systems view is to enable the organization to work as an efficient and effective system.

The problem-solving process consists of several key elements. Standards and information provide the desired state and the current state, respectively, and managers consider alternative solutions while adhering to the constraints. By going through this process, a solution to the problem is achieved. The selection of the best alternative can be accomplished by analysis, judgment, and bargaining.

Symptoms are only indications of a problem, which can be structured, unstructured, or semistructured, depending on the proportion of elements and relationships that are known. In solving these problems, managers can make programmed or nonprogrammed decisions. Programmed decisions represent solutions that are known to work, whereas nonprogrammed decisions represent custom-tailored solutions.

The DSS was originally envisioned as a way to solve problems that had eluded computer processing in the early 1970s. It was intended to help the manger solve semistructured problems. Subsequently, the DSS has been expanded to include group processing (achieving a GDSS), artificial intelligence, and OLAP.

There are four types of models: physical, narrative, graphic, and mathematical. All facilitate understanding and communication, but mathematical models can also predict the future. Mathematical models can be static or dynamic, probabilistic or deterministic, and optimizing or suboptimizing. The act of using a model is called *simulation*, and it requires the manager to enter scenario data elements and decision variables. By trying various decisions, the manager plays the what-if game. Modeling can provide a learning experience, enable consideration of a larger number of alternatives, predict the future, and permit some problems to be solved at less cost. However, it is often difficult to model the business system, and a high degree of mathematical skills are required for complex models. An electronic spreadsheet can be used for models of reasonable size.

Artificial intelligence has been applied in business through expert systems, neural networks, genetic algorithms, and intelligent agents. An expert system can function as a DSS. It requires a knowledge base, which often consists of a network of rules, and an inference engine that can analyze the knowledge base and assign a value to the solution, called the goal variable. The knowledge base contains knowledge that is gathered by a knowledge engineer from an expert. Expert systems can be developed using a programming language or an expert system shell.

Group decision support systems (GDSSs) facilitate problem solving by providing a conducive environment, which can be achieved in the form of decision rooms, local area networks, legislative sessions, and computer-mediated conferences.

The DSS is a fitting way to conclude our discussion of MIS. The DSS was intended to improve the focus of MIS efforts and ended up being a new application of the computer to problem-solving support. Of all the efforts to apply the computer in business as an information system, the DSS has been the most successful.

Key Terms

desired state
current state
solution criterion
symptom
model
entity
static model
dynamic model
probabilistic model
deterministic model
optimizing model
suboptimizing model, satisficing model
simulation
scenario
decision variable
what-if game
expert system
neural network
genetic algorithm
intelligent agent
knowledge base
problem domain
inference engine
goal variable
expert system shell
case-based reasoning (CBR)
synchronous exchange
asynchronous exchange
facilitator
parallel communication
anonymity

Key Concepts

- systems view
- problem structure
- programmed and nonprogrammed decisions
- decision support system (DSS)
- artificial intelligence (AI)
- group decision support system (GDSS)

Questions

1. What are Simon's four stages of problem solving?
2. Which frameworks would you use in applying the systems approach?
3. What form do both internal and environmental constraints take?
4. What are the three approaches to selecting the best alternative, according to Mintzberg?
5. What is meant by problem structure?
6. What MIS weakness did Gorry and Scott-Morton seek to overcome?
7. How did Gorry and Scott-Morton use the term *decision support system*?
8. Name the different outputs from a DSS.
9. What are the four types of models?
10. What advantages are offered by all types of models?
11. How can mathematical models be classified?
12. What two types of data are entered into a mathematical model to begin the simulation?
13. What type of data does the manager manipulate when playing the what-if game?
14. Which of the two mathematical modeling disadvantages were addressed by the electronic spreadsheet?
15. What are the spreadsheet columns used for in a dynamic model?
16. What are the four main parts of an expert system?
17. What is a goal variable?
18. Explain the difference between a synchronous and an asynchronous exchange.
19. Why is anonymity important in a GDSS setting?

Topics for Discussion

1. What would be an example of a good problem? How could a manager use the systems approach to solve it?
2. Give an example of a solution criterion and explain how it is derived.
3. Would you use programmed decisions to solve a structured problem?

PROBLEMS

1. Create an electronic spreadsheet model to prepare the operating budget in Figure 11.11. Use the same data as in the figure. Play the what-if game to see the effect of changing the *actual salary* to \$10,500 and then to \$8,500.
2. Create an electronic spreadsheet model to prepare the cash flow model in Figure 11.12. Use the same data as in the figure. Play the what-if game to see the effect of changing the *cash out* figure in month 1 to 2,000, then 3,000.
3. Create an electronic spreadsheet model to produce the inventory planning model in Figure 11.5. When the ending balance drops to or below the reorder point, the order quantity is entered as a receipt 3 days after the reorder point is detected (lead time of 3 days). Simulate 100 days.

Case Problem

HERITAGE HOMES

More and more young couples are buying older houses and remodeling them as a way of avoiding the high costs of building. In the Wilmington, Delaware, area, about a half-dozen construction firms specialize in remodeling. One is Heritage Homes, owned by Alvin and James Bradberry. The Bradberrys have received a disproportionately large share of the remodeling business because of their ability to come in with lower bids than other firms.

When contractors receive invitations to bid, they meet with the owners to inspect the house. To make accurate bids, the contractors must be able to visualize from the owners' descriptions and their own observations the work that will be required and then estimate the cost. Because the contractors know they invariably will encounter some unanticipated difficulties once work begins, they add a cushion to their bids. The Bradberrys know their business so well that they do not have to add much of a cushion. That has been the key to their success.

One rainy morning, when the Bradberrys can't work outdoors, they are in the office talking about their computer-based proposal preparation system. Alvin has written some programs that compute certain materials costs, and James has developed a word processing file used in preparing the written documents.

ALVIN: *What do you think about us using an expert system to do our bidding? I've been doing some reading and that seems to be the coming thing. I doubt if any other contractors have such a system and it might help us keep our competitive edge.*

JAMES: *I read the same article that you did but I'm not convinced that those systems are as good as they're made out to be. For one thing, you need an expert. Who would that be?*

ALVIN: *Us. We're the experts. We know this business better than anybody else. We hit every bid right on the nose. All we have to do is get our knowledge inside the computer—and watch our smoke!*

JAMES: *I'm not sure I could describe what goes through my head as I work up the bid. It just comes naturally.*

ALVIN: *Oh, I think if you stick with anything long enough, you can do it. I wrote those materials cost programs with no sweat.*

JAMES: *But you don't have time for a lot of programming. There are more important things for you to do.*

ALVIN: *I could do it in my spare time. We're in no big hurry.*

JAMES: *Well, it would be nice if we didn't have to spend so much time on the bids. If we could do it faster, we could do more bidding and get more jobs. I'm convinced that there is an unlimited*

Case Problem continued

supply of remodeling jobs in Wilmington, and we've always talked about branching out to other cities.

ALVIN: *Exactly. Maybe over the next few months, we could keep notes as we work up the bids—you know, write down what's going through our minds.*

JAMES: *That's not a bad idea. We always carry a clipboard with us when we check out a house. We could just be more detailed in our note taking.*

ALVIN: *After we accumulate a good set of notes, we might work up a form that we could fill out for each job—enter all the data, such as number of rooms, room size, condition of the wiring, plumbing, and so on. Then it would be a simple matter of entering the data from the form into the expert system.*

JAMES: *Sounds good. Say, it's stopped raining. Let's get to work. We can daydream some other time.*

ASSIGNMENT

1. Does this sound like a good expert system application? Explain.
2. Do you think that Alvin and James qualify as experts? Why or why not?
3. Should they develop the system themselves or let someone else do it? Support your answer.
4. Assuming that an expert system is produced, how could Alvin and James benefit?

NOTES

[1]Herbert A. Simon, *The New Science of Management Decision*, rev. ed., (Englewood Cliffs, New Jersey, Prentice Hall, 1977).
[2]Henry Mintzberg, "Planning on the Left Side and Managing on the Right," *Harvard Business Review* 54 (July–August 1976), 55.
[3]Simon, op. cit., 1977.
[4]Simon, op. cit., 1977.
[5]G. Anthony Gorry and Michael S. Scott-Morton, "A Framework for Management Information Systems," *Sloan Management Review* 13 (Fall 1971), 55–70.
[6]George W. Gershefski, "Building a Corporate Financial Model," *Harvard Business Review* 47 (July–August 1969), 39.
[7]This definition paraphrases one found in Clyde W. Holsapple and Andrew B. Whinston, *Business Expert Systems* (Homewood, IL: Irwin, 1987), 4.
[8]"Artificial Intelligence," Wikipedia, EN.WIKIPEDIA.ORG/WIKI/ARTIFICIAL_INTELLIGENCE, August 18, 2005.
[9]Lee Thé, "AI Automates a Help Desk," *Datamation* 42 (January 15, 1996), 54ff.
[10]Clarence Ellis, Simon Gibbs, and Gail Rein, "Groupware: Some Issues and Experiences," *Communications of the ACM* 34 (January 1991), 40.
[11]For more information on EMS, see Alan R. Dennis, Joey F. George, Len M. Jessup, Jay F. Nunamaker, Jr., and Douglas R. Vogel, "Information Technology to Support Electronic Meetings," *MIS Quarterly* 12 (December 1988), 591–624.
[12]Karen Auguston Field, "If It Ain't Broke, Fix It," *Design News* 57(20) (October 21, 2002), 21.

PART 4

Projects

Putting what you have learned into practice is the best way to remember a lesson. The projects in this part of the text reinforce the lessons taught in the chapters. Each project has specific learning objectives. You will be guided through a detailed example that covers all the skills you will need to complete the project's assignment. You will then complete the project assignment using the skills you have just learned.

All of the projects use Microsoft software, because it is the most widely used personal productivity software. Some projects address basic concepts and skills. Others address advanced skills and more complicated software features.

These projects represent the types of applications many managers face in their early careers. Completing these projects will teach you the skills necessary to work with the information systems you will likely encounter when you graduate from college. By completing multiple projects on the same topic, such as databases, you will gain a broader picture of the benefits provided by these tools.

Project 1

Everyday Technology Skills

Learning Objectives

- Understand resources that can help you manage information technology.
- Locate sources for commercial as well as free software to keep your computer safe.
- Understand the importance of e-mail.

Introduction

Many students know only the basics about their computers, but as a future manager and professional you are required to have a deeper understanding. As common as computers are at school and in the workplace, most users have a poor understanding of the everyday maintenance of the computer and its applications. It is important that you know how to keep your computer working properly and free of viruses so that you can complete your schoolwork. It is extremely important for organizations to maintain their computers, because problems with one computer can quickly spread to others across the organization's network.

E-mail is both a formal and informal communications channel for organizations. Messages can be stored indefinitely and transmitted to thousands of people. They can also be used as evidence in legal actions. Sixty percent of surveyed employers admit to using software that monitors employee e-mail.[1] E-mail etiquette is so important to managers and professionals that a whole section of this project is devoted to it.

OPERATING SYSTEMS

An operating system can be thought of as the computer program that runs all the other programs on your computer. It controls devices such as the hard drive and the mouse. It has **utilities**, which are small programs that are able to copy files, install new application software, arrange the desktop appearance of your computer, and much more.

Because the operating system affects how your computer performs, you should know how to maintain it. In this project, we are only concerned with operating systems on personal computers, not those that might be used to run a Web server or a large mainframe computer.

Microsoft Windows

Microsoft Windows is the most popular operating system for microcomputers. Some people are unhappy with Windows, but no one can dispute its widespread use in business applications. Almost every manager or professional will use a Windows operating system at some point in his or her career. Windows has been around since 1981 and has changed many times to reflect the increase in computer power and the diversity of devices that attach to computers.

VERSIONS The most recent Windows operating system for PCs is Windows XP. Microsoft has announced that its next operating system, Vista, will be released in 2006. Note that Microsoft Office is not an operating system; it is a collection of software application programs that includes Excel, Word, PowerPoint, and Access. The Windows XP operating system comes in "Professional" and "Home" editions; their features are similar as far as this project is concerned.

You should be aware that Microsoft releases service packs for its operating systems. A *service pack* is a collection of updates that fix errors in the code that affect security and/or the efficiency of the operating system. The computer that was used to type this chapter uses the Windows XP Professional operating system with service pack 2 installed. It is simple to find out the operating system and version on your computer.

Click the "Start" button (bottom-left side of your Windows screen) and then select "Control Panel." When the pop-up window appears, click "System." Information about your computer system (hardware and operating system) is displayed under the tab marked "General," as shown in Figure P1.1.

Figure P1.1 has been edited so that it does not show specific information about the computer user. When you view the pop-up screen referred to in Figure P1.1, you will see information about the PC owner as well as the type of computer processor (central processing unit), its processing speed, and the amount of random access memory (RAM) available.

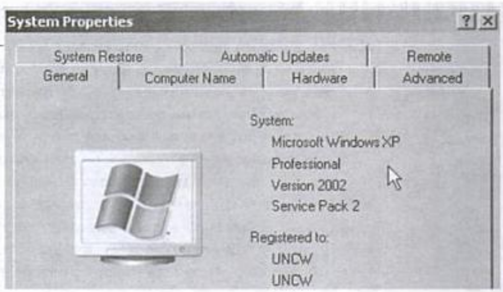


Figure P1.1 **Display of System Properties from the Control Panel**

UPDATES As new application programs are developed and new types of hardware are designed, the operating system must be updated to take advantage of these new resources. Security is another reason to update your operating system. Hackers are continually trying to find ways to break into the operating system and take control of your computer. Microsoft and other vendors are continually trying to prevent attacks from hackers.

How do you get updates and how much do they cost? Updates to the Windows operating systems are free and can be obtained from the Microsoft Web site. You should never believe an e-mail message that tells you to click a link for an operating system update. To access Windows updates, type WWW.MICROSOFT.COM into a Web browser to go to the Microsoft Web site and then choose the "Windows Update" link. Do not choose the "Office Update" link; that link looks for updates to Excel, Word, and other Office software on your computer. You can also open Microsoft's Internet Explorer and choose the "Tools" command followed by the "Windows Update" subcommand. Note that if you are using a computer in your school's computer lab, you may not be allowed to update the operating system.

In general, you should access the Microsoft Web page and check for operating system updates at least once a month. If you have not updated the Windows operating system on your computer, the Web site may warn you that it needs to install an update application onto your computer. You should accept this option as long as you are at the official Microsoft Web site. Most people use the "Express" option for updates, because they are only concerned about security updates (Figure P1.2).

You can choose to have Microsoft automatically update your operating system and Microsoft Office products on your computer. Look at the right-hand side of Figure P1.2. Follow the instructions that appear on the screen to automate operating system updates.

Automatic updates raise two concerns. First, most people only choose to update their operating system and decline updates for Microsoft Office products. Second, high-speed Internet access is desirable for the updates. If you have a dial-up modem, it may take a long time to download updates to your computer.

Other Operating Systems

Microsoft is not the only vendor that offers operating systems for microcomputers. Apple Computer makes Mac OS X. In addition, standard microcomputers from Lenovo, Dell, Gateway, and others can use the UNIX operating system. UNIX is an open-source system, which means it is free for anyone to copy, use, and improve. However, you should be aware that some vendors sell a modified version of the free version of Unix and their proprietary

Figure P1.2 **Windows Operating System Update Web Page**

versions are not free. Mac OS X is a Unix-like operating system, but it is not free; it is proprietary to Apple Computer. Linux, a popular variant of Unix, is free, and anyone can use it without paying a fee. If you have a Unix operating system variant, such as Linux, you can get updates from the distributor's Web site.

APPLICATION SOFTWARE

Many managers and professionals use the Microsoft Office suite of products (Word, Excel, PowerPoint, and Access) to complete their everyday tasks. Because communication is an important task in all organizations, it is important to understand how the application software is identified with specific users and kept safe from threats.

As a manager and professional, you should be concerned about the software on your microcomputer. Information systems professionals will be concerned about computer programs on servers and mainframes; you need only worry about the software applications on your microcomputer. Because many organizations have networks connecting employees' microcomputers, computer viruses and other threats can spread throughout the entire organization very quickly. You are the first line of defense against these threats.

Identification

Why is it important that you be able to establish the version of the application software on your computer? Because different versions of the same software application (such as Microsoft Word) may have different features. For example, Word 2003 has a feature to track changes made to a Word document. Clicking the "Tools" command followed by the "Track Changes" subcommand turns on the feature. Tracking who changed what and when is very useful if two or more people are working on the same document. However, some earlier versions of Word did not have the "Track Changes" feature. One of the reasons larger organizations attempt to standardize their application software and its version is to ensure that everyone in the organization creates compatible documents.

Let's assume that you use Microsoft Word to create documents. Open Word on your computer. To determine the version of Word you are using, click the "Help" command followed by the "About Microsoft Word" subcommand. (The subcommand may also be "About

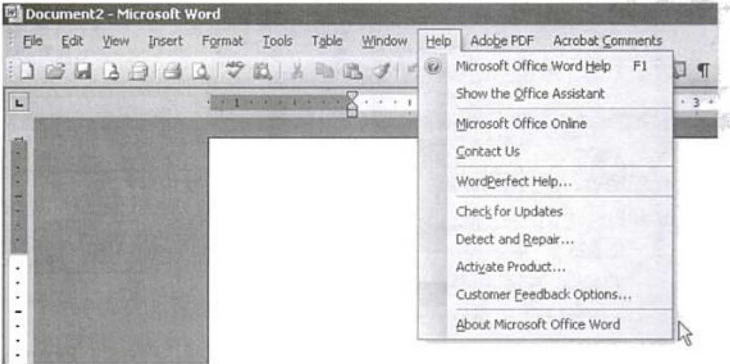


Figure P1.3 **Commands to Display Your Version of Microsoft Word**

Microsoft Office Word.") Figure P1.3 shows the command sequence, and Figure P1.4 displays the information about Word. Note that using the "File" command followed by the "Properties" subcommand will yield information about the person who created the document as well as important facts about when the document was created and modified.

Updates

Just as you can update the operating system, you can also update applications. Go to the Microsoft Web site and select "Office Update." As an alternative, if you are in Word, Excel, PowerPoint, or some other Microsoft application, you can click the "Help" command followed by the "Check for Updates" subcommand. Note that if you are using a computer in the computer lab of your school, you may not be allowed to update software on that computer.

Most application updates increase the efficiency of the application's operation. Some of the updates may solve security issues, but these are not as frequent as security updates for an

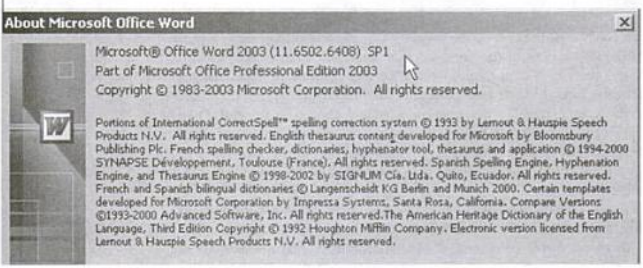


Figure P1.4 **The Version of Microsoft Word Used to Create This Chapter**

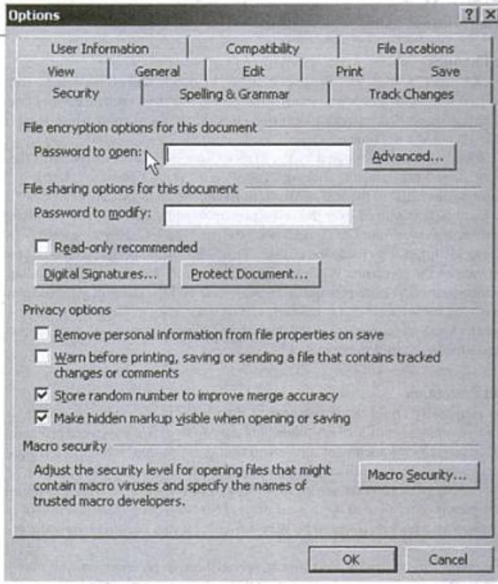


Figure P1.5 **Password Protecting a Microsoft Word File**

VIRUSES AND SPYWARE

Viruses and spyware are serious problems. Spyware is not considered to be malicious; it is not sent to your computer to cause it to stop working or to steal sensitive information. In contrast, viruses are created to destroy or steal information on your computer and cause your computer to become unusable. Some people believe that hackers create viruses for the recognition gained if a large number of computers can be infected. If that is true, it would explain why many viruses are targeted at Microsoft, because such a large number of computers use its operating systems and application software.

Almost every computer that accesses the Internet has some amount of spyware. Too many spyware applications on a computer can slow its speed and performance.

Threats and Hoaxes

Reputable organizations try very hard to keep viruses from being spread from their Web site. You will not receive an e-mail from a reputable organization that contains a link to update your operating system—that e-mail would be a hoax. Also, legitimate organizations do not send e-mails with links that ask you for account information or passwords. You should only acquire updates or exchange information about accounts by visiting the organization's Web site and then accessing the appropriate links inside that Web site.

The term *phishing* (pronounced "fishing") is used to describe e-mails that ask for sensitive information by pretending to be a legitimate request from an organization. Do not send any sensitive information (passwords, account numbers, credit card number, and similar information) via an e-mail. Visit the Web site directly; Web sites are much more secure than e-mail.

Downloads and updates for operating systems and software applications should only be accessed from the organizations' Web sites.

Protection

There is no excuse for not installing antivirus and antispyware on your computer and keeping it up-to-date. Viruses and spyware on your computer can quickly spread through a network at work or at school. Your unprotected computer could be the source of infection for hundreds or thousands of other computers.

COMMERCIAL PROTECTION Norton (WWW.NORTON.COM) and McAfee (WWW.MCAFEE.COM) are two widely known commercial vendors of antivirus and antispyware software. These products are purchased on a time-limited basis, such as by a yearly fee, and updates within that time are included in the purchase price.

Microsoft offers antispyware for free to users of Windows operating systems. In a way, the antispyware is not free, because you must have purchased Microsoft Windows in order for the antispyware to work. The test version of Microsoft Windows AntiSpyware is available from the Microsoft Web site.

FREE PROTECTION Grisoft (WWW.GRISOFT.COM) offers free as well as commercial antivirus and antispyware applications. SpyBot (WWW.SPYBOT.COM) also offers free and commercial versions of its antispyware product. The name of the Grisoft software is AVG; the free version has been very good at detecting and deleting viruses.

Ad-Aware (WWW.LAVASOFT.COM) is another highly regarded antispyware application. The personal edition is free, although you can purchase other Ad-Aware products that are more convenient and self-updating.

If you cannot afford to purchase antivirus and antispyware software, then visit the Grisoft Web site for its free AVG antivirus software and the Lavasoft Web site for its free antispyware.

E-MAIL

E-mail is so easy to use that people overlook its importance. E-mail is vital to business communications. Few users take advantage of all of their e-mail application's features, thus they do not use e-mail to its full potential. Also note that U.S. courts have repeatedly ruled that organizations have the right to monitor e-mail sent or received on computers owned by the organization.

Implications in the Workplace

Almost every e-mail you have ever sent is probably stored somewhere. E-mail passes through servers on its journey from the sender to receiver, and most of these servers are backed up frequently, keeping an extensive log of e-mail communications. This is one reason why networks are so reliable; they have backups so that they can quickly recover from problems and resend any lost communications.

When you delete an e-mail, it is moved to a "deleted" file folder within your e-mail application. However, you must also delete e-mail from the "deleted" file folder to remove it from your computer. Figure P1.6 displays e-mail folders from the Microsoft Outlook e-mail application. Notice that 80 e-mails have been deleted. When they were deleted, they were removed from the "Inbox," but they are still in the computer's memory. They will remain in the computer's memory until they are deleted from the "Deleted Items" folder.

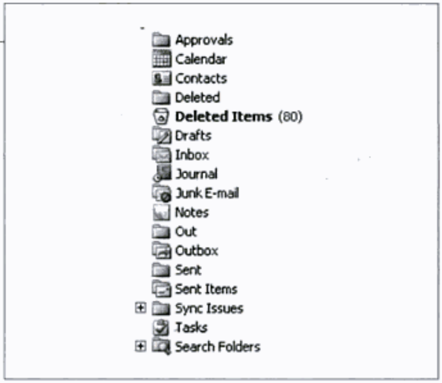


Figure P1.6 **Microsoft Outlook List of Folders Showing Deleted Items**

E-Mail Etiquette at Work

Most people can express themselves better in conversation than in written communication. For example, telling jokes or using sarcasm is something many people find difficult to do in writing but have no problem with in face-to-face conversations. Because e-mail messages can last a long time and be forwarded to other persons, it is important that you always be clear and polite in your e-mail communications.

Beware of using the "Reply all" e-mail feature. You can see the sender of an e-mail message in the "From" box and the recipients in the "To" box, but you do not know who will receive a blind carbon copy of the message. Most e-mail applications allow the sender to send the message to an address that will not be displayed in either the "To" or "From" boxes. When you select "Reply," only the sender gets the message, but by selecting "Reply all," the sender, recipients, and even recipients in the blind carbon copy get the message.

Do not send lengthy e-mail messages. If you have a long message, create a document and attach it to the e-mail message. Then include a short explanation of the document in the e-mail. Some organizations limit the size of attachments they allow; you may need to place the document on a Web server and send a link to the document in the e-mail message.

Never trust that e-mail you send to one person will not be distributed to others. E-mail is not like a joke told at lunch or an unguarded comment made in an office. E-mail is a written statement that can last a long time and be distributed to people you had no intention hearing your thoughts.

Personal E-Mail Accounts

People frequently believe that if they use a private e-mail account, such as AOL, on their computer at work then the e-mail messages they send and receive are private. They are wrong. If you are using resources of your organization—hardware or software or communications networks—then the organization has the right to monitor the e-mail messages.

Personal e-mail should be conducted on a computer you purchase using software you buy and a communications network you pay for. It is common for persons to use computer resources at their workplace for private e-mail messages; organizations allow for some personal use of computing resources, just like they allow limited personal use of the office phone. But understand that the organization has the right to monitor how its resources are being used.

Summary

The operating system is important because it is the program that runs your computer. Operating systems should be updated frequently, because new hardware is continually being developed, new software is being written, and hackers are always looking to take control of your computer. Visit the Web site of the vendor of your operating system to acquire updates. Never believe an e-mail message that contains a link to update your operating system or any software on your computer.

You should be able to identify not only the software applications on your computer but also the versions of the software. Because different versions have different features, files created by different versions may be incompatible.

You should also learn how to track changes made to files. Organizations place high importance on teamwork, and the documents created by teams should display who made changes and when.

Keep your computer free of viruses and spyware. The wide use of the Internet means that your computer could infect hundred or thousands of other computers. Commercial and free antivirus and antispyware software are available from a number of organizations.

E-mail is a powerful tool, but you must respect it. Some people have difficulty expressing themselves in writing, and misunderstandings can result. If a misunderstanding occurs, try to correct the problem. Be aware that something you send to one person in an e-mail can be sent to many other people. Be polite and careful in the e-mail messages you write.

Assignment

1. Visit the computer lab at your school and determine what operating system (as well as family and version) is used on the computers. What operating system is used on your personal computer?
2. Open Microsoft Word on a computer in your school's computer lab (assuming Microsoft Word is on the computer). Select the "File" command followed by the "Properties" subcommand and write down all of the "summary" information you find. On your computer, what information do you find after using the "File" and "Properties" commands?
3. Open Excel and enter the value 5 in cell A1 and the value 10 in cell A2. In cell A3, enter the formula "= A1 + A2" (without the quotation marks). Now choose the "Tools" and "Track Changes" commands so that changes will be tracked.

   In cell A3, enter the formula "= A1 * A2" (without the quotation marks). Describe what is displayed on the screen when you move the mouse cursor over cell A3.
4. Open Word and write a paragraph about yourself. Select "Tools," "Options," and then "Security" to set a password to open the file and a password to modify the file. Make the password to open the file "fire" and use "water" as the password to modify the file. Do not include the quotation marks and be sure to use lowercase letters. Now save the file and write down a description of the process as you try to (a) open the file and (b) make a change to the file.
5. Check the current operating system and version on your computer (not a computer in you school's computer lab) and write down the information. Update the operating system on your computer and write down the information about your operating system after the update is complete.
6. Go to the Lavasoft Web site and download the free, personal edition of Ad-Aware to your computer. Run the Ad-Aware antispyware program and write down the number of spyware files found on your computer.

Notes

[1]Pui-Wing Tam, Erin White, Nick Wingfield, and Kris Maher, "Snooping E-Mail by Software Is Now a Workplace Norm," *Wall Street Journal (Eastern Edition)*, March 9, 2005, B-1.

Project 2

Web/HTML Project Using Microsoft® FrontPage

Learning Objectives

- Understand the advantages and disadvantages of developing a Web page using Microsoft FrontPage.
- **Be able** to create a basic Web page.
- **Know how to control** formatting of words and images on a Web page.
- **Know how to create tables and lists on a Web page.**
- **Know how to create links to other Web pages, e-mail, and other sections of the Web page.**

Introduction

In this project, we demonstrate how to use the Notepad text editor to create a Web page. You created the same Web page in Project 2 with FrontPage. We create the same Web page in Projects 2 and 3 in order to contrast the two different approaches to Web page generation. Your instructor may require you to complete both projects in order to appreciate the differences between using FrontPage and Notepad to develop a Web page.

This project presents a step-by-step example that illustrates the techniques and concepts that are required to create a Web page in Notepad. The example is not the assignment; the assignment comes after the example. By working through the example provided, you will learn how to complete the assignment. An image of the completed example is shown in Figure P3.1.

EXAMPLE

In this example, we create a Notepad document that will be saved in a Hypertext Markup Language (HTML) format so that it can be used as a Web page. The example Web page is a product sheet for a pizzeria so that someone browsing the Internet can see what the restaurant offers. The example contains the standard set of Web features that appear on almost all Web pages: lists, images, links, and a table.

Note that the presentation and layout of the information are important. The company name, "University Pizza," is displayed prominently at the center and top of the Web page in large, red letters. This is followed by a list of locations where the pizza can be purchased. The location list is indented, with bullets before each location. This is a common unordered list layout that implies no particular importance as to which location is more important than another.

Now look at the list of reasons that follow "Why order from us?" This is an ordered list. An ordered list implies that the most important item is listed first. The default order uses numbers, but Roman numerals and letters of the alphabet can also be used. Similarly, a disc (small circle) is the default bullet for an unordered list, but other shapes can be used.

After the locations where the pizza can be purchased, a table is shown that presents pizza prices according to topping and size. The table has four columns and four rows.

The image of a chef holding a tray of pizza is just an image found from another application. You can use any image you wish, but this image is one that is appropriate for a Web page that promotes pizza sales. Notice that it is centered on the Web page. Like paragraphs and words, images can be aligned to the left side, the center, or the right side of the Web page.

The Web page has three links. The first, "Contact Us" is a link to send an e-mail. "Link to My School" is a hyperlink to your school's Web page. The last link, "Go To Top of Page," is a navigation aid for the Web page. Long Web pages sometimes require navigation aids so that users can jump to different parts of the page quickly. This technique enables users to quickly jump to the part of the page of interest and skip unwanted information. When designing Web pages, it may be better to have a single, long Web page rather than several short Web pages so that when users print the Web page they will get all the information at once instead of having to print one short page, link to another Web page, print that short page, and so forth, until all the information is printed.

University Pizza

Locations
- Library
- Recreation Center
- 101 North Main

Topping	*Small*	*Medium*	*Large*
pepperoni	$5.75	$8.50	$10.25
sausage	$6.75	$10.50	$14.50
vegetarian	$3.95	$6.50	$9.25

Why Order from us?
1. it is the best pizza you ever tasted
2. our prices are great
3. fast delivery

Contact Us

Link To My School

Go To Top Of Page

Figure P3.1
Completed Example

SECTIONS OF AN HTML DOCUMENT

HTML documents consist of two sections. The "head" section conveys information to the Web browser software; the "body" section determines what the user will see displayed on the screen. Information in the head section includes the title of the Web page. The title is displayed in the top, blue line of the Web browser, above the information on the Web page itself. Other information can be included in the head to denote the author of the page, keywords that will be useful for Web searches, and more. Most information in the head is never seen by the viewer of the Web page.

The body section contains the part most people think of as the Web page. Images, tables, lists, and links all occur in the body. The body lists the HTML commands (represented as words enclosed in angle brackets) and the actual text and images to be presented on the Web page. Commands have distinct beginnings and endings so that the Web browser software understands what commands to apply to specific Web page content.

Many useful HTML guides are available. 2K Communications provides a comprehensive set of HTML tutorials and instructions (WWW.2KWEB.NET/HTML-TUTORIAL). W3Schools (WWW.W3SCHOOLS.COM/HTML) also provides a number of useful tutorials. All of the instructions needed for this assignment are contained in this project, but these additional sources can aid you in the development of other Web pages.

MAKING THE NOTEPAD DOCUMENT

A short Notepad document can be used to create the Web page. Figure P3.2 shows the document that creates the Web page. Note that the line numbers in Figure P3.2 are for reference only; they are not typed into the Notepad document. The instructions that follow guide you through creating a Notepad document that will generate a Web page similar to the one shown in Figure P3.1. Do not be alarmed if your document does not look *exactly* like the one shown in Figure P3.1, but it should look similar.

These instructions will always direct you to the commands and subcommands that achieve the desired effect. However, note that icons exist that can perform the same operations with the single click of the mouse. If you move the cursor over an icon and wait a moment, an explanation box will appear that tells what action is performed by clicking the icon. However, not all computers display the same set of icons, so this example will use the commands and subcommands.

Begin by opening Notepad and creating a new document. Click the "Start" command (to the bottom left of the screen) and then choose the "Programs" subcommand. Depending on your particular version of Windows, either the Notepad program will appear in a list or you may have to click the "Accessories" subcommand before the Notepad program choice is available.

Type lines 1 through 5 of Figure P3.2 into the Notepad document. Remember, do not type in the line numbers; they are for reference only. *Do not try to view the document using a Web browser until you have completed the entire example.* HTML expects beginning and ending commands—such as "<html>" and "</html>." If you were to type only part of the example and try to view it as a Web page, the browser would not find the ending commands, such as "</html>." The browser will try to "fix" the errors, which may result in a Web page very different from what you would expect. Always complete your Web page before trying to view it in a browser.

Lines 1 through 5 establish that the title of the Web page will be "University Pizza" and begin the body section of the HTML code. Line 6 is a placeholder, a place on the Web page where the cursor can be directed. The line "" is an anchor. We know this because there is a beginning angle bracket followed by the command "a," which stands for "anchor," which is a place within the document or on some other HTML document where the user can be directed via a hyperlink. In HTML, commands can be in uppercase or lowercase; it does not matter whether you enter your HTML code in uppercase or lowercase letters.

The first part of our example (see Figure P3.1) is to place "University Pizza" at the top center of the Web page in large, red letters. Line 7 contains the HTML to begin a paragraph (denoted by the "p" command) that will be aligned in the center of the Web page. In line 8, the font size is increased by three steps, much like choosing three items down in a drop-down menu. Notice that the font command also changes the color of "University Pizza" to red. These changes should not apply to all of the text on the page; therefore, we must turn off these changes to the default font (line 10) and to the default paragraph alignment (line 11).

Next, we wish to list the locations where the pizza is sold. A blank line is left after a paragraph, but in line 12 we use the "line break" command ("
") to insert an additional blank line. We create an unordered list in line 13 and give it the title "Locations." Then we create three list items—Library, Recreation Center, and 101 North Main Street—using the "<li>" command. Notice that the "unordered list" command is turned off with the code in line 17.

We are ready to create a table for pizza prices. The table in Figure P3.1 has four rows and four columns. The first row contains the words "Topping," "Small," "Medium," and "Large" in italics. The text in each of the data cells of the table is centered. A table data cell is marked with "td," as shown in line 20.

Figure P3.2 **Notepad Document to Create the Web Page Example**

```
<html>
<head>
<title>University Pizza</title>
</head>
<body>
<a name="top_of_page"></a>
<p align=center>
<font size=+3 color=red>
University Pizza
</font>
</p>
<br>
<ul>Locations
<li>Library
<li>Recreation Center
<li>101 North Main
</ul>
<table>
<tr>
<td align=center><i>Topping</i></td>
<td align=center><i>Small</i></td>
<td align=center><i>Medium</i></td>
<td align=center><i>Large</i></td>
</tr>
<tr>
<td align=center>pepperoni</td>
<td align=center>$5.75</td>
<td align=center>$8.50</td>
<td align=center>$10.25</td>
</tr>
<tr>
<td align=center>sausage</td>
<td align=center>$6.75</td>
<td align=center>$10.50</td>
<td align=center>$14.50</td>
</tr>
<tr>
<td align=center>vegetarian</td>
<td align=center>$3.95</td>
<td align=center>$6.50</td>
<td align=center>$9.25</td>
</tr>
</table>
<p align=center>
<img src="PizzaMan.gif" border=0>
</p>
<ol>Why Order from us?
<li>it is the best pizza you ever tasted
<li>our prices are great
<li>fast delivery
</ol>
<p align=right>
<a href="mailto:JohnDoe@company.com">Contact Us</a>
</p>
<p align=right>
<a href="http://www.MySchool.edu">Link To My School</a>
</p>
<p align=center>
<a href="#top_of_page">Go To Top Of Page</a>
</body>
</html>
```

Creating tables in HTML is simple, but tedious. You have to specify the start and end of not only the table, but also of each row and each data cell. Line 18 begins the table; note that the command could also set lines around the cells of the table. If the command were "<table border=1>" then a thin border would be produced; "<table border=10>" would create fat lines around each cell.

Look at line 19 in Figure P3.2. It is the command to start a new row in the table. Line 18 started the table, but line 19 tells HTML to start a row. Lines 20 through 23 create four data cells that represent the column headings. Note from Figure P3.1 that these headings are italicized. The "<i>" and "</i>" commands around the words cause them to be displayed in italics. Also note that the contents of the table data cells are centered.

It is very important to remember to begin and end each data cell, row, and the table itself. Forgetting just one of the endings can cause the Web browser to try to correct your mistake, and the results can be difficult to predict. Be very careful as you type HTML code into the Notepad document.

Images are not embedded in the HTML code, but are instead referenced by an "image" command. In Figure P3.1, the source file containing the image of the chef holding a pizza is "PizzaMan.gif," and it is located in the same directory as the HTML file. "Img" is the abbreviation for image, and "src" is the abbreviation for the source file that contains the image. Line 44 creates a paragraph that is centered in the Web page. Line 45 tells HTML to use the file "PizzaMan.gif" with no border around the image; that is, "border=0." Line 46 turns off the center paragraph alignment so that alignment will go back to the default, which is left alignment.

The ordered list of "Why order from us?" is shown on lines 47 through 51. It begins with "<ol>Why order from us?" as the title of the list. An ordered list (coded "ol") uses numbers to denote the sequence of the list items. You do not enter the number values, the Web browser will generate the numbers to be displayed.

The last three items in Figure P3.1 are links. The first two links are aligned to the right-hand side of the Web page. Lines 52 and 54 are the starting and ending commands that cause the paragraph to be aligned on the right-hand side.

Now we discuss the three types of links on this site: one to another Web page, one to an e-mail program, and one to some other part of the Web page being browsed. The first hyperlink (line 53) is "mailto:JohnDoe@company.com." The "mailto:" segment instructs the Web browser to link to the computer's e-mail software and to insert "JohnDoe@company.com" as the recipient of the e-mail message. For your assignment, you should substitute your own e-mail address for "JohnDoe@company.com." The phrase "Contact Us" is all that the user sees on the Web page; the "anchor" command remains invisible. Do not forget to end the anchor command with "," or else the rest of the Web page will link to the e-mail program as well.

The second hyperlink is to a fictitious Web site. The phrase "Link to My School" is displayed to the user, and you should use your own school Web address here. For example, the Web site for the University of North Carolina Wilmington is HTTP://WWW.UNCW.EDU. Do not forget to use the whole Web address, including the "http://." If you leave "http://" out of the address, the link will not work. Notice that this link is also placed on the right-hand side of the Web page.

The last link is a hyperlink reference to a place on the Web page. Look back at line 6 in Figure P3.2. Note that it is a named reference point within the Web page; its name is "top_of_page." Line 59 hyperlinks to the named reference point. The "#" character in the hyperlink reference "#top_of_page" tells the Web browser that the hyperlink point is within the current Web page.

The last two lines of Figure P3.2 contain "</body>" and "</html>" commands. It is very important to end with these two HTML commands so that the Web browser can interpret the Web page correctly.

Figure P3.3 **Saving the HTML File**

SAVING THE EXAMPLE

You must save the document as an HTML file. The default type of document in Notepad is a text document, and the .txt file extension will be added automatically to the file name if the file is saved in "text" mode. A Web browser will not interpret text documents. Choose "File" followed by "Save As" and Figure P3.3 will appear.

Enter a file name such as "UniversityPizza.htm," but without the quotation marks. Figure P3.4 shows that the file type chosen (i.e., "Save as type") must be "All Files" and the encoding must be "ANSI." If you fail to choose "All Files" as the file type, the Web page will probably not work and, even worse, the extension ".txt" will be added to the end of your file name.

VIEW THE WEB PAGE

Once the Web page has been saved, you can view it to see if it works correctly. You do not need to close the Notepad program; it can remain open while you view your file with the Web browser. Open your Web browser and choose the "File" command followed by the "Open" subcommand. Type in the file name or "Browse" to it and click the "OK" button. Your Web page will appear in the browser.

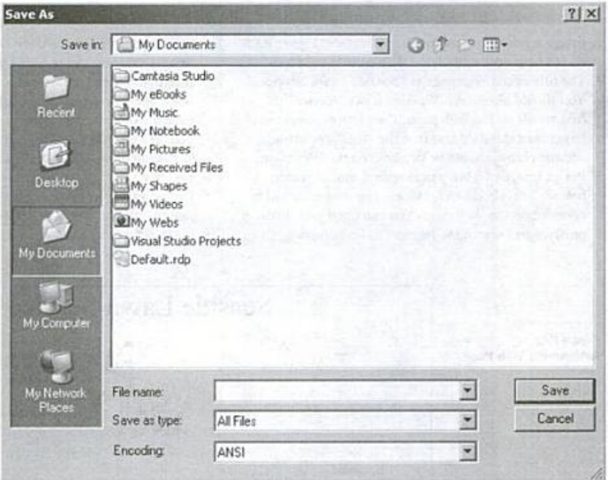


Figure P3.4 **"Save As" Type and Encoding**

If you need to make any corrections, choose the Notepad editor again. Edit the HTML code and save the document again. It is very important that each time you save the HTML file using Notepad that the file type is "All Files." Reopen the Web browser and choose the "View" command followed by the "Refresh" subcommand. Repeat the process until you are satisfied with your Web page.

ADVANTAGES AND DISADVANTAGES OF USING NOTEPAD

What you see displayed on a Web page is not what the Web browser uses to create the page. HTML is fairly easy to learn, but coding can be tedious and typing mistakes can have disastrous effects. Besides, the strength of managers is in their business talent, and not in HTML coding skills.

The disadvantages of creating a Web page with a text editor such as Notepad are having to learn HTML commands and the coding process. Though simple, coding HTML in Notepad is time consuming. However, there are two advantages to coding HTML in Notepad: the code is efficient and the manager understands more about how Web pages work.

Managers either purchase Web pages as completed products from vendors or pay wages to employees to do the work. It is important for managers to be informed consumers during the Web page development process. After having created a Web page, you are in a better position to clearly express what you need in a Web page and know whether your requests are simple or complex.

Assignment

1. Create a product sheet for a lawn service. Figure P3.5 shows how your completed Web page should look.
2. The title of the Web page is "Seaside Lawn Service." You should also make "Seaside Lawn Service" the first words on the Web page. They letters should be larger than standard text (use the "font" command), and the phrase should be centered on the Web page.
3. Put an image of a lawn mower or a similar image below "Seaside Lawn Service." The image should be centered on the Web page. You can open your Internet browser and search the Internet to find an image to use. Yahoo! (WWW.YAHOO.COM) has a section of images that you can search. Once you have located an image, move the mouse to the image, right-click, and select the "Save Picture As" option. Make sure you save the image to the same folder that you have saved your HTML file to.
4. Create an unordered list of locations that matches Figure P3.5.
5. Create a table of mowing services and prices. Note that the words "Lot Size," "Mowing," and "Edging" are in bold font. The "<i>" HTML command results

Figure P3.5
Assignment Web Page

Seaside Lawn Service

Locations

- New Bern; call 555-9010
- Del Ray; call 555-0190
- Pine Village; call 555-8118

Lot Size	**Mowing**	**Edging**
one acre or less	$35	$10
two acres or less	$65	$18

Top Reasons To Call

1. best price
2. reliable service
3. 20 years of experience
4. yards mowed in less than one hour

Contact Us

Link To USDA

Go To Top Of Page

in italicized text; "" results in bold text. Don't forget that "" turns off the bold font. Also be sure to center the words in each data cell.

6. Create an ordered list that identifies the four top reasons to call Seaside Lawn Service.
7. Create the following three links: "Contact Us," "Link to USDA," and "Go To Top Of Page." They are aligned to the left, center, and right of the Web page, respectively. Your Web page must mimic this alignment. "Contact Us" must be a "mailto" anchor link that goes to your e-mail address. "Link to USDA" goes to the U.S. Department of Agriculture at WWW.USDA.GOV (don't forget the "http://" requirement). "Go To Top Of Page" must point to the top of your Web page. It will be difficult for you to confirm that the link works unless you resize the Web page so that the entire page cannot be seen at the same time.

Project 5

Web/HTML Book Purchase Form

Learning Objectives

- Understand how forms capture information from Web page users.
- Understand the use of text boxes and text areas to acquire typed input from a user.
- Know how to create a radio button and a check box to acquire user input from a mouse click.
- Know how to create a choice of options from a drop-down menu.

Introduction

This project assumes that you have some knowledge of HTML (hypertext markup language) and how to use Notepad as a text editor. If you have completed Project 3, you have sufficient knowledge to begin this project. Project 4 is a companion project; it covers the same learning objectives as this project, but uses a different example. Projects 4 and 5 both present Web/HTML form concepts so that instructors have the option to further enforce form concepts with two projects or to assign different projects to students in different semesters.

Forms provide a mechanism for gathering information from Web page users. Without forms, communication on the Web would be one way—from the Web page to the viewer. Organizations need to capture information from Web site visitors in order to make their Web sites interactive. This project involves the generation of a form for use in purchasing textbooks.

This project creates the form but does not provide the Web browser with instructions for processing the form results. Information from a form is generally e-mailed to the firm or assimilated into its database. It is not particularly difficult to generate e-mail form responses. However, many schools prohibit students from e-mailing form data or capturing it to a database because of concerns over security or excessive use of computer resources. If your school allows e-mail responses to forms, you may wish to use a free service that e-mails form answers to your e-mail account. Response-O-Matic (WWW.RESPONSE-O-MATIC.COM) is a very popular service that is free and easy to use.

EXAMPLE

The example creates a form to purchase a textbook for an information systems course. The completed Web page form is shown in Figure P5.1. It represents the five most common techniques for capturing information from a Web site. The first technique is a text field (such as the "Name" field) in which the user types one line of data. A drop-down menu ("What course are you taking?") uses a small amount of space on the Web page and presents a number of mutually exclusive choices to the user. The radio button technique ("What type of book do you prefer?") is appropriate when a few mutually exclusive choices are offered. The check box ("What else would you like?") is similar to a radio button, but the user may select one or more of the choices. The last input technique in the example is a text area for comments. It allows the user to enter several lines of data into a single input.

Each of these techniques has its advantages. Drop-down menus offer mutually exclusive choices, just like radio buttons; however, they take up less space on the computer screen. If there are 50 or more choices (such as selecting a state for a mailing address), drop-down menus are superior to radio buttons. However, radio buttons have the advantage of displaying all of the choices to the user at a single glance.

Text areas allow multiple lines; text fields allow only a single line. A text area could hold an entire address, but firms may wish to use text fields to break the address into parts—city, state, and so forth. The choice of field type should be driven by how the firm wants to display the form and use the information gathered.

Each input field has two characteristics: a field name and a value. A field could be named "Color," and its value might be "red," "white," "blue," or some other color. The user sees text

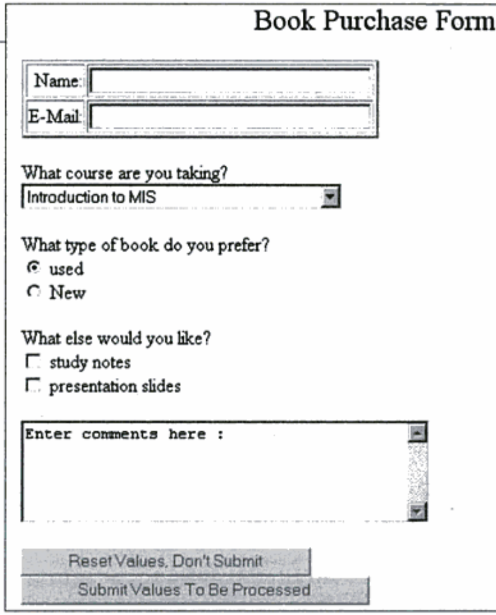


Figure P5.1
Completed Form

displayed on the computer screen, but the computer recognizes field names and the values assigned to those fields.

SECTIONS OF THE EXAMPLE FORM

The form begins in the same manner as Project 3. A significant difference is in lines 6 and 50 of the HTML code, which are used to generate the form (see Figure P5.2). The line numbers in the figure are for reference only—they do not actually appear in the file of HTML code for the Web page. The set of "<form>" and "</form>" commands tells the Web browser that the Web page will capture information from the user. Without the commands to initiate and end a form, the Web page cannot capture information from the user.

From Figure P5.2, you can see that the request for a name and an e-mail address is enclosed in a table. Lines 13 and 17 are the commands that capture input for the user's name and e-mail address. Notice that the input type is "text," which instructs the Web browser that the user will type text into the input field. The command allows a size of 35, so a maximum

```
<html>
<head>
<title>Book Purchase</title>
</head>
<body>
<form>
<p align=center>
<font size=+2>Book Purchase Form</font>
</p>
<table border=2>
<tr>
<td align=right>Name: </td>
<td><input type="text" name="Student" size=35></td>
</tr>
<tr>
<td align=right>E-Mail: </td>
<td><input type="text" name="EmailAddr" size=35></td>
</tr>
</table>
<br>
What course are you taking?
<br>
<select name="Course">
<option value="MIS213">Introduction to MIS</option>
<option value="MIS216">Introduction to Visual Basic Programming</option>
<option value="MIS315">Database Management Systems</option>
<option value="MIS316">Programming Applications</option>
<option value="MIS411">Systems Analysis and Design</option>
</select>
<br><br>
What type of book do you prefer?
<br>
<input type="radio" name="Prefer" value="U" checked> Used
<br>
<input type="radio" name="Prefer" value="N"> New
<br><br>
What else would you like?
<br>
<input type="checkbox" name="Notes" value="yes"> study notes
<br>
<input type="checkbox" name="Slides" value="yes"> presentation slides
<br><br>
<textarea name="Comments" rows=5 cols=40 wrap="yes">
Enter comments here :
</textarea>
<br><br>
<input type="reset" value="Reset Values, Don't Submit">
<br>
<input type="submit" value="Submit Values To Be Processed">
</form>
</body>
</html>
```

Figure P5.2 **HTML Code for the Example** of 35 characters can be typed into the text boxes. Note that line 20 ("
") just inserts a blank line onto the form.

The next section of the Web page asks about the course being taken by the student. Lines 23 through 29 show how the selection and options are defined. The student sees course names, such as "Introduction to MIS," "Introduction to Visual Basic," and "Systems Analysis and Design." When the student chooses one of those options, the form sends the value associated with the choice. For example, a student choice of "Database Management Systems" causes the form to send the value "MIS315" to be processed.

Drop-down menus are also called selection boxes; they present the user with a list of mutually exclusive choices. An icon of a downward-pointing triangle is used to signify a drop-down menu. That icon is shown in Figure P5.1 just to the right of the phrase "Introduction to MIS."

Note that there is a beginning and ending command for the selection (lines 23 and 29), and each option of the selection list has its own beginning and ending. The "/" before the command name denotes the end of a command. The name of the selection field is in the "selection" command, but the value assigned to the field is generated from an "option" command. Generally, the first option in the list of options will be the value shown on the Web page. Note that "Introduction to MIS" is displayed in Figure P5.1, and it is the first option within the "select" command. However, if "<option value='MIS315' selected> Database Management Systems</option>" were substituted for line 26, the word "selected" would cause the "Database Management Systems" option to be the one displayed by default on the Web page.

The next section of the form asks whether the student prefers a used or new book. Note four important features: the field type, the field name, the field value, and the fact that the "used" choice is checked by default. The field type of "radio" causes the Web browser to assign a circle that can be checked with a mouse click. The field name ("Prefer") is the same value in lines 33 and 35. Using the same field name is what causes the choices between radio buttons to be mutually exclusive. A given field name can have only one value—the value assigned when the circle is chosen by a mouse click. A common mistake is misspelling the field name between radio button statements, which allows more than one button to be chosen.

Notice the "value" field in line 33. When the circle before the phrase "used" is checked, but the form registers the value "U" in the "Prefer" field. The Web page user sees the phrase "used," but the form sees the value "U" when the circle is checked.

The word "checked" in line 33 causes the Web page to have the "used" choice checked by default. Notice that line 35 does not contain the word "checked." Only one choice for the radio button field should have "checked" in its input command. Otherwise, the Web browser cannot know which of the mutually exclusive choices should be checked.

Radio buttons should be used for a limited number of exclusive choices. If many choices are presented, they can take up an excessive amount of space on the Web page. An advantage of radio buttons is that all of the available choices are presented at once.

When a user can select more than one choice, check boxes should be used. Figure P5.1 presents check boxes for additional class-related items that can be purchased—notes and slides. Lines 39 and 41 in Figure P5.2 create the check boxes in the example for purchasing study notes and presentation slides. Note that the field name is different in lines 39 and 41; each line creates its own field and multiple check boxes may be chosen. If the student wants study notes, then the "Notes" field will have the value of "yes." If the field is not chosen, then the computer does not assign a value to "Notes."

As with other commands, what the user sees on the computer screen may not be what the form records. If the user chooses the option of "presentation slides," then the "Notes" field would contain the value "yes."

The last field of the example (lines 43 to 45) solicits additional comments from the student. The form assumes that the student may need more than a single line of text to offer a comment. A text area is used for such comments. The name of the text area is set to "Comments," and the user is provided 5 rows of 40 characters each to make comments. Notice that there is a "wrap" field and its value is set to "yes." The Web browser will automatically wrap text to the next line (like a word processor) as the comments are typed.

Line 44 lies between the beginning and ending commands of the text area. The phrase "Enter comments here:" is displayed on the computer screen within the text area. If line 44 were removed, there would be no default text in the text area.

Two special types of input are required to commit the Web browser to act on the information collected by a form: reset and submit. The "Submit" command is shown in line 49 of Figure P5.2. The value displayed in the button created by this command is "Submit Values To Be Processed." In most forms, an action is specified in the "form" command (line 6), and the Web browser would execute the actions specified when the "Submit" button is clicked. We have chosen not to act upon the data collected by the form; clicking the "Submit" button merely restarts the Web page that contains the form.

The "Reset" command in line 47 presents the phrase "Reset Values, Don't Submit" in the button. Clicking that button resets all of the choices to those originally provided within the HTML commands. This is similar to a user erasing responses from a paper form.

SAVING THE EXAMPLE

You must save the document as an HTML file. The default type of document in Notepad is a text document, and the .txt file extension will be added automatically to the file name if the file is saved in "text" mode. A Web browser will not interpret text documents.

Enter a file name such as "Book.htm" for your project, but without the quotation marks. The file type chosen ("Save as type") must be "All Files," and the encoding is "ANSI." If you fail to choose "All Files" as the file type, the Web page will probably not work, and, even worse, the extension ".txt" will be added to the end of your file name.

VIEW THE WEB PAGE

Once the Web page has been saved, you can view it to see if it works correctly. You do not need to close the Notepad program; it can remain open while you view your file with the Web browser. Open your Web browser and choose the "File" command followed by the "Open" subcommand. Type in the file name or "Browse" to it and click the "OK" button. Your Web page will appear in the browser.

If you need to make any corrections, choose the Notepad editor again. Edit the document's HTML code and save the document again. It is very important that each time you save the HTML file using Notepad, the file type is "All Files." Reopen the Web browser and choose the "View" command followed by the "Refresh" subcommand. Repeat the process until you are satisfied with your Web page.

Assignment

1. Create a "Hi-Tech" food order form using Notepad that looks similar to Figure P5.3.
2. Note that the title for the Web page is "Food Choice." See line 3 of Figure P5.2 to see how the Web page title is described.
3. The name label and the text box field associated with it in Figure 5.3 are not contained in a table. The text box field for the name should be limited to 25 characters. Remember that the "
" command puts blank lines after words on the Web page.
4. Two types of orders are possible: "take out" or "eat here." The default choice should be "take out." The values assigned to the choices are "Out" and "In."
5. Four food choices are offered in the drop-down menu: "hot dog," "hamburger," "chicken fingers," and "green salad." The values used by the form that correspond to these choices must be "dog," "burger," "chicken," and "salad."
6. Create two check boxes: one for iced tea and one for French fries. The default for both check boxes is that they are not checked.
7. Create a text area with 5 rows of 40 characters each. The word wrap feature should be turned on and the phrase "Special instructions:" must appear within the text area box.
8. The last two buttons on the form must submit the form and reset the values entered on the form.

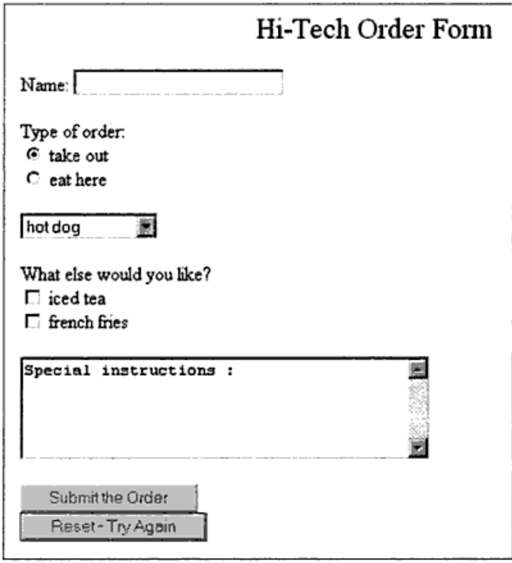


Figure P5.3
Assignment for Hi-Tech Order Form

Project 6

Spreadsheet Basics

Learning Objectives

- Know how to format spreadsheet cells.
- Understand how to use formulas to make calculations.
- Know how to use multiple datasheets.
- Understand how to create conditional calculations using IF. . .THEN statements.

Introduction

This project uses Microsoft Excel to create a basic spreadsheet. The appearance of a spreadsheet is important; therefore, in this project you will learn how to format the values in the cells of a spreadsheet. This example uses a single spreadsheet file that contains two datasheets. The first datasheet contains invoice items; the second contains information on price. A built-in Excel function enters the system date (the computer's date) into the invoice.

Spreadsheets are a common business application. They can be used to perform calculations and conditional logic that would otherwise be difficult for managers to carry out. Calculations are computed quickly and without errors. By using spreadsheets rather than relying on manual calculations, managers reduce the risk of mathematical errors that can affect their decision making. As an additional benefit, spreadsheets are visually pleasing and can often be printed and used as documentation of the business process.

EXAMPLE

This example creates an invoice. Figure P6.1 displays the "Invoice" datasheet; Figure P6.2 displays the "Discount" datasheet. The tab that is highlighted at the bottom of the screen tells you which datasheet is being displayed.

The invoice contains four items: chair, table, lamp, and pillow. Each item has a unit price; a discount is displayed based on the unit price. The unit price, minus any discount, multiplied by the number of units ordered determines the extended price.

The extended prices are added to determine the invoice total. The amount due from the customer depends on when the customer pays the invoice. The date "7/4/06" is the date the invoice was generated. On that date, the customer simply pays the total amount. However, if the customer waits 30 days before paying (until 8/3/06), the amount to be paid is 101 percent of the total, or $2,228.33. After 60 days, the amount owed is 103 percent of the total.

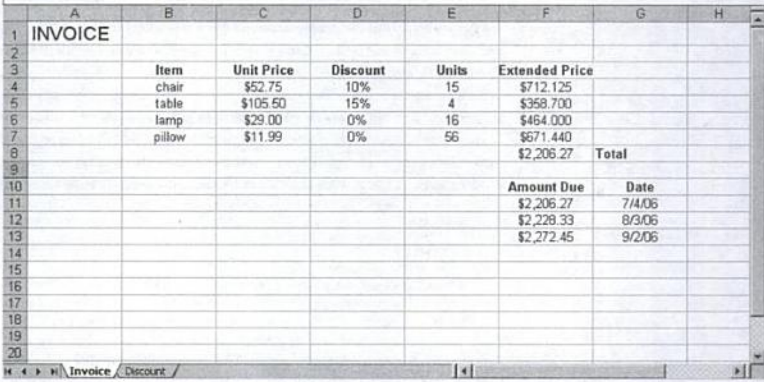
Notice that days, not months, were added to the original purchase date. That is why the subsequent dates are 8/3/06 and 9/2/06. Not all months have 30 days.

Spreadsheet cells in the "Invoice" datasheet are formatted so that they are visually appealing. Cells in the "Discount" datasheet have been left in their default format, because the user will generally not view this datasheet. Spreadsheets are more than simple calculating programs; they can be used to provide relatively sophisticated information systems capabilities to firms. As such, the appearance of the spreadsheet should be in a form that aids decision making.

Begin the example by opening the Excel program. Notice that there are three datasheet tabs at the bottom of the screen (see Figure P6.3): "Sheet1," "Sheet2," and "Sheet3." We only need two datasheets for our example, and we wish to label them "Invoice" and "Discount." Click the "Sheet3" tab and then choose the "Edit" command followed by the "Delete Sheet" command. Make sure you choose "Delete Sheet" and not the "Delete" subcommand. After deleting "Sheet3," two datasheets remain.

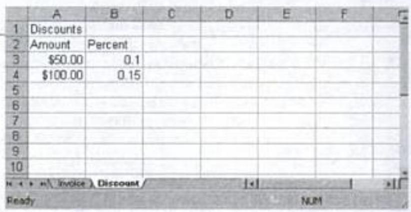
Double-click the "Sheet1" tab to highlight the phrase "Sheet1." Press the "Delete" button to eliminate the name "Sheet1" and type "Invoice" for the tab label. Double-click the "Sheet2" tab, delete it, and type "Discount." You now have the correct datasheet labels on the two sheets needed for this example.

Figure P6.1 Invoice Datasheet for the Example



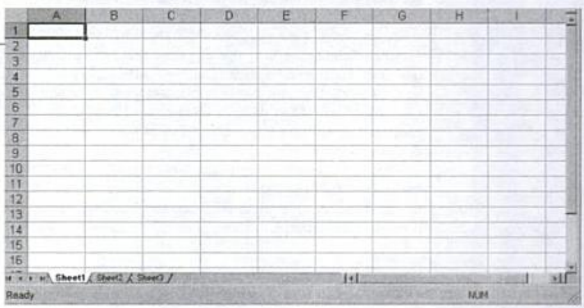
	A	B	C	D	E	F	G
1	INVOICE						
2							
3		Item	Unit Price	Discount	Units	Extended Price	
4		chair	$52.75	10%	15	$712.125	
5		table	$105.50	15%	4	$358.700	
6		lamp	$29.00	0%	16	$464.000	
7		pillow	$11.99	0%	56	$671.440	
8						$2,206.27	Total
9							
10						Amount Due	Date
11						$2,206.27	7/4/06
12						$2,228.33	8/3/06
13						$2,272.45	9/2/06

Figure P6.2 Discount Datasheet for the Example



	A	B
1	Discounts	
2	Amount	Percent
3	$50.00	0.1
4	$100.00	0.15

Figure P6.3 Open New Excel Spreadsheet



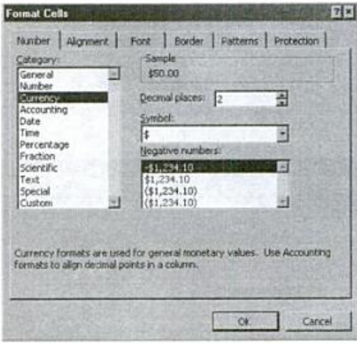


Figure P6.4
Formatting Cells as Currency Values

DISCOUNT DATASHEET

The contents of the "Discount" datasheet (Figure P6.2) will be entered first. The purpose of this datasheet in our example is to establish two unit price amounts that establish discount percentages. In our example, if the unit price amount is greater than or equal to $100, then the discount is 15 percent. A price greater than or equal to $50 results in a discount of 10 percent.

You must enter the values into the cells as they are shown in Figure P6.2. The formulas used in the "Invoice" datasheet depend on the values of specific cells in the "Discount" datasheet. Notice that the percent values are left as .1 and .15; they have not been formatted as percentages with percent signs. The dollar amounts—$50.00 and $100.00—have been formatted. After typing the values "50" and "100" into cells A3 and A4, highlight the cells and choose the "Format" command followed by the "Cells" subcommand and the screen in Figure P6.4 appears. Choose a currency format with two decimal places to achieve the desired format for these values.

INVOICE DATASHEET

The "Invoice" datasheet is more complex. Begin by making the column widths wide enough so that they hold the values and headings of the invoice. Use the mouse to select columns A through G, then choose the "Format" command followed by the "Column" and "Width" commands. When Figure P6.5 appears, select a column width of 13.

Now you can enter data without the values exceeding the size of the cells. You should begin by entering the data values into cells that do not require calculations. Your values may not appear in the same format as on the "Invoice" datasheet; we will format the fields after values have been entered.

Cell A1 has the entry "Invoice." Cells B3 to B7 have the words "Item," "chair," "table," "lamp," and "pillow." The unit prices are similarly entered in cells C3 through C7. Skip the D column; those values will be calculated later. Enter the units into cells E3 through E7. Enter the words "Discount" in cell D3 and "Extended Price" in cell F3. Enter "Total," "Amount Due," and "Date" in cells G8, F10, and G10, respectively.

Figure P6.5 **Changing Column Width**

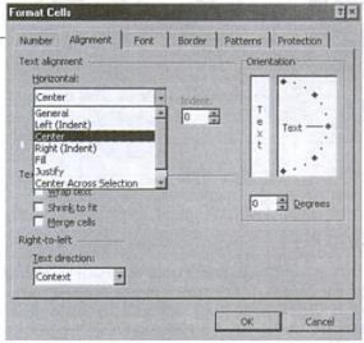


Figure P6.6 **Formatting Cells to Be Centered**

We wish to center the text in cells A1 to G13. Highlight the entire area by clicking the mouse on cell A1, and while holding the mouse button down drag the cursor to cell G13. Release the mouse button (the entire area will be highlighted) and choose the "Format" command followed by the "Cells" subcommand. Choose the alignment tab and the screen shown in Figure P6.6 appears. We wish for these values to be centered.

The one exception for centering is cell G8, where the word "Total" appears. The word "Total" should be aligned to the left-hand side of the cell. Using Figure P6.4 as a guide, format cells C4 through C7 as currency fields with two decimal places. Format cells D4 through D7 as percentages with zero decimal places. Cells F4 through F7 should be currency with three decimal places. The "Total" amount (cell F8) and the values under "Amount Due" should all be currency with two decimal places.

The discounts depend on the unit price and the values in the "Discount" datasheet. This is a conditional formula that requires an "IF" statement to generate a value. Typically, an "IF" statement tells Excel that a value will be placed in the cell based on certain conditions. There will be a comparison (such as if one cell has a greater value than another) followed by the value to place in the target cell if the comparison is true, followed by a value to be placed in the cell if the comparison is not true. Our "IF" statement is more complex, because if the comparison is not true we wish to perform a second comparison; that is, a second "IF" statement.

Figure P6.7 shows the "IF" statement for cell D4. Look at the top line of the datasheet, above the cells. If the value in cell C4 is greater than or equal to the value in the "Discount"

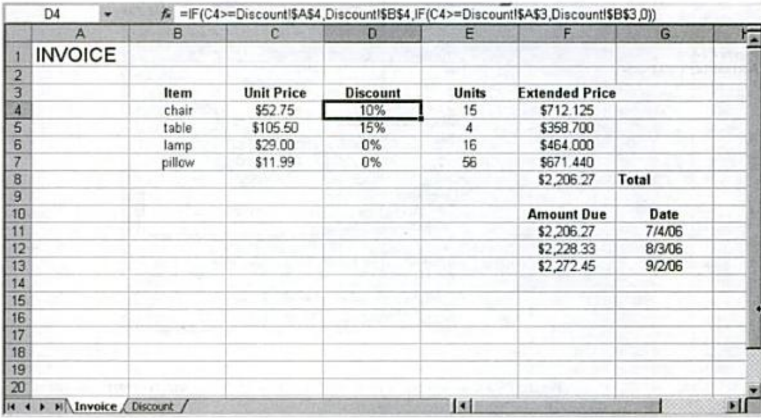


Figure P6.7 **Formula for Calculating Discounts**

datasheet ("Discount!") cell value of $A$4, then the value of "Discount" datasheet cell $B$4 will be placed into the cell. The cell could have been denoted as simply A4 in the "Discount" datasheet, but with the "$" preceding the column and row designations we can cut and paste this formula into other cells.

If the value in C4 is not greater or equal to Discount!$A$4, then another comparison is performed. When the value in C4 is greater than or equal to Discount!$A$3, then this cell becomes the value in Discount!$B$3. If neither comparison is true, the value becomes zero.

One caution: The ordering of the "IF" statements is critical when two or more are nested in a formula. An "IF" statement will stop as soon as a comparison is true. We had to take the largest value first (Discount!$A$4 equals $100). Assume that the unit price was $150. If the formula had compared the value to Discount!$A$3 first (a value of only $50), it would have been true and a discount of 10 percent would be placed in D4 instead of the correct value of 15 percent.

The extended price is the unit price multiplied by one minus the discount multiplied by the number of units purchased. The current date is placed in cell G11 as the Excel function "=NOW( )" (without the quotation marks). Cell G12 is simply cell G11 plus 30; cell G13 is cell G11 plus 60. The dates are formatted as month-day-year—no hours, minutes, or seconds should be displayed. Figure P6.4 displays the screen where formatting these cells occurs.

The last set of cells (F11 through G13) reflect the time value of money when paying the invoice. The amount due today (in cell F11) is simply the total of the extended prices—enter "=F8" into cell F11. After 30 days, the amount owed is 101 percent of the total; after 60 days, the amount owed is 103 percent of the total. Enter "=F8*1.01" into cell F12 and "=F8*1.03" into cell F13.

Figure P6.8
Formatting Cell Fonts

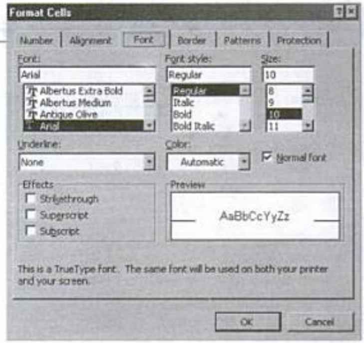


Figure P6.8 displays the screen resulting from choosing the "Format" command followed by the "Cells" command and then clicking the "Font" tab. You can make column headings bold and/or change the font size of the word "Invoice" in cell A1. Changing the fonts of cells can make the invoice more visually appealing.

SAVING THE EXAMPLE

You should save your example as "ExampleP6"; Excel will automatically add the .xls extension to the file name. This way you can refer to the example as you work the assignment below.

ASSIGNMENT

1. Create a spreadsheet for orders. Figures P6.9 and P6.10 display the format of the two datasheets. Format the cells the same way (centered, currency, etc.) as shown in those figures.
2. The extended price is the price multiplied by the number of units ordered.
3. The total is the sum of the extended prices.
4. The discount is obtained from the "Discounts" datasheet. If the total is greater than or equal to the amount in cell A3 of the "Discounts" datasheet, then the discount amount is the total in cell D7 of the "Order form" datasheet multiplied by the value in B3 of the "Discount" datasheet. Don't forget that in formulas on the spreadsheet you add an exclamation point after the datasheet name. For example, "Discounts!A3." If the total is greater than or equal to the amount in cell A2 of the "Discounts" datasheet, then the discount is the percent from "Discounts" datasheet cell B2 multiplied by the total.
5. The net amount is the total minus the discount.
6. The "Today" field should use Excel's "NOW()" function.
7. The amount due after 10 days is 112 percent of the total. The date of "Past" is 10 days from the date in "NOW()".

	A	B	C	D	E	F	G	H	I
1	**Paint Order**								
2									
3	**Product**	**Unit Price**	**Units**	**Extended Price**					
4	1 gallon	$5.75	7	$40.25					
5	5 gallon	$24.50	1	$24.50					
6	20 gallon	$87.95	8	$703.60					
7				$768.35	**Total**				
8				$38.42	**Discount**				
9				$729.93	**Net Amount**				
10									
11					**Today**	09/27/06			
12					**Past**	10/07/06	**Pay**	$817.52	
13									
14									

Order Form / Discounts

Figure P6.9
Assignment, Order Form Datasheet

	A	B	C	D	E	F	G	H	I
1	if greater than	discount %							
2	500	0.05							
3	1000	0.10							
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									

Order Form / Discounts

Figure P6.10
Assignment, Discounts Datasheet

Project 8

Spreadsheets with Data Capture—College Computing Example

Learning Objectives

- Know how to use formulas to make calculations.
- Be able to use multiple datasheets.
- Understand data-capture techniques such as drop-down menus, check boxes, and radio buttons.
- Know how to use Excel's built-in functions.
- Know how to develop macros and execute them with command buttons.

Introduction

In this project, you will learn how to use Microsoft Excel to create a spreadsheet with data-capture capabilities. You should have a basic understanding of Excel spreadsheets before attempting this project. If you have completed Project 6, then you have sufficient knowledge to begin this project.

Project 7 is a companion project; it covers the same learning objectives but uses a different example. Projects 7 and 8 both examine spreadsheets and data-capture concepts so that instructors have the option to further enforce these concepts with two projects or to assign different projects to students in different semesters.

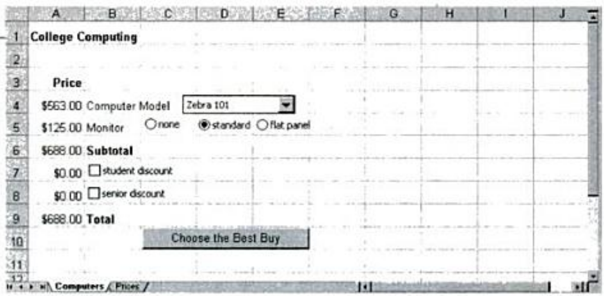
It is important to know how to capture data in spreadsheets with mouse clicks for two reasons: (1) it offers a way to easily capture complicated or extended amounts of data and (2) it reduces data-entry errors. For example, book titles are frequently four words long or more. When book titles are presented to the user in a drop-down menu, the user can simply click the choice and avoid typing in a long book name. Also, it eliminates the opportunity for the user to enter the book title incorrectly.

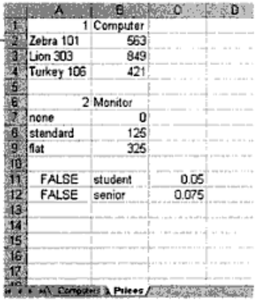
The use of mouse clicks to capture data improves the quality and speed of data capture from the user. However, this technique requires more effort when designing the spreadsheet. First, all of the possible input choices must be entered into the spreadsheet. Second, the drop-down menus, radio buttons, and check boxes must then be inserted into the spreadsheet.

EXAMPLE

This example generates a price sheet for purchasing a computer from College Computing. The purchaser may choose a computer model and a type of monitor. The purchaser may also be able to take advantage of two discounts. A drop-down menu (also called a *combo box*), radio buttons, and a check box are used to capture the purchaser's choices. The spreadsheet also has a command button that automatically makes selections for the "best buy." Figures P8.1 and P8.2 display the "Computers" and "Prices" datasheets of the spreadsheet.

Figure P8.1 **College Computing Example—Computers Datasheet**





	A	B	C	D
1	1	Computer		
2	Zebra 101	563		
3	Lion 303	849		
4	Turkey 106	421		
5				
6	2	Monitor		
7	none	0		
8	standard	125		
9	flat	325		
10				
11	FALSE	student	0.05	
12	FALSE	senior	0.075	
13				
14				
15				
16				
17				

Figure P8.2 **College Computing Example—Prices Datasheet**

The datasheet that will supply the data-capture values must be completed first. The values in the "Prices" datasheet will be displayed on the "Computers" datasheet. Data-capture techniques, such as drop-down menus, will not work until values are specified.

Begin this example by opening Excel and creating a new spreadsheet. Delete one datasheet so that only two datasheets remain. Change the name of the first datasheet to "Computers" and the second datasheet to "Prices."

PRICES DATASHEET

The "Prices" datasheet provides information for a drop-down menu, a set of radio buttons, and a check box. Three computer model choices are presented to the user; they are listed in cells A2 through A4 of the "Prices" datasheet. The model choices have specific dollar amounts that are presented in cells B2 through B4 of the "Prices" datasheet.

A radio button will be generated for the mutually exclusive choices of no monitor, a standard monitor, and a flat-panel monitor. The price changes based on the monitor selected. A check box will be used to capture information about a discount for students and one for seniors.

Choose the "Prices" datasheet and enter the values shown in Figure P8.2. *It is very important that you enter the values into the correct cells, because the following instructions assume that the locations of data-capture choices relate to the cells in Figure P8.2.*

Note that it is not required to have values in cells A1, A6, A11, and A12. In general, these cells would be left blank, because they are where the results from the "Computers" datasheet are reported. Those cells contain the results of the choices you see in Figure P8.1 so that you can see how results are reported. However, if you place values in cells A11 and A12, make sure that they are in capital letters, as in Figure P8.2.

COMPUTERS DATASHEET

Place the phrase "College Computing" in cell A1 of the "Computers" datasheet. Next, set the height for rows 1 through 11 to 18 by highlighting the rows and choosing the "Format," "Row," and "Height" commands. By setting the height to 18, the data-capture commands will fit in a row and the spreadsheet will be more visually appealing. Enter "Price" in cell A3. Enter the values in cells B4, B5, B6, and B9 as shown in Figure P8.1. Once the labels are entered, you are ready to define the data-capture techniques.

The toolbar that provides the form choices must be displayed. If the "Forms" toolbar is already displayed on your screen (see Figure P8.3), then you are ready to use the icons to develop the data-capture techniques. If the "Forms" toolbar is not displayed, choose the

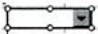


***Figure P8.5* Drop-Down Menu Box with Handles**

menu box will appear (Figure P8.5); you can tell it is selected to accept instructions because of the handles that appear at the corners and edges of the box.

Choose the "Format" command followed by the "Control" subcommand to display the screen that allows you to enter the location of menu choices and the input choice. Figure P8.6 displays this screen. Notice that the "Control" tab is displayed. The input range for the choices is "Prices!$A$2:$A$4," and the cell link that records the choice is "Prices!$A$1." You can see what the ranges should by viewing the "Options" datasheet in Figure P8.2. Note that the drop-down menu is located on the "Computers" datasheet, so the "Prices!" segment of the range tells Excel to look at the "Prices" datasheet cells for menu values and results. The exclamation point is important; it denotes that the "Prices" datasheet is where the designated cells are located.

Creating radio buttons for the monitor choices is a similar process. Click the radio button icon (Figure P8.3) and then create a radio button next to the word "Monitor" on the "Computers" datasheet. Your button should look similar to Figure P8.7. With the radio button highlighted, choose the "Format Control" command. The screen in Figure P8.8 will appear.

Choose the "checked" option so that no monitor (the "none" choice) is the default option. The cell-link value (the result of checking the radio button) should be "Prices!$A$6." Close the control screen for the radio button and click the mouse cursor inside the box of the radio button. Change the phrase "Option button..." to "none."

Create a second radio button for the "standard" choice and a third radio button for the "flat panel" choice. Make sure that the cell link for the "standard" and "flat panel" radio buttons is "Prices!$A$6." Setting the same cell link for all three radio buttons is what makes the choice mutually exclusive.

When the purchaser clicks the "none" radio button, a value of 1 will be placed in the cell link. Choosing the "standard" radio button will cause a value of 2 to be placed in the link. The order in which the radio buttons are created is important: The first radio button generates a value of 1, the second generates a value of 2, and so on.

The third data-capture technique is a check box. This technique will be used to capture data about two types of discounts. The purchaser can use a check box to select a student discount or a senior discount. Choose the check box icon from the "Forms" toolbar and draw the check

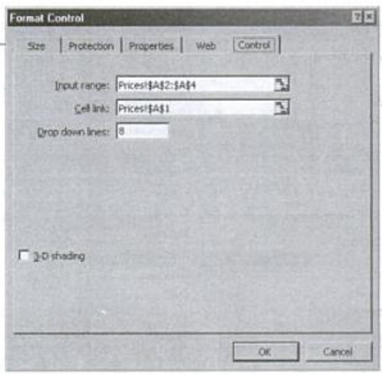


***Figure P8.6* Format Control for a Drop-Down Menu**

***Figure P8.7* Creating a Radio Button**

CALCULATING VALUES BASED ON CHOICES

We must now associate dollar values on the "Computers" datasheet with the choices captured from the purchaser. We begin by capturing the price of the computer model chosen. The "Prices" datasheet shows the computer prices associated with each computer model. The Lion 303 model has a price of $849; the Turkey 106 has a price of $421. We need to relate the purchaser's choice from the drop-down menu to the list of prices.

Excel provides a "Choose" function that will let us associate prices with menu choices. Figure P8.11 displays the function "=CHOOSE(Prices!A1, Prices!B2, Prices!B3, Prices!B4)" for cell A4 of the "Computers" datasheet. The general format of the "Choose" function is to specify an index and then specify the choices based on the index, such as "(index, choice #1, choice #2, etc.)." If the index value is 1, then the first choice is displayed. If the index value is 3, then the third choice is displayed. In our example, if the index (represented as the result of the drop-down menu choice reported in cell Prices!A1) is 2 then the second choice (the value from cell Prices!B3) is reported.

In a similar fashion, set the value of cell A5 in the "Computers" datasheet as "=CHOOSE (Prices!A6, Prices!B7, Prices!B8, Prices!B9)." "Choose" functions are very useful in associating prices and other attributes with drop-down menu choices. They avoid complicated "IF. . ." statements.

Cell A7 should denote the amount of the student discount. If the "student discount" check box is marked, the value in cell Prices!A11 will be "TRUE" and the amount of the discount should be retrieved from cell Prices!C11. The calculation for cell A7 in the "Computers" datasheet (Figure P8.12) should read "=IF(Prices!A11=TRUE, (-Prices!C11*A6), 0)." This statement says that if the student discount is checked (the value in cell Prices!A11 is "TRUE"), then enter the discount amount here. The amount is a negative number showing the product of the discount amount from Prices!C11 multiplied by the subtotal amount from cell A6 on the "Computers" datasheet. If the check box is not checked, the value is zero.

The senior discount requires a similar formula. The values of the discount must be retrieved from the "Prices" datasheet and not coded into the "IF. . ." statements. The dollar amount of the discount depends on the dollar amount of the subtotal.

The subtotal is the sum of cells A4 and A5; the total is the sum of cells A6, A7, and A8. Remember, the discounts are expressed as negative amounts.

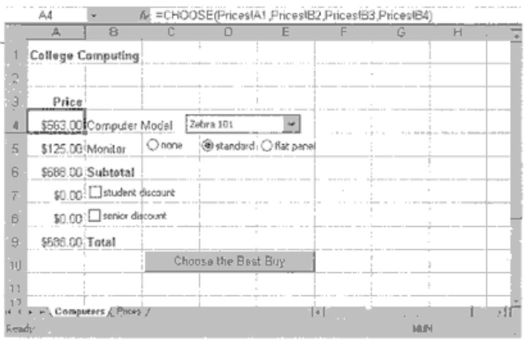


Figure P8.11 **Choose Function Example**

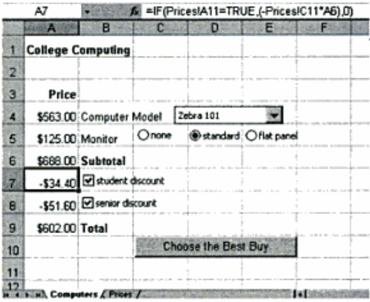


Figure P8.12
Computing the Student Discount

CHOOSING THE BEST BUY

Macros can be generated in Excel either by writing programming code or by recording the sequence of keystrokes performed by the user. Recording keystrokes is an effective and easy tool. Recording a sequence of keystrokes into a macro is a helpful way to complete a complex sequence of steps with a single keystroke.

At some point, you may design a spreadsheet that is particularly complex. One application of the spreadsheet may require you to reformat all of the currency values, change the row heights, add new fields, and change formulas for calculating results. Even if you are proficient at using Excel, you could make a mistake in performing one of these steps.

More important, you would not be able to entrust these actions to one of your subordinates who might not be proficient in Excel. In order to achieve efficiency, avoid mistakes, and enable subordinates with little training to accomplish the same results, you can record the sequence of steps in a macro that can be run later with the click of a mouse.

The "best buy" for our example will be the Zebra 101 computer model and a standard monitor. The best buy is not affected by discounts, so you ignore those check boxes. Choices are made by specifying values in the "Prices" datasheet. Mouse clicks for form choices are not recorded by the macro.

To create a macro that chooses the "best buy" for the purchaser, begin by choosing the "Tools" command followed by the "Macro" and "Record New Macro" commands, as shown in Figure P8.13. Name this new macro "Best."

At this point, every cursor click and keystroke will be recorded. To create a macro to choose the best buy, click on cell A10 in the "Computers" datasheet. If you are not in the "Computers" datasheet when you begin the macro, navigate to the "Computers" datasheet. Every mouse click is important: It is important to begin this macro by choosing a cell in the "Computers" datasheet. Even if the cursor is already pointing to cell A10 in the "Computers" datasheet when you begin recording the macro, click cell A10 again.

Navigate to the "Prices" datasheet and enter the value "1" (without quotation marks) in cell A1. That selects the first menu choice, Zebra 101, for the computer model. Next enter the value "2" in cell A6. That relates to the second radio button created, the button for a standard monitor.

Even if the values "1" and "2" are already in cells A1 and A6, enter the values again. The macro must record that you are entering values, not just moving the cursor around on the datasheet.

Navigate back to the "Computers" datasheet. Click the cursor on cell A10 so that at the end of the macro execution you are taken to the "Computers" datasheet and to the cell where the by clicking the cursor in the button (while the handles surround the button) and deleting the "Button..." phrase and typing "Choose the Best Buy." After you have created the command button, you have completed the example.

SAVING AND EDITING THE EXAMPLE

Save your example as "ExampleP8." Excel will automatically add the .xls extension to the file name. This way you can refer to the example as you work the assignment.

Try using the spreadsheet you have just created. Your school may have set macro security such that Excel does not want to run a spreadsheet with macros. If this occurs, choose the "Tools" command followed by "Macro" and "Security" to set the security level to medium. Make sure that the data-capture techniques work correctly. Also make sure that the calculations and formatting are correct. If you have an error in a drop-down menu, check box, or radio button, then you will need to edit the field. The first problem you have is selecting the field; Excel assumes that you want to enter data when you click the cursor on the field.

Assume that the drop-down menu does not work correctly. Move the cursor over the drop-down menu and the cursor image changes to a fist with one finger extended (see Figure P8.15). Press the right mouse button (as opposed to the left mouse button, which is normally pressed) and you will see the menu of choices shown in Figure P8.16. When you choose the "Format Control" option, the screen for the drop-down menu appears, just as it did in Figure P8.6. Now you can make any necessary changes to the drop-down menu. Similar steps are taken to edit the check boxes and radio buttons.

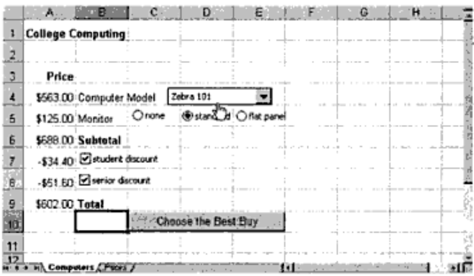


Figure P8.15 **Highlighting the Drop-Down Menu**

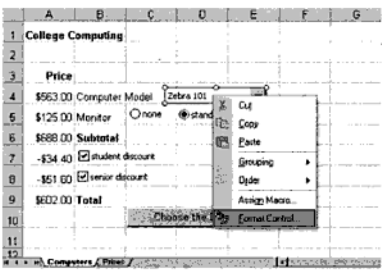
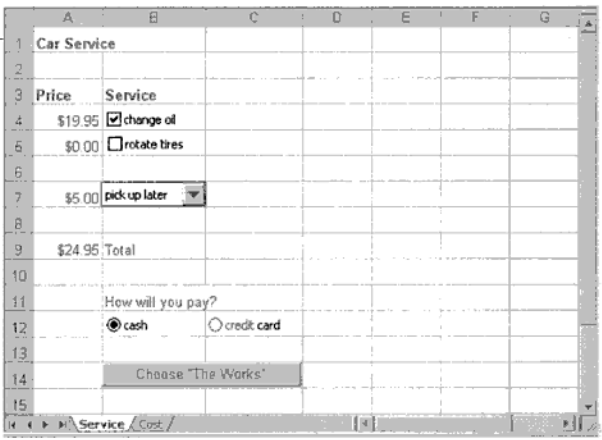


Figure P8.16 **Editing the Drop-Down Menu**

Assignment

1. Create a spreadsheet that documents car services that has datasheets similar to those shown in Figures P8.17 and P8.18.
2. Your spreadsheet should have only two datasheets. Delete the third datasheet and name the remaining two datasheets "Service" and "Cost."
3. Enter the values into the "Cost" datasheet as shown in Figure P8.18. These values should be entered first because values in the "Cost" datasheet control what is displayed on the "Service" datasheet.
4. Enter the labels shown in the "Service" datasheet in cells A1, A3, and B3.
5. Cell B4 in the "Service" datasheet is a check box about changing oil. The result of choosing the check box (i.e., the cell link) is in cell B1 of the "Cost" datasheet. Create check boxes for the services of changing oil and rotating tires. The default selection should be for changing oil.
6. In cell A4 of the "Service" datasheet, the price is retrieved using an "IF. . ." statement based on whether TRUE or FALSE is found in cell B1 of the "Cost" datasheet. Create the prices for the oil change and rotate tires options. If a service is not chosen, the price is zero.
7. Create a drop-down menu for whether the car is serviced while you wait or if you will pick the car up later. The control link is cell B4 on the "Cost" datasheet.
8. The price associated with the drop-down menu is in cell A9 of the "Service" datasheet. You must use a "CHOOSE" function (not an "IF. . ." statement) to select the appropriate price for picking the car up later or having it serviced while you wait.
9. The total price is the sum of the charges.
10. Create two radio buttons (Figure P8.17) on the "Service" datasheet that are linked to cell B8 on the "Cost" datasheet.
11. When the credit card choice is selected, use an "IF. . ." statement in cell D12 of the "Service" datasheet to display "Enter card number _____"; otherwise, cell D12 should be blank. (Blank is represented as "".) Figure P8.19 illustrates an entry for a credit card number.
12. Create a macro that chooses "The Works" for service. It should include changing the oil, rotating the tires, service while you wait, and credit card payment.

Figure P8.17 **Service Datasheet for Assignment Sample**



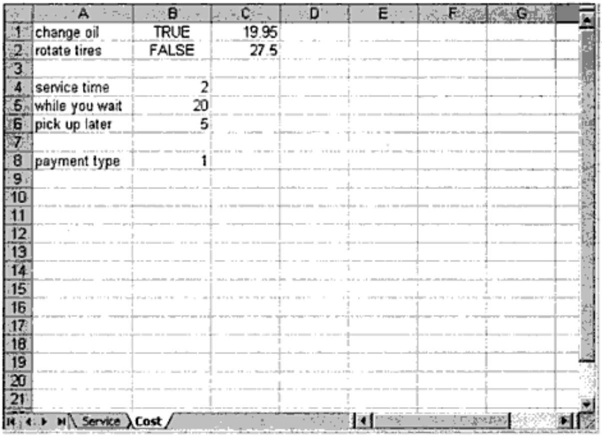


Figure P8.18 **Cost Datasheet for Assignment Sample**

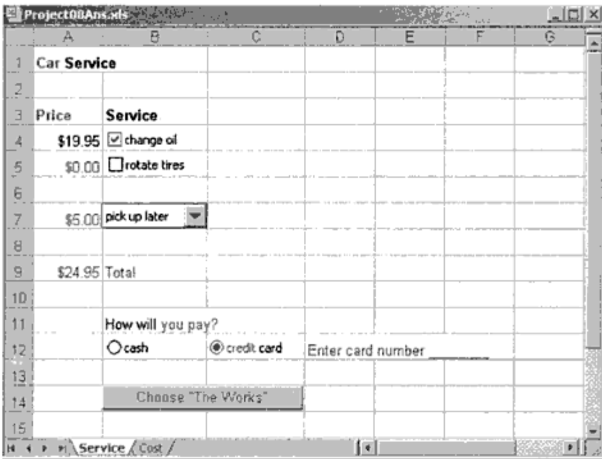


Figure P8.19 **Showing an Entry for Credit Card Number**

Project 9

Database Forms and Reports

Learning Objectives

- Know how to use an existing database file.
- Understand how to create a form for a database table.
- Know how to generate data value restrictions for data fields on a form.
- Understand how to create reports based on a single database table and on multiple database tables.
- Know how to calculate summaries of fields on a report.
- Know how to alter the format of reports.

Introduction

This project uses Microsoft Access to create a form and several reports for an existing database. The initial database can be downloaded from the Prentice Hall Web site for the text at WWW.PRENHALL.COM/MCLEOD—"mcleod" must be in lowercase letters. The database for this project concerns classes and the books used in those classes. The database also contains records of students who have copies of books to sell.

An Access database is a single file. Although there may be many tables in a database, they are all contained in the single database file, along with any forms, reports, or other components of the database. You should create a copy of the data file with your database on a regular basis.

Within Access, you can use the "Edit" command to cut and paste objects. Objects include tables, reports, and similar components of the database. You cannot copy the database itself from within Access. To copy the entire database, such as for a backup copy, you must copy the entire database file using Windows Explorer or by clicking the "My Computer" icon.

One caution about using database software is that the size of the database file can grow quickly. Users like to use features such as the "Undo" command that can easily reverse mistakes. Such features come at a price—they require a lot of disk space to guide the reversal of actions taken. To keep your database file a reasonable size, you should compact it on a regular basis, such as every time you exit Access.

From within Access, the "Tools," "Database Utilities," and "Compact and Repair Database" sequence of commands will compact your database to remove all of the deletions and missteps that you may have performed while using the database. You can change the Access settings to automatically compact the database each time you exit Access. You can set Access to automatically compact the database when you exit the program by selecting "Tools," followed by "Options," "General," and "Compact on Close." However, many universities limit the ability of students to change computer settings, so you may have to explicitly compact your database each time you use Access.

EXAMPLE

This example will generate a data entry form for the STUDENT table. It will also create a report of class enrollments and a list of books used in those classes, along with their prices. These exercises illustrate common database applications. This project uses the ***Textbook*** database that will be provided by your instructor or downloaded from the Prentice Hall Web site.

Textbook Database

The ***Textbook*** database consists of four tables that relate to each other by common values. The tables and their data fields are shown in Figure P9.1. The STUDENT table contains four fields: *FirstName*, *LastName*, *BookNumb*, and *CopiesToSell*. The key fields of the tables are shown in bold font. It takes the combination of values from the *FirstName*, *LastName*, and *BookNumb* fields to make a key (a unique value) for the STUDENT table. The *ClassNumb* field is the only field needed to be the key of the CLASS table.

Fields from different tables can be combined when a common value exists between the two tables. For example, the field *BookNumb* is in both the STUDENT table and the BOOK table. If the value of *BookNumb* is 409 in both the BOOK table and in the STUDENT table, then the name of the student from the STUDENT table can be associated with the book title of

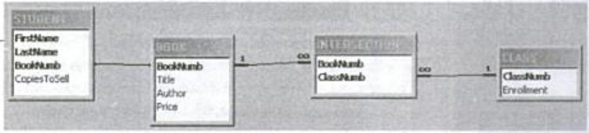


Figure P9.1 **Tables and Fields in the *Textbook* Database**

Figure P9.2 **Values in the STUDENT Table**

STUDENT : Table

FirstName	LastName	BookNumb	CopiesToSell
Amy	Abner	409	1
Bell	Ringer	32	1
Bette	Chancer	32	10
Betty	Donner	12	1
Betty	Donner	371	1
Bill	Eschew	16	3
Bill	Eschew	31	2
Bill	Eschew	32	2
Bill	Eschew	191	2
Bill	Eschew	200	1
Bill	Leer	191	1
Bill	Leer	371	5
Brian	Janski	409	1
Charles	Darling	121	1
Charles	Darling	371	1
Chris	Lee	12	1
Cindy	Rellash	12	2
Cindy	Rellash	24	1
Cindy	Rellash	191	5
Claire	Moore	27	6

Record: 38 of 60

the BOOK record. From Figure P9.2, you can see that Amy Abner and Brian Janski both have book number 409 to sell. Book number 409 (see Figure P9.3) has a title of "Management Information Systems" and was authored by McLeod and Schell.

For the projects and assignments in this text, you will use an existing database; you will not be required to create a database or tables within a database. Any changes to the format or values in fields will be accomplished through the use of forms and reports.

Begin this project by opening the Access program and then opening the ***Textbook*** database. Figure P9.4 will appear. Notice from Figure P9.4 that the "Tables" tab is chosen.

Creating a Form

You can use forms to enter data into a table. Forms not only facilitate data entry, but they display one record from the table at a time. Because a database table may contain many records, displaying one record at a time can make it easier for the user to view the records. In our example, we will create a form for the STUDENT table.

In addition to simple data viewing and data entry, forms can be used to test the values entered and reject erroneous ones. In the ***Textbook*** database, book numbers should have values less than 1,000, and that rule will be placed in the form design. Data rules in the definition of the data field itself are automatically enforced within a form. During the definition of the STUDENT table, the data field *CopiesToSell* was constrained to be a value of 10 or less; any form generated will enforce that rule.

BookNumb	Title	Author	Price
12	Finance for Me	Poe and Tattem	$78.75
16	Stock Crisis	Plankton	$35.90
24	Counting Pennies	Durgee	$108.10
31	Costing Products	Gough and Howe	$123.45
32	The Growing Economy	Birch	$72.00
101	Personnel Files	Hiram	$78.24
121	Employee Termination	Fletcher	$72.10
191	Selling Yourself	Tattem and Green	$83.00
206	Market Research	Shi	$95.62
231	Data Mining	Thurston and Gradston	$101.50
276	Cash Management	Packard	$29.75
371	Counting By The Numbers	Bongberd	$61.00
409	Management Information Systems	McLeod and Schell	$60.50

Figure P9.3 **Values in the BOOK Table**

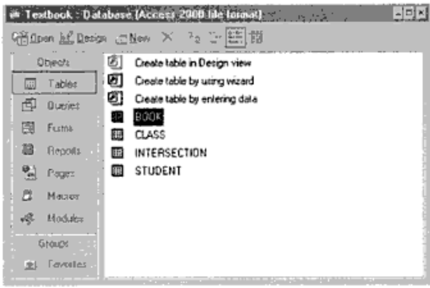


Figure P9.4 ***Textbook* Database Screen**

Click the "Forms" tab and the "Create form by using wizard" option, as shown in Figure P9.5. A "wizard" is a procedure that Access uses to walk you step-by-step through the development of an object (such as a form). You can use wizards to generate many of the forms and reports you will need. Sometimes you may need to modify the form or report, but that will be discussed later.

Double-click the "Create form by using wizard" option. When the screen in Figure P9.6 appears, use the drop-down menu to choose the STUDENT table. When Figure P9.7 appears, highlight each field (such as *FirstName*) and then move it to the "Selected Fields" area by clicking the ">" button. Then click the "Next" button.

In the next screen, select a "columnar" form layout. Then select "standard" style in the following screen. Moving from one screen to the next is achieved by clicking the "Next" button. When the screen in Figure P9.8 appears, change the title to "Student Data Entry Form." Now click the "Finish" button. Figure P9.9 appears with the completed form. Spend a moment clicking the buttons to move through the records. If you click the navigation button that moves to a new record, all the fields are blank; Access expects you to enter new data.

Enter a new record. The first name should be "Aaron" (do not include the quotation marks around any of these data entries). The last name should be "Ackerman," the number of the book is "409," and the copies to sell should be "11." When you try to move to the next record, Figure P9.10 appears. Remember that the data field definition for the *CopiesToSell* field was set to 10 or less. Access enforces this rule as values are entered into the form.

Figure P9.5 **Screen to Create a Form**

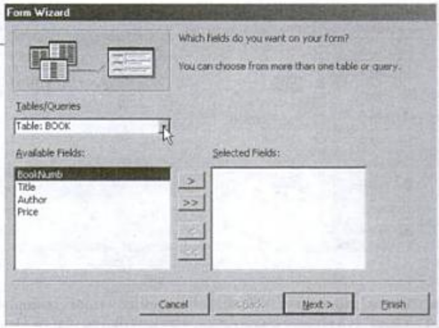


Figure P9.6 **Choose Fields from a Table**

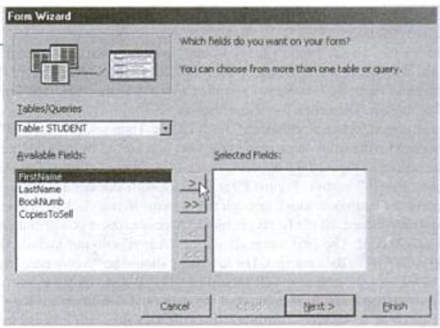


Figure P9.7 **Choose Each Field from the STUDENT Table**

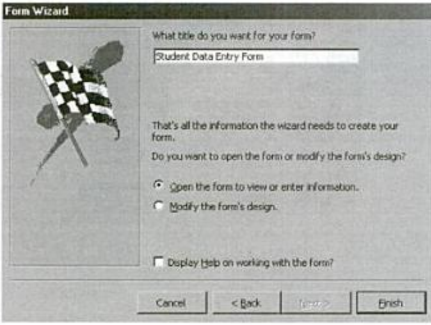


Figure P9.8 **Change the Form Name**

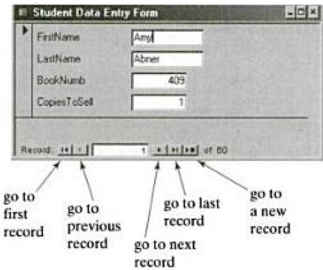


Figure P9.9 **Resulting Form for Student Data**

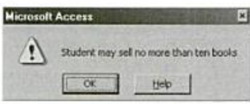


Figure P9.10 **The Number of Copies to Be Sold Must Be 10 or Fewer**

Records with more than 10 copies to sell will not be added to the STUDENT table. You must change the number of books to sell to be 10 or less before you can continue.

Choose the "View" command followed by the "Design View" subcommand and Figure P9.11 appears. You may have to expand the image by dragging one of its corners to see the entire form. Click the *BookNumb* field with the right mouse button. Make sure that the data field and not the field label is chosen; the data field has a white background. Choose the "Properties" option, as shown in Figure P9.12.

When Figure P9.13 appears, enter the validation rule and validation text as they appear on the screen. The "All" tab is selected so that all properties are displayed. Note that the value

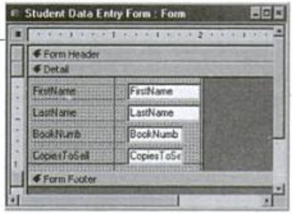


Figure P9.11 **Design View of Student Data Entry Form**

Figure P9.12 **Choosing to Change Properties of a Data Field**

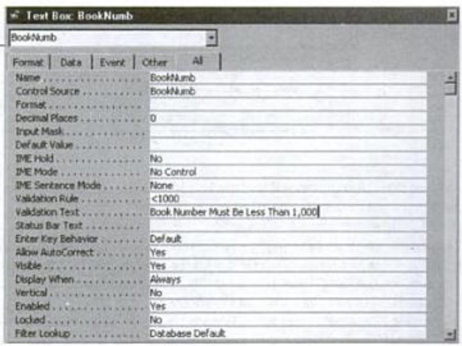


Figure P9.13 **Changing the Rule for Book Number Values**

"1000" does not have a comma for the validation rule, but the validation text shows "1,000." Do not enter quotation marks in properties of data fields. Close the screen in Figure P9.13 and go back to data entry by choosing the "View" command followed by the "Form View" subcommand. Enter a new record of "Aaron," "Ackerman," "1010," and "1" for the fields. Note that the error message you receive after entering "1010" is the validation text you entered as a property of the *BookNumb* field. Change the *BookNumb* field value to "101" and continue.

A Report from One Table

A report on class enrollments can be made from the CLASS table. The completed report should look like Figure P9.14. The class and the number of students enrolled is all that needs to be displayed.

Create a report by choosing the "Report" tab and the "Create report by using wizard" option shown in Figure P9.15. Choose the CLASS table from the drop-down menu and both the *ClassNumb* and *Enrollment* fields as shown in Figure P9.16 by using the ">" button. Click the "Next" button to move to the next screen.

You do not want any additional grouping, so simply choose the "Next" button when that screen appears. You do wish to sort the report by *ClassNumb* records, so choose *ClassNumb* from the drop-down menu, as shown in Figure P9.17. For the next two report wizard screens, use a "tabular" layout and a "corporate" style.

Report of Class Enrollments

Class	Enrollment
ACG205	117
ACG206	102
ECN401	49
FIN201	25
FIN301	15
MGT305	68
MIS330	152
MIS370	24
MIS401	78
MKT305	55
MKT405	2

Figure P9.14 **Report of Class Enrollments**

Figure P9.15 **Steps to Begin Creating a New Report**

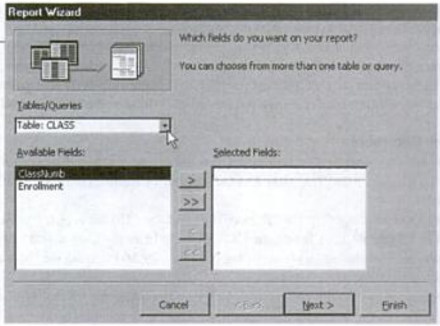


Figure P9.16
Choosing a Table and Fields for the Report

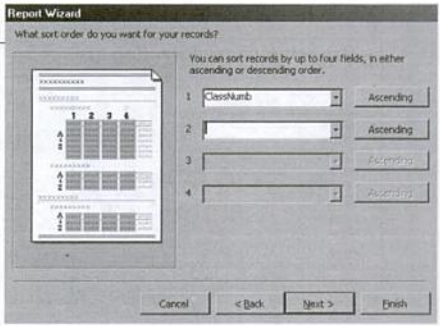


Figure P9.17
Choosing to Sort the Report

Make the report title "Report of Class Enrollments" and click the "Finish" button. What you see should be similar to the report shown in Figure P9.14. A small change should be made for the label of the class; it should be changed from the default field name of "ClassNumb" to simply "Class." We will see how to accomplish this shortly.

Choose the "View" command followed by the "Design View" command, as shown in Figure P9.18, and Figure P9.19 will appear. Several parts of the report design require your attention. First, look at the ruler space and see that the report width is 6.5 inches. This relates to a standard sheet of paper, which is 8.5 inches wide, less the 2 inches of margins for the report. If you accidentally extend the width of the report, then you will see one page of report followed by what appears to be a blank page. The page is not blank; Access is merely trying to display the part of the report beyond the 6.5-inch range.

The report has a header and a footer. This means a section of the report is reserved at the beginning and end. Items in the report header will be written only once, at the beginning of the report. Items in the report footer will be written only once, at the end of the report. As you

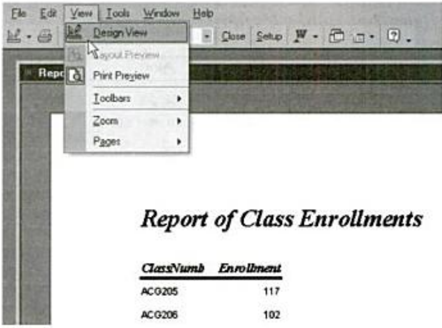


Figure P9.18 **Choosing the Design View of the Report**

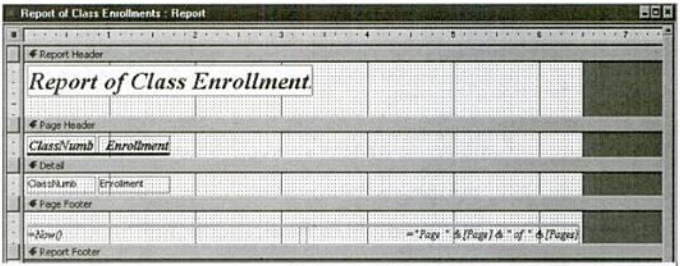


Figure P9.19 **Design View of Report of Class Enrollments**

can see, this report has nothing in the report footer. The pages also have headers and footers; information in these headers and footers appears at the top and bottom of each page of the report. The page footer shows the date (the "Now()" function) and the page of the report. The detail section displays every record retrieved from the database for the report.

Click the "ClassNumb" label in the page header to select the field; handles appear at the field's edges and corners. Click inside the field and the cursor changes so that you can edit the text of the label. The label should be changed to read "Class" instead of "ClassNumb."

You can save the report by closing the screen and following the instructions provided. You can also choose the "File" command followed by the "Save" command and then close the screen. The name of the saved report will be the name you provided to the wizard—"Report of Class Enrollments."

A Report from Multiple Tables

Part of the "Report of Books Used in Each Class" is shown in Figure P9.20. It requires information from the BOOK table as well as the CLASS table. The books used for each class are shown with the book price; at the end of each class record the sum of prices for the books used in the class is displayed.

Report of Books Used in Each Class

Class	Book	Price	
ACG205			
	Costing Products	$123.45	
		$123.45	Sum
ACG206			
	Counting By The Numbers	$61.00	
		$61.00	Sum
ECN401			
	The Growing Economy	$72.00	
		$72.00	Sum
FIN201			
	Finance for Me	$78.75	
	Stock Crisis	$35.90	
		$114.65	Sum
FIN301			
	Cash Management	$29.75	
	The Growing Economy	$72.00	

Figure P9.20 **Part of the Report of Books Used in Each Class**

To generate the sum, the report has to be grouped on a field. In this report, the field *ClassNumb* is used for grouping, and the prices of books used in each member of the group are summed. A header and a footer can be created for any data field upon which a group is formed.

Create a new report by using the same process as above. When you are presented with a screen like that shown in Figure P9.16, choose the CLASS table from the drop-down menu and the *ClassNumb* field. Then go back to the drop-down menu and choose the BOOK table and choose the *Title* field and the *Price* field. Now move to the next screen.

Just choose the "Next" button when you see the screen asking "How do you want to view your data?" The default display is the way you wish to view the data. At the next screen, do not choose any additional grouping—click the "Next" button. Two important screens are shown in Figures P9.21 and P9.22. In Figure P9.21, you should use the drop-down menu to

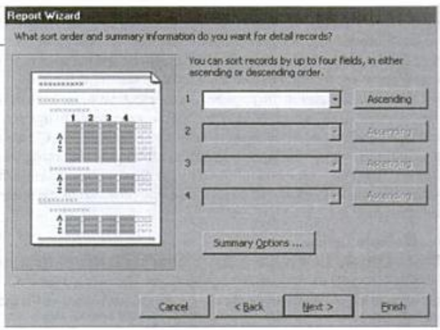


Figure P9.21 **Order and Summary Options for the Multiple Table Report**

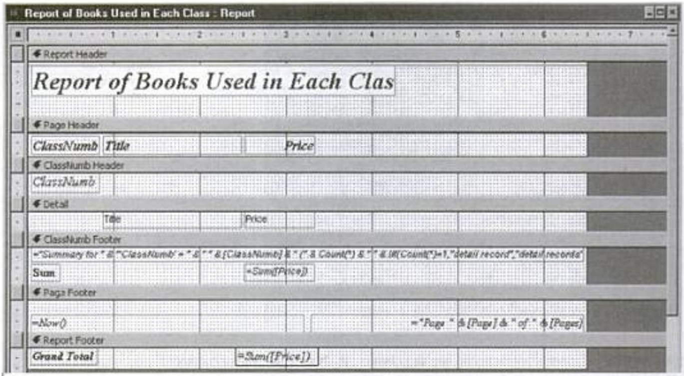


Figure P9.24 Design View of Report of Books Used in Each Class

Begin by changing to the design view—the "View" command followed by the "Design View" subcommand. When the screen in Figure P9.24 appears, you can make the modifications. Change the "ClassNumb" label in the page header to be "Class." Do not change the *ClassNumb* field in the *ClassNumb* header. Click the mouse once on the field "='Summary for' & . . ." in the *ClassNumb* footer. Once it is highlighted with handles, press the "Delete" key to remove the field.

Notice that the *Price* field is summed in the *ClassNumb* footer. That means that for each *ClassNumb* value in the report, the sum of the prices of books used in the class will be reported in the *ClassNumb* footer. A sum of prices for the entire report is shown in the report footer of the design view. The report sum is labeled as the "Grand Total," whereas the sum for a given *ClassNumb* is labeled "Sum."

You need to drag the "Sum" label to the right-hand side of the "=Sum([Price])" field in the ClassNumb footer so that your report looks like Figure P9.20. Click the "Sum" label and do not release the mouse button. Simply drag the "Sum" label to where you wish it to appear on the report. Any selected field can also be moved by moving the cursor to the top, left-hand corner of the field, and the cursor will change to a fist with a finger pointing up. When that occurs, you can press the left mouse button and drag the field to another part of the report design screen.

Switch back and forth from the design view to print preview to see how your changes affect the appearance of the report. When you are finished, your report should look similar to Figure P9.20. Close the report window and save your changes.

Assignment

1. Create a form for entering data into the BOOK table. Place all the fields from the BOOK table into the form. For the *Price* field, create a validation rule that requires the price to be less than or equal to $150. Remember to add validation text as an error message as well as the validation rule. Also remember that the validation rule does not allow the "$" sign; just use the value "150."

2. Create a report of those students selling books. The finished report should look similar to Figure P9.25. Note that the labels for the last name and first name columns have been changed from the default field names of "LastName" and "FirstName" to "Last Name" and "First Name," respectively. It may be hard to see in the figure, but you add a space between "First" and "Name" to make "First Name" and repeat this for the last name. Field names should be labeled so that they are easier to understand than the default values. Make your fields wide enough to contain the values for the field. For example, the default width of the title field is not wide enough to show several book titles; you should widen it.

   As you progress through the report wizard, you are presented with a choice for grouping. Group by last name and then first name, but do not group by title. A later wizard choice will let you sort the titles. You should sort the titles in ascending order.

Students Selling Books

Last Name	*First Name*	*Title*
Abner		
	Amy	
		Management Information Systems
Chancer		
	Bette	
		The Growing Economy
Cole		
	Lee	
		Stock Crisis
	Nick	
		Management Information Systems
Costa		
	Maria	
		Finance for Me
		The Growing Economy
Darling		
	Charles	
		Counting By The Numbers
		Employee Termination

Figure P9.25 **Partial Listing of Report of Students Selling Books**

Project 11

Database Queries—*ClassProjects* Database

Learning Objectives

- Know how to create queries using one or multiple tables.
- Understand how to limit query results with single and multiple constraints.
- Understand how a query can request constraint values from the query user.
- Know how to use queries that look for partial values in fields.
- Know how to make computations within queries on both numeric and text fields.

Introduction

This project uses Microsoft Access to create queries for an existing database. The initial database can be downloaded from the Prentice Hall Web site for the text at www.prenhall.com/mcleod—"mcleod" must be in lowercase letters. The database for this project, ***ClassProjects****, concerns classes and the projects used in those classes.*

Project 10 is a companion project; it covers the same learning objectives but uses a different database example. Projects 10 and 11 both cover query concepts so that instructors have the option to further enforce those concepts with two projects or to assign different projects to students in different semesters.

An Access database is a single file. Although a database may have many tables, they are all contained in a single database file, along with any queries, reports, or other components of the database. You should create a copy of the data file with your database on a regular basis.

Within Access, you can use the "Edit" command to cut and paste objects. Objects include tables, queries, and similar database components. You cannot copy the database itself from within Access. To copy the entire database, such as for a backup copy, you must copy the database file using Windows Explorer or by clicking on the "My Computer" icon.

One caution about using database software is that the size of the database file can grow quickly. Users like to use features such as the "Undo" command that can easily reverse mistakes. Such features come at a price—they require a lot of disk space to guide the reversal of actions taken. To keep your database file at a reasonable size, you should compact it on a regular basis, such as every time you exit Access.

From within Access, the "Tools," "Database Utilities," and "Compact and Repair Database" sequence of commands will compact your database to remove all of the deletions and missteps that you may have performed while using the database. You can set Access to automatically compact the database when you exit the program by selecting "Tools," followed by "Options," "General," and "Compact on Close." However, many universities limit the ability of students to change computer settings, so you may have to manually compact your database each time you use Access.

EXAMPLE

This example will generate a number of queries from the ***ClassProjects*** database. The ***ClassProjects*** database will be provided by your instructor or downloaded from the Prentice Hall Web site. Managers typically use queries to look for specific records; the query finds records that have certain field values. Other queries can be used to compute new values based on the values of other fields in the query.

It is important for decision makers to be able to generate their own queries. First, decision makers who can create queries gain immediate access to the power of a database. Second, decision makers may not know exactly which records in the database are needed until a query is generated, its results are seen, and more queries are created in an iterative process until the results desired are ultimately generated. Third, decision makers cannot have an intuitive understanding of the database unless they have a hands-on understanding of the data values and relationships in the database.

Information is an essential decision-making tool. The understanding of the database gained by writing queries trains a decision maker to use that tool better.

ClassProjects Database

The ***ClassProjects*** database consists of three tables that relate to each other by common values. The tables and their data fields are shown in Figure P11.1. The COURSE table contains three fields: *Code*, *Description*, and *Abbreviation*. The key fields of the tables are shown in bold font. It takes the combination of values from the *Code* and *Number* fields to make a key (a unique value) for the PROJECT table. The *Abbreviation* field is the only field needed to be the key of the DEPARTMENT table.

Fields from different tables can be combined when a common value exists between the tables. For example, the *Abbreviation* field is in both the DEPARTMENT table and the COURSE table. If the value in the *Abbreviation* field is "INT" in both the DEPARTMENT and COURSE tables, then the name of the department from the DEPARTMENT table can be associated with the description of the course in the COURSE record. From Figure P11.2, you can see that the courses "Cultural Diversity," "Spanish for Business," and "French for Business" each have a value of "INT" for the *Abbreviation* field. The "INT" value in the *Abbreviation* field of the DEPARTMENT table (see Figure P11.3) indicates that the three courses are in the International Business department.

For the projects and assignments in this text, you will use an existing database; you will not be required to create a database or tables within a database.

Begin this project by opening Access and then opening the ***ClassProjects*** database. Notice from Figure P11.4 that the "Queries" tab is chosen.

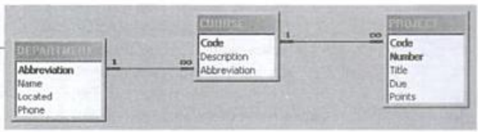


Figure P11.1 Tables and Fields in the *ClassProjects* Database

Figure P11.2 **Fields and Values in the COURSE Table**

Code	Description	Abbreviation
ACG201	Financial Accounting	ACGFIN
ACG301	Cost Accounting	ACGFIN
ECN375	Global Markets	ECN
ECN460	Banking Regulations	ECN
FIN305	Personal Finance	ACGFIN
INT100	Cultural Diversity	INT
INT201	Spanish for Business	INT
INT202	French for Business	INT
MGT300	Introduction to Management	MGTMKT
MIS105	Information Systems Literacy	ISOM
MIS315	Database Management Systems	ISOM
MKT300	Introduction to Marketing	MGTMKT
MKT444	Marketing Research	MGTMKT
POM250	Introduction to Operations Management	ISOM
STA230	Descriptive Statistics	ISOM

Figure P11.3 **Fields And Values in the DEPARTMENT Table**

Abbreviation	Name	Located	Phone
ACGFIN	Accounting and Finance	Dobo Hall	910-1800
ECN	Economics	Randall	910-0900
INT	International Business	Dobo Hall	910-0900
ISOM	Information Systems and Operations Management	Cameron Hall	910-3600
MGTMKT	Management and Marketing	Cameron Hall	910-4500

Figure P11.4 ***ClassProjects* Database Screen**

Creating a Query with Constraints

Records in the PROJECT table are shown in Figure P11.5. If a query were constructed without constraints, all of the records in the table would be displayed in the query result. It is more productive to restrict the records displayed to those that fit some decision-making criteria. Let's look at projects that earn more than 35 points.

Double-click the phrase "Create query in Design view," as shown in Figure P11.4, and Figure P11.6 appears. For this query, choose the PROJECT table from the list by highlighting the PROJECT choice and clicking the "Add" button. Close the screen that shows the tables by clicking the "Close" button.

Figure P11.7 appears, and it is in query-by-example format. Query-by-example (QBE) is a format whereby the user can specify what is desired without having to write computer code to retrieve records from the database. Each column in QBE can be a field to be displayed. The top row is where the field name is provided. The second row indicates the name of the table that contains the field. The third row provides an option of sorting the results, and the fourth row lets the user decide if the values are to be displayed on the report. The remaining rows are used to provide constraints on the rows that will be displayed.

Figure P11.5 **Fields and Values in the PROJECT Table**

PROJECT : Table

Code	Number	Title	Due	Points
FIN305	1	Personal Portfolio	11/14/2006	35
INT201	1	Nouns	9/17/2006	15
INT201	2	Verbs	11/21/2006	25
INT202	1	Nouns	9/17/2006	15
INT202	2	Verbs	11/21/2006	25
MIS105	1	Home Page Development	9/15/2006	25
MIS105	2	Working With Windows	11/13/2006	50
MIS315	1	Alumni Database	12/5/2006	20
MKT444	1	Finding Customers	10/31/2006	50
MKT444	2	Segmenting Customers	11/21/2006	50
MKT444	3	Customer Service	12/12/2006	40

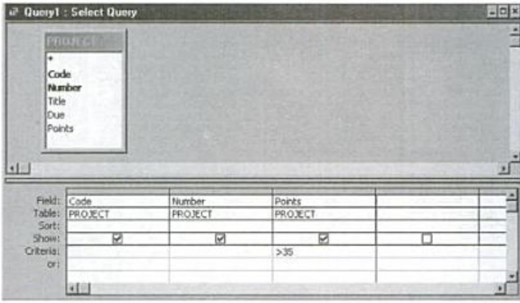


Figure P11.8
Constrain the Query to Points Greater Than 35

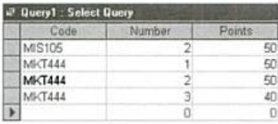


Figure P11.9 **Results of Constraining the Points Greater Than 35**

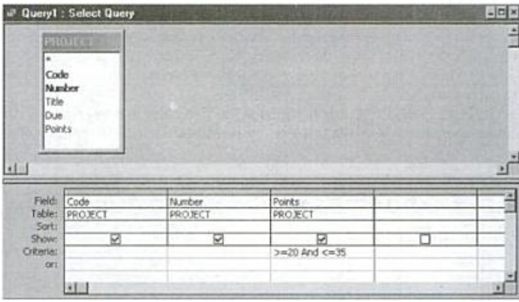


Figure P11.10
Constraining Points to Be Greater Than or Equal to 20 But Less Than or Equal to 35

points are greater than or equal to 20 but less than or equal to 35, use the constraint in Figure P11.10.

Notice in Figure P11.11 that when one set of constraints or another triggers the display of a record, the constraints are shown on different lines. That is why the word "or" is below the word "Criteria" on the QBE. This example demonstrates how to constrain query results to those records with points either less than 20 or greater than 40. You can toggle between the design and datasheet views to see the results of the queries and how they are constructed.

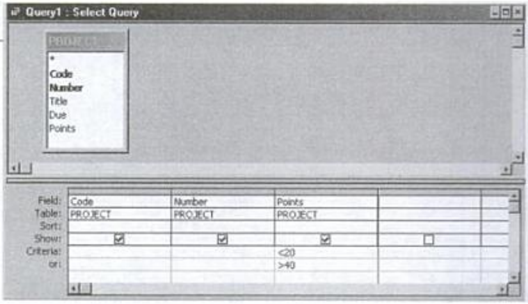


Figure P11.11 Constraining Points to be Less Than 20 or Greater Than 40

Parameter Query

Sometimes a decision maker will know which field constrains a query but not know the value of the constraint. Access allows parameter queries—queries that let a user provide a value as the query runs. For example, suppose the decision maker is looking for projects with unusually low or high points. The decision maker could code the point amounts into the query, as in Figure P11.11, or the query code could be written so that the decision maker is asked to provide the amounts each time the query runs.

In the earlier query, the values of 20 or 40 were used. If the decision maker wished to change those limits, the query would have to be rewritten. Look at Figure P11.12. The phrase "<[points should be below]" is one criterion. The "<" sign simply means that when the point value is less than the entered value, the record should be displayed. By placing square brackets, "[" and "]," around the phrase, Access will display the phrase as a question to the user when the query is run.

Figure P11.13 shows the screen displayed by the first query. It is important to note that the parameter query requires square brackets, not parentheses, around the phrase to be asked

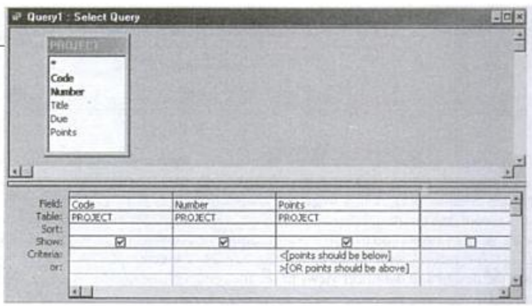


Figure P11.12 A Parameter Query

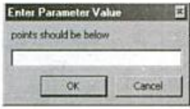


Figure P11.13 **The Query Will Ask for a Parameter Value**

of the user. Save the query by using the "File" command followed by the "Save" subcommand. When asked, name the query "Points," but do not include the quotation marks.

Inexact Constraints

Constraints on fields containing text can be difficult to create, because what constitutes a match may be ambiguous. For example, what if you are looking for a course named "Management?" You can see from the values of the *Description* field in Figure P11.2 that the word "Management" is part of three course descriptions. If the constraint is entered as shown in Figure P11.14, Access will not find the record.

The "Management" phrase looks for an exact match for the entire field value in the database records. Because "Management" is not an exact match of an entire *Description* field, no records are displayed by the query.

Access uses two characters as wildcards in the matching of text fields. The asterisk, "*," is a wildcard that matches any value or string of values, even a null value. A null value is the special case where there is no value at all. A question mark, "?," is a wildcard match for a single character. Table P11.1 shows how wildcards match with certain phrases. Figure P11.15 shows a query with a wildcard match looking for the word "for."

Note that because a word, such as "for," is surrounded by spaces, the constraint uses "* for *" and not "*for*." The constraint "*for*" would display the record "Information Systems Literacy." Also, Access will find a match even if the letter case does not match. "AAA" in the database record would match the constraint of "aaa." Some database management software requires the case to match as well as the letters.

Queries Requiring More Than One Table

Queries that require data fields from more than one table require that the tables supplying field values as well as the tables used to navigate between those tables be included in the QBE. For example, assume that you want to create a query that displays the department name

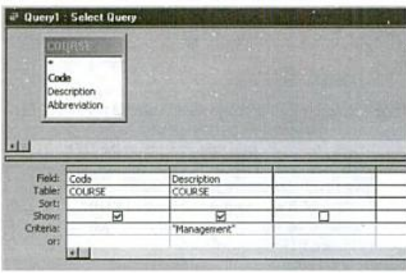


Figure P11.14 **Incorrect Constraint to Find a "Management" Record**

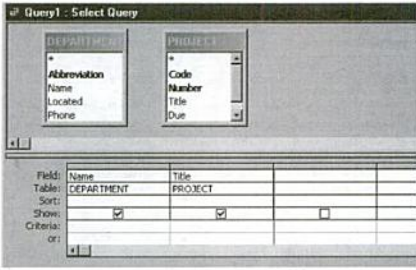


Figure P11.16 **Incorrect Query to Display Department Names with Project Titles**

Name	Title
Accounting and Finance	Personal Portfolio
Economics	Personal Portfolio
International Business	Personal Portfolio
Information Systems and Operations Management	Personal Portfolio
Management and Marketing	Personal Portfolio
Accounting and Finance	Nouns
Economics	Nouns
International Business	Nouns
Information Systems and Operations Management	Nouns
Management and Marketing	Nouns
Accounting and Finance	Verbs
Economics	Verbs
International Business	Verbs

Figure P11.17 **Some Results from the Incorrect Query to Display Department Names with Project Titles**

Without the links between the tables, the query does not restrict itself to records that match. Figure P11.18 illustrates the correct query; Figure P11.19 displays the query results. Note that because the INT201 and INT202 courses use the same project titles ("Nouns" and "Verbs"), these titles are shown twice on the report.

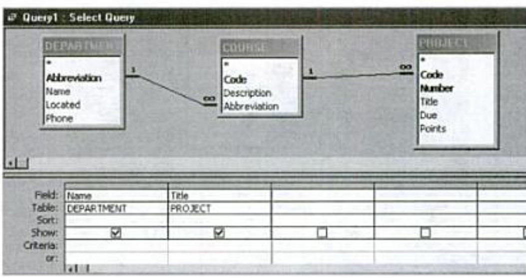


Figure P11.18 **Correct Query to Display Departments for Projects**

Figure P11.19 **Query Results Showing Departments and Project Titles**

Name	Title
Accounting and Finance	Personal Portfolio
International Business	Nouns
International Business	Verbs
International Business	Nouns
International Business	Verbs
Information Systems and Operations Management	Home Page Development
Information Systems and Operations Management	Working With Windows
Information Systems and Operations Management	Alumni Database
Management and Marketing	Finding Customers
Management and Marketing	Segmenting Customers
Management and Marketing	Customer Service

Note that when using multiple tables in a query when there is no matching value between the tables the records with no match are not displayed in the query results. This is because linkage between tables is usually performed with matched values between tables. To display unmatched records, we must modify the linkage between the tables.

Let's assume that you need to know which courses do not require a project. By looking at the relationships among tables in Figure P11.1, we can see that if a course (a *Code* field value in the COURSE table) does not require a project then there will be no corresponding course code in the PROJECT table. In QBE terms, the COURSE table will have a *Code* record value, but the *Code* value in the PROJECT table will be null.

To write a query to find those courses that do not require a project, we must edit the property joining the COURSE and INTERSECTION tables and place a constraint on the *Code* field in the PROJECT table. Begin by creating a query as shown in Figure P11.20. Notice that the query is taking the *Code* field from both the COURSE and PROJECT tables.

Place the cursor on the line joining the tables; try to place it halfway between the two tables. When you press the right mouse button, the screen in Figure P11.21 appears. Choose the "Join Properties" option. From the screen in Figure P11.22, choose the second option so that all records from the COURSE table will be included. Even if there is no matching record in the PROJECT table, such as when the course does not require a project, the record from COURSE will be included in the report.

You can see from running the query (Figure P11.23) that the course "ACG201" and others do not require a project. To display only those courses that do not require projects, we constrain the *Code* field value in the PROJECT table to be null. That query is shown in Figure P11.24. The phrase "Is Null" is a special constraint in Access.

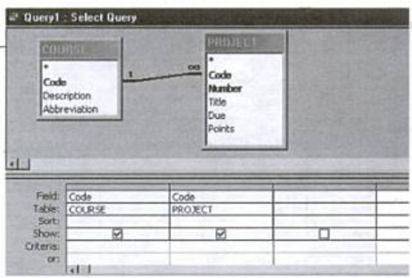


Figure P11.20 **Begin Building Query to Find Courses Without Projects**

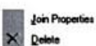


Figure P11.21 **Choices after Selecting the Line Joining Tables**

Data Field Concatenation and Calculation

Data fields with text values can be concatenated; the characters can be added together with other characters and other text fields. Numeric fields are subject to mathematical operations. These operations can take place within a query so that values in the database do not need to be changed.

For example, in the PROJECT table the *Code* and *Number* fields are separate. Figure P11.25 demonstrates how the fields can be shown separately and together in a single, concatenated field label. For example, the second project for MIS105 would be "MIS105-2." "Label:[Code] & "-" & [Number]" shows that the field names from the Access database are surrounded by square brackets. Notice that a dash has been inserted between "MIS105" and "2." Also notice in Figure P11.25 that the phrase "Label:" appears before the concatenation of the *Code* and *Number* fields. This is so a new description for the column can be included in the display.

Because some courses have more than one project, a decision maker may wish to see the number of projects and the number of points for all projects on a single record. The only two fields in such a query should be *Code* and *Points*. Choose the "View" command followed by the "Totals" subcommand and another row, "Total," is inserted into the query design, as shown in Figure P11.25. Create a query that is similar to Figure P11.26.

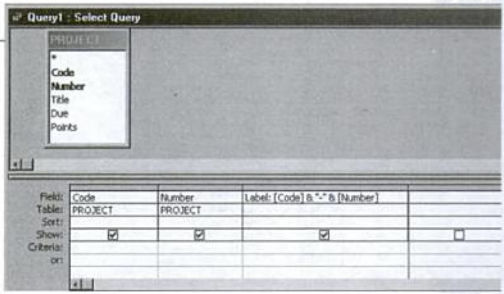


Figure P11.25 **Query to Concatenate *Code* and *Number* Fields**

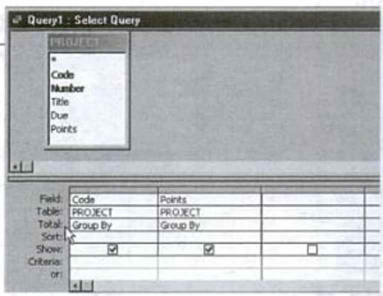


Figure P11.26 **Query with the "Total" Row Included**

With the "Total" row in the query, we have a new set of options that can be used for decision making. You can look at the project points in one of two ways: (1) as the count of number of projects the student has to complete or (2) as the sum of the points across the course projects. When the "Total" row is added to the query design, the default value for a column is "Group By"; clicking the drop-down menu presents many other choices.

One option, "Count," tells Access to record the number of times a record is encountered. Another option, "Sum," calculates the mathematical total of the values in the field. For a sum or count to be computed, the function must be applied to a field or fields that are grouped together. In our example, we have been grouping records together by the project code.

Figure P11.27 shows a query that will calculate both the count of the number of projects for a given course as well as the sum of the project points for that course. Notice that the *Points* field is in the query twice, once with the "Count" option and once with the "Sum" option. Figure P11.28 displays a listing of the query results.

Computations can be applied to numeric fields and date fields. Assume that the decision maker wants to know the number of points needed for an "A" grade for each project. An "A" would be calculated as 90 percent of the possible points. Figure P11.29 shows the query that would generate such a report. (Notice that the "Total" row has been removed from the query, because summing or counting is not required.)

Assume the instructor decides that projects could be turned in 1 week late with a deduction of 5 points from the maximum grade. The query calculations are shown in Figure P11.30. The calculated field "Late" adds 7 days to the original due date and subtracts 5 points from the original number of points assigned to the project. The results of the query are shown in Figure P11.31.

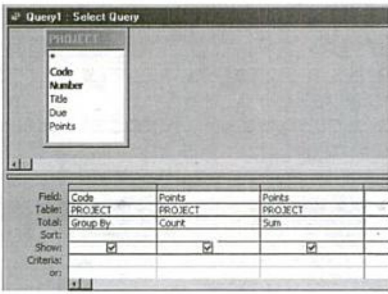


Figure P11.27 **Query Design with Count and Sum Features**

Query1 : Select Query

Code	CountOfPoints	SumOfPoints
FIN305	1	35
INT201	2	40
INT202	2	40
MIS105	2	75
MIS315	1	20
MKT444	3	140

Figure P11.28 **Query Results of Count and Sum Functions**

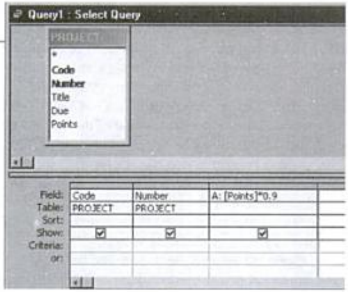


Figure P11.29 **Query to Calculate Project Points Needed for an "A" Grade**

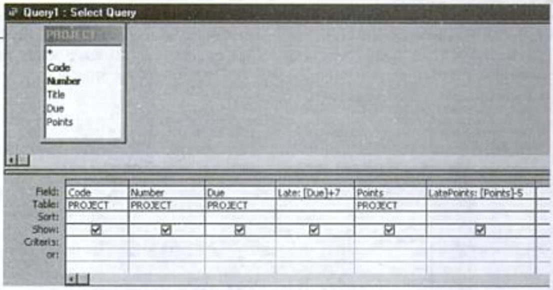


Figure P11.30 **Query to Calculate Late Due Dates and Reduced Points**

Figure P11.31 **Results of Query to Calculate Late Due Dates and Reduced Points**

Query1 : Select Query

Code	Number	Due	Late	Points	LatePoints
FIN305	1	11/14/2006	11/21/2006	35	30
INT201	1	9/17/2006	9/24/2006	15	10
INT201	2	11/21/2006	11/28/2006	25	20
INT202	1	9/17/2006	9/24/2006	15	10
INT202	2	11/21/2006	11/28/2006	25	20
MIS105	1	9/15/2006	9/22/2006	25	20
MIS105	2	11/13/2006	11/20/2006	50	45
MIS315	1	12/5/2006	12/12/2006	20	15
MKT444	1	10/31/2006	11/7/2006	50	45
MKT444	2	11/21/2006	11/28/2006	50	45
MKT444	3	12/12/2006	12/19/2006	40	35

ASSIGNMENT

1. Create a query from the PROJECT table that shows projects worth less than or equal to 25 points. Show the *Code, Number, Title,* and *Points* fields. Save the query as "Query01."
2. Create a query that shows records in the PROJECT table where the points are more than 20 and less than 40. Show the *Code, Number, Title,* and *Points* fields. Save the query as "Query02."
3. Create a query that displays PROJECT records where either the number of points is greater than 40 or the due date is earlier than 11/15/2006. Show the *Code, Number, Points,* and *Due* fields. Don't forget that you would code a date of July 4, 2006, as "#7/4/2006#" (without quotation marks). The "#" marks tell Access that the field is a date and not to perform a division operation on the numbers. Save the results as "Query03."
4. Display all the COURSE records where the course begins with "MKT." Save the results in "Query04."
5. List all COURSE records where "C" is the second character in the *Course* field. Only show the *Course* field and save the results as "Query05."
6. Make a parameter query where the user is asked to provide a course code and the course code, project number, and project title are displayed. Save the query as "Query06."
7. What courses from the International Business department do not have any projects? Only display the course codes and save the results in "Query07."
8. For each due date, count the number of projects due on that date. The individual projects should be labeled "Assign" and should be composed of the *Code* field, a dash, and the *Number* field. For example, one assignment would be "FIN305-1." Store the resulting query as "Query08."
9. Sum the number of points for projects for each course. Save the results as "Query09."
10. Which project from the PROJECT table has the latest due date? Show the department name, the course code, and the due date. Typically, a user would create one query to find the last due date and then join that saved query with another query showing the desired fields. Save the results as "Query10."

Project 12

Reports Based on Queries

Learning Objectives

- Know how to create a report based on query results.
- Be able to pass query parameters to reports.
- Understand how built-in Access functions can be used to change the content of a report.
- Understand how to generate field values based on query values.
- Know how to make calculations within reports.

Introduction

This project uses Microsoft Access to create queries for an existing database. The initial database may be provided by your instructor or it can be downloaded from the Prentice Hall Web site for the text at WWW.PRENHALL.COM/MCLEOD ("mcleod" must be in lowercase letters). The database for this project, ***Textbook,*** *concerns classes and the books used in those classes. The database also contains records of students who have copies of books to sell.*

Project 12 contains some advanced database concepts for queries and reports. If you have completed Project 9 and either Project 10 or 11, then you should be prepared for this project.

Managers often need to generate reports based on the results of queries. The reports may require calculated fields to display meaningful labels on codes from the database. Fields may have to be moved and reformatted to create visually appealing reports. Decision makers need to understand how to generate reports from queries so that data can be filtered to a relevant set of facts for decision making.

An Access database is a single file. Although there may be many tables in a database, they are all contained in the single database file, along with any queries, reports, or other components of the database. You should create a copy of the data file with your database on a regular basis.

Within Access, you can use the "Edit" command to cut and paste objects. Objects include tables, queries, reports, and similar database components. You cannot copy the database itself from within Access. To copy the entire database, such as for a backup copy, you must copy the database file using Windows Explorer or by clicking the "My Computer" icon.

One caution about using database software is that the size of the database file can grow quickly. Users like to use features such as the "Undo" command that can easily reverse mistakes. Such features come at a price—they require a lot of disk space to guide the reversal of actions taken. To keep your database file a reasonable size, you should compact it on a regular basis, such as every time you exit Access.

From within Access, the "Tools," "Database Utilities," and "Compact and Repair Database" sequence of commands will compact your database to remove all of the deletions and missteps that you may have performed while using the database. You can set Access to automatically compact the database when you exit the program by selecting "Tools," followed by "Options," "General," and "Compact on Close." However, many universities limit the ability of students to change computer settings, so you may have to manually compact your database each time you use Access.

EXAMPLE

This example will generate queries and reports from data in the ***Textbook*** database. The ***Textbook*** database will be provided by your instructor or downloaded from the Prentice Hall Web site. Managers typically use queries to look for specific records; the query finds records that have certain field values. Reports based on query results must usually be modified from the default report settings so that they are visually appealing.

Information is an essential decision-making tool. The understanding of the database gained by writing queries trains a decision maker to make better use of that tool. Being able to create reports based on query results also enables decision makers to produce documents for their subordinates.

Textbook Database

The ***Textbook*** database consists of four tables that relate to each other by common values. The tables and their data fields are shown in Figure P12.1. The STUDENT table contains four fields: *FirstName*, *LastName*, *BookNumb*, and *CopiesToSell*. The key fields of the tables are shown in bold font. A combination of values from the *FirstName*, *LastName*, and ***BookNumb*** fields make a key (a unique value) for the STUDENT table. The *ClassNumb* field is the only field needed to be the key of the CLASS table.

Fields from different tables can be combined when a common value exists between two tables. For example, the field *BookNumb* is in both the STUDENT table and the BOOK table. If the value of *BookNumb* is 409 in the BOOK table and in the STUDENT table, then the name of the student from the STUDENT table can be associated with the book title of the BOOK record. From Figure P12.2, you can see that Amy Abner and Brian Janski both have book number 409 to sell. Book number 409 (see Figure P12.3) has a title of "Management Information Systems" and was authored by McLeod and Schell.

For the projects and assignments in this text, you will use an existing database; you will not be required to create a database or tables within a database.

Begin this project by opening Access and then opening the ***Textbook*** database. Notice from Figure P12.4 that the "Queries" tab is chosen.

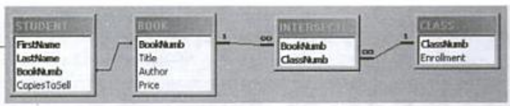


Figure P12.1 Tables and Fields in the *Textbook* Database

Figure P12.2 **Fields and Values in the STUDENT Table**

STUDENT : Table

FirstName	LastName	BookNumb	CopiesToSell
Amy	Abner	409	1
Bell	Ringer	32	1
Bette	Chancer	32	10
Betty	Donner	12	1
Betty	Donner	371	1
Bill	Eschew	16	3
Bill	Eschew	31	2
Bill	Eschew	32	2
Bill	Eschew	191	2
Bill	Eschew	200	1
Bill	Leer	191	1
Bill	Leer	371	5
Brian	Janski	409	1
Charles	Darling	121	1
Charles	Darling	371	1
Chris	Lee	12	1
Cindy	Rellash	12	2
Cindy	Rellash	24	1
Cindy	Rellash	191	5
Claire	Moore	27	6

Record: 38 of 60

Creating the Report of Books Required for Classes

Create a report using the Access "report wizard"; use the "Books for Classes" query as the source for the report. When asked, choose the *ClassNumb, Title,* and *Level* fields for the report. Remember that the field named "Level" was generated using the "Mid$" function. It is important that the field was named in the query, because that is how Access recognizes the value generated by the query.

You do not have to do any grouping other than the default, but when you advance to the screen shown in Figure P12.11 you should choose to sort the results based on the values in the *Title* field. As you proceed through the next set of options the report layout and style can be your choice, but "Stepped" and "Corporate" are often used. Make the title of the report "Books Required for Classes." Click the "Finish" button and view the results.

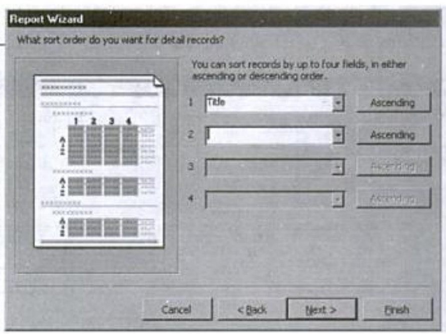
The report is similar to Figure P12.5, but some changes are required. The biggest change is to replace the course level values (1, 2, 3, and 4) with the labels "Freshman," "Sophomore," "Junior," and "Senior." We can begin with the simpler changes in format. Change to the design view of the report and move the fields until they are in similar positions to Figure P12.12 with the changed labels.

Notice that the label is now "Class," not "ClassNumb," and that the label "Level" is now "Course Level." Also notice that the label "Title" has been dragged into the *ClassNumb* header.

Highlight the *Level* field in the *ClassNumb* header and delete it. In its place, we will create a new field to choose a "Freshman," "Sophomore," "Junior," or "Senior" value. If the toolbox is not already visible on the design, choose the "View" command followed by the "Toolbox" subcommand to make the toolbox appear. Click the textbox icon ("abl") and place a box in the design where you just deleted the *Level* field. You want to have some room, so begin the box about 2 inches from the left-hand side. Remember that there is a ruler at the top of the design so you can tell where you are on the design screen. Your screen will look similar to Figure P12.13.

Click on the label field "Text. . ." and delete it. Click the "Unbound" field and then click the right mouse button so you can choose "Properties." Figure P12.14 shows the control source formula for choosing the course level. "=Choose([Level], "Freshman," "Sophomore," "Junior," "Senior")" begins by calling the Access function "Choose." The function has an index and a set of values. The index is a number (in our case 1, 2, 3, or 4). Based on the index value, the value displayed in the report is either the first, second, third,

Figure P12.11 **Sort Report Records by Title**



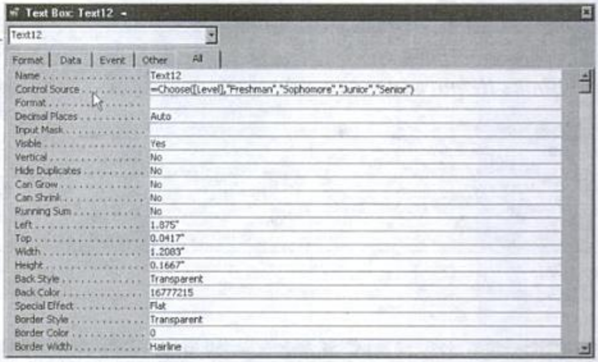


Figure P12.14 **Control Source Formula for Choosing Course Level**

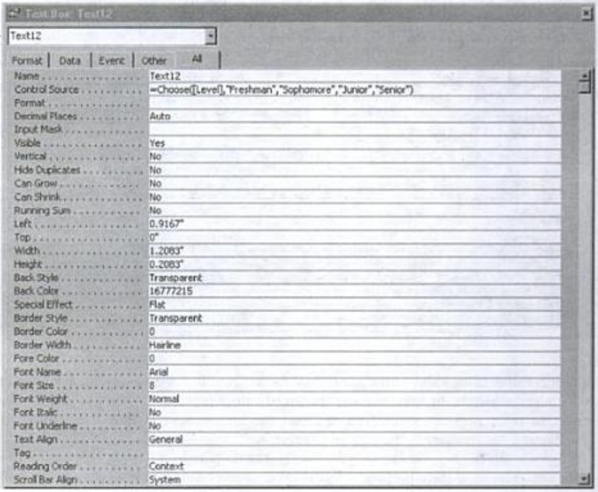


Figure P12.15 **Changing Field Fonts**

CREATING A REPORT FROM A PARAMETER QUERY

Decision makers may wish to limit the information in a report by using a constrained query. When the constraint is a constant the report can be generated with a title that reflects the constraint value. However, it is more difficult to capture values entered in a parameter query to be

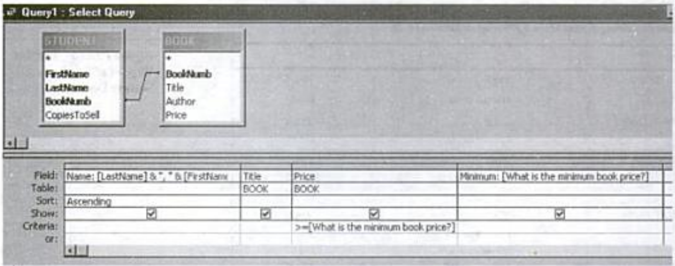


Figure P12.18 **Parameter Query with Added Field to Capture Constraint Value**

As shown in Figure P12.18, another column must be added to the parameter query. The field is given the name "Minimum" so that the field and its value can be passed to the report generator. When you run the query, notice that the value of *Minimum* is a constant; it is always the value supplied to the query. Note that the parameter "[What is the minimum book price?]" and the value added in the field row must be spelled exactly the same. Otherwise, Access acts as if the query has two parameters. Exit the query-building process and name the query "Ask Minimum Price."

Creating the Report Based on the Parameter Query

Begin creating a new report using the report wizard feature of Access. The source for the report should be the "Ask Minimum Price" query that you just created. Choose all the fields (*Name, Title, Price*, and *Minimum*) for the report. Group the report based on the *Name* field. When Figure P12.19 appears, choose to sort on *Title* field values.

The "stepped" layout and "corporate" style should be chosen. Name the report "Students Selling Books" and click the "Finish" button. The report created will have to be changed before it resembles the finished report shown in Figure P12.16. Begin by changing to the report design view. Delete the report title (in the report header), the *Minimum* field, and the

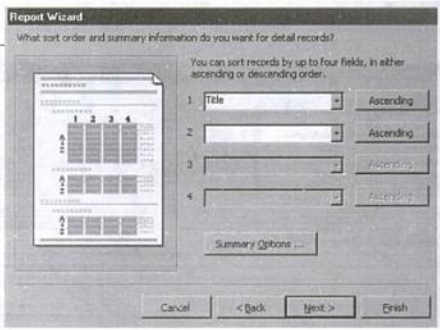


Figure P12.19 **Sort Based on Title Values**

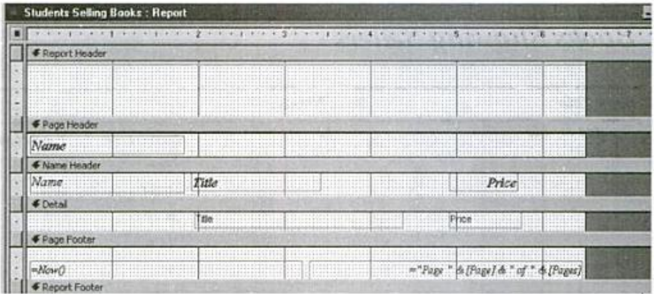


Figure P12.20 **Intermediate Design of Report Based on Parameter Query**

"Minimum" label. Then move titles and fields until they are arranged in the same manner as shown in Figure P12.20.

The last step is to create the report title. Make sure that the Toolbox is displayed in the design and choose the "Text Box" icon ("abl"). Create a field in the "Report Header" section. Delete the "Text" box and click on the "Unbound" box with the right mouse button so that you can choose the *Properties* field. Enter the formula shown in Figure P12.21 into the control source of the unbound field. The formula concatenates the string "Students Selling Books With a Price of at Least $" with the *Minimum* field.

One reason that the parameter value is placed in the title is because it needs to be shown only once, because the value is a constant. Another reason is that the parameter value entered should be displayed in a prominent part of the report. While you are in the properties, change the font size and font type of the report title to look like Figure P12.16.

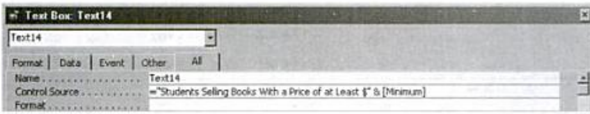


Figure P12.21 **Control Source Formula**

Assignment

1. Create a report of books being sold by students similar to the one shown in Figure P12.22. Note that the labels for the fields have been altered from the default field name. Also, the titles for last name and first name were moved into the book number header. The report is sorted by book number (not title) and also by last name and first name.
2. Make a report based on a parameter query where the user is asked to provide a class number such as "MKT305." The resulting report should be similar to Figure P12.23. Be careful to move the class number field into the report header so that the class number appears as part of the report title. Also, when the report is designed you may find that the class number field in the design view needs to be changed to a text box. In the design view, right click the class number field and choose to "change to" a text box.

Students Selling Books

Student	Title	Price	Copies	Extended
Abner, Amy				
	Management Information Systems	$60.50	1	$60.50
			Total	$60.50
Ackerman, Aaron				
	Management Information Systems	$60.50	10	$605.00
			Total	$605.00
Chancer, Bette				
	The Growing Economy	$72.00	10	$720.00
			Total	$720.00
Cole, Lee				
	Stock Crisis	$35.90	1	$35.90
			Total	$35.90
Cole, Nick				
	Management Information Systems	$60.50	1	$60.50
			Total	$60.50
Costa, Maria				
	Finance for Me	$78.75	1	$78.75
	The Growing Economy	$72.00	2	$144.00
			Total	$222.75

Figure P12.24 Sample Report of Students Selling Books

3. Create a report similar to Figure P12.24. This report is based on a query that combines last and first names and also calculates an extended price as the book price times the number of copies sold. Be careful that you do not name a field in the query as "Student," because that is the name of a table in the database. You must keep sums of the extended price for each student. Group the output records by student name. *Hint:* Figure P12.19 shows a "Summary Options" button that must be chosen for the report to calculate the sum of extended prices.

GLOSSARY

Chapter 1

mainframe a large, centrally located computer used by a large organization.

multitasking when more than one user appears to be working on the computer at the same time. Enabled by the computer's ability to break tasks into subtasks and intersperse the work of subtasks among more than one task.

information specialist a person who has a full-time responsibility for developing and/or operating information systems.

minicomputer (mini) the name given to the first small-scale computer.

microcomputer (micro) a small, relatively inexpensive, and powerful system, given the name because when it came on the market it was even smaller than the minicomputer.

personal computer (PC) a small, relatively inexpensive, and powerful system used for both business and personal applications.

Moore's Law the informal law recognizing that computer power doubles every 18 months.

physical system a system that consists of physical resources—materials, personnel, machines, and/or money.

virtual system a system that consists of data and information that represent a physical system.

data facts and figures that are generally unusable due to their large volume and unrefined nature.

information processed data that is meaningful, usually telling users something that they did not already know.

management information system (MIS) a computer-based system that provides information to users with similar needs.

personal productivity system an electronic system such as one providing for electronic spreadsheets, electronic mail, voice mail, electronic calendaring, audio conferencing, video conferencing, computer conferencing, and facsimile transmission that increases the productivity of problem solvers.

virtual office the concept that office work can be done at virtually any geographic location as long as the site is linked electronically to other locations.

enterprise resource planning (ERP) system a computer-based system that enables the management of all of the firm's resources on an organization-wide basis.

management level the hierarchal level of the firm where managers are located—top (strategic planning), middle (management control), and lower (operational control).

management function any one of the activities that all managers perform (plan, organize, staff, direct, and control, according to Henri Fayol).

managerial role any one of the ten roles that all managers perform, according to Henry Mintzberg.

problem a condition or event that is harmful or potentially harmful to a firm, or is beneficial or potentially beneficial.

solution the outcome of a problem-solving activity.

decision a particular selected course of action.

problem-solving phase a basic phase in solving a problem (intelligence, design, choice, and review, according to Herbert A. Simon).

Chapter 2

general systems model of the firm a diagram that shows the flow of physical and virtual resources through the firm.

environmental element a person or organization that interfaces with the firm by means of resource flows.

supply chain the flow of physical resources from suppliers to the firm and then to the firm's customers.

supply chain management the management of the flow of resources through the supply chain.

competitive advantage the use of information to gain leverage in the marketplace.

value chain the primary and support activities that contribute to margin.

interorganizational system (IOS) electronic linkages among firms so that all of the firms work together as a coordinated unit, achieving benefits that each could not achieve alone.

value system the linkage of value chains of members of a distribution channel.

dimension of competitive advantage strategic, tactical, and operational advantage.

multinational corporation (MNC) a firm that operates across products, markets, nations, and cultures.

global information system (GIS) an information system used by a multinational corporation.

transborder data flow (TDF) the flow of machine-readable data across a national boundary.

information resource computer hardware, software, information specialists, users, facilities, databases, and information.

knowledge management a broad term that describes the process of organizing a firm's information so that it can easily be captured, stored, processed, and used by decision makers.

dimension of information value relevancy, accuracy, timeliness, and completeness.

chief information officer (CIO), chief technology officer (CTO) the senior manager of information services who contributes managerial skills in solving problems relating not only to the information resources but also to other areas of the firm's operations.

strategic planning for information resources (SPIR) the concurrent development of strategic plans for information services and the firm.

Chapter 3

electronic commerce (e-commerce) a business transaction that uses network access, computer-based systems, and a Web browser interface.

business-to-consumer (B2C) electronic commerce transactions between a business and the final consumer of the product.

business-to-business (B2B) electronic commerce transactions between businesses where neither is the final consumer.

electronic government (e-gov) electronic commerce practiced by the government.

business intelligence (BI) the activity of gathering information about the elements in the environment that interact with your firm.

search engine a special computer program that asks a user for a word or group of words to be found; typically searches Web sites on the Internet.

vendor stock replenishment a special type of interorganizational system in which suppliers are allowed access to the firm's computer-based inventory system for the purpose of replenishing the stock.

electronic data interchange (EDI) direct computer-to-computer transmissions among multiple firms of data in a machine-readable, structured format.

value-added network (VAN) when the services that operate and manage the communications line (sometimes called the circuit) are provided in addition to the communications line itself.

extranet using information technology commonly associated with the Internet, the sharing of sensitive computer-based information with a few trusted firms.

virtual sales sales made by a firm that does not operate a physical storefront.

hybrid sales sometimes called "brick and click," sales from firms that have both a physical storefront and a Web site where customers can purchase products.

mobile commerce (m-commerce) the use of cell phones and personal digital assistants (PDAs) to engage in wireless electronic commerce.

third-generation (3G) telecommunications technology that is data capable.

hypertext documents in an electronic form that are linked together, usually with Web browser software.

cyberspace the world of the Internet and the World Wide Web.

virtual mall a collection of multiple retailer home pages under a single mall name.

Chapter 4

systems analyst the information specialist who works with users in developing and improving information systems.

database administrator (DBA) the information specialist who has responsibility for the database.

Webmaster the information specialist who is responsible for the content and presentation of the firm's Web site.

network specialist the information specialist who works with systems analysts and users in establishing data networks.

programmer the information specialist who uses the documentation provided by the systems analyst to code computer programs.

operator the information specialist who runs large-scale computing equipment.

divisional information officer (DIO) the manager of the information resources in a business area.

visioning network the organizational structure that enables the CIO to work with top management.

innovation network the organizational structure that interfaces the CIO with business areas in the development of innovative applications.

sourcing network the organizational structure that interfaces information services with vendors.

end-user computing the development by users of all or part of their information systems.

computer literacy the ability to use computer resources to accomplish necessary processing.

information literacy understanding how to use information at each step of the problem-solving process, where that information can be obtained, and how to share information with others.

office automation (OA) all of the formal and informal electronic systems primarily concerned with the communication of information to and from persons both inside and outside the firm.

telecommuting how employees who work at home commute electronically.

hoteling the idea that the firm provides a central facility that is shared by employees when the need for office space and support arises.

virtual organization the concept that none of the firm's operations are tied to physical locations.

Chapter 5

processor (central processing unit or CPU) where data processing is performed.

memory (random access memory or RAM) the storage area on the computer's circuit board.

storage fixed storage that is either permanently installed in the computer or removable storage that can be removed and replaced with other removable storage.

human-captured data input captured by a person typing on a keyboard, clicking a mouse, touching a monitor, speaking into a microphone, or a similar interaction.

machine-captured data data captured by an electronic or mechanical device.

resolution the number of pixels—individual dots of light—on a monitor or dots of ink on a printed page.

multimedia the use of more than one input/output medium at a time.

smart phone a cell phone that can perform tasks that are typically associated with microcomputers.

GSM (Global System for Mobile Communication) the most widely adopted communications protocol in Europe, Asia, Africa, and Australia.

hacker a person who tries to break into computer systems in order to gather information, deny owner access, delete files, or otherwise disrupt use of the system.

computer virus a small computer program that replicates by inserting itself into computer programs or files.

worm a self-contained file or program that can delete files, change files, send e-mail, and cause other problems.

spyware a small computer program that monitors what you are doing with your computer resources.

system software software that performs certain fundamental tasks that relate to the hardware and not to the applications.

user friendly computer software that is simple and intuitive to use.

protocol the specification for formatting data to be transferred between communications equipment.

packet a piece of the total data to be communicated, combined with the address of the destination computer, the sending computer, and other control information.

cable modem a modem connection to the Internet via the coaxial cable that is common for receiving cable television.

private line (leased line, dedicated line) a circuit that is always open to only your communication traffic.

virtual private network (VPN) a network that offers the security and speed of a private line but also the low cost of the Internet.

tunneling software software that establishes a set of intermediary locations of the telephone equipment to provide privacy and speed.

terminal a device that has no storage or processor; it simply provides a means of input and output.

Token Ring peer-to-peer communication protocol allowing each computer to act as its own controller when it controls the "token" (proprietary to IBM).

Ethernet an open protocol for peer-to-peer communications.

data transmission crash two or more peer computers try to send data at the same time, causing the data from one computer to be mixed up with data communicated by the other computer(s).

IP address a four-part set of numbers (each ranging from 0 to 255), separated by periods, designating the network, host, subnetwork, and computer being addressed.

local area network (LAN) a group of computers and other devices (such as printers) that are connected together by a common medium other than that provided by the public telephone system.

metropolitan area network (MAN) a network that has a physical distance limit of roughly 30 miles.

wide area network (WAN) a network that exceeds the distance of both LANs and MANs.

Internet the collection of networks worldwide that can be joined together.

intranet a network that uses the same network protocols as the Internet but limits accessibility to computer resources to a select group of persons in the organization.

extranet an intranet that is expanded to include users beyond the firm.

Chapter 6

data field the smallest unit of data representing the smallest amount of data that might be retrieved from a computer at a given time.

record a collection of related data fields.

file a collection of related records.

database, general definition the collection of all the firm's computer-based data.

database, restrictive definition the collection of data under the control of database management system software.

relational database structure joining tables by implicit relationships.

flat file a table that does not have repeating columns.

key a field (or combination of fields) that contains a value that uniquely identifies each record in the table.

database management system (DBMS) a software application that stores the structure of the database, the data itself, relationships among data in the database, and forms and reports pertaining to the database.

hierarchical database structure data groups, subgroups, and further subgroups.

physical relationship a relationship that is established by data addresses.

implicit relationship a relationship that is implied from the data values being the same in fields that are common between tables.

data redundancy repeating data fields and values in a table or group of tables.

data consistency data values in two fields that logically should have the same value and do in fact have the same value.

database concept logical integration of records across multiple physical locations.

data independence the ability to make changes in the data structure without making changes to the application programs that process the data.

data dictionary the definition of the data stored in the database and managed by the database management system.

enterprise data model the description of all of the firm's data.

entity-relationship diagram (ERD) graphical documentation of entities—logical chunks of data—and the relationships between entities.

class diagram graphical documentation of an object class, showing fields in the class and actions (sometimes referred to as methods) that act upon the class.

form a display of a single database record, produced by the DBMS.

report a display of aggregated data from the database, produced by the DBMS in a format that facilitates decision making.

query a request for the database to display selected records.

query by example (QBE) a way for the manager to question the database by describing the desired appearance of the information.

structured query language (SQL) the code that relational database management systems use to perform their database tasks.

Chapter 7

systems approach a series of problem-solving steps that ensures the problem is understood, alternative solutions are considered, and the selected solution works.

problem trigger a signal that things are going better or worse than expected.

symptom a condition that is produced by the problem and is not the root cause of the problem.

evaluation criteria measures of how well an alternative would solve the problem.

methodology a recommended way of doing something.

systems development life cycle (SDLC) an application of the systems approach to the development of an information system.

waterfall approach a name given to the traditional system development life cycle.

prototype a version of a potential system that provides the developers and potential users with an idea of how the system in its completed form will function.

evolutionary prototype a prototype that is continually refined until it contains all of the functionality that the users require of the new system.

requirements prototype a prototype that is developed as a way to define the functional requirements of the new system when the users are unable to articulate exactly what they want.

rapid application development (RAD) James Martin's SDLC that is intended to produce systems quickly without sacrificing quality.

enterprise the entire firm.

SWAT team a development team with specialized skills, with SWAT standing for "skilled with advanced tools."

phased development an approach to developing an information system that consists of six phases—preliminary investigation, analysis, design, preliminary construction, final construction, and system test and installation.

reengineering, business process reengineering the process of reworking the system.

reverse engineering the process of following the system development life cycle in a backward sequence to identify a system's elements and their interrelationships, as well as to create documentation at a higher level of abstraction than currently exists.

functionality the job that a system performs.

forward engineering the process of following the system development life cycle in the normal manner while engaged in business process reengineering.

data flow diagram (DFD) a graphic representation of a system that uses symbols to depict processes, data flows, data stores, and environmental elements.

terminator an environmental element that interfaces with a system, given the name because it marks the point at which the system terminates.

process an action taken on data.

data flow a group of logically related data elements (ranging from a single data element to one or more files) that travels from one process to another or between a process and a data store or terminator.

data store a repository of data.

Figure 0 diagram a data flow diagram that identifies the major processes of the system.

context diagram a data flow diagram that positions the system in an environmental context.

Figure *n* diagram a data flow diagram that documents a single process of a DFD in a greater amount of detail than the Figure 0 diagram, with the letter *n* representing the number of the process on the next higher level that is being documented.

leveled DFDs a hierarchy of data flow diagrams, ranging from the context diagram to the lowest-level diagram, that are used to document a system.

use case a narrative description in an outline form of the dialog that occurs between a primary and a secondary system.

ping-pong format a use case diagram consisting of two narratives, where the numbering indicates how the tasks alternate between the primary and secondary systems.

MIS steering committee a committee that directs the use of the firm's computing resources.

project team all of the persons who participate in the development of an information system, led by a project team leader.

Gantt chart a horizontal bar chart that includes a time-phased bar for each task to be performed.

network diagram a drawing that identifies activities linked to show the sequence in which they are to be performed; also called a CPM (for Critical Path Method) diagram or PERT (for Program Evaluation and Review Technique) chart.

Chapter 8

critical success factor (CSF) one of a few key activities that spell success or failure for any type of organization.

transaction processing system an information system that gathers data describing the firm's activities, transforms the data into information, and makes the information available to users both inside and outside the firm.

distribution system the transaction processing system used by firms that distribute products or services—manufacturers, wholesalers, and retailers.

organizational information system an information system tailored to one of the business areas of the firm—such as finance, human resources, information services, manufacturing, or marketing—that produces information that managers use in making decisions and solving problems.

marketing information system (MKIS) a system that produces information relating to the firm's marketing activities.

access control file a specification of the levels of access that are available to a user.

virus protection software software designed to prevent a security breach before it occurs.

insider threat prediction tool software aimed at identifying potential intruders before they have the opportunity to inflict harm.

firewall a filter that restricts the flow of data between points on a network—usually the firm's internal network and the Internet.

cryptography the coding of stored or transmitted data by means of mathematical processes as a security precaution.

contingency planning activity aimed at being able to continue to operate after an information system disruption, called *disaster planning* during the early years of computing.

contingency plan a formal written document that spells out in detail the actions to be taken when there is a disruption, or threat of disruption, in any part of the firm's computing operation.

emergency plan measures that ensure the safety of employees when disaster strikes.

backup plan arrangements for backup computing facilities in the event that the regular facilities are destroyed or damaged beyond use.

hot site a complete computing facility that is made available by a supplier to its customers for use during an emergency.

cold site only the building facilities that house computing resources, to be used in the event of an emergency, that the firm either constructs or rents from a supplier.

vital records plan the plan that specifies how paper documents, microforms, and magnetic and optical storage media that are necessary for carrying on the firm's business will be secured.

Chapter 10

morals traditions of belief about right and wrong conduct.

ethics a suite of guiding beliefs, standards, or ideals that pervades an individual or a group or community of people.

laws formal rules of conduct that a sovereign authority, such as a government, imposes on its subjects or citizens.

ethics culture the setting provided by the firm's executives that encourages ethical business practices.

corporate credo a succinct statement of the values that the firm seeks to uphold.

ethics program an effort consisting of multiple activities designed to provide employees with direction in carrying out the corporate credo.

ethics audit a meeting between an internal auditor and a manager for the purpose of learning how the manager's unit is carrying out the corporate credo.

computer ethics the analysis of the nature and social impact of computer technology as well as the corresponding formulation and justification of policies for the ethical use of such technology (as defined by James H. Moor).

logical malleability the ability to program a computer to do practically anything you want it to do.

transformation factor the fact that computers can drastically change the way we do things.

invisibility factor a view of the computer as a black box, where processing is unobservable.

internal auditor a person who performs the same analyses as an external auditor but who has a broader range of responsibilities and is an employee of the firm.

financial audit an audit that verifies the accuracy of the firm's records and is the type of activity performed by external auditors.

operational audit an audit that is not conducted to verify the accuracy of records but rather to validate the effectiveness of procedures.

concurrent audit an ongoing operational audit.

Chapter 11

problem solving a response to things going well and to things going badly.

decision making the process of solving a problem by selecting from alternative solutions.

systems view regarding business operations as systems embedded within a larger environmental setting.

desired state what the system should achieve.

current state what the system is achieving.

solution criterion what it will take to bring the current state to the desired state.

structured problem a problem that consists of elements and relationships among elements, all of which are understood by the problem solver.

unstructured problem a problem that consists of no elements or relationships among elements that are understood by the problem solver.

semistructured problem a problem that consists of some elements and relationships among elements that are understood by the problem solver, and some that are not.

programmed decision a decision for which a definite procedure has been worked out so that it is not treated as new each time it is encountered.

nonprogrammed decision a decision for which a definite procedure has not been worked out ahead of time so that it must be treated as new each time it is encountered.

decision support system (DSS) a system that is designed to help a specific manager solve a specific problem.

model an abstraction of something; can exist in a physical, narrative, graphic, or mathematical form.

entity the object or activity that is represented by a model.

static model a model that does not include time as a variable.

dynamic model a model that includes time as a variable.

probability the chance that something will happen.

probabilistic model a model that includes probabilities.

deterministic model a model that does not include probabilities.

optimizing model a model that selects the best solution among the alternatives.

suboptimizing model, satisficing model a model that permits a manager to enter a set of decisions; once this step is completed the model will project an outcome.

simulation the act of using a model.

scenario the conditions that influence a simulation.

what-if game use of a mathematical model to perform the iterative process of trying out decision alternatives.

artificial intelligence (AI) the activity of providing such machines as computers the ability to display behavior that would be regarded as intelligent if it were observed in humans.

expert system a computer program that attempts to represent the knowledge of human experts in the form of heuristics.

knowledge base the portion of an expert system that contains facts that describe the problem area and knowledge representation techniques that describe how the facts fit together in a logical manner.

problem domain the problem area addressed by an expert system.

inference engine the portion of an expert system that performs reasoning by using the contents of the knowledge base in a particular sequence.

goal variable the solution of a problem to be solved by an expert system.

expert system shell a ready-made processor that can be tailored to a specific problem domain through the addition of the appropriate knowledge base.

case-based reasoning the logic applied by an expert system that uses historical data as the basis for identifying problems and recommending solutions.

group decision support system (GDSS), group support system (GSS), computer-supported cooperative work (CSCW), computerized collaborative work support, electronic meeting system (EMS) a computer-based system that supports groups of people engaged in problem solving.

groupware software used to support group problem solving.

synchronous exchange the interaction among group problem solvers who meet at the same time.

asynchronous exchange the interaction among group problem solvers who do not meet at the same time.

facilitator a person whose chief task is to keep a group discussion on track.

parallel communication when all participants of a group problem solving session enter comments at the same time.

anonymity when members of a group problem solving session are unable to tell who entered a particular comment.

INDEX

D

E

F

G

H

J

K

L

O

P

Q

R

S

LOW PRICE EDITION

Premier12

PEARSON
Education

ISBN 978-81-317-1949-7
9 788131 719497