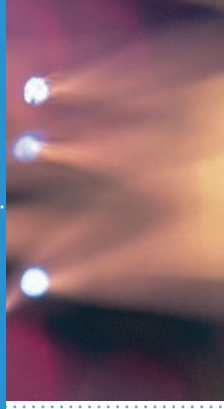
Fundamentals of

Information Systems

6E

RALPH STAIR • GEORGE REYNOLDS

SIXTH EDITION



Fundamentals of Information Systems

Sixth Edition

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For Lila and Leslie
—RMS

To my grandchildren: Michael, Jacob, Jared, Fievel, Aubrey, Elijah, Abrielle, Sofia, Elliot
—GWR

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PART

1

Information Systems in Perspective

CHAPTER

1

An Introduction to Information Systems in Organizations

PRINCIPLES	LEARNING OBJECTIVES
▪ The value of information is directly linked to how it helps decision makers achieve the organization's goals.	▪ Distinguish data from information and describe the characteristics used to evaluate the quality of data.
▪ Knowing the potential impact of information systems and having the ability to put this knowledge to work can result in a successful personal career, organizations that reach their goals, and a society with a higher quality of life.	▪ Identify the basic types of business information systems and discuss who uses them, how they are used, and what kinds of benefits they deliver.
▪ System users, business managers, and information systems professionals must work together to build a successful information system.	▪ Identify the major steps of the systems development process and state the goal of each.
▪ The use of information systems to add value to the organization can also give an organization a competitive advantage.	▪ Identify the value-added processes in the supply chain and describe the role of information systems within them. ▪ Identify some of the strategies employed to lower costs or improve service. ▪ Define the term *competitive advantage* and discuss how organizations are using information systems to gain such an advantage.
▪ IS personnel is a key to unlocking the potential of any new or modified system.	▪ Define the types of roles, functions, and careers available in information systems.

Information Systems in the Global Economy
Braskem S.A., Brazil

The Power of Information in the Petrochemical Industry

You've probably heard that "information is power." In fact, the power of information depends on how it serves a specific need at a certain time. For example, when you are deciding which automobile to buy, the fact that the Yankees won the 2009 World Series is of no value to you. Information is most powerful when it enables strategic decision making. It must be delivered to the right person at the right time with as little effort as possible. For businesses, correctly managing strategic information can mean the difference between success and failure. Consequently, today's businesses invest a large percentage of their budgets in systems designed to deliver the right information to the right people at the right time. Such is the case for Braskem S.A.

Braskem S.A. is the largest petrochemical company in Latin America, with annual revenue of $13 billion (US) and 5,500 employees. Braskem was created in 2002 out of the merger of six Brazilian companies. Its 13 chemical plants produce basic raw materials such as ethylene, propylene, and chlorine, which are used in the production of thermoplastic resins. Braskem then sells the resins to manufacturers of plastic products. Toothbrushes, baby bottles, backpacks, automotive parts, and computer parts are all made from thermoplastic resins produced by Braskem, ExxonMobile, Dow Chemical, and other petrochemical companies.

Recently, Braskem invested heavily in an information systems (IS) development effort to provide all of its 4,000 office and production staff access to information from one central source using one system. In planning and developing the new system, Braskem IS managers needed to consider many factors. The system would handle science and research information as well as production, business, and financial information. Such enterprise-wide systems are often referred to as enterprise resource planning systems (ERPs). Braskem wanted the system to be implemented within a year—a tall order for an ERP. Braskem executives also wanted the system to help the company's employees make it one of the world's top 10 petrochemical companies.

Although this may seem a lot to ask of an IS, information systems do directly influence the implementation of smart business processes. An IS can either hamper people from proper business practices or it can help them establish best practices across an organization. "Best practices" refers to insightful business practices that are proven to provide a competitive advantage. Braskem wanted its new information systems to help establish best practices and streamline its essential business processes. Braskem's chief information officer (CIO), Stefan Lanna Lepecki, investigated what type of information systems the top global petrochemical companies were using. He soon discovered that 9 of the top 10 companies used information systems developed by SAP.

SAP is a multinational software development and consulting corporation with headquarters in Waldorf, Germany. Having worked with major petrochemical companies, SAP system engineers were well acquainted with the business and with systems that guide best business practices. After gaining the approval of the steering committee, top executives, and even the workers in the plant, Braskem hired SAP to build the new system. Rather than viewing the project as a technology initiative, Braskem embraced it as a business process transformation. Systems engineers, business managers, and hourly employees would all be involved.

Braskem's CIO kept customization requests to a minimum to implement a system that, for the most part, used the same standard SAP software that other petrochemical compa-

nies used. The system required Braskem to get a new technology infrastructure including new hardware, databases, telecommunications equipment, and software. It was implemented within one year. In the final stages of development, Braskem instituted a rigorous training regimen for the 4,000 employees who would be working with the system. Using simulations, each employee was required to advance through eight skill levels before being allowed to use the real system. Although training required 63,930 people hours, it ensured that employees used the best practices and procedures that the system supported. The result was an improvement of business processes across the enterprise.

Braskem no longer suffers the frustration of working with different systems at different sites. Today, information flows freely among Braskem's plants and offices, with executives, managers, and employees accessing up-to-the-minute information from any Braskem location. They can also access the system from mobile devices when they travel. The company has reduced its maintenance, repair, and operations costs. The improved efficiency of its systems also allows Braskem to reduce the amount of inventory it keeps on hand because inventory now ships when it rolls off the production line. In general, business tasks require fewer people and take less time with the new system. The system also complies with government regulations such as the Sarbanes-Oxley Act designed to keep business practices transparent. The new IS puts Braskem in an ideal position to gain market share and reach its goals.

As you read this chapter, consider the following:

- How might the information system used at Braskem depend on the various components of a computer-based information system: hardware, software, databases, telecommunications, people, and procedures?
- How do computer-based information systems like Braskem's help businesses implement best practices?

Why Learn About Information Systems in Organizations?

Information systems are used in almost every imaginable profession. Entrepreneurs and small business owners use information systems to reach customers around the world. Sales representatives use information systems to advertise products, communicate with customers, and analyze sales trends. Managers use them to make multimillion-dollar decisions, such as whether to build a manufacturing plant or research a cancer drug. Financial advisors use information systems to advise their clients to help them save for their children's education and retirement. From a small music store to huge multinational companies, businesses of all sizes could not survive without information systems to perform accounting and finance operations. Regardless of your college major or chosen career, information systems are indispensable tools to help you achieve your career goals. Learning about information systems can help you land your first job, earn promotions, and advance your career.

Why learn about information systems in organizations? What is in it for you? Learning about information systems will help you achieve your goals. Let's get started by exploring the basics of information systems.

People and organizations use information every day. Many retail chains, for example, collect data from their stores to help them stock what customers want and to reduce costs. The components that are used are often called an information system. An **information system (IS)** is a set of interrelated components that collect, manipulate, store, and disseminate data and information and provide a feedback mechanism to meet an objective.[1] It is the feedback mechanism that helps organizations achieve their goals, such as increasing profits or improving customer service.[2] Businesses can use information systems to increase revenues and reduce costs. This book emphasizes the benefits of an information system, including speed, accuracy, increased revenues, and reduced costs.

Today we live in an information economy.[3] Information itself has value, and commerce often involves the exchange of information rather than tangible goods. Systems based on

computers are increasingly being used to create, store, and transfer information. Using information systems, investors make multimillion-dollar decisions, financial institutions transfer billions of dollars around the world electronically, and manufacturers order supplies and distribute goods faster than ever before. Computers and information systems will continue to change businesses and the way we live. To prepare for these innovations, you need to be familiar with fundamental information concepts.

INFORMATION CONCEPTS

Information is a central concept of this book. The term is used in the title of the book, in this section, and in almost every chapter. To be an effective manager in any area of business, you need to understand that information is one of an organization's most valuable resources. This term, however, is often confused with *data*.

Data, Information, and Knowledge

Data consists of raw facts, such as an employee number, total hours worked in a week, inventory part numbers, or sales orders. As shown in Table 1.1, several types of data can represent these facts. When facts are arranged in a meaningful manner, they become information. **Information** is a collection of facts organized and processed so that they have additional value beyond the value of the individual facts. For example, sales managers might find that knowing the total monthly sales suits their purpose more (i.e., is more valuable) than knowing the number of sales for each sales representative. Providing information to customers can also help companies increase revenues and profits. FedEx, a worldwide leader in shipping packages and products around the world, believes that information about a package can be as important as the package itself for many of its customers.[4] Increasingly, information generated by FedEx and other organizations is being placed on the Internet. In addition, many universities are now placing course information and content on the Internet. Using the Open Course Ware program, the Massachusetts Institute of Technology (MIT) places class notes and contents on the Internet for many of its courses.[5]

data
Raw facts, such as an employee number, total hours worked in a week, inventory part numbers, or sales orders.

information
A collection of facts organized in such a way that they have additional value beyond the value of the individual facts.

Table 1.1
Types of Data

Data	Represented by
Alphanumeric data	Numbers, letters, and other characters
Image data	Graphic images and pictures
Audio data	Sound, noise, or tones
Video data	Moving images or pictures

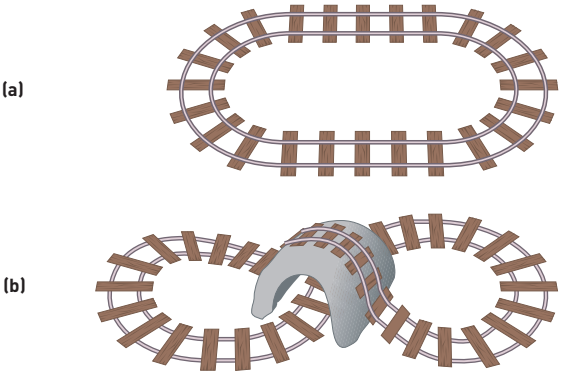
Data represents real-world things. Hospitals and healthcare organizations, for example, maintain patient medical data, which represents actual patients with specific health situations. In many cases, hospitals and healthcare organizations are converting data to electronic form. Some have developed electronic records management (ERM) systems to store, organize, and control important data. However, data—raw facts—has little value beyond its existence. The U.S. federal stimulus plan could invest as much as $2 billion into helping healthcare organizations develop a medical records program to store and use the vast amount of medical data that is generated each year.[6] Medical records systems can be used to generate critical health-related information, saving money and lives.

Here is another example of the difference between data and information. Consider data as pieces of railroad track in a model railroad kit. Each piece of track has limited inherent value as a single object. However, if you define a relationship among the pieces of the track, they will gain value. By arranging the pieces in a certain way, a railroad layout begins to

emerge (see Figure 1.1a). Data and information work the same way. Rules and relationships can be set up to organize data into useful, valuable information.

Figure 1.1

Defining and Organizing Relationships Among Data Creates Information



The type of information created depends on the relationships defined among existing data. For example, you could rearrange the pieces of track to form different layouts. Adding new or different data means you can redefine relationships and create new information. For instance, adding new pieces to the track can greatly increase the value—in this case, variety and fun—of the final product. You can now create a more elaborate railroad layout (see Figure 1.1b). Likewise, a sales manager could add specific product data to his or her sales data to create monthly sales information organized by product line. The manager could use this information to determine which product lines are the most popular and profitable.

process
A set of logically related tasks performed to achieve a defined outcome.

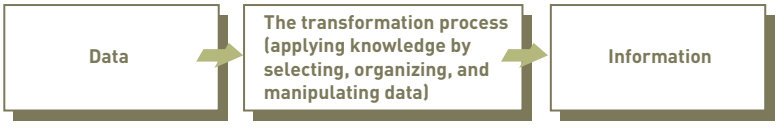
knowledge
The awareness and understanding of a set of information and ways that information can be made useful to support a specific task or reach a decision.

Turning data into information is a **process**, or a set of logically related tasks performed to achieve a defined outcome. The process of defining relationships among data to create useful information requires knowledge. **Knowledge** is the awareness and understanding of a set of information and the ways that information can be made useful to support a specific task or reach a decision. Having knowledge means understanding relationships in information. Part of the knowledge you need to build a railroad layout, for instance, is the understanding of how much space you have for the layout, how many trains will run on the track, and how fast they will travel. Selecting or rejecting facts according to their relevancy to particular tasks is based on the knowledge used in the process of converting data into information. Therefore, you can also think of information as data made more useful through the application of knowledge. *Knowledge workers (KWs)* are people who create, use, and disseminate knowledge and are usually professionals in science, engineering, business, and other areas.[7] A *knowledge management system (KMS)* is an organized collection of people, procedures, software, databases, and devices used to create, store, and use the organization's knowledge and experience.[8] Research has shown that the success of a KMS is linked to how easy it is to use and how satisfied users are with it.[9]

In some cases, people organize or process data mentally or manually. In other cases, they use a computer. Where the data comes from or how it is processed is less important than whether the data is transformed into results that are useful and valuable. This transformation process is shown in Figure 1.2.

Figure 1.2

The Process of Transforming Data into Information



The Characteristics of Valuable Information

To be valuable to managers and decision makers, information should have the characteristics described in Table 1.2. These characteristics make the information more valuable to an organization. Many shipping companies, for example, can determine the exact location of

inventory items and packages in their systems, and this information makes them responsive to their customers. In contrast, if an organization's information is not accurate or complete, people can make poor decisions, costing thousands, or even millions, of dollars. If an inaccurate forecast of future demand indicates that sales will be very high when the opposite is true, an organization can invest millions of dollars in a new plant that is not needed. Furthermore, if information is not relevant, not delivered to decision makers in a timely fashion, or too complex to understand, it can be of little value to the organization.

Table 1.2

Characteristics of Valuable Information

Characteristics	Definitions
Accessible	Information should be easily accessible by authorized users so they can obtain it in the right format and at the right time to meet their needs.
Accurate	Accurate information is error free. In some cases, inaccurate information is generated because inaccurate data is fed into the transformation process. (This is commonly called garbage in, garbage out [GIGO].)
Complete	Complete information contains all the important facts. For example, an investment report that does not include all important costs is not complete.
Economical	Information should also be relatively economical to produce. Decision makers must always balance the value of information with the cost of producing it.
Flexible	Flexible information can be used for a variety of purposes. For example, information on how much inventory is on hand for a particular part can be used by a sales representative in closing a sale, by a production manager to determine whether more inventory is needed, and by a financial executive to determine the total value the company has invested in inventory.
Relevant	Relevant information is important to the decision maker. Information showing that lumber prices might drop might not be relevant to a computer chip manufacturer.
Reliable	Reliable information can be trusted by users. In many cases, the reliability of the information depends on the reliability of the data-collection method. In other instances, reliability depends on the source of the information. A rumor from an unknown source that oil prices might go up might not be reliable.
Secure	Information should be secure from access by unauthorized users.
Simple	Information should be simple, not overly complex. Sophisticated and detailed information might not be needed. In fact, too much information can cause information overload, whereby a decision maker has too much information and is unable to determine what is really important.
Timely	Timely information is delivered when it is needed. Knowing last week's weather conditions will not help when trying to decide what coat to wear today.
Verifiable	Information should be verifiable. This means that you can check it to make sure it is correct, perhaps by checking many sources for the same information.

Depending on the type of data you need, some quality attributes become more valuable than others. For example, with market-intelligence data, some inaccuracy and incompleteness is acceptable, but timeliness is essential. Getco, a Chicago-based stock-trading company, requires the most timely market information possible so it can place profitable trades.[10] Getco uses an approach called high-frequency trading that requires powerful and very fast computers to make its trades. On some days, Getco can account for 10 to 20 percent of the total trading volume for some stocks. Market intelligence might alert you that competitors are about to make a major price cut. The exact details and timing of the price cut might not be as important as being warned far enough in advance to plan how to react. On the other hand, accuracy, verifiability, and completeness are critical for data used in accounting to manage company assets such as cash, inventory, and equipment.

The Value of Information

The value of information is directly linked to how it helps decision makers achieve their organization's goals. Valuable information can help people in their organizations perform

tasks more efficiently and effectively. Consider a market forecast that predicts a high demand for a new product. If you use this information to develop the new product and your company makes an additional profit of $10,000, the value of this information to the company is $10,000 minus the cost of the information. Valuable information can also help managers decide whether to invest in additional information systems and technology. A new computerized ordering system might cost $30,000 but generate an additional $50,000 in sales. The *value added* by the new system is the additional revenue from the increased sales of $20,000. Most corporations have cost reduction as a primary goal. Using information systems, some manufacturing companies have slashed inventory costs by millions of dollars. Other companies have increased inventory levels to increase profits. Walmart, for example, uses information about certain regions of the country and specific situations to increase needed inventory levels of certain products and improve overall profitability. In other cases, the value of information can be realized in cost savings. Shermag, a Canadian furniture manufacturing company, was able to use a sophisticated computer system to achieve the company's cost reduction goal.[11] The company was able to reduce total costs by more than 20 percent by using optimization software to reduce material and manufacturing costs.

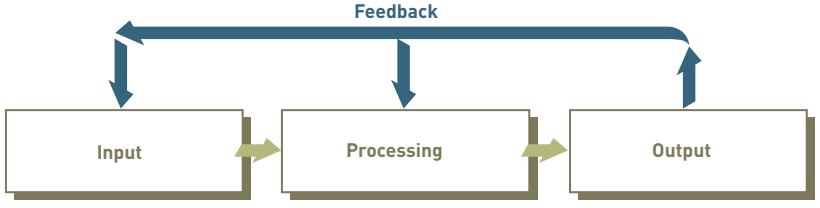
WHAT IS AN INFORMATION SYSTEM?

As mentioned previously, an information system (IS) is a set of interrelated elements or components that collect (input), manipulate (process), store, and disseminate (output) data and information and provide a corrective reaction (feedback mechanism) to meet an objective (see Figure 1.3). The feedback mechanism is the component that helps organizations achieve their goals, such as increasing profits or improving customer service.

Figure 1.3

The Components of an Information System

Feedback is critical to the successful operation of a system.



Input, Processing, Output, Feedback

input
The activity of gathering and capturing raw data.

Input

In information systems, **input** is the activity of gathering and capturing raw data. In producing paychecks, for example, the number of hours every employee works must be collected before paychecks can be calculated or printed. In a university grading system, instructors must submit student grades before a summary of grades for the semester or quarter can be compiled and sent to students.

processing
Converting or transforming data into useful outputs.

Processing

In information systems, **processing** means converting or transforming data into useful outputs. Processing can involve making calculations, comparing data and taking alternative actions, and storing data for future use. Processing data into useful information is critical in business settings.

Processing can be done manually or with computer assistance. In a payroll application, the number of hours each employee worked must be converted into net, or take-home, pay. Other inputs often include employee ID number and department. The processing can first involve multiplying the number of hours worked by the employee's hourly pay rate to get gross pay. If weekly hours worked exceed 40, overtime pay might also be included. Then deductions—for example, federal and state taxes or contributions to insurance or savings plans—are subtracted from gross pay to get net pay.

After these calculations and comparisons are performed, the results are typically stored. *Storage* involves keeping data and information available for future use, including output, discussed next.

Output

In information systems, **output** involves producing useful information, usually in the form of documents and reports. Outputs can include paychecks for employees, reports for managers, and information supplied to stockholders, banks, government agencies, and other groups. In some cases, output from one system can become input for another. For example, output from a system that processes sales orders can be used as input to a customer billing system.

output
Production of useful information, usually in the form of documents and reports.

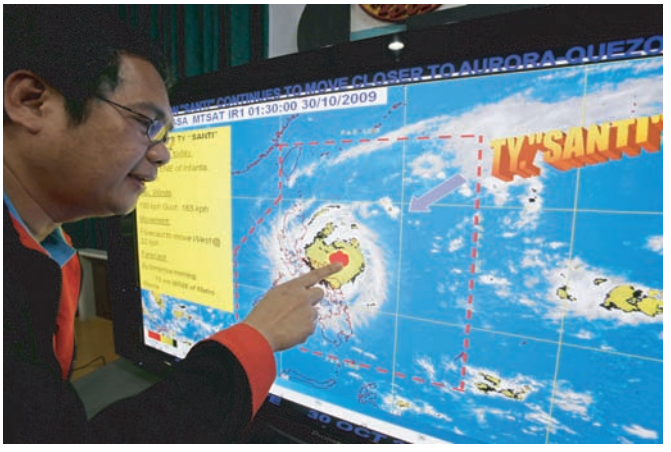
Feedback

In information systems, **feedback** is information from the system that is used to make changes to input or processing activities. For example, errors or problems might make it necessary to correct input data or change a process. Consider a payroll example. Perhaps the number of hours an employee worked was entered as 400 instead of 40. Fortunately, most information systems check to make sure that data falls within certain ranges. For number of hours worked, the range might be from 0 to 100 because it is unlikely that an employee would work more than 100 hours in a week. The information system would determine that 400 hours is out of range and provide feedback. The feedback is used to check and correct the input on the number of hours worked to 40. If undetected, this error would result in a very high net pay on the printed paycheck!

feedback
Output that is used to make changes to input or processing activities.

Feedback is also important for managers and decision makers. For example, a furniture maker could use a computerized feedback system to link its suppliers and plants. The output from an information system might indicate that inventory levels for mahogany and oak are getting low—a potential problem. A manager could use this feedback to decide to order more wood from a supplier. These new inventory orders then become input to the system. In addition to this reactive approach, a computer system can also be proactive—predicting future events to avoid problems. This concept, often called **forecasting**, can be used to estimate future sales and order more inventory before a shortage occurs. According to the CIO of Coty Fragrance, which produces Jennifer Lopez and Vera Wang brands, "If we can't meet demand, it annoys the retailers, the consumers lose interest, and we lose sales."[12] Forecasting is also used to predict the strength and landfall sites of hurricanes, future stock-market values, and who will win a political election. Disappointed with existing weather forecasting systems, Robert Baron developed a more sophisticated forecasting approach that used radar data along with other meteorological data to forecast storms and weather. Today, his weather forecasting software generates about $25 million in annual revenues. [13]

forecasting
Predicting future events to avoid problems.



Forecasting systems can help meteorologists predict the strength and landfall sites of tropical storms.

(Source: Courtesy of AP Photo/Bullit Marquez.)

Manual and Computerized Information Systems

As discussed earlier, an information system can be manual or computerized. For example, some investment analysts manually draw charts and trend lines to assist them in making investment decisions. Tracking data on stock prices (input) over the last few months or years, these analysts develop patterns on graph paper (processing) that help them determine what stock prices are likely to do in the next few days or weeks (output). Some investors have made millions of dollars using manual stock analysis information systems. Of course, today many excellent computerized information systems follow stock indexes and markets and suggest when large blocks of stocks should be purchased or sold (called *program trading*) to take advantage of market discrepancies.

Computer-Based Information Systems

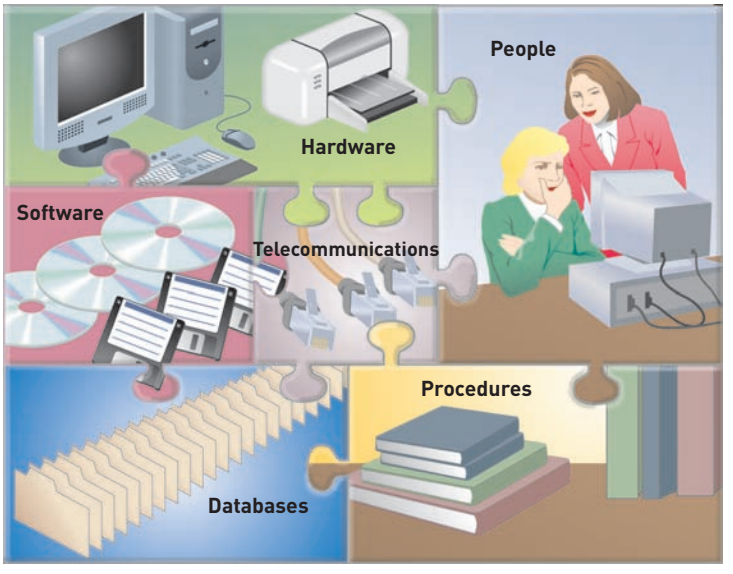
computer-based information system (CBIS)
A single set of hardware, software, databases, telecommunications, people, and procedures that are configured to collect, manipulate, store, and process data into information.

technology infrastructure
All the hardware, software, databases, telecommunications, people, and procedures that are configured to collect, manipulate, store, and process data into information.

A **computer-based information system (CBIS)** is a single set of hardware, software, databases, telecommunications, people, and procedures that are configured to collect, manipulate, store, and process data into information. Lloyd's Insurance in London used a CBIS to reduce paper transactions and convert to an electronic insurance system. The CBIS allows Lloyd's to insure people and property more efficiently and effectively. Lloyd's often insures the unusual, including actress Betty Grable's legs, Rolling Stone Keith Richards's hands, and a possible appearance of the Loch Ness Monster (Nessie) in Scotland, which would result in a large payment for the person first seeing the monster.

The components of a CBIS are illustrated in Figure 1.4. *Information technology (IT)* refers to hardware, software, databases, and telecommunications. Telecommunications also includes networks and the Internet. A business's **technology infrastructure** includes all the hardware, software, databases, telecommunications, people, and procedures that are configured to collect, manipulate, store, and process data into information. The technology infrastructure is a set of shared IS resources that form the foundation of each computer-based information system.

Figure 1.4
The Components of a Computer-Based Information System



Hardware

hardware
The physical components of a computer that perform the input, processing, storage, and output activities of the computer.

Hardware consists of the physical components of a computer that perform the input, processing, storage, and output activities of the computer. Input devices include keyboards, mice, and other pointing devices; automatic scanning devices; and equipment that can read magnetic ink characters. Processing devices include computer chips that contain the central processing unit and main memory. Advances in chip design allow faster speeds, less power consumption, and larger storage capacity. Some specialized computer chips will be able to monitor power consumption for companies and homeowners.[14] SanDisk and other

companies make small, portable chips that are used to conveniently store programs, data files, and more.[15] The publisher of this book, for example, used this type of chip storage device to send promotional material for this book to professors and instructors.

Processor speed is also important. Today's more advanced processor chips have the power of 1990s-era supercomputers that occupied a room measuring 10 feet by 40 feet. A large IBM computer used by U.S. Livermore National Laboratories to analyze nuclear explosions is one of the fastest computers in the world (up to 300 teraflops—300 trillion operations per second).[16] The super-fast computer, called Blue Gene, costs about $40 million.[17] It received the *National Medal of Technology and Innovation* award from President Barack Obama. Small, inexpensive computers and handheld devices are also becoming popular. Inexpensive netbooks are small, inexpensive laptop computers that can cost less than $500 and be used primarily to connect to the Internet.[18] In addition, the iPhone by Apple Computer can perform many functions that can be done on a desktop or laptop computer.[19] The One Laptop Per Child computer costs less than $200.[20] The Classmate PC by Intel will cost about $300 and include some educational software. Both computers are intended for regions of the world that can't afford traditional personal computers. The country of Peru, for example, has purchased about 350,000 laptops loaded with about 100 books for children, who also teach their parents how to use the inexpensive computers.[21] According to the founder of One Laptop Per Child, "If that doesn't give you goose bumps, I don't know what will."

The One Laptop Per Child Computer costs less than $200, and is designed for regions of the world that can't afford traditional personal computers.

(Source: Courtesy of AFP/Getty Images.)

The many types of output devices include printers and computer screens. Some touch-sensitive computer screens, for example, can be used to execute functions or complete programs, such as connecting to the Internet or running a new computer game or word processing program.[22] Many special-purpose hardware devices have also been developed. Computerized event data recorders (EDRs) are now being placed into vehicles. Like an airplane's black box, EDRs record vehicle speed, possible engine problems, driver performance, and more. The technology is being used to document and monitor vehicle operation, determine the cause of accidents, and investigate whether truck drivers are taking required breaks. In one case, an EDR was used to help convict a driver of vehicular homicide. In another case, an EDR in a police officer's car showed that the officer may have run a stop light and accelerated to more than 70 miles per hour on a road with a speed limit of 35 miles per hour before an accident that killed two teenagers.[23]

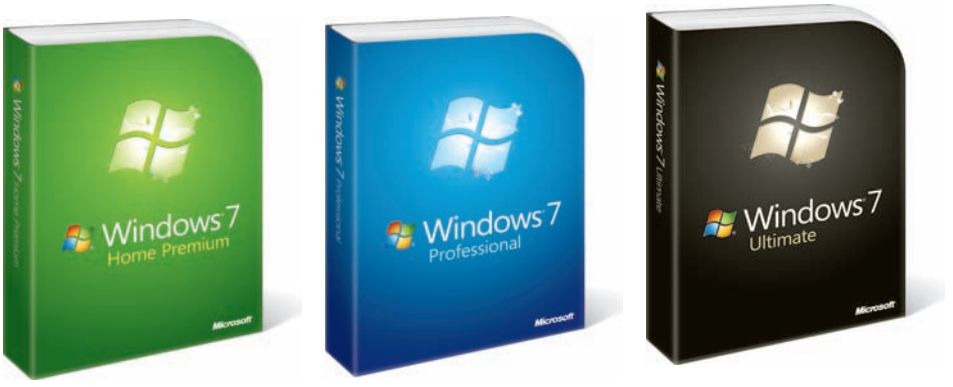
Software

Software consists of the computer programs that govern the operation of the computer. These programs allow a computer to process payroll, send bills to customers, and provide managers with information to increase profits, reduce costs, and provide better customer service. Fab Lab software, for example, controls tools such as cutters, milling machines, and other devices.[24] One Fab Lab system, which costs about $20,000, has been used to make radio frequency tags to track animals in Norway, engine parts to allow tractors to run on processed castor beans in India, and many other fabrication applications. SalesForce (*www.salesforce.com*) sells software to help companies manage their salesforce and help improve customer satisfaction.[25]

software
The computer programs that govern the operation of the computer.

The two types of software are *system software*, such as Microsoft Windows Vista and Windows 7, which controls basic computer operations, including start-up and printing, and *applications software*, such as Microsoft Office 2010, which allows you to accomplish specific tasks, including word processing or tabulating numbers.[26] Software is needed for computers of all sizes, from small handheld computers to large supercomputers. The Android operating system by Google and Microsoft's Mobile 6.5, for example, are operating systems for cell phones and small portable devices.[27] Although most software can be installed from CDs, many of today's software packages can be downloaded through the Internet.

Sophisticated application software, such as Adobe Creative Suite 4, can be used to design, develop, print, and place professional-quality advertising, brochures, posters, prints, and videos on the Internet.[28] Nvidia's GeForce 3D is software that can display images on a computer screen that appear three-dimensional (3D) when viewed using special glasses.[29]



Windows 7 is systems software that controls basic computer operations, including start-up and printing.

(Source: Courtesy of Microsoft Corporation.)

Databases

database
An organized collection of facts and information.

A **database** is an organized collection of facts and information, typically consisting of two or more related data files. An organization's database can contain facts and information on customers, employees, inventory, competitors' sales, online purchases, and much more. A database manager for a large bank, for example, has developed a patented security process that generates a random numeric code from a customer's bank card that can be verified by a computer system through a customer database.[30] Once the bank card and customer have been verified, the customer can make financial transactions.

Data can be stored in large data centers, within computers of all sizes, in the Internet, and in smart cell phones and small computing devices.[31] The New York Stock Exchange (NYSE) and other exchanges are using database systems to get better business information and intelligence to help them run successful and profitable operations.[32] The huge increase in database storage requirements, however, often requires more storage devices, more space to house the additional storage devices, and additional electricity to operate them.[33]

Telecommunications, Networks, and the Internet

telecommunications
The electronic transmission of signals for communications; enables organizations to carry out their processes and tasks through effective computer networks.

Telecommunications is the electronic transmission of signals for communications, which enables organizations to carry out their processes and tasks through effective computer networks. Telecommunications can take place through wired, wireless, and satellite transmissions.[34] The Associated Press was one of the first users of telecommunications in the 1920s, sending news over 103,000 miles of wire in the United States and almost 10,000 miles of cable across the ocean. Today, telecommunications is used by organizations of all sizes and individuals around the world. With telecommunications, people can work at home or while traveling. This approach to work, often called *telecommuting,* allows a telecommuter living in England to send his or her work to the United States, China, or any location with telecommunications capabilities.

networks
Computers and equipment that are connected in a building, around the country, or around the world to enable electronic communication.

Networks connect computers and equipment in a building, around the country, or around the world to enable electronic communication. Wireless transmission allows aircraft drones, such as Boeing's Scan Eagle, to fly using a remote control system to monitor commercial buildings or enemy positions.[35] The drones are smaller and less- expensive versions of the Predator and Global Hawk drones that the U.S. military used in the Afghanistan and Iraq conflicts. According to a Navy Rear Admiral, "There are all sorts of levels of stealthiness. Operators have been deploying it in an undetectable fashion; at a certain low altitude, you can't hear it or see it."

The **Internet** is the world's largest computer network, consisting of thousands of interconnected networks, all freely exchanging information. Research firms, colleges, universities, high schools, hospitals, and businesses are just a few examples of organizations using the Internet. Beth Israel Deaconess Medical Center, for example, allows doctors to use its Internet site to provide better patient care and reduce costs.[36] The doctors pay a monthly service fee to use the hospital's Internet site. Increasingly, businesses and people are using the Internet to run and deliver important applications, such as accessing vast databases, performing sophisticated business analysis, and getting a variety of reports. This concept, called *cloud computing,* allows people to get the information they need from the Internet (the cloud) instead of from desktop or corporate computers.[37] According to the CIO of Avon Products, "Today, wherever you are, you can connect to all the information you need." Some applications are available to everyone (public cloud computing), while other applications are only available to corporate employees and managers (private cloud computing).[38]

Internet
The world's largest computer network, consisting of thousands of interconnected networks, all freely exchanging information.

Doctors use cloud computing and other types of Web sites to provide better patient care and reduce costs.

(Source: © B Busco/Getty Images.)

People use the Internet to research information, buy and sell products and services, make travel arrangements, conduct banking, download music and videos, read books, and listen to radio programs, among other activities.[39] Bank of America allows people to check their bank balances and pay their bills on the Internet using Apple's iPhone and other handheld devices.[40] Internet sites like MySpace (*www.myspace.com*) and Facebook (*www.facebook.com*) have become popular places to connect with friends and colleagues. People can also send short messages of up to 140 characters using Twitter (*www.twitter.com*) over the Internet.[41] Some people, however, fear that this increased usage can lead to problems, including criminals hacking into the Internet and gaining access to sensitive personal information.

Large computers, personal computers, and today's cell phones, such as Apple's iPhone, can access the Internet.[42] This not only speeds communications, but also allows people to conduct business electronically. Internet users can create *Web logs (blogs)* to store and share their thoughts and ideas with others around the world. Using *podcasting*, you can download audio programs or music from the Internet to play on computers or music players. One of the authors of this book uses podcasts to obtain information on information systems and technology.

The *World Wide Web (WWW)*, or the *Web*, is a network of links on the Internet to documents containing text, graphics, video, and sound. Information about the documents and access to them are controlled and provided by tens of thousands of special computers called Web servers. The Web is one of many services available over the Internet and provides access to millions of documents. New Internet technologies and increased Internet communications and collaboration are collectively called *Web 2.0*. [43]

ETHICAL AND SOCIETAL ISSUES

Who Is Interested in Your Social Network Updates?

More than two-thirds of the world's online population use social networks such as Facebook, MySpace, and Twitter to stay in touch with friends. It is likely that you are one of them. In 2008, social networks became more popular than e-mail, with 66.8 percent of Internet users accessing member communities. Most members of social networks use a posting feature that allows them to share their day-to-day thoughts and activities with their circle of friends. Facebook calls these postings "updates," while Twitter calls them "tweets." Most users do not realize the value of their comments, updates, or tweets to people outside their circle.

Businesses are flocking to social networks to harvest consumer sentiment for use in guiding product development. They are also watching social networks to confront negative publicity. The broad scale use of social networks and the careful analysis of billions of messages have made it possible to collect public sentiment and build customer relations in a manner never done before. But sifting through the babble to discover comments of interest is challenging.

A number of information system companies have sprung up to provide products designed to monitor social media. Companies such as Alterian, Radian6, Attensity, Visible Technologies, Conversion, and Nielsen Online provide social media monitoring systems for businesses and organizations. As a young technology, there is no standard approach to social media monitoring. Similar to a search engine, the systems typically traverse the continuous streams of comments in social networks, looking for key terms related to specified products. Artificial intelligence (AI) techniques that automate the interpretation of user comments make it possible to quickly identify comments of particular interest. Ultimately, they generate analytic and performance reports for the human expert to evaluate. Systems that monitor social media enable useful information to be drawn from billions of seemingly mundane and unrelated messages.

Monitoring social media can focus on brand reputation management, public relations, or even market research. Companies such as Comcast, a major communications company, hire full-time social media experts who interact with customers online to address problems and complaints. For example, if you complain about Comcast service on Twitter, you might be contacted by a Comcast employee offering to help you.

The social network service owners are well aware of the value of the information that flows over their networks. Most of them intend to build their business through the comments and attention of their members. Whether through targeted ads or selling access to user data, social networks can become very lucrative businesses. Why else would Twitter, a service with apparently no business model, be worth over a billion dollars? Twitter's goal is to grow to one billion members and provide interested parties with the pulse of the planet.

How do users feel about their "personal" comments being harvested to make billions for Internet companies? With social network growth rates in 2009 ranging from 228 percent for Facebook to 1,382 percent for Twitter, users are either unaware or unconcerned. Regardless of what users think, it is likely that businesses will increasingly analyze the continuous flow of data over social networks to generate insights they can use.

Discussion Questions

1. Do you think it is ethical for social networks to sell access to user information to businesses for market research and other uses? Why or why not?
2. What service does the monitoring of social media ultimately provide for consumers?

Critical Thinking Questions

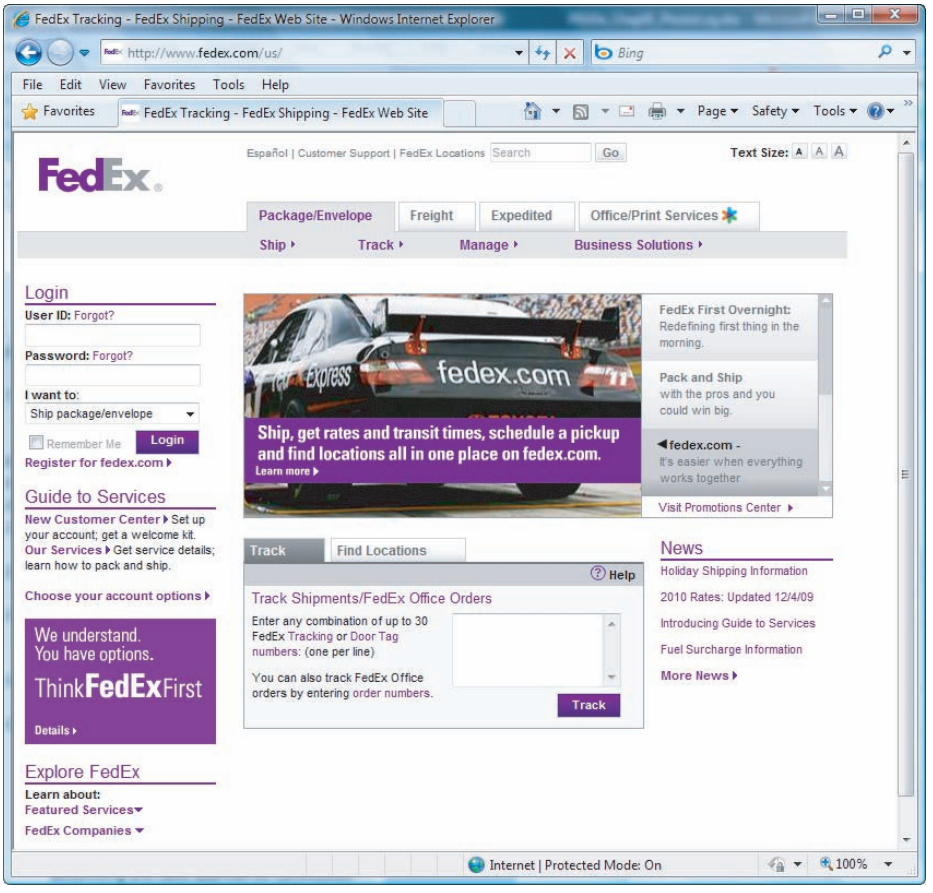
1. What competitive advantage does the monitoring of social media provide to companies that invest in it?
2. Why is the monitoring of social media considered a CBIS?

SOURCES: Ostrow, Adam, "Social Networking More Popular than Email," *Mashable*, March 9, 2009, *http://mashable.com/2009/03/09/social-networking-more-popular-than- email*; Zabin, Jeff, "Finding Out What They're Saying About You Is Worth Every Penny," *E-Commerce Times*, November 12, 2009, *www.ecommercetimes.com/rsstory/68624.html*; Bensen, Connie, "Do you know what people are saying about you?" *Reuters UK*, September 14, 2009, *http://blogs.reuters.com/great-debate-uk/2009/09/14/do-you-know-what-people-are- saying-about-you*; Schonfeld, Erick, "Twitter's Internal Strategy Laid Bare: To Be "The Pulse of the Planet," *TechCrunch*, July 16, 2009, *www.techcrunch.com/2009/07/16/twitters-internal-strategy-laid-bare-to-be-the-pulse-of- the-planet*; Reisner, Rebecca, "Comcast's Twitter Man," *Business Week*, January 13, 2009, *www.businessweek.com/managing/content/jan2009/ca20090113_373506.htm*; McCarthy, Carolina, "Nielsen: Twitter's growing really, really, really, really fast," CNET, March 2009, *http://news.cnet.com/8301-13577_3-10200161-36.html*; Nielsen Staff, "Social Networking's New Global Footprint," *NielsenWire*, March 9, 2009, *http://blog.nielsen.com/nielsenwire/global/social-networking-new-global-footprint/.*

The technology used to create the Internet is also being applied within companies and organizations to create **intranets**, which allow people in an organization to exchange information and work on projects. ING DIRECT Canada (*www.ingdirect.ca/en*), for example, used its intranet to get ideas from its employees. According to one corporate executive, "Many of the ideas we've been able to implement are from front-line staff who talk to our customers every day and know what they want." [44] Companies often use intranets to connect its employees around the globe. An **extranet** is a network based on Web technologies that allows selected outsiders, such as business partners and customers, to access authorized resources of a company's intranet. Many people use extranets every day without realizing it—to track shipped goods, order products from their suppliers, or access customer assistance from other companies. Penske Truck Leasing, for example, uses an extranet (*www.MyFleetAtPenske.com*) for Penske leasing companies and its customers.[45] The extranet site allows customers to schedule maintenance, find Penske fuel stops, receive emergency roadside assistance, participate in driver training programs, and more. If you log on to the FedEx site (*www.fedex.com*) to check the status of a package, for example, you are using an extranet.

intranet
An internal network based on Web technologies that allows people within an organization to exchange information and work on projects.

extranet
A network based on Web technologies that allows selected outsiders, such as business partners and customers, to access authorized resources of a company's intranet.

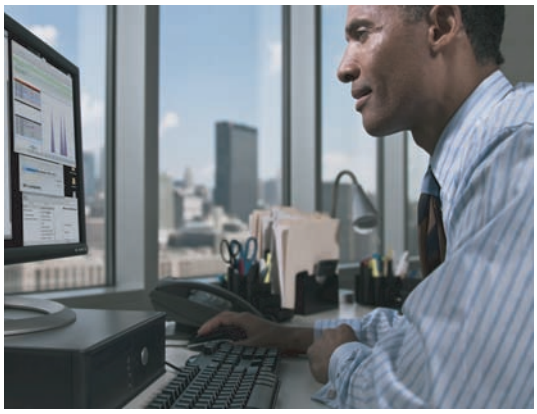


When you log on to the FedEx site (*www.fedex.com*) to check the status of a package, you are using an extranet.

(Source: *www.fedex.com*.)

People

People are the most important element in most computer-based information systems. They make the difference between success and failure for most organizations. Information systems personnel include all the people who manage, run, program, and maintain the system, including the CIO, who manages the IS department.[46] Users are people who work with information systems to get results. Users include financial executives, marketing representatives, manufacturing operators, and many others. Certain computer users are also IS personnel.



The chief information officer (CIO) manages the Information Systems department, which includes all the people who manage, run, program, and maintain a computer-based information system.

(Source: © Ryan McVay/Getty Images.)

procedures
The strategies, policies, methods, and rules for using a CBIS.

Procedures

Procedures include the strategies, policies, methods, and rules for using the CBIS, including the operation, maintenance, and security of the computer. For example, some procedures describe when each program should be run. Others describe who can access facts in the database or what to do if a disaster, such as a fire, earthquake, or hurricane, renders the CBIS unusable. Good procedures can help companies take advantage of new opportunities and avoid potential disasters. Poorly developed and inadequately implemented procedures, however, can cause people to waste their time on useless rules or result in inadequate responses to disasters, such as hurricanes or tornadoes.

Now that we have looked at computer-based information systems in general, we will briefly examine the most common types used in business today. These IS types are covered in greater detail in Part 3.

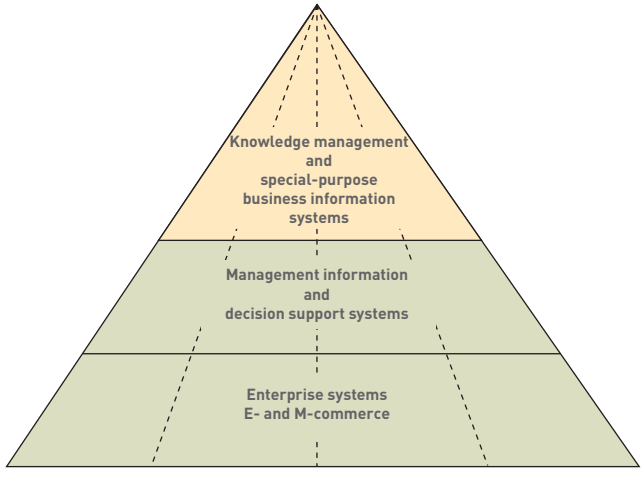
BUSINESS INFORMATION SYSTEMS

The most common types of information systems used in business organizations are those designed for electronic and mobile commerce, transaction processing, management information, and decision support. In addition, some organizations employ special-purpose systems, such as virtual reality, that not every organization uses. Although these systems are discussed in separate sections in this chapter and explained in greater detail later, they are often integrated in one product and delivered by the same software package. See Figure 1.5. For example, some business information systems process transactions, deliver information, and support decisions. Figure 1.6 shows a simple overview of the development of important business information systems discussed in this section.

Figure 1.5

Business Information Systems

Business information systems are often integrated in one product and can be delivered by the same software package.



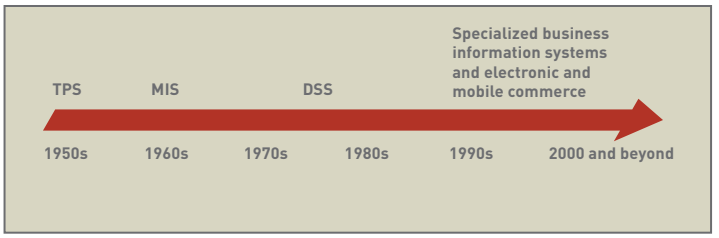


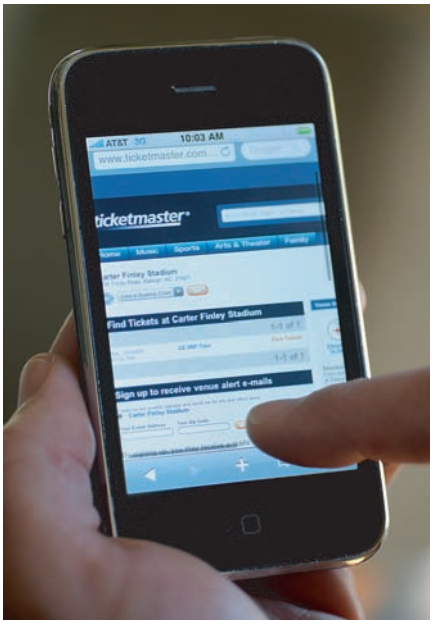
Figure 1.6
The Development of Important Business Information Systems

Electronic and Mobile Commerce

E-commerce involves any business transaction executed electronically between companies (business-to-business, or B2B), companies and consumers (business-to-consumer, or B2C), consumers and other consumers (consumer-to-consumer, or C2C), business and the public sector, and consumers and the public sector.[47] Some of the stimulus funds in 2009, for example, were aimed at increasing electronic record keeping and electronic commerce for healthcare facilities.[48] E-commerce offers opportunities for businesses of all sizes to market and sell at a low cost worldwide, allowing them to enter the global market. **Mobile commerce (m-commerce)** is the use of mobile, wireless devices to place orders and conduct business. M-commerce relies on wireless communications that managers and corporations use to place orders and conduct business with handheld computers, portable phones, laptop computers connected to a network, and other mobile devices. Today, mobile commerce has exploded in popularity with advances in smartphones, including Apple's iPhone.[49] Customers are using their cell phones to purchase concert tickets from companies such as Ticketmaster Entertainment (*www.ticketmaster.com*) and Tickets (*www.tickets.com*).[50]

e-commerce
Any business transaction executed electronically between companies (business-to-business, or B2B), companies and consumers (business-to-consumer, or B2C), consumers and other consumers (consumer-to-consumer, or C2C), business and the public sector, and consumers and the public sector.

mobile commerce (m-commerce)
Transactions conducted anywhere, anytime.



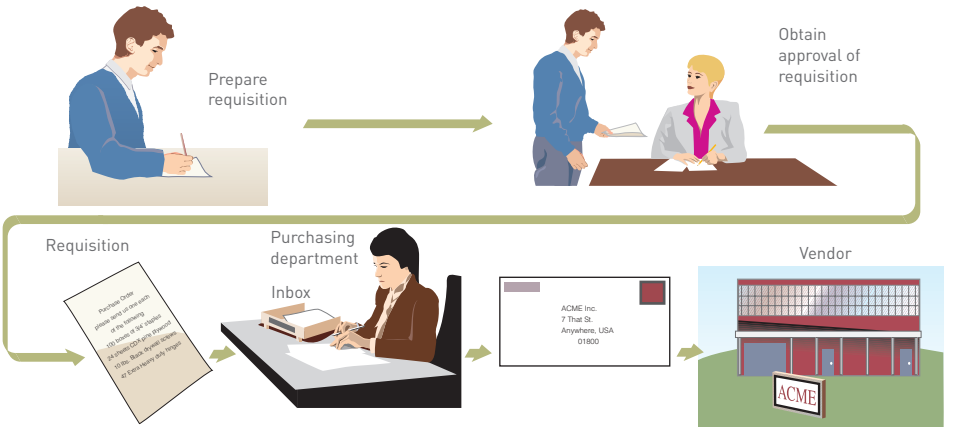
With mobile commerce (m-commerce), people can use cell phones to pay for goods and services anywhere, anytime.

(Source: Courtesy of Davie Hinshaw/MCT/Landov.)

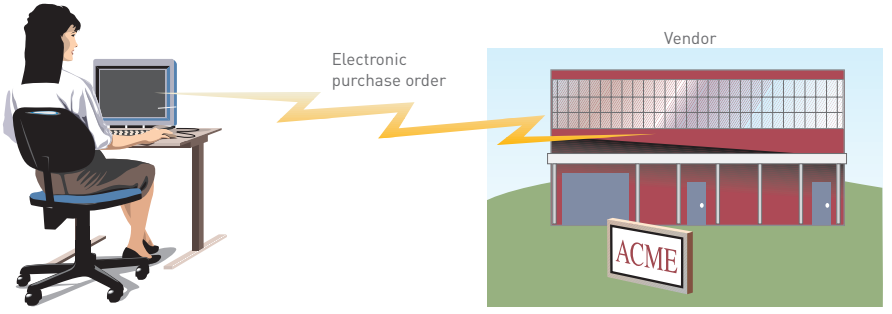
E-commerce offers many advantages for streamlining work activities. Figure 1.7 provides a brief example of how e-commerce can simplify the process of purchasing new office furniture from an office supply company. In the manual system, a corporate office worker must get approval for a purchase that exceeds a certain amount. That request goes to the purchasing department, which generates a formal purchase order to procure the goods from the approved vendor. Business-to-business e-commerce automates the entire process. Employees go directly to the supplier's Web site, find the item in a catalog, and order what they need at a price set by their company. If management approval is required, the manager is notified automatically. As the use of e-commerce systems grows, companies are phasing out their traditional systems. The resulting growth of e-commerce is creating many new business opportunities.

Figure 1.7

E-Commerce Greatly Simplifies Purchasing



Traditional process for placing a purchase order



E-commerce process for placing a purchase order

E-commerce can enhance a company's stock prices and market value. Today, several e-commerce firms have teamed up with more traditional brick-and-mortar businesses to draw from each other's strengths. For example, e-commerce customers can order products on a Web site and pick them up at a nearby store.

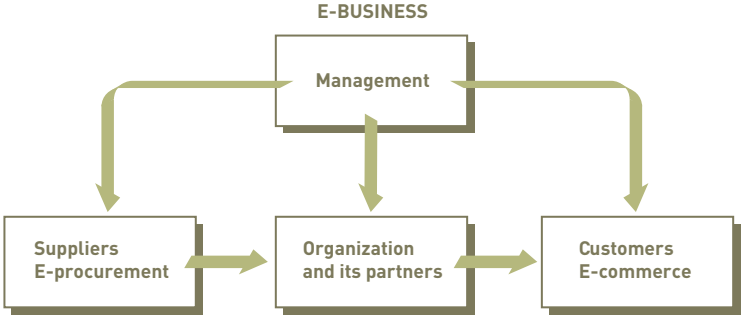
In addition to e-commerce, business information systems use telecommunications and the Internet to perform many related tasks. *Electronic procurement (e-procurement)*, for example, involves using information systems and the Internet to acquire parts and supplies. **Electronic business (e-business)** goes beyond e-commerce and e-procurement by using information systems and the Internet to perform all business-related tasks and functions, such as accounting, finance, marketing, manufacturing, and human resource activities. E-business also includes working with customers, suppliers, strategic partners, and stakeholders. Compared to traditional business strategy, e-business strategy is flexible and adaptable. See Figure 1.8.

electronic business (e-business)
Using information systems and the Internet to perform all business-related tasks and functions.

Figure 1.8

Electronic Business

E-business goes beyond e-commerce to include using information systems and the Internet to perform all business-related tasks and functions, such as accounting, finance, marketing, manufacturing, and human resources activities.



Enterprise Systems: Transaction Processing Systems and Enterprise Resource Planning

Enterprise systems that process daily transactions have evolved over the years and offer important solutions for businesses of all sizes. Traditional transaction processing systems are still being used, but increasingly, companies are turning to enterprise resource planning systems. These systems are discussed next.

Transaction Processing Systems

Since the 1950s, computers have been used to perform common business applications. Many of these early systems were designed to reduce costs by automating routine, labor-intensive business transactions. A **transaction** is any business-related exchange such as payments to employees, sales to customers, or payments to suppliers. Processing business transactions was the first computer application developed for most organizations. A **transaction processing system (TPS)** is an organized collection of people, procedures, software, databases, and devices used to perform and record business transactions. If you understand a transaction processing system, you understand basic business operations and functions.

transaction
Any business-related exchange, such as payments to employees, sales to customers, and payments to suppliers.

transaction processing system (TPS)
An organized collection of people, procedures, software, databases, and devices used to perform and record business transactions.

One of the first business systems to be computerized was the payroll system (see Figure 1.9). The primary inputs for a payroll TPS are the number of employee hours worked during the week and the pay rate. The primary output consists of paychecks. Early payroll systems produced employee paychecks and related reports required by state and federal agencies, such as the Internal Revenue Service. Other routine applications include sales ordering, customer billing and customer relationship management, and inventory control.

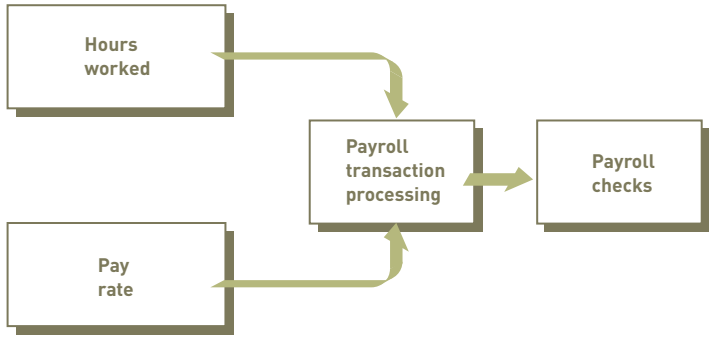


Figure 1.9
A Payroll Transaction Processing System
In a payroll TPS, the inputs (numbers of employee hours worked and pay rates) go through a transformation process to produce outputs (paychecks).

Enterprise systems help organizations perform and integrate important tasks, such as paying employees and suppliers, controlling inventory, sending invoices, and ordering supplies. In the past, companies accomplished these tasks using traditional transaction processing systems. Today, they are increasingly being performed by enterprise resource planning systems.

Enterprise Resource Planning

An **enterprise resource planning (ERP) system** is a set of integrated programs that manages the vital business operations for an entire multisite, global organization.[51] Pick n Pay, a South African (SA) food retailer, used ERP to reduce costs and the prices paid by customers. According to the chief executive officer, "We are happy to play our part in ensuring that SA's economy continues to perform well, particularly given the pressures being felt globally."[52]

enterprise resource planning (ERP) system
A set of integrated programs capable of managing a company's vital business operations for an entire multisite, global organization.

Information and Decision Support Systems

The benefits provided by an effective TPS or ERP, including reduced processing costs and reductions in needed personnel, are substantial and justify their associated costs in computing equipment, computer programs, and specialized personnel and supplies. Companies soon realized that they could use the data stored in these systems to help managers make better decisions, whether in human resource management, marketing, or administration. Satisfying the needs of managers and decision makers continues to be a major factor in developing information systems.

SAP AG, a German software company, is one of the leading suppliers of ERP software. The company employs more than 50,000 people in more than 120 countries.

(Source: *www.sap.com.*)

Management Information Systems

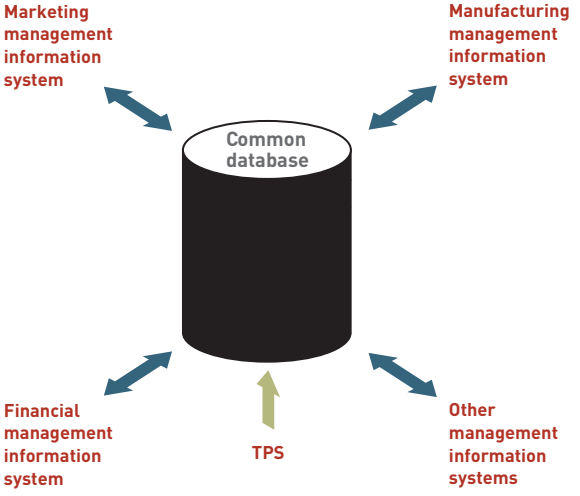
management information system (MIS)
An organized collection of people, procedures, software, databases, and devices that provides routine information to managers and decision makers.

A **management information system** (**MIS**) is an organized collection of people, procedures, software, databases, and devices that provides routine information to managers and decision makers. An MIS focuses on operational efficiency. Manufacturing, marketing, production, finance, and other functional areas are supported by MISs and linked through a common database. MISs typically provide standard reports generated with data and information from the TPS or ERP (see Figure 1.10). Dell Computer, for example, used manufacturing MIS software to develop a variety of reports on its manufacturing processes and costs.[53] Dell was able to double its product variety, while saving about $1 million annually in manufacturing costs as a result.

Figure 1.10

Management Information System

Functional management information systems draw data from the organization's transaction processing system.

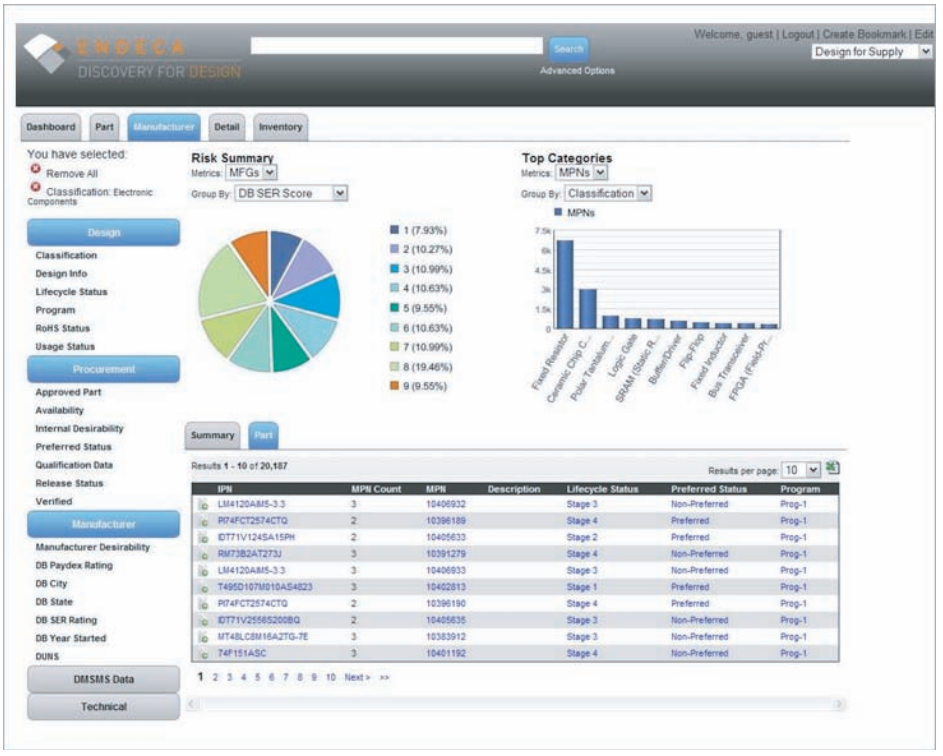


MISs were first developed in the 1960s and typically use information systems to produce managerial reports. In many cases, these early reports were produced periodically—daily, weekly, monthly, or yearly. Because of their value to managers, MISs have proliferated throughout the management ranks.

Decision Support Systems

By the 1980s, dramatic improvements in technology resulted in information systems that were less expensive but more powerful than earlier systems. People quickly recognized that computer systems could support additional decision-making activities. A **decision support system (DSS)** is an organized collection of people, procedures, software, databases, and devices that support problem-specific decision making. The focus of a DSS is on making effective decisions. Whereas an MIS helps an organization "do things right," a DSS helps a manager "do the right thing."[54]

decision support system (DSS)
An organized collection of people, procedures, software, databases, and devices used to support problem-specific decision making.



Endeca provides Discovery for Design, decision support software that helps businesspeople assess risk and analyze performance. The data shown here is for electronic component development.

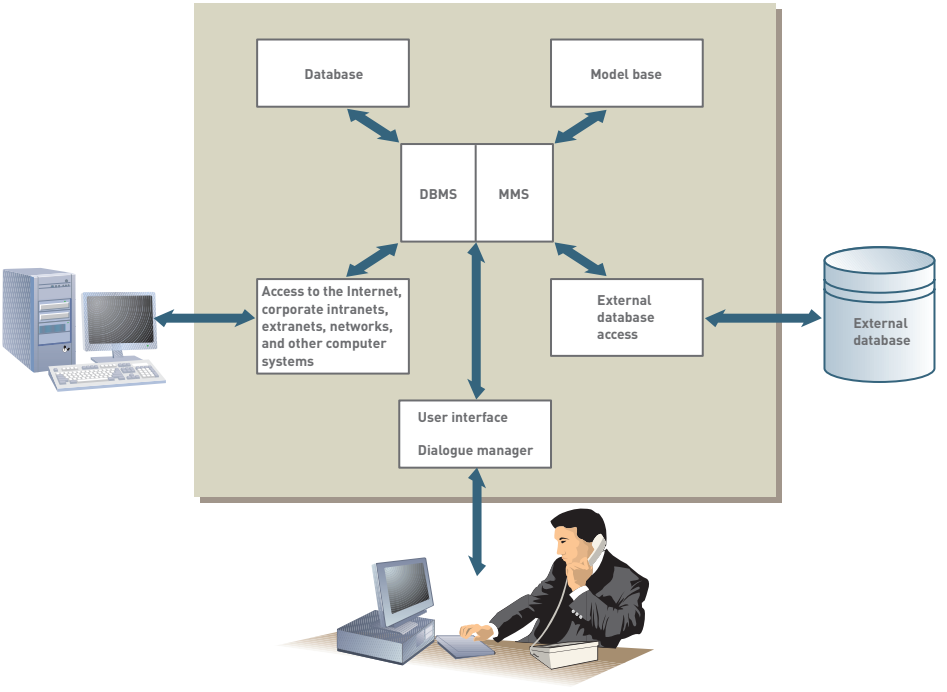
(Source: Courtesy of Endeca Technologies, Inc.)

A DSS can include a collection of models used to support a decision maker or user (model base), a collection of facts and information to assist in decision making (database), and systems and procedures (user interface or dialogue manager) that help decision makers and other users interact with the DSS (see Figure 1.11). Software is often used to manage the database—the database management system (DBMS)—and the model base—the model management system (MMS). Not all DSSs have all of these components.

In addition to DSSs for managers, other systems use the same approach to support groups and executives. A *group support system* includes the DSS elements just described as well as software, called *groupware*, to help groups make effective decisions. Kraft, for example, used iPhones and other mobile devices to help managers and workers stay connected and work together on important projects.[55] An executive support system, also called an *executive information system*, helps top-level managers, including a firm's president, vice presidents, and members of the board of directors, make better decisions. Healthland and Performance Management Institute, a healthcare company, has developed an executive information system to help small community and rural hospital executives make better decisions about delivering quality health care to patients and increasing the efficient delivery of healthcare services for hospitals.[56] The American Recovery and Reinvestment Act provides funds for qualifying healthcare companies that invest in better information and decision support systems. An executive support system can assist with strategic planning, top-level organizing and staffing, strategic control, and crisis management.

Figure 1.11

Essential DSS Elements



Specialized Business Information Systems: Knowledge Management, Artificial Intelligence, Expert Systems, and Virtual Reality

In addition to TPSs, MISs, and DSSs, organizations often rely on specialized systems. Many use *knowledge management systems (KMSs)*, an organized collection of people, procedures, software, databases, and devices, to create, store, share, and use the organization's knowledge and experience.[57] Advent, a San Francisco company that develops investment software for hedge funds, used a KMS to help its employees locate and use critical knowledge to help its customers.[58]

In addition to knowledge management, companies use other types of specialized systems. Experimental systems in cars can help prevent accidents. These new systems allow cars to communicate with each other using radio chips installed in their trunks. When two or more cars move too close together, the specialized systems sound alarms and brake in some cases. Some specialized systems are based on the notion of **artificial intelligence (AI)**, in which the computer system takes on the characteristics of human intelligence. The field of artificial intelligence includes several subfields (see Figure 1.12). Some people predict that, in the future, we will have nanobots, small molecular-sized robots, traveling throughout our bodies and in our bloodstream, monitoring our health.[59] Other nanobots will be embedded in products and services.[60]

artificial intelligence (AI)
A field in which the computer system takes on the characteristics of human intelligence.

A Nissan Motor Company car swerves back into its lane on its own shortly after it ran off the track during a test of the Lane Departure Prevention feature, which also sounds a warning when the car veers out of its lane.

(Source: © AP Photo/Katsumi Kasahara.)

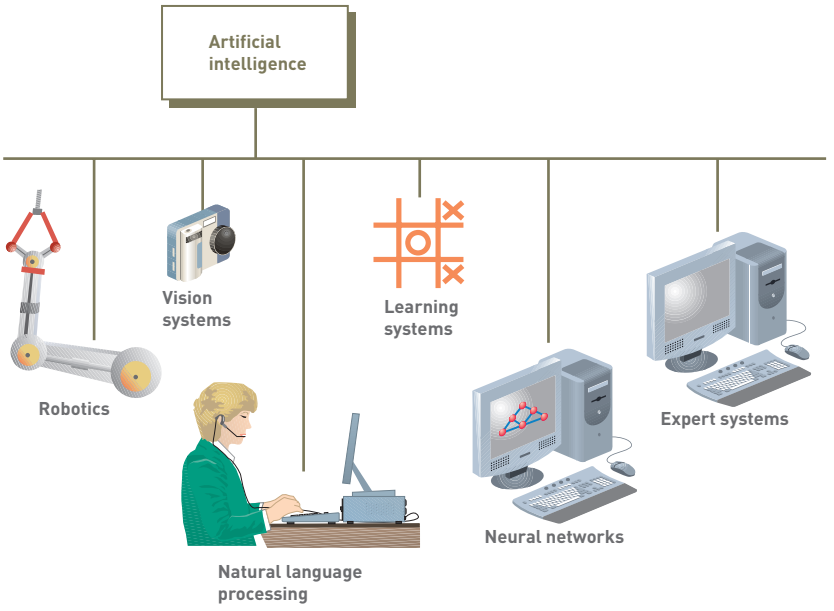


Figure 1.12
The Major Elements of Artificial Intelligence

Artificial Intelligence

Robotics is an area of artificial intelligence in which machines take over complex, dangerous, routine, or boring tasks, such as welding car frames or assembling computer systems and components. Honda Motor has spent millions of dollars on advanced robotics that allows a person to give orders to a computer using only his or her thoughts. The new system uses a special helmet that can measure and transmit brain activity to a computer. [61] A robot used by a Staples distribution center in the Denver area is able to locate items in a 100,000 square foot warehouse and pack them into containers to be shipped to other Staples stores.[62] Vision systems allow robots and other devices to "see," store, and process visual images. Natural language processing involves computers understanding and acting on verbal or written commands in English, Spanish, or other human languages. Learning systems allow computers to learn from past mistakes or experiences, such as playing games or making business decisions. Neural networks is a branch of artificial intelligence that allows computers to recognize and act on patterns or trends.[63] Some successful stock, options, and futures traders use neural networks to spot trends and improve the profitability of their investments.

Expert Systems

Expert systems give the computer the ability to make suggestions and function like an expert in a particular field, helping enhance the performance of the novice user. The unique value of expert systems is that they allow organizations to capture and use the wisdom of experts and specialists.[64] Therefore, years of experience and specific skills are not completely lost when a human expert dies, retires, or leaves for another job. The U.S. Army uses the Knowledge and Information Fusion Exchange (KnIFE) expert system to help soldiers in the field make better military decisions based on successful decisions made in previous military engagements. The collection of data, rules, procedures, and relationships that must be followed to achieve value or the proper outcome is contained in the expert system's **knowledge base**.

expert system
A system that gives a computer the ability to make suggestions and function like an expert in a particular field.

knowledge base
The collection of data, rules, procedures, and relationships that must be followed to achieve value or the proper outcome.

Virtual Reality and Multimedia

Virtual reality and multimedia are specialized systems that are valuable for many businesses and nonprofit organizations. Many imitate or act like real environments. These unique systems are discussed in this section.

virtual reality
The simulation of a real or imagined environment that can be experienced visually in three dimensions.

Virtual reality is the simulation of a real or imagined environment that can be experienced visually in three dimensions.[65] One healthcare company, for example, is experimenting with a virtual reality game designed to help treat cancer in young adults and children. Developed by HopeLab (*www.hopelab.org*), the virtual reality game called Re-Mission shows young adults and children how to combat cancer.

Originally, virtual reality referred to immersive virtual reality, which means the user becomes fully immersed in an artificial, computer-generated 3D world. The virtual world is presented in full scale and relates properly to the human size. Virtual reality can also refer to applications that are not fully immersive, such as mouse-controlled navigation through a 3D environment on a graphics monitor, stereo viewing from the monitor via stereo glasses, stereo projection systems, and others. Boeing, for example, used virtual reality and computer simulation to help design and build its Dreamliner 787.[66] The company used 3D models from Dassault Systems to design and manufacture the new aircraft. Retail stores are using virtual reality to help advertise high-end products on the Internet.

The Cave Automatic Virtual Environment (CAVE) is a virtual reality room that allows users to completely immerse themselves in a virtual car interior while operating a workstation in a factory.

(Source: © Sipa via AP Images.)

Figure 1.13
A Head-Mounted Display

The head-mounted display (HMD) was the first device to provide the wearer with an immersive experience. A typical HMD houses two miniature display screens and an optical system that channels the images from the screens to the eyes, thereby presenting a stereo view of a virtual world. A motion tracker continuously measures the position and orientation of the user's head and allows the image-generating computer to adjust the scene representation to the current view. As a result, the viewer can look around and walk through the surrounding virtual environment.

(Source: Courtesy of 5DT, Inc. *www.5dt.com.*)

A variety of input devices, such as head-mounted displays (see Figure 1.13), data gloves, joysticks, and handheld wands, allow the user to navigate through a virtual environment and to interact with virtual objects. Directional sound, tactile and force feedback devices, voice recognition, and other technologies enrich the immersive experience. Because several people can share and interact in the same environment, virtual reality can be a powerful medium for communication, entertainment, and learning.

Multimedia is a natural extension of virtual reality. It can include photos and images, the manipulation of sound, and special 3D effects. Once used primarily in movies, 3D technology can be used by companies to design products, such as motorcycles, jet engines, bridges, and more.[67] Autodesk, for example, makes exciting 3D software that companies can use to design large skyscrapers and other buildings.[68] The software can also be used by Hollywood animators to develop action and animated movies.

SYSTEMS DEVELOPMENT

Systems development is the activity of creating or modifying information systems. Systems development projects can range from small to very large and are conducted in fields as diverse as stock analysis and video game development. Individuals from around the world are using the steps of systems development to create unique applications for the iPhone.[69] Apple has special tools for iPhone application developers, including GPS capabilities and audio streaming, to make it easier for people to craft unique applications. Apple is also allowing these systems developers to charge users in a variety of ways, including fixed prices and subscription fees. Recall that individuals and companies are increasingly developing "cloud computing" applications that can be run from the Internet.[70] These applications have additional systems development challenges, such as making sure that the data and programs on the Internet are safe and secure from hackers and corporate spies.

systems development
The activity of creating or modifying existing business systems.

People inside a company can develop systems, or companies can use *outsourcing*, hiring an outside company to perform some or all of a systems development project. Outsourcing allows a company to focus on what it does best and delegate other functions to companies with expertise in systems development. The drug company Pfizer, for example, used outsourcing to allow about 4,000 of its busy employees to outsource some of their jobs functions to other individuals or companies around the globe, allowing them to concentrate on key tasks.[71] Any outsourcing decision should depend on the company and the project being considered for outsourcing.

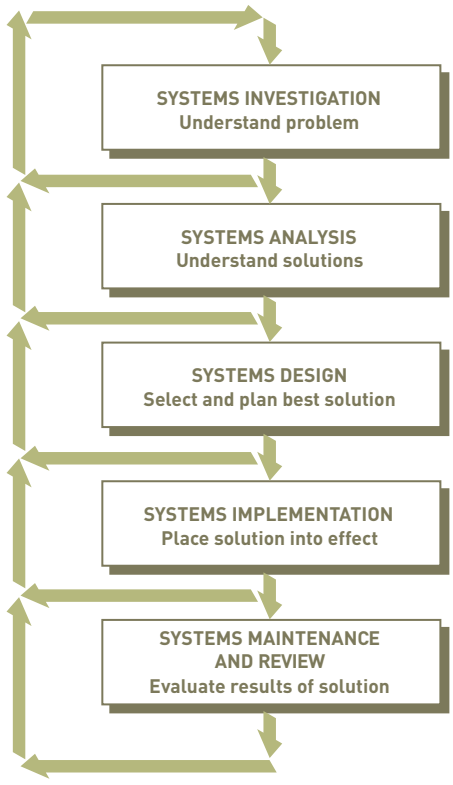
Some systems development efforts fail to meet their cost or schedule goals. Systems development failures can be a result of poor planning and scheduling, insufficient management of risk, poor requirements determination, and lack of user involvement. One strategy for improving the results of a systems development project is to divide it into several steps, each with a well-defined goal and set of tasks to accomplish (see Figure 1.14). These steps are summarized next.

Systems Investigation and Analysis

The first two steps of systems development are systems investigation and analysis. The goal of the *systems investigation* is to gain a clear understanding of the problem to be solved or opportunity to be addressed. After an organization understands the problem, the next question is, "Is the problem worth solving?" Given that organizations have limited resources—people and money—this question deserves careful consideration. If the decision is to continue with the solution, the next step, *systems analysis*, defines the problems and opportunities of the existing system. During systems investigation and analysis, as well as design maintenance and review, discussed next, the project must have the complete support of top-level managers and focus on developing systems that achieve business goals.

Figure 1.14

An Overview of Systems Development



Systems Design, Implementation, and Maintenance and Review

Systems design determines how the new system should be developed to meet the business needs defined during systems analysis. For some companies, this involves environmental design that attempts to use systems development approaches that are kind to the environment and make a profit. Gazelle, for example, used systems design to develop the software and systems needed to recycle computer and electronic systems for a profit. According to the company founder, "What we're doing here is buying dollars for 80 cents."[72] *Systems implementation* involves creating or acquiring the various system components (hardware, software, databases, etc.) defined in the design step, assembling them, and putting the new system into operation. For many organizations, this includes purchasing software, hardware, databases, and other IS components. The purpose of *systems maintenance and review* is to check and modify the system so that it continues to meet changing business needs. Increasingly, companies are hiring outside companies to do their design, implementation, maintenance, and review functions.

ORGANIZATIONS AND INFORMATION SYSTEMS

organization
A formal collection of people and other resources established to accomplish a set of goals.

An **organization** is a formal collection of people and other resources established to accomplish a set of goals. The primary goal of a for-profit organization is to maximize shareholder value, often measured by the price of the company stock. Nonprofit organizations include social groups, religious groups, universities, and other organizations that do not have profit as their goal. As discussed in this chapter, the ability of an organization to achieve its goals is often a function of the organization's overall structure, culture, and ability to change.

An organization is a system, which means that it has inputs, processing mechanisms, outputs, and feedback. An organization constantly uses money, people, materials, machines and other equipment, data, information, and decisions. As shown in Figure 1.15, resources

such as materials, people, and money serve as inputs to the organizational system from the environment, go through a transformation mechanism, and then are produced as outputs to the environment. The outputs from the transformation mechanism are usually goods or services, which are of higher relative value than the inputs alone. Through adding value or worth, organizations attempt to increase performance and achieve their goals. According to one chief information officer (CIO) for a large healthcare company, "As business executives, other than the CEO, CIOs are best positioned to help drive business outcomes … to increase top- and bottom-line performance."[73]

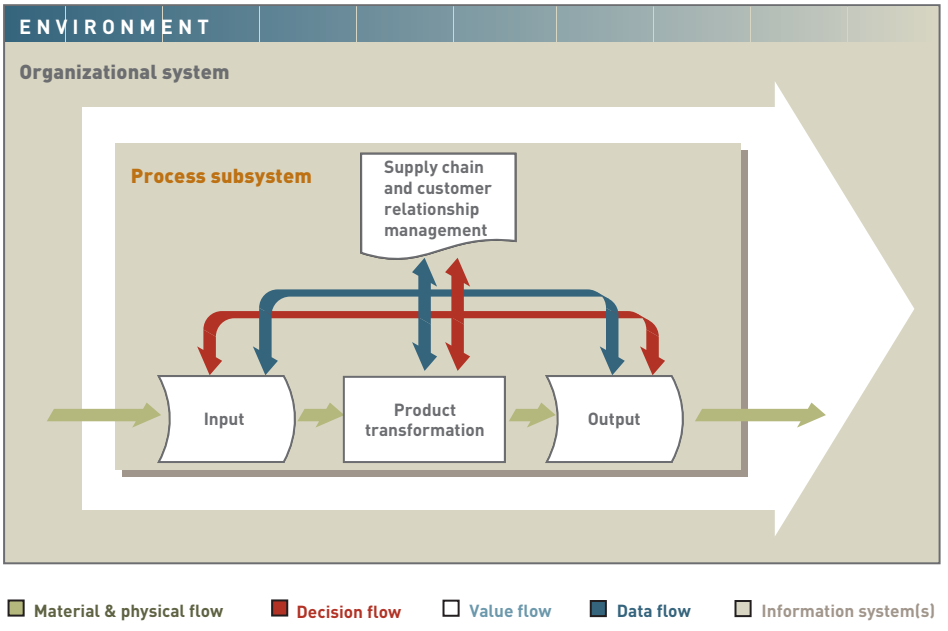


Figure 1.15
A General Model of an Organization

Information systems support and work within all parts of an organizational process. Although not shown in this simple model, input to the process subsystem can come from internal and external sources. Just prior to entering the subsystem, data is external. After it enters the subsystem, it becomes internal. Likewise, goods and services can be output to either internal or external systems.

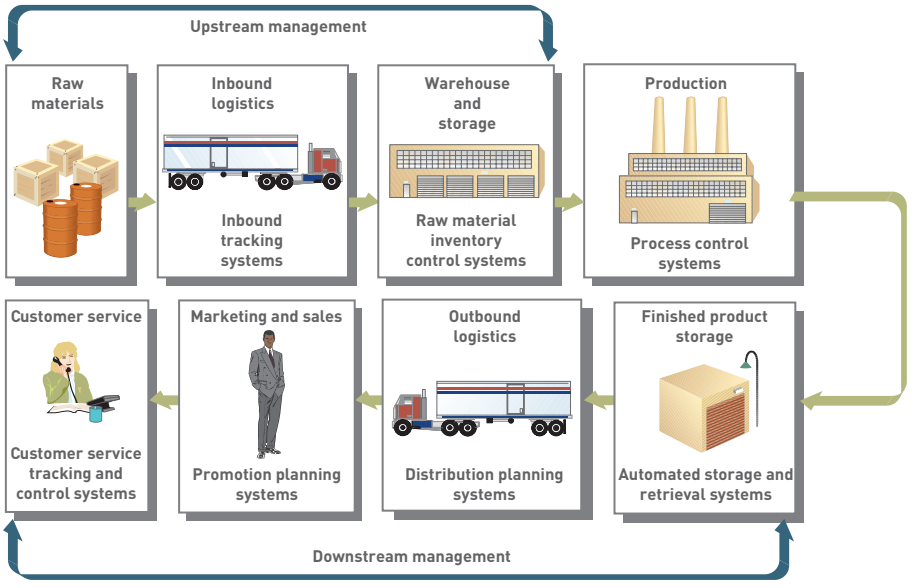
Providing value to a stakeholder—customer, supplier, manager, shareholder, or employee—is the primary goal of any organization. The value chain, first described by Michael Porter in a 1985 *Harvard Business Review* article, reveals how organizations can add value to their products and services. The **value chain** is a series (chain) of activities that includes inbound logistics, warehouse and storage, production and manufacturing, finished product storage, outbound logistics, marketing and sales, and customer service (see Figure 1.16). You investigate each activity in the chain to determine how to increase the value perceived by a customer. Depending on the customer, value might mean lower price, better service, higher quality, or uniqueness of product. The value comes from the skill, knowledge, time, and energy that the company invests in the product or activity. The value chain is just as important to companies that don't manufacture products, such as tax preparers, retail stores, legal firms, and other service providers. By adding a significant amount of value to their products and services, companies ensure success.

value chain
A series (chain) of activities that includes inbound logistics, warehouse and storage, production, finished product storage, outbound logistics, marketing and sales, and customer service.

Figure 1.16

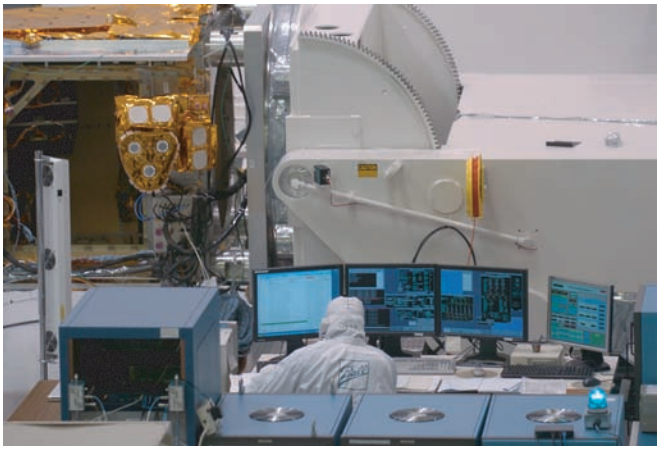
The Value Chain of a Manufacturing Company

Managing raw materials, inbound logistics, and warehouse and storage facilities is called *upstream management*. Managing finished product storage, outbound logistics, marketing and sales, and customer service is called *downstream management*.



Combining a value chain with just-in-time (JIT) inventory means companies can deliver materials or parts when they are needed. Ball Aerospace uses JIT to help reduce inventory costs and enhance customer satisfaction.

(Source: AP Photo/Denver Post, R. J. Sangosti.)



INFORMATION SYSTEMS @ WORK

Aldra Manages Workflow to Support Customization

Aldra Fenster und Türen GmbH, or Aldra for short, is a leading door and window manufacturer with over 300 dealers in Germany and Scandinavia. Aldra is well known for its precision craftsmanship in manufacturing intricate, custom-designed windows. In the early 1970s, the company developed a unique method of manufacturing windows from plastic. Combined with its customization service, this cost-saving manufacturing innovation gave Aldra a leg up on the competition.

Aldra's custom window design and manufacturing has created challenges in its corporate workflow and information processing. Mass-producing windows and doors in standard sizes is far easier than creating custom designs, where production techniques change from one item to the next. At Aldra, most orders have unique requirements in terms of size, shape, materials, function, and embedded technology. To support custom orders, Aldra must provide considerable flexibility in both its manufacturing processes and its information systems.

Providing customized manufacturing does not excuse Aldra from meeting the tight deadlines imposed by costly construction projects. Aggressive construction schedules rarely allow for the extra time required to produce custom products. Aldra found that the complexities of building its high-quality products were causing confusion in the order processing system and delays in manufacturing, leading to missed deadlines. Order specifications were sometimes incomplete or incorrect, and correcting orders is time consuming. Lack of coordination among departments resulted in additional errors that occasionally resulted in costly idle time on the production line. The lack of coordination also led to errors in calculating manufacturing costs, which reduced profits. Aldra set out to implement a new system that would assist the company in managing its value chain and corporate workflow.

Aldra purchased information systems from Infor Corporation that allowed the company to better coordinate efforts across departments. Using the software, Aldra now models its critical core processes (workflows) and then uses the models to improve communication across the value chain. The models define the specific employees involved in the various stages of the process. The system then generates daily activities for each employee displayed in a particular area on the computer desktop. As activities approach their deadline, they are moved to the top of the list. Employees also receive e-mail notices of new or pressing actions needing attention.

Aldra's new workflow management system depends on a corporate-wide system that stores and manipulates all order details. Top managers can view orders to see how they are progressing through the value chain so that they can intervene when necessary.

Aldra implemented the new system in an unusually short amount of time. The company spent three days installing the system, another three days training managers in how to model workflow processes, and two weeks to model processes and train users. The benefits of the new system were almost immediately apparent. Within weeks, the company's adherence to delivery dates was improved by over 95 percent. Cost estimates are now reliably calculated. Employees make more productive use of their time, and customers are happy. Aldra is looking to expand the use of its new systems to other areas of its business.

Discussion Questions

1. What problems did Aldra's new information systems address, and what was the root of those problems?
2. How did Aldra's new systems assist employees in being more productive?

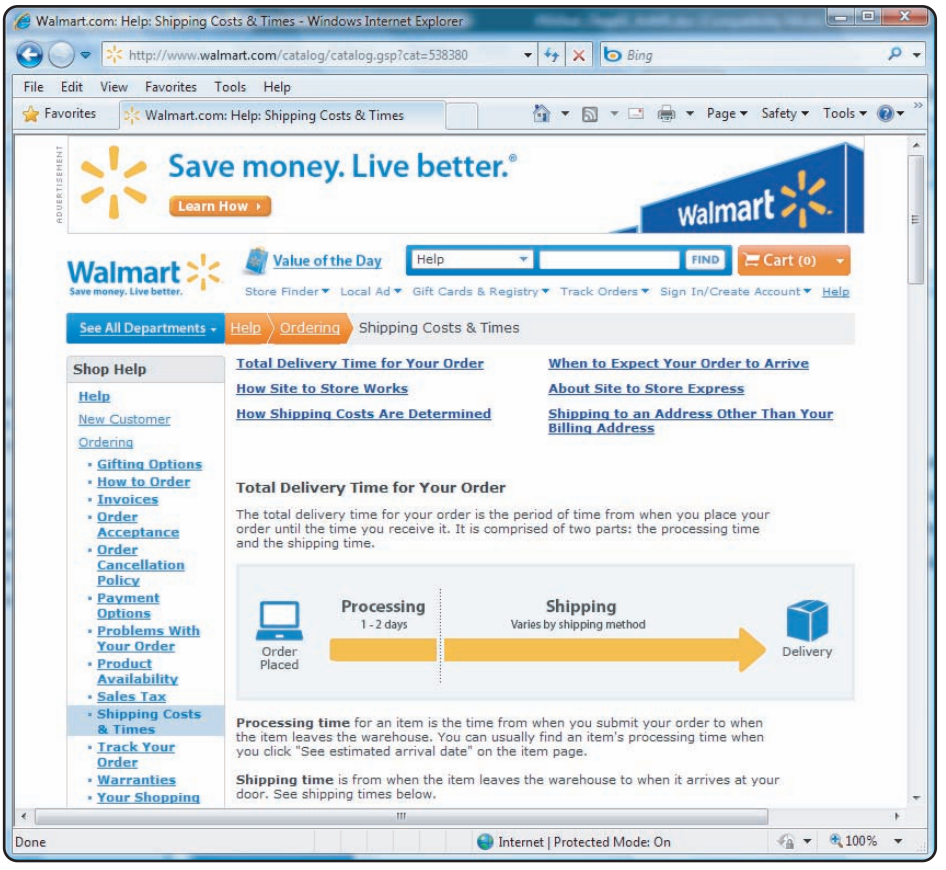
Critical Thinking Questions

1. What lessons can be learned from this case in terms of managing information in a value chain?
2. How does an organization determine when it is worthwhile to invest in a system such as Aldra's workflow management system?

SOURCES: Infor Staff, "Aldra Fenster und Türen GmbH," Aldra Customer Profile, accessed December 24, 2009, *www.infor.com/content/casestudies/29666 1*; Infor ERP systems Web site, accessed December 24, 2009; Aldra Web site (translated), accessed December 24, 2009, *www.aldra.de*.

Walmart's use of information systems is an integral part of its operation. The company gives suppliers access to its inventory system, so the suppliers can monitor the database and automatically send another shipment when stocks are low, eliminating the need for purchase orders. This speeds delivery time, lowers Walmart's inventory carrying costs, and reduces stockout costs.

(Source: *www.walmart.com*.)



Managing the supply chain and customer relationships are two key elements of managing the value chain. *Supply chain management (SCM)* helps determine what supplies are required for the value chain, what quantities are needed to meet customer demand, how the supplies should be processed (manufactured) into finished goods and services, and how the shipment of supplies and products to customers should be scheduled, monitored, and controlled.[74] Companies use a number of approaches to manage their supply chain. Some automotive companies, for example, require that their suppliers locate close to manufacturing plants. Other companies have considered purchasing suppliers to manage their supply chain.[75] Sysco, a Texas-based food distribution company, uses a sophisticated supply chain management system that incorporates software and databases to prepare and ship over 20 million tons of meats, produce, and other food items to restaurants and other outlets every year.[76] The huge company supplies one in three cafeterias, sports stadiums, restaurants, and other food stores.

Customer relationship management (CRM) programs help companies of all sizes manage all aspects of customer encounters, including marketing and advertising, sales, customer service after the sale, and programs to retain loyal customers.[77] Often, CRM software uses a variety of information sources, including sales from retail stores, surveys, e-mail, and Internet browsing habits, to compile comprehensive customer profiles. CRM systems can also get customer feedback to help design new products and services. See Figure 1.17. To be of most benefit, CRM programs must be tailored for each company or organization. Duke Energy, an energy holding company, uses Convergys (*www.convergys.com*) to provide CRM software that is specifically configured to help the energy company manage its customer's use of energy grids and energy services.[78] Oracle, SalesForce, and other companies develop and sell CRM software.[79] CRM software can also be purchased as a service and delivered over the Internet instead of being installed on corporate computers.

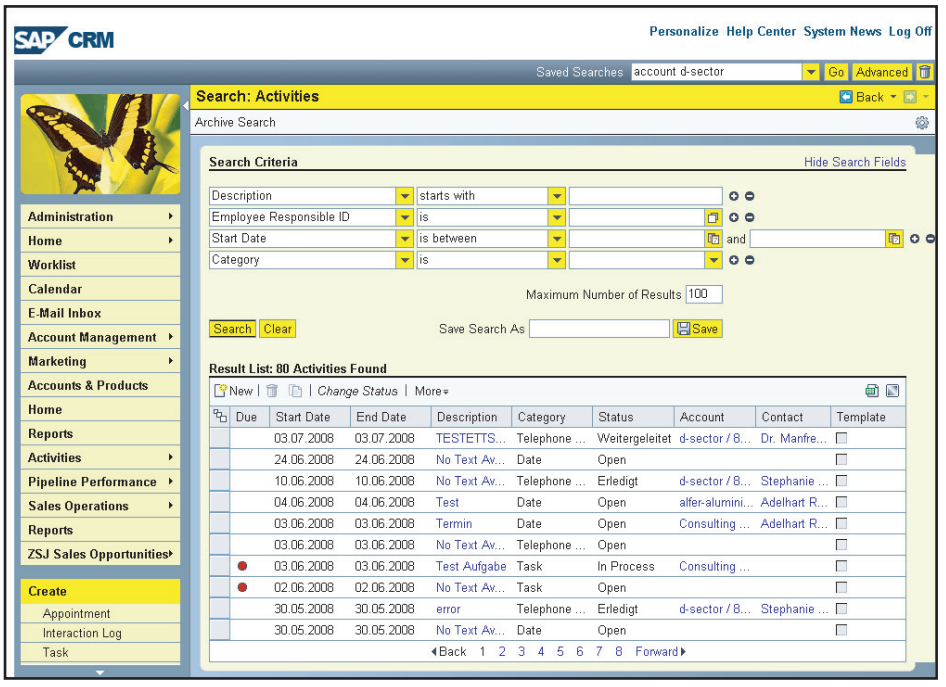


Figure 1.17

SAP CRM

Companies in more than 25 industries use SAP CRM to reduce cost and increase decision-making ability in all aspects of their customer relationship management.

(Source: *www.sap.com*.)

Organizational Culture and Change

Culture is a set of major understandings and assumptions shared by a group, such as within an ethnic group or a country. **Organizational culture** consists of the major understandings and assumptions for a business, corporation, or other organization. The understandings, which can include common beliefs, values, and approaches to decision making, are often not stated or documented as goals or formal policies. For example, Procter & Gamble has an organizational culture that places an extremely high value on understanding its customers and their needs. As another example, employees might be expected to be clean-cut, wear conservative outfits, and be courteous in dealing with all customers. Sometimes organizational culture is formed over years. In other cases, top-level managers can form it rapidly by starting a "casual Friday" dress policy. Organizational culture can also have a positive effect on the successful development of new information systems that support the organization's culture. Some healthcare professionals believe that a good organizational culture can improve patient health and safety.[80]

culture
A set of major understandings and assumptions shared by a group.

organizational culture
The major understandings and assumptions for a business, corporation, or other organization.

Organizational change deals with how for-profit and nonprofit organizations plan for, implement, and handle change. Change can be caused by internal factors, such as those initiated by employees at all levels, or by external factors, such as activities wrought by competitors, stockholders, federal and state laws, community regulations, natural occurrences (such as hurricanes), and general economic conditions. Organizational change occurs when two or more organizations merge. When organizations merge, however, integrating their information systems can be critical to future success. When VeriSign, for example, acquired and merged with a number of companies, it had to integrate various information systems.[81] According to the chief information officer of VeriSign, "By being decisive and making the goals and objectives clear, we were able to fuse multiple teams into a single unit, which in the end was smaller and far more productive."

organizational change
How for-profit and nonprofit organizations plan for, implement, and handle change.

Change can be sustaining or disruptive.[82] *Sustaining change* can help an organization improve the supply of raw materials, the production process, and the products and services it offers. Developing new manufacturing equipment to make disk drives is an example of a sustaining change for a computer manufacturer. The new equipment might reduce the costs of producing the disk drives and improve overall performance. *Disruptive change,* on the other hand, can completely transform an industry or create new ones, which can harm an organization's performance or even put it out of business. In general, disruptive technologies might not originally have good performance, low cost, or even strong demand. Over time, however,

they often replace existing technologies. They can cause profitable, stable companies to fail when they don't change or adopt the new technology. On a positive note, disruptive change often results in new, successful companies and offers consumers the potential of new products and services at reduced costs and superior performance. An institute called Singularity University, located at the NASA Ames Research Center in California, offers workshops on how to deal with disruptive change.[83] The purpose of the institute is to prepare managers and executives for the fast, ever-changing nature of information systems.

When VeriSign acquired and merged with a number of companies, it had to integrate various information systems.

(Source: *www.verisign.com.*)

User Satisfaction and Technology Acceptance

To be effective, reengineering and continuous improvement efforts must result in satisfied users and be accepted and used throughout the organization. Over the years, IS researchers have studied user satisfaction and technology acceptance as they relate to IS attitudes and usage.[84] Although user satisfaction and technology acceptance started as two separate theories, some believe that they are related concepts.[85]

User satisfaction with a computer system and the information it generates often depend on the quality of the system and the value of the information it delivers to users.[86] A quality information system is usually flexible, efficient, accessible, and timely. Recall that quality information is accurate, reliable, current, complete, and delivered in the proper format.[87]

technology acceptance model (TAM)
A model that describes the factors leading to higher levels of acceptance and usage of technology.

The **technology acceptance model** (**TAM**) specifies the factors that can lead to better attitudes about the information system, along with higher acceptance and usage of the system in an organization.[88] These factors include the perceived usefulness of the technology, the ease of its use, the quality of the information system, and the degree to which the organization supports its use.[89] Studies have shown that user satisfaction and technology acceptance are critical in health care.[90] Doctors and other healthcare professionals need training and time to accept and use medical records technology and databases to reduce medical errors and save lives.

technology diffusion
A measure of how widely technology is spread throughout the organization.

You can determine the actual usage of an information system by the amount of technology diffusion and infusion.[91] **Technology diffusion** is a measure of how widely technology is spread throughout an organization. An organization in which computers and information systems are located in most departments and areas has a high level of technology diffusion.[92] Some online merchants such as Amazon.com have a high diffusion and use computer systems to perform most of their business functions, including marketing, purchasing,

and billing. **Technology infusion**, on the other hand, is the extent to which technology permeates an area or department. In other words, it is a measure of how deeply embedded technology is in an area of the organization. Some architectural firms, for example, use computers in all aspects of designing a building from drafting to final blueprints. See Figure 1.18. The design area, thus, has a high level of infusion. Of course, a firm can have a high level of infusion in one part of its operations and a low level of diffusion overall. The architectural firm might use computers in all aspects of design (high infusion in the design area), but not to perform other business functions, including billing, purchasing, and marketing (low diffusion). Diffusion and infusion often depend on the technology available now and in the future, the size and type of the organization, and the environmental factors that include the competition, government regulations, suppliers, and so on. This is often called the technology, organization, and environment (TOE) framework.[93]

technology infusion
The extent to which technology is deeply integrated into an area or department.

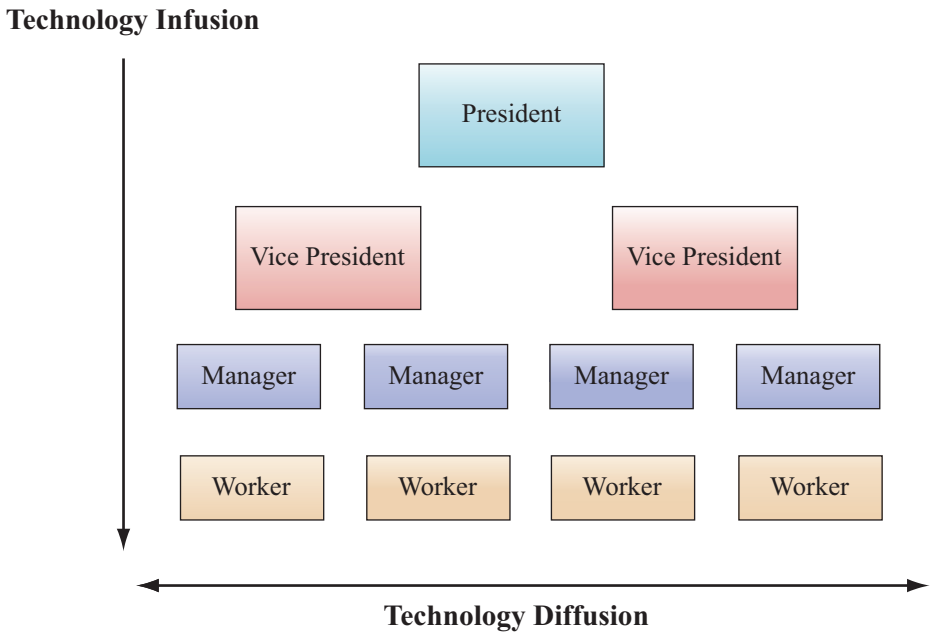


Figure 1.18
Technology Infusion and Diffusion

Although an organization might have a high level of diffusion and infusion, with computers throughout the organization, this does not necessarily mean that information systems are being used to their full potential. In fact, the assimilation and use of expensive computer technology throughout organizations varies greatly.[94] Providing support and help to employees usually increases the use of a new information system.[95] Companies also hope that a high level of diffusion, infusion, satisfaction, and acceptance will lead to greater performance and profitability.[96] How appropriate and useful the information system is to the tasks or activities being performed, often called *Task-Technology Fit (TTF),* can also lead to greater performance and profitability.[97]

COMPETITIVE ADVANTAGE

A **competitive advantage** is a significant and (ideally) long-term benefit to a company over its competition, and can result in higher-quality products, better customer service, and lower costs. According to the chief information officer of a large consulting company, "An efficiently run IT organization can be a significant source of competitive advantage."[98] An organization often uses its information system to help achieve a competitive advantage. A large Canadian furniture manufacturing company, for example, achieved a competitive advantage by reducing total operating costs by more than 20 percent using its information

competitive advantage
A significant and (ideally) long-term benefit to a company over its competition.

system to streamline its supply chain and reduce the cost of wood and other raw materials.[99] In his book *Good to Great,* Jim Collins outlines how technology can be used to accelerate companies to greatness.[100] Table 1.3 shows how a few companies accomplished this move. Ultimately, it is not how much a company spends on information systems but how it makes and manages investments in technology. Companies can spend less and get more value.

Table 1.3

How Some Companies Used Technologies to Move from Good to Great

(Source: Data from Jim Collins, *Good to Great*, Harper Collins Books, 2001, p. 300.)

Company	Business	Competitive Use of Information Systems
Gillette	Shaving products	Developed advanced computerized manufacturing systems to produce high-quality products at low cost
Walgreens	Drug and convenience stores	Developed satellite communications systems to link local stores to centralized computer systems
Wells Fargo	Financial services	Developed 24-hour banking, ATMs, investments, and increased customer service using information systems

Taking advantage of the existing situation, including an economic downturn, can also help a firm achieve a competitive advantage. In 2009 and 2010, while some companies struggled with the economy and slumping sales, other companies were investing in information systems to give them a long-term advantage.[101] UPS, for example, planned on investing about $1 billion in new information systems. According to the company's CIO, "We firmly believe the strong companies will come out of this downturn stronger. This is an opportunity to get your company positioned to grow on the upturn."

Factors That Lead Firms to Seek Competitive Advantage

five-forces model
A widely accepted model that identifies five key factors that can lead to attainment of competitive advantage, including (1) the rivalry among existing competitors, (2) the threat of new entrants, (3) the threat of substitute products and services, (4) the bargaining power of buyers, and (5) the bargaining power of suppliers.

A number of factors can lead to attaining a competitive advantage. Michael Porter, a prominent management theorist, suggested a now widely accepted competitive forces model, also called the **five-forces model**. The five forces include (1) the rivalry among existing competitors, (2) the threat of new entrants, (3) the threat of substitute products and services, (4) the bargaining power of buyers, and (5) the bargaining power of suppliers. The more these forces combine in any instance, the more likely firms will seek competitive advantage and the more dramatic the results of such an advantage will be.

Rivalry Among Existing Competitors

Typically, highly competitive industries are characterized by high fixed costs of entering or leaving the industry, low degrees of product differentiation, and many competitors. Although all firms are rivals with their competitors, industries with stronger rivalries tend to have more firms seeking competitive advantage. To gain an advantage over competitors, companies constantly analyze how they use their resources and assets. This *resource-based view* is an approach to acquiring and controlling assets or resources that can help the company achieve a competitive advantage. For example, a transportation company might decide to invest in radio-frequency technology to tag and trace products as they move from one location to another.

Threat of New Entrants

A threat appears when entry and exit costs to an industry are low and the technology needed to start and maintain a business is commonly available. For example, a small restaurant is threatened by new competitors. Owners of small restaurants do not require millions of dollars to start the business, food costs do not decline substantially for large volumes, and food processing and preparation equipment is easily available. When the threat of new market entrants is high, the desire to seek and maintain competitive advantage to dissuade new entrants is also usually high.

Threat of Substitute Products and Services

Companies that offer one type of goods or services are threatened by other companies that offer similar goods or services. The more consumers can obtain similar products and services

that satisfy their needs, the more likely firms are to try to establish competitive advantage. For example, consider the photographic industry. When digital cameras became popular, traditional film companies had to respond to stay competitive and profitable. Traditional film companies, such as Kodak and others, started to offer additional products and enhanced services, including digital cameras, the ability to produce digital images from traditional film cameras, and Web sites that could be used to store and view pictures.

In the restaurant industry, competition is fierce because entry costs are low. Therefore, a small restaurant that enters the market can be a threat to existing restaurants.

(Source: © 2010, Emin Kuliyev. Used under license from Shutterstock.com.)

Bargaining Power of Customers and Suppliers

Large customers tend to influence a firm, and this influence can increase significantly if the customers can threaten to switch to rival companies. When customers have a lot of bargaining power, companies increase their competitive advantage to retain their customers. Similarly, when the bargaining power of suppliers is strong, companies need to improve their competitive advantage to maintain their bargaining position. Suppliers can also help an organization gain a competitive advantage. Some suppliers enter into strategic alliances with firms and eventually act as a part of the company. Suppliers and companies can use telecommunications to link their computers and personnel to react quickly and provide parts or supplies as necessary to satisfy customers.

Strategic Planning for Competitive Advantage

To be competitive, a company must be fast, nimble, flexible, innovative, productive, economical, and customer oriented. It must also align its IS strategy with general business strategies and objectives. [102] Given the five market forces previously mentioned, Porter and others have proposed a number of strategies to attain competitive advantage, including cost leadership, differentiation, niche strategy, altering the industry structure, creating new products and services, and improving existing product lines and services.[103] In some cases, one of these strategies becomes dominant. For example, with a cost leadership strategy, cost can be the key consideration, at the expense of other factors if need be.

- **Cost leadership.** Deliver the lowest possible cost for products and services. Walmart and other discount retailers have used this strategy for years. Cost leadership is often achieved by reducing the costs of raw materials through aggressive negotiations with suppliers, becoming more efficient with production and manufacturing processes, and reducing warehousing and shipping costs. Some companies use outsourcing to cut costs when making products or completing services.
- **Differentiation.** Deliver different products and services. This strategy can involve producing a variety of products, giving customers more choices, or delivering higher-quality products and services. Many car companies make different models that use the same basic parts and components, giving customers more options. Other car companies attempt to increase perceived quality and safety to differentiate their products and appeal to consumers who are willing to pay higher prices for these features. Companies that try to differentiate their products often strive to uncover and eliminate counterfeit products produced and delivered by others.

Walmart and other discount retailers have used a cost leadership strategy to deliver the lowest possible price for products and services.

(Source: © Jeff Zelevansky/Getty Images.)

- **Niche strategy.** Deliver to only a small, niche market. Porsche, for example, doesn't produce inexpensive economy cars. It makes high-performance sports cars and SUVs. Rolex only makes high-quality, expensive watches. It doesn't make inexpensive, plastic watches that can be purchased for $20 or less.

Porsche is an example of a company with a niche strategy, producing only high-performance sports cars and SUVs.

(Source: © 2010, Max Earey. Used under license from Shutterstock.com.)

strategic alliance (strategic partnership)
An agreement between two or more companies that involves the joint production and distribution of goods and services.

- **Altering the industry structure.** Change the industry to become more favorable to the company or organization. The introduction of low-fare airline carriers, such as Southwest Airlines, has forever changed the airline industry, making it difficult for traditional airlines to make high profit margins. Creating strategic alliances can also alter the industry structure. A **strategic alliance**, also called a **strategic partnership**, is an agreement between two or more companies that involves the joint production and distribution of goods and services. The investment firm American Diversified Holdings, for example, developed a strategic alliance with Invent Pharmaceuticals to help the pharmaceutical company with investments, regulatory issues, and business operations.[104] According to the chairman of American Diversified Holdings, "This alliance with Invent Pharma will enhance our investment focus in the biotech industry."
- **Creating new products and services.** Introduce new products and services periodically or frequently. This strategy always helps a firm gain a competitive advantage, especially for the computer industry and other high-tech businesses. If an organization does not introduce new products and services every few months, the company can quickly stagnate, lose market share, and decline. Companies that stay on top are constantly developing

new products and services. Apple Computer, for example, introduced the iPod, iPhone, and iPad as new products.

- **Improving existing product lines and services.** Make real or perceived improvements to existing product lines and services. Manufacturers of household products are always advertising new and improved products. In some cases, the improvements are more perceived than actual refinements; usually, only minor changes are made to the existing product, such as to reduce the amount of sugar in breakfast cereal.
- **Other strategies.** Some companies seek strong *growth* in sales, hoping that it can increase profits in the long run due to increased sales. Being the *first to market* is another competitive strategy. Apple Computer was one of the first companies to offer complete and ready-to-use personal computers. Some companies offer *customized* products and services to achieve a competitive advantage. Dell, for example, builds custom PCs for consumers. *Hire the best people* is another example of a competitive strategy. The assumption is that the best people will determine the best products and services to deliver to the market and the best approach to deliver these products and services. Having *agile* information systems that can rapidly change with changing conditions and environments can be a key to information systems success and a competitive advantage.[105] Achieving a high level of efficiency and effectiveness is an important challenge of developing an agile information system. Other challenges included satisfying various governmental regulations, meeting customer requirements, and maintaining a good growth level. *Innovation* is another competitive strategy.[106] Vodafone relied on outside help to provide innovative solutions in its wireless business.[107] According its chief executive, "The only way to create a fertile environment for innovation is to have open platforms and leverage them." Natural Selection, a San Diego company, originally developed a computer program that attempted to analyze past inventions and suggest future ones.[108] Although the original program was not an immediate success, the approach has been used by General Electric, the U.S. Air Force, and others to cut costs and streamline delivery routes of products. According to one expert, "Successful innovations are often built on the back of failed ones." A lack of innovation can lead to a loss in competitiveness and long-term profitability.[109] Some believe that less innovation has led to lower productivity, lower profits, and lower wages and salaries for managers and workers. Companies can also combine one or more of these strategies. In addition to customization, Dell attempts to offer low-cost computers (cost leadership) and top-notch service (differentiation).

PERFORMANCE-BASED INFORMATION SYSTEMS

Businesses have passed through at least three major stages in their use of information systems. In the first stage, organizations focused on using information systems to reduce costs and improve productivity. TransUnion, a large credit reporting company, reduced computer-related costs by about $2.5 million annually by investing $50,000 in a corporate social networking Internet site.[110] According to the chief technology officer, "The savings mostly come out of teams that would have historically said 'Buy me more hardware' or 'I need a new software tool' who figured out how to solve their problems without asking for those things." In another example, the National ePrescribing Patient Safety Initiative offers powerful software to doctors to reduce medication errors and costs. Companies can also use software tools, such as Apptio's IT Cost Optimization Solutions, to cut the costs of computer upgrades, reduce the number of computers, and help determine what to charge business units for providing computer services and equipment.[111]

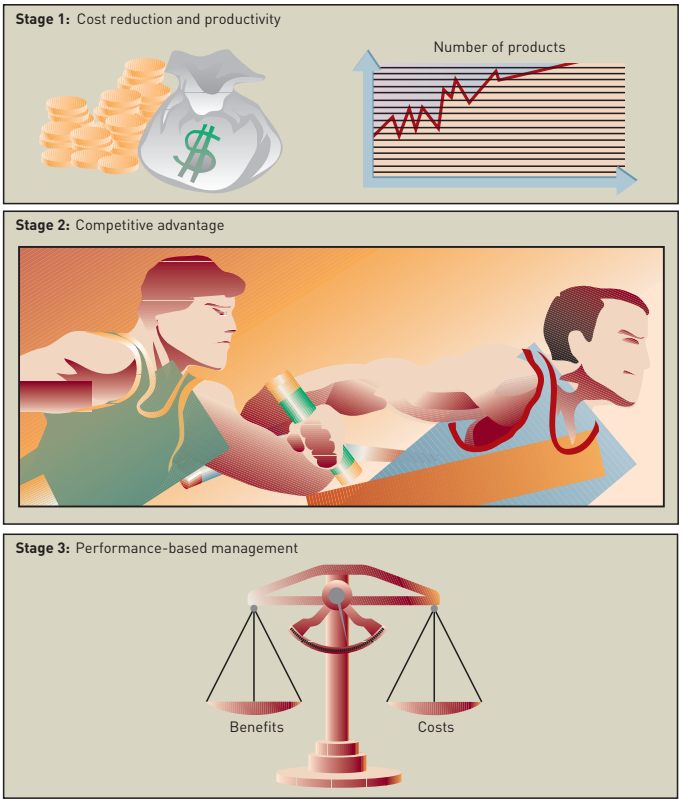
The second stage was defined by Porter and others. It was oriented toward gaining a competitive advantage. In many cases, companies spent large amounts on information systems and downplayed the costs.

Today, companies are shifting from strategic management to performance-based management of their information systems. In this third stage, companies carefully consider both

strategic advantage and costs. They use productivity, return on investment (ROI), net present value, and other measures of performance to evaluate the contributions their information systems make to their businesses. Figure 1.19 illustrates these stages. This balanced approach attempts to reduce costs and increase revenues.

Figure 1.19

Three Stages in the Business Use of Information Systems



Productivity

productivity
A measure of the output achieved divided by the input required.

Developing information systems that measure and control productivity is a key element for most organizations. **Productivity** is a measure of the output achieved divided by the input required. A higher level of output for a given level of input means greater productivity; a lower level of output for a given level of input means lower productivity. The numbers assigned to productivity levels are not always based on labor hours—productivity can be based on factors such as the amount of raw materials used, resulting quality, or time to produce the goods or service. The value of the productivity number is not as significant as how it compares with other time periods, settings, and organizations. Xerox has developed an information system to increase printer productivity and reduce costs called Lean Document Production (LDP) solutions.[112] According to one researcher, "These solutions, which Xerox has implemented in approximately 100 sites to date, have provided dramatic productivity and cost improvements for both print shops and document-manufacturing facilities."

$$\text{Productivity} = (\text{Output} / \text{Input}) \times 100\%$$

After a basic level of productivity is measured, an information system can monitor and compare it over time to see whether productivity is increasing. Then, a company can take corrective action if productivity drops below certain levels. An automotive company, for example, might use robots in assembling new cars to increase its labor productivity and reduce costs. In addition to measuring productivity, an information system can be used within a process to significantly increase productivity. Thus, improved productivity can result in faster customer response, lower costs, and increased customer satisfaction.

Return on Investment and the Value of Information Systems

One measure of IS value is **return on investment** (**ROI**). This measure investigates the additional profits or benefits that are generated as a percentage of the investment in IS technology. A small business that generates an additional profit of $20,000 for the year as a result of an investment of $100,000 for additional computer equipment and software would have a return on investment of 20 percent ($20,000/$100,000). ROI calculations can be complex, including investment returns over multiple years and the impact of the time value of money. According to the chief technology officer for the Financial Industry Regulatory Authority, "ROI is a key metric for technology initiatives."[113] Some researchers believe that how an IS function is managed and run is one of the best indicators of the value of the system to the organization and its return on investment.[114] Because of the importance of ROI, many computer companies provide ROI calculators to potential customers. ROI calculators are typically provided on a vendor's Web site and can be used to estimate returns. Kodak, for example, has an ROI calculator for many of its products based on lifetime value to customers.[115]

return on investment (ROI)
One measure of IS value that investigates the additional profits or benefits that are generated as a percentage of the investment in IS technology.

The National ePrescribing Patient Safety Initiative offers software to doctors to reduce medication errors and costs.

(Source: *www.nationalerx.com*.)

Earnings Growth

Another measure of IS value is the increase in profit, or earnings growth, the system brings. For instance, a mail-order company might install an order-processing system that generates a seven percent earnings growth compared with the previous year.

Market Share and Speed to Market

Market share is the percentage of sales that a product or service has in relation to the total market. If installing a new online catalog increases sales, it might help a company increase its market share by 20 percent. Information systems can also help organizations bring new

products and services to customers in less time. This is often called speed to market. Speed can also be a critical performance objective for many organizations. The New York Stock Exchange, for example, is building a large facility the size of several football fields to house super-fast trading systems that can be used by large hedge funds and institutional investors.[116]

Customer Awareness and Satisfaction

Although customer satisfaction can be difficult to quantify, about half of today's best global companies measure the performance of their information systems based on feedback from internal and external users. Some companies and nonprofit organizations use surveys and questionnaires to determine whether the IS investment has increased customer awareness and satisfaction.

Total Cost of Ownership

total cost of ownership (TCO)
The sum of all costs over the life of an information system, including the costs to acquire components such as the technology, technical support, administrative costs, and end-user operations.

Another way to measure the value of information systems was developed by the Gartner Group and is called the **total cost of ownership (TCO).** TCO is the sum of all costs over the life of the information system, including the costs to acquire components such as the technology, technical support, administrative costs, and end-user operations. Hitachi uses TCO to promote its projectors to businesses and individuals.[117] TCO is also used by many other companies to rate and select hardware, software, databases, and other computer-related components.

Return on investment, earnings growth, market share, customer satisfaction, and TCO are only a few measures that companies use to plan for and maximize the value of their IS investments. Regardless of the difficulties, organizations must attempt to evaluate the contributions that information systems make to assess their progress and plan for the future. Information systems and personnel are too important to leave to chance.

Risk

In addition to the return-on-investment measures of a new or modified system discussed earlier, managers must also consider the risks of designing, developing, and implementing these systems. Information systems can sometimes be costly failures. The risks of designing, developing, and implementing new or modified systems are covered in more detail in Chapter 8, which discuss systems development.

CAREERS IN INFORMATION SYSTEMS

Realizing the benefits of any information system requires competent and motivated IS personnel, and many companies offer excellent job opportunities. As mentioned earlier, *knowledge workers (KWs)* are people who create, use, and disseminate knowledge. They are usually professionals in science, engineering, business, and other areas that specialize in information systems. Numerous schools have degree programs with such titles as information systems, computer information systems, and management information systems. These programs are typically offered by information schools, business schools, and within computer science departments. Information systems skills can also help people start their own companies.

Skills that some experts believe are important for IS workers to have include those in the following list.[118] Nontechnical skills are also important for IS personnel, including communication skills, a detailed knowledge of the organization, and how information systems can help the organization achieve its goals. All of the following skills are discussed in the chapters throughout this book.

1. Program and application development
2. Help Desk and technical support
3. Project management

4. Networking
5. Business intelligence
6. Security
7. Web 2.0
8. Data center
9. Telecommunications.

The U.S. Department of Labor's Bureau of Labor Statistics (*www.bls.gov*) publishes the fastest growing occupations and predicts that many technology jobs will increase through 2012 or beyond. Table 1.4 summarizes some of the best places to work as an IS professional.[119] Career development opportunities, training, benefits, retention, diversity, and the nature of the work itself are just a few of the qualities these top employers offer.

Table 1.4

Best Places to Work as an IS Professional

Source: "Best Places to Work in IT," *Computerworld,* June 16, 2009.

Company	Additional Benefits
General Mills	Auto service facilities and fitness center
Genentech	Relaxation, meditation, and mindfulness programs
San Diego Gas & Electric	Good retirement program
University of Pennsylvania	Many excellent campus events and activities
Monsanto	Flex schedules and telecommuting options
Securian Financial Group	Career growth opportunities
Verizon	Innovation and working with new technologies
JM Family Enterprises	Employee growth and deals on the Toyota vehicles the company represents
USAA	Flexible work schedules
University of Miami	Good compensation plan and many university benefits

Opportunities in information systems are also available to people from foreign countries, including Russia and India. The U.S. H-1B and L-1 visa programs seek to allow skilled employees from foreign lands into the United States. These programs, however, are limited and usually in high demand. The L-1 visa program is often used for intracompany transfers for multinational companies. The H-1B program can be used for new employees.

Roles, Functions, and Careers in IS

IS offers many exciting and rewarding careers. Professionals with careers in information systems can work in an IS department or outside a traditional IS department as Web developers, computer programmers, systems analysts, computer operators, and many other positions. There are also opportunities for IS professionals in the public sector. The U.S. stimulus package of 2009, for example, budgeted about $1 billion to develop better systems, including computer programs to deliver disability claims for the federal government.[120] This massive project will require a large number of IS professionals. In addition to technical skills, IS professionals need skills in written and verbal communication, an understanding of organizations and the way they operate, and the ability to work with people and in groups. Today, many good information, business, and computer science schools require these business and communications skills of their graduates. At the end of every chapter, you will find career exercises that will help you explore careers in IS and career areas that interest you.

Most medium to large organizations manage information resources through an IS department. In smaller businesses, one or more people might manage information resources, with support from outsourced services. (Recall that outsourcing is also popular with larger organizations.) As shown in Figure 1.20, the IS organization has three primary responsibilities: operations, systems development, and support.

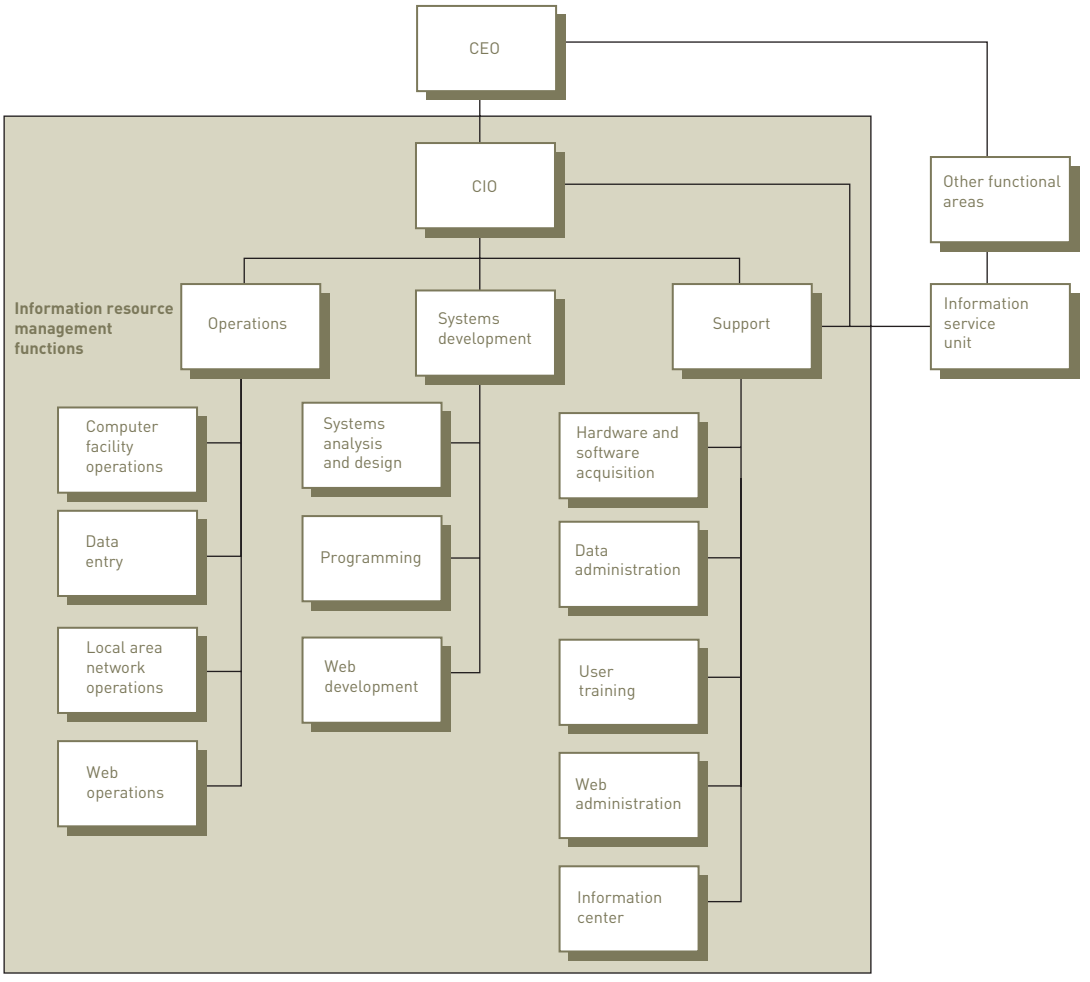


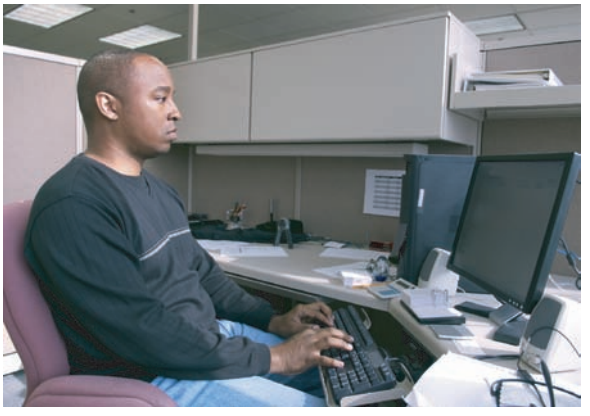
Figure 1.20

The Three Primary Responsibilities of Information Systems

Each of these elements—operations, systems development, and support—contains sub-elements that are critical to the efficient and effective performance of the organization.

Operations

System operators primarily run and maintain IS equipment, and are typically trained at technical schools or through on-the-job experience. They are responsible for efficiently starting, stopping, and correctly operating mainframe systems, networks, tape drives, disk devices, printers, and so on. Other operations include scheduling, hardware maintenance, and preparing input and output. Data-entry operators convert data into a form the computer system can use, using terminals or other devices to enter business transactions, such as sales orders and payroll data. In addition, companies might have local area network and Web operators who run the local network and any Web sites the company has.



Web developers create and maintain company Web sites.

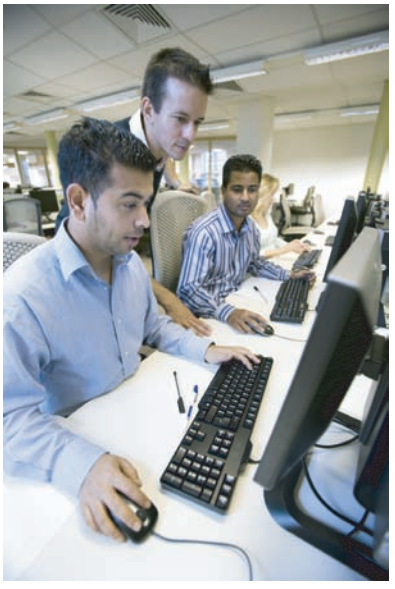
(Source: © iStockphoto/David H. Lewis.)

Systems Development

The systems development component of a typical IS department focuses on specific development projects and ongoing maintenance and review. Systems analysts and programmers, for example, address these concerns to achieve and maintain IS effectiveness. The role of a systems analyst is multifaceted. *Systems analysts* help users determine what outputs they need from the system and construct plans for developing the necessary programs that produce these outputs. Systems analysts then work with one or more programmers to make sure that the appropriate programs are purchased, modified from existing programs, or developed. A *computer programmer* uses the plans created by the systems analyst to develop or adapt one or more computer programs that produce the desired outputs. A meteorologist and several part-time programmers from the University of Alabama developed weather forecasting software that used radar data along with other meteorological data to forecast storms and weather.[121] Today, the weather forecasting company employs about 100 people, including many programmers, to keep the software current. To help businesses select the best analysts and programmers, companies such as TopCoder offer tests to evaluate the proficiency and competence of current IS employees or job candidates. TopCoder Collegiate Challenge allows programming students to compete with other programmers around the world.[122] In addition, with the dramatic increase in the use of the Internet, intranets, and extranets, many companies have Web or Internet developers who create effective and attractive Web sites for customers, internal personnel, suppliers, stockholders, and others who have a business relationship with the company.

Support

The support component of a typical IS department provides user assistance in hardware and software acquisition and use, data administration, user training and assistance, and Web administration. Increasingly, training is done using the Internet. Microsoft, for example, offers free training in areas including time management, marketing, sales, and others (*office.microsoft.com/en-us/officelive/FX102119031033.aspx*). Other companies, such as Hewlett Packard (*www.hp.com/sbso*), also offer online training courses and programs. In many cases, support is delivered through an information center.



IS personnel provide assistance in hardware and software acquisition, data administration, user training and assistance, and Web administration.

(Source: © iStockphoto/Chris Schmidt.)

Because IS hardware and software are costly, a specialized support group often manages computer hardware and software acquisitions. This group sets guidelines and standards for the rest of the organization to follow in making purchases. A database administrator focuses on planning, policies, and procedures regarding the use of corporate data and information. For example, database administrators develop and disseminate information about the

corporate databases for developers of IS applications. In addition, the database administrator monitors and controls database use. Web administration is another key area for support staff. With the increased use of the Internet and corporate Web sites, Web administrators are sometimes asked to regulate and monitor Internet use by employees and managers to make sure that it is authorized and appropriate. User training is a key to get the most from any information system, and the support area ensures that appropriate training is available. Training can be provided by internal staff or from external sources.

information center
A support function that provides users with assistance, training, application development, documentation, equipment selection and setup, standards, technical assistance, and troubleshooting.

The support component typically operates the information center. An **information center** provides users with assistance, training, application development, documentation, equipment selection and setup, standards, technical assistance, and troubleshooting. Although many firms have attempted to phase out information centers, others have changed their focus from technical training to helping users find ways to maximize the benefits of the information resource.

Information Service Units

information service unit
A miniature IS department.

An **information service unit** is basically a miniature IS department attached and directly reporting to a functional area in a large organization. Notice the information service unit shown in Figure 1.20. Even though this unit is usually staffed by IS professionals, the project assignments and the resources necessary to accomplish these projects are provided by the functional area to which it reports. Depending on the policies of the organization, the salaries of IS professionals staffing the information service unit might be budgeted to either the IS department or the functional area.

Typical IS Titles and Functions

The organizational chart shown in Figure 1.20 is a simplified model of an IS department in a typical medium-sized or large organization. Many organizations have even larger departments, with increasingly specialized positions such as librarian or quality assurance manager. Smaller firms often combine the roles shown in Figure 1.20 into fewer formal positions.

Chief Information Officer

The role of the chief information officer (CIO) is to employ an IS department's equipment and personnel to help the organization attain its goals.[123] The CIO is usually a vice president concerned with the overall needs of the organization, sets corporate- wide policies, and plans, manages, and acquires information systems.[124] In one survey, more than 60 percent of CIOs reported directly to the president of the company or the chief executive officer (CEO). According to another survey, almost 80 percent of CIOs are actively involved in or consulted on most major decisions. The CIO of Sunoco and President of the Society for Information Management described one of his duties as follows: "In 30 seconds, be able to describe how your company makes money. Make sure that your style and behavior are aligned with your company's culture and style."[125] The chief information officer of the Financial Industry Regulatory Authority agrees with this approach and said: "New CIOs need to understand how the business functions and build strong relationships with their business partners."[126] CIOs can also help companies avoid damaging ethical challenges by monitoring how companies are complying with a large number of laws and regulations.[127]

The high level of the CIO position reflects that information is one of the organization's most important resources. A good CIO is typically a visionary who provides leadership and direction to the IS department to help an organization achieve its goals. CIOs need both technical and business skills. In giving advice to other CIOs, the CIO of Wipro said, "Keep in close touch with the business side and focus on delivering continuous business value."[128] For federal agencies, the Clinger-Cohen Act of 1996 requires that a CIO coordinate the purchase and management of information systems.[129] The U.S. federal government has also instituted a CIO position to manage federal IS projects, including budgets and deadlines.[130] In 2009, Vivek Kundra was the first person appointed to this new position—CIO of the United States.

A company's CIO is usually a vice president who sets corporate-wide policies, and plans, manages, and acquires information systems.

(Source: © iStockphoto/Jacob Wackerhausen.)

Depending on the size of the IS department, several people might work in senior IS managerial levels. Some job titles associated with IS management are the CIO, vice president of information systems, manager of information systems, and chief technology officer (CTO). A central role of all these people is to communicate with other areas of the organization to determine changing needs. Often these employees are part of an advisory or steering committee that helps the CIO and other IS managers make decisions about the use of information systems. Together they can best decide what information systems will support corporate goals. The CTO, for example, typically works under a CIO and specializes in networks and related equipment and technology.

LAN Administrators

Local area network (LAN) administrators set up and manage the network hardware, software, and security processes. They manage the addition of new users, software, and devices to the network. They also isolate and fix operations problems. LAN administrators are in high demand and often solve both technical and nontechnical problems.

Internet Careers

The use of the Internet to conduct business continues to grow and has stimulated a steady need for skilled personnel to develop and coordinate Internet usage. As shown in Figure 1.20, these careers are in the areas of Web operations, Web development, and Web administration. As with other areas in IS, many top-level administrative jobs are related to the Internet. These career opportunities are found in both traditional companies and those that specialize in the Internet.

Internet jobs within a traditional company include Internet strategists and administrators, Internet systems developers, Internet programmers, and Internet or Web site operators. Some companies suggest a new position, chief Internet officer, with responsibilities and a salary similar to the CIO's.

In addition to traditional companies, Internet companies offer exciting career opportunities. These companies include Google, Amazon.com, Yahoo!, eBay, and many others. Systest, for example, specializes in finding and eliminating digital bugs that could halt the operation of a computer system.[131]

Often, the people filling IS roles have completed some form of certification. **Certification** is a process for testing skills and knowledge resulting in an endorsement by the certifying authority that an individual is capable of performing a particular job. Certification frequently involves specific, vendor-provided or vendor-endorsed coursework. Popular certification programs include Microsoft Certified Systems Engineer, Certified Information Systems Security Professional (CISSP), Oracle Certified Professional, Cisco Certified Security Professional (CCSP), and many others.

certification
A process for testing skills and knowledge, which results in a statement by the certifying authority that confirms an individual is capable of performing a particular kind of job.

Other IS Careers

To respond to the increase in attacks on computers, new and exciting careers have developed in security and fraud detection and prevention. Today, many companies have IS security positions, such as a chief information security officer or a chief privacy officer. Some universities offer degree programs in security or privacy. It is even possible to work from home in an IS field. Programmers, systems developers, and others are also working from home in developing new information systems.

In addition to working for an IS department in an organization, IS personnel can work for large consulting firms, such as Accenture (*www.accenture.com*), IBM (*www.ibm.com/services*), EDS (*www.eds.com*), and others.[132] Some consulting jobs can entail frequent travel because consultants are assigned to work on various projects wherever the client is. Such roles require excellent project management and people skills in addition to IS technical skills. Related career opportunities include computer training, computer and computer equipment salespersons, computer repair and maintenance, and many others.

Other IS career opportunities include being employed by technology companies, such as Microsoft (*www.microsoft.com*), Google (*www.google.com*), Dell (*www.dell.com*), and many others. Such a role enables an individual to work on the cutting edge of technology, which can be extremely challenging and exciting. As some computer companies cut their services to customers, new companies are being formed to fill the need. With names such as Speak with a Geek and Geek Squad, which is located in many Best Buy stores, these companies are helping people and organizations with their computer-related problems that computer vendors are no longer solving.

Some people start their own IS businesses from scratch, such as Craig Newmark, founder of Craig's List.[133] In the mid 1990s, Newmark was working for a large financial services firm and wanted to give something back to society by developing an e-mail list for arts and technology events in the San Francisco area. This early e-mail list turned into Craig's List. According to Newmark, to run a successful business, you should "Treat people like you want to be treated, including providing good customer service. Listening skills and effective communication are essential." Other people are becoming IS entrepreneurs, working from home writing programs, working on IS projects with larger businesses, or developing new applications for the iPhone or similar devices.

Working in Teams

Most IS careers involve working in project teams that can consist of many of the positions and roles discussed earlier. Thus, it is always good for IS professionals to have good communications skills and the ability to work with other people. Many colleges and universities have courses in information systems and related areas that require students to work in project teams. At the end of every chapter in this book, we have "team activities" that require teamwork to complete a project. You may be required to complete one or more of these team-oriented assignments.

Getting the best team of IS personnel to work on important projects is critical in successfully developing new information systems or modifying existing ones.[134] Increasingly, companies and IS departments seek teams with varying degrees of skills, ages, and approaches. According to the managing director of Accenture, a large IS consulting company, "Every project team we build has an entire spectrum of age and experience represented. Diversity guarantees the best project result and usually some layer of innovation."[135]

Finding a Job in IS

Traditional approaches to finding a job in the information systems area include on-campus visits from recruiters and referrals from professors, friends, and family members. Many colleges and universities have excellent programs to help students develop résumés and conduct job interviews. Developing an online résumé can be critical to finding a good job. Many companies accept résumés online and use software to search for keywords and skills used to screen job candidates. Thus, having the right keywords and skills can mean the difference between getting a job interview and not being considered.

Increasingly, students are using the Internet and other sources to find IS jobs. Many Web sites, such as Dice.com, CareerBuilder.com, TheLadders.com, LinkedIn.com, Computerjobs.com, and Monster.com, post job opportunities for Internet careers and more traditional careers.[136] Most large companies list job opportunities on their Web sites. These sites allow prospective job hunters to browse job opportunities, locations, salaries, benefits, and other factors. In addition, some sites allow job hunters to post their résumés. Many of the social networking sites, including MySpace and Facebook, can be used to help get job leads. Corporate recruiters also use the Internet or Web logs (blogs) to gather information on existing job candidates or to locate new job candidates. In addition, many professional organizations and user groups can be helpful in finding a job, staying current once employed, and seeking new career opportunities, including the Association for Computer Machinery (ACM – *www.acm.org*), the Association of Information Technology Professionals (AITP – *www.aitp.org*), Apple User Groups (*www.apple.com/usergroups*), and Linux users groups located around the world. Many companies, including Microsoft, Viacom, and others, use Twitter, an Internet site that allows short messages of 140 characters or less, to advertise job openings.[137] People who have quit jobs or have been laid off often use informal networks of colleagues or business acquaintances to help find new jobs.[138]

As with other areas in IS, many top-level administrative jobs are related to the Internet, such as Internet systems developers and Internet programmers.

(Source: © iStockphoto/Frances Twitty.)

GLOBAL CHALLENGES IN INFORMATION SYSTEMS

Changes in society as a result of increased international trade and cultural exchange, often called globalization, have always had a significant impact on organizations and their information systems. In his book *The World Is Flat,* Thomas Friedman describes three eras of globalization.[139] (See Table 1.5.) According to Friedman, we have progressed from the globalization of countries to the globalization of multinational corporations and individuals. Today, people in remote areas can use the Internet to compete with and contribute to other people, the largest corporations, and entire countries. These workers are empowered by high-speed Internet access, making the world flatter. In the Globalization 3.0 era, designing a new airplane or computer can be separated into smaller subtasks and then completed by a person or small group that can do the best job. These workers can be located in India, China, Russia, Europe, and other areas of the world. The subtasks can then be combined or reassembled into the complete design. This approach can be used to prepare tax returns, diagnose a patient's medical condition, fix a broken computer, and many other tasks.

Global markets have expanded. People and companies can get products and services from around the world, instead of around the corner or across town. These opportunities, however, introduce numerous obstacles and issues, including challenges involving culture, language, and many others.

Table 1.5
Eras of Globalization

Era	Dates	Characterized by
Globalization 1.0	Late 1400–1800	Countries with the power to explore and influence the world
Globalization 2.0	1800–2000	Multinational corporations that have plants, warehouses, and offices around the world
Globalization 3.0	2000–today	Individuals from around the world who can compete and influence other people, corporations, and countries by using the Internet and powerful technology tools

- **Cultural challenges.** Countries and regional areas have their own cultures and customs that can significantly affect individuals and organizations involved in global trade.
- **Language challenges.** Language differences can make it difficult to translate exact meanings from one language to another.
- **Time and distance challenges.** Time and distance issues can be difficult to overcome for individuals and organizations involved with global trade in remote locations. Large time differences make it difficult to talk to people on the other side of the world. With long distance, it can take days to get a product, a critical part, or a piece of equipment from one location to another location.
- **Infrastructure challenges.** High-quality electricity and water might not be available in certain parts of the world. Telephone services, Internet connections, and skilled employees might be expensive or not readily available.
- **Currency challenges.** The value of different currencies can vary significantly over time, making international trade more difficult and complex.
- **Product and service challenges.** Traditional products that are physical or tangible, such as an automobile or bicycle, can be difficult to deliver to the global market. However, *electronic products (e-products)* and *electronic services (e-services)* can be delivered to customers electronically, over the phone, networks, through the Internet, or other electronic means. Software, music, books, manuals, and advice can all be delivered globally and over the Internet.
- **Technology transfer issues.** Most governments don't allow certain military-related equipment and systems to be sold to some countries. Even so, some believe that foreign companies are stealing intellectual property, trade secrets, and copyrighted materials, and counterfeiting products and services.
- **State, regional, and national laws.** Each state, region, and country has a set of laws that must be obeyed by citizens and organizations operating in the country. These laws can deal with a variety of issues, including trade secrets, patents, copyrights, protection of personal or financial data, privacy, and much more. Laws restricting how data enters or exits a country are often called *transborder data-flow* laws. Keeping track of these laws and incorporating them into the procedures and computer systems of multinational and transnational organizations can be very difficult and time consuming, requiring expert legal advice.
- **Trade agreements.** Countries often enter into trade agreements with each other. The North American Free Trade Agreement (NAFTA) and the Central American Free Trade Agreement (CAFTA) are examples. The European Union (EU) is another example of a group of countries with an international trade agreement.[140] The EU is a collection of mostly European countries that have joined together for peace and prosperity. Additional trade agreements include the Australia-United States Free Trade Agreement (AUSFTA), signed into law in 2005, and the Korean-United States Free Trade Agreement (KORUS-FTA), signed into law in 2007. Free trade agreements have been established between Bolivia and Mexico, Canada and Costa Rica, Canada and Israel, Chile and Korea, Mexico and Japan, the United States and Jordan, and many others.[141]

SUMMARY

Principle:

The value of information is directly linked to how it helps decision makers achieve the organization's goals.

Data consists of raw facts; information is data transformed into a meaningful form. The process of defining relationships among data requires knowledge. Knowledge is an awareness and understanding of a set of information and the way that information can support a specific task. To be valuable, information must have several characteristics: It should be accurate, complete, economical to produce, flexible, reliable, relevant, simple to understand, timely, verifiable, accessible, and secure. The value of information is directly linked to how it helps people achieve their organization's goals.

Information systems are sets of interrelated elements that collect (input), manipulate and store (process), and disseminate (output) data and information. Input is the activity of capturing and gathering new data, processing involves converting or transforming data into useful outputs, and output involves producing useful information. Feedback is the output that is used to make adjustments or changes to input or processing activities.

Principle:

Knowing the potential impact of information systems and having the ability to put this knowledge to work can result in a successful personal career, organizations that reach their goals, and a society with a higher quality of life.

Information systems play an important role in today's businesses and society. The key to understanding the existing variety of systems begins with learning their fundamentals. The types of systems used within organizations can be classified into four basic groups: (1) e-commerce and m-commerce, (2) TPS and ERP, (3) MIS and DSS, and (4) specialized business information systems.

E-commerce involves any business transaction executed electronically between parties such as companies (business-to-business), companies and consumers (business-to-consumer), business and the public sector, and consumers and the public sector. The major volume of e-commerce and its fastest-growing segment is business-to-business transactions that make purchasing easier for big corporations. E-commerce offers opportunities for small businesses by enabling them to market and sell at a low cost worldwide, thus enabling them to enter the global market. Mobile commerce (m-commerce) are transactions conducted anywhere, anytime. M-commerce relies on the use of wireless communications to allows managers and corporations to place orders and conduct business using handheld computers, portable phones, laptop computers connected to a network, and other mobile devices.

The most fundamental system is the transaction processing system (TPS). A transaction is any business-related exchange. The TPS handles the large volume of business transactions that occur daily within an organization. TPSs include order processing, purchasing, accounting, and related systems.

An enterprise resource planning (ERP) system is a set of integrated programs that is capable of managing a company's vital business operations for an entire multisite, global organization. Although the scope of an ERP system may vary from company to company, most ERP systems provide integrated software to support the manufacturing and finance business functions of an organization.

A management information system (MIS) uses the information from a TPS to generate information that is useful for management decision making. The focus of an MIS is primarily on operational efficiency. A decision support system (DSS) is an organized collection of people, procedures, databases, and devices used to support problem-specific decision making. The DSS differs from an MIS in the support given to users, the decision emphasis, the development and approach, and system components, speed, and output. The specialized business information systems include knowledge management systems, artificial intelligence systems, expert systems, multimedia, and virtual reality systems. Knowledge management systems are organized collections of people, procedures, software, databases and devices used to create, store, share, and use the organization's knowledge and experience.

Principle:

System users, business managers, and information systems professionals must work together to build a successful information system.

Systems development is the activity of creating or modifying existing business systems. The goal of the systems investigation is to gain a clear understanding of the problem to be solved or opportunity to be addressed. If the decision is to continue with the solution, the next step, systems analysis, defines the problems and opportunities of the existing system. Systems design determines how the new system will work to meet the business needs defined during systems analysis. Systems implementation involves creating or acquiring the various system components (hardware, software, databases, etc.) defined in the design step, assembling them, and putting the new system into operation. The purpose of systems maintenance and review is to check and modify the system so that it continues to meet changing business needs.

Principle:

The use of information systems to add value to the organization can also give an organization a competitive advantage.

An organization is a formal collection of people and various other resources established to accomplish a set of goals. The primary goal of a for-profit organization is to maximize shareholder value. Nonprofit organizations include social groups, religious groups, universities, and other organizations that do not have profit as the primary goal. Organizations are systems with inputs, transformation mechanisms, and outputs.

Value-added processes increase the relative worth of the combined inputs on their way to becoming final outputs of the organization. The value chain is a series (chain) of activities that includes (1) inbound logistics, (2) warehouse and storage, (3) production, (4) finished product storage, (5) outbound logistics, (6) marketing and sales, and (7) customer service.

Supply chain management (SCM) helps determine what supplies are required, what quantities are needed to meet customer demand, how the supplies are to be processed (manufactured) into finished goods and services, and how the shipment of supplies and products to customers is to be scheduled, monitored, and controlled. Customer relationship management (CRM) programs help a company manage all aspects of customer encounters, including marketing and advertising, sales, customer service after the sale, and programs to help keep and retain loyal customers. CRM can help a company collect customer data, contact customers, educate customers on new products, and actively sell products to existing and new customers.

Organizations use information systems to support organizational goals. Because information systems typically are designed to improve productivity, methods for measuring the system's impact on productivity should be devised. In the late 1980s and early 1990s, overall productivity did not seem to increase with increases in investments in information systems. Often called the *productivity paradox*, this situation troubled many economists who were expecting to see dramatic productivity gains. In the early 2000s, however, productivity again seemed on the rise.

Organizational culture and change are important internal issues that affect most organizations. Organizational culture consists of the major understandings and assumptions for a business, a corporation, or an organization. Organizational change deals with how for-profit and nonprofit organizations plan for, implement, and handle change. Change can be caused by internal or external factors. Many European countries, for example, adopted the euro, a single European currency, which changed how financial companies do business and how they use their information systems.

User satisfaction with a computer system and the information it generates often depends on the quality of the system and the resulting information. A quality information system is usually flexible, efficient, accessible, and timely. The extent to which technology is used throughout an organization is a function of technology diffusion, infusion, and acceptance. Technology diffusion is a measure of how widely technology is in place throughout an organization. Technology infusion is the extent to which technology permeates an area or department. The technology acceptance model (TAM) investigates factors, such as perceived usefulness of the technology, ease of use of the technology, the quality of the information system, and the degree to which the organization supports the use of the information system, to predict IS usage and performance.

Competitive advantage is usually embodied in either a product or service that has the most added value to consumers and that is unavailable from the competition or in an internal system that delivers benefits to a firm not enjoyed by its competition. The five-forces model covers factors that lead firms to seek competitive advantage: rivalry among existing competitors, the threat of new market entrants, the threat of substitute products and services, the bargaining power of buyers, and the bargaining power of suppliers. Three strategies to address these factors and to attain competitive advantage include altering the industry structure, creating new products and services, and improving existing product lines and services.

The ability of an information system to provide or maintain competitive advantage should also be determined. Several strategies for achieving competitive advantage include enhancing existing products or services or developing new ones, as well as changing the existing industry or creating a new one.

Developing information systems that measure and control productivity is a key element for most organizations. A useful measure of the value of an IS project is return on investment (ROI). This measure investigates the additional profits or benefits that are generated as a percentage of the investment in IS technology. Total cost of ownership (TCO) can also be a useful measure.

Principle:

IS personnel is a key to unlocking the potential of any new or modified system.

Information systems personnel typically work in an IS department that employs a chief information officer, systems analysts, computer programmers, computer operators, and a number of other people. The overall role of the chief information officer (CIO) is to employ an IS department's equipment and personnel in a manner that will help the organization attain its goals. Systems analysts help users determine what outputs they need from the system and construct the plans for developing the necessary programs that produce these outputs. Systems analysts then work with one or more programmers to make sure that the appropriate programs are purchased, modified from existing programs, or developed. The major responsibility of a computer programmer is to use the plans developed by the systems analyst to develop or adapt one or more computer programs

that produce the desired outputs. Computer operators are responsible for starting, stopping, and correctly operating mainframe systems, networks, tape drives, disk devices, printers, and so on. LAN administrators set up and manage the network hardware, software, and security processes. Trained personnel are also increasingly needed to set up and manage a company's Internet site, including Internet strategists, Internet systems developers, Internet programmers, and Web site operators. Information systems personnel may also work in other functional departments or areas in a support capacity. In addition to technical skills, IS personnel also need skills in written and verbal communication, an understanding of organizations and the way they operate, and the ability to work with people (users). In general, IS personnel are charged with maintaining the broadest enterprise-wide perspective.

In addition to working for an IS department in an organization, IS personnel can work for one of the large consulting firms, such as Accenture, EDS, and others. Another IS career opportunity is to be employed by a hardware or software vendor developing or selling products.

Today's information systems have led to greater globalization. High-speed Internet access and networks that can connect individuals and organizations around the world create more international opportunities. Global markets have expanded. People and companies can get products and services from around the world, instead of around the corner or across town. These opportunities, however, introduce numerous obstacles and issues, including challenges involving culture, language, and many others.

CHAPTER 1: SELF-ASSESSMENT TEST

The value of information is directly linked to how it helps decision makers achieve the organization's goals.

1. A(n) _____ is a set of interrelated components that collect, manipulate, and disseminate data and information and provide a feedback mechanism to meet an objective.
2. What consists of raw facts, such as an employee number?
   a. bytes
   b. data
   c. information
   d. knowledge

Knowing the potential impact of information systems and having the ability to put this knowledge to work can result in a successful personal career, organizations that reach their goals, and a society with a higher quality of life.

3. A(n) _____ consists of hardware, software, databases, telecommunications, people, and procedures.
4. Computer programs that govern the operation of a computer system are called _____.
   a. feedback
   b. feedforward
   c. software
   d. transaction processing system
5. What is an organized collection of people, procedures, software, databases and devices used to create, store, share, and use the organization's experience and knowledge?
   a. TPS (transaction processing system)
   b. MIS (management information system)
   c. DSS (decision support system)
   d. KMS (knowledge management system)

System users, business managers, and information systems professionals must work together to build a successful information system.

6. What involves creating or acquiring the various system components (hardware, software, databases, etc.) defined in the design step, assembling them, and putting the new system into operation?
   a. systems implementation
   b. systems review
   c. systems development
   d. systems design
7. _____ involves anytime, anywhere commerce that uses wireless communications.
8. _____ involves contracting with outside professional services to meet specific business needs.

The use of information systems to add value to the organization can also give an organization a competitive advantage.

9. _____ change can help an organization improve raw materials supply, the production process, and the products and services offered by the organization.
10. Technology infusion is a measure of how widely technology is spread throughout an organization. True or False?

IS personnel is a key to unlocking the potential of any new or modified system.

11. Who is involved in helping users determine what outputs they need and constructing the plans needed to produce these outputs?

a. the CIO
b. the applications programmer
c. the systems programmer
d. the systems analyst

12. An information center provides users with assistance, training, and application development. True or False?
13. The _____ is typically in charge of the information systems department or area in a company.

CHAPTER 1: SELF-ASSESSMENT TEST ANSWERS

(1) information system (2) b (3) computer-based information system (CBIS) (4) c (5) d (6) a (7) Mobile commerce (m-commerce) (8) Outsourcing (9) Sustaining (10) False (11) d (12) True (13) chief information officer (CIO)

REVIEW QUESTIONS

1. What are the components of any information system?
2. Describe the different types of data.
3. Identify at least six characteristics of valuable information.
4. What is a computer-based information system? What are its components?
5. What are the most common types of computer-based information systems used in business organizations today? Give an example of each.
6. What is the difference between e-commerce and m-commerce?
7. Describe three applications of multimedia.
8. What is a knowledge management system? Give an example.
9. What is the technology acceptance model (TAM)?
10. What is user satisfaction?
11. What are some general strategies employed by organizations to achieve competitive advantage?
12. Define the term *productivity.* Why is it difficult to measure the impact that investments in information systems have on productivity?
13. What is customer relationship management?
14. What is the total cost of ownership?
15. What is the role of the systems analyst? What is the role of the programmer?
16. What is the operations component of a typical IS department?
17. What is the role of the chief information officer?

DISCUSSION QUESTIONS

1. Describe the "ideal" automated auto license plate renewal system for the drivers in your state. Describe the input, processing, output, and feedback associated with this system.
2. Describe the "ideal" automated class registration system for a college or university. Compare this "ideal" system with what is available at your college or university.
3. You have decided to open an Internet site to buy and sell used music CDs to other students. Describe the value chain for your new business.
4. How is it that useful information can vary widely from the quality attributes of valuable information?
5. What is the difference between DSS and knowledge management?
6. Discuss the potential use of virtual reality to enhance the learning experience for new automobile drivers. How might such a system operate? What are the benefits and potential drawbacks of such a system?
7. Discuss how information systems are linked to the business objectives of an organization.
8. You have been hired to work in the IS area of a manufacturing company that is starting to use the Internet to order parts from its suppliers and offer sales and support to its customers. What types of Internet positions would you expect to see at the company?
9. How would you measure technology diffusion and infusion?
10. You have been asked to participate in the preparation of your company's strategic plan. Specifically, your task is to analyze the competitive marketplace using Porter's five-forces model. Prepare your analysis, using your knowledge of a business you have worked for or have an interest in working for.
11. Based on the analysis you performed in the preceding discussion question, what possible strategies could your organization adopt to address these challenges? What role could information systems play in these strategies? Use Porter's strategies as a guide.
12. You have been hired as a sales representative for a sporting goods store. You would like the IS department to develop

new software to give you reports on which customers are spending the most at your store. Describe your role in getting the new software developed. Describe the roles of the systems analysts and the computer programmers.

13. Imagine that you are the CIO for a large, multinational company. Outline a few of your key responsibilities.
14. You have decided to open an Internet site to buy and sell used music CDs to other students. Describe the supply chain for your new business.
15. What sort of IS position would be most appealing to you—working as a member of an IS organization, being a consultant, or working for an IS hardware or software vendor? Why?
16. What are your career goals, and how can a computer-based information system be used to achieve them?

PROBLEM-SOLVING EXERCISES

1. Prepare a data disk and a backup disk for the problem-solving exercises and other computer-based assignments you will complete in this class. Create one directory for each chapter in the textbook (you should have 9 directories). As you work through the problem-solving exercises and complete other work using the computer, save your assignments for each chapter in the appropriate directory. On the label of each disk be sure to include your name, course, and section. On one disk, write "Working Copy"; on the other, write "Backup."
2. Search through several business magazines (*Business Week, Computerworld, PC Week,* etc.) or an Internet search engine for recent articles that describe potential social or ethical issues related to the use of an information system. Use word-processing software to write a one-page report summarizing what you discovered.
3. Using a word-processing program, write a detailed job description of a systems analyst for a medium-sized manufacturing company. Use a graphics program to make a presentation on the requirements for the new CIO.

TEAM ACTIVITIES

1. Before you can do a team activity, you need a team! The class members may self-select their teams, or the instructor may assign members to groups. Once your group has been formed, meet and introduce yourselves to each other. You will need to find out the first name, hometown, major, and e-mail address and phone number of each member. Find out one interesting fact about each member of your team, as well. Come up with a name for your team. Put the information on each team member into a database and print enough copies for each team member and your instructor.
2. Have your team interview a company that recently introduced new technology. Write a brief report that describes the extent of technology infusion and diffusion.
3. With your team, interview one or more instructors or professors at your college or university. Describe how they keep current with the latest teaching and research developments in their field.

WEB EXERCISES

1. Throughout this book, you will see how the Internet provides a vast amount of information to individuals and organizations. We will stress the World Wide Web, or simply the Web, which is an important part of the Internet. Most large universities and organizations have an address on the Internet, called a Web site or home page. The address of the Web site for the publisher of this text is *www.cengage.com*. You can gain access to the Internet through a browser, such as Internet Explorer or Netscape. Using an Internet browser, go to the Web site for this publisher. What did you find? Try to obtain information on this book. You may be asked to develop a report or send an e-mail message to your instructor about what you found.

2. Go to an Internet search engine, such as *www.google.com* or *www.yahoo.com*, and search for information about artificial intelligence. Write a brief report that summarizes what you found.
3. Use the Internet to search for information about a company that has excellent or poor product quality in your estimation. You can use a search engine, such as Google, or a database at your college or university. Write a brief report describing what you found. What leads to higher-quality products? How can an information system help a company produce higher quality products?

CAREER EXERCISES

1. In the Career Exercises found at the end of every chapter, you will explore how material in the chapter can help you excel in your college major or chosen career. Write a brief report on the career that appeals to you the most. Do the same for two other careers that interest you.
2. Research careers in finance, management, information systems, and two other career areas that interest you. Describe the job opportunities, job duties, and the possible starting salaries for each career area in a report.
3. Pick the five best companies for your career. Describe how each company uses information systems to help achieve a competitive advantage.

CASE STUDIES

Case One

Information System as an Effective Force Against H1N1 Pandemic

Information systems are valuable to businesses for tracking business activities in real-time, as they occur. They are also valuable to the medical community for tracking the spread of viruses such as the H1N1 virus, also known as the swine flu. New Jersey-based Emergency Medical Associates (EMA) operates 21 emergency rooms in hospitals across New Jersey, New York, and Pennsylvania. With information mined from its diverse locations, EMA is in an ideal position to spot an outbreak of the flu in its early stages. All it requires is an information system to provide valuable information in a timely manner.

EMA's CIO and information systems specialists applied proven business information management techniques to their medical information needs. They understood that tracking medical statistics across their 21 emergency rooms was similar to tracking sales statistics across retail outlets. They required the same business intelligence (BI) and reporting tools used by successful businesses. Business intelligence or BI systems are designed to extract, or mine, useful information out of the data collected by businesses or organizations into databases. That data may consist of detailed sales information collected at the time of a sale or patient symptom information collected at the time of an examination.

EMA began by installing a database management system from Oracle. The database was shared by all of its 21 emergency rooms over a high-speed private network. EMA then contracted with SAP to install its BusinessObjects XI tool set to function as the company's BI platform. BusinessObjects can sort and sift through data in the database to find patterns and exceptions. Combining the BusinessObjects system with other software including Xcelsius and Crystal Reports (powerful reporting software), and Web Intelligence (providing a Web interface to the system), EMA created a system that generates insightful reports and visualizations about medical conditions on a regular schedule and on demand.

Today, EMA physicians and nurses, depending on their needs, can access 27 dashboards, which provide statistics displayed in charts and lists that are updated as information is entered into the database. They also have access to 30 daily reports from the system informing them of the current status in all of their emergency rooms and of any changes in the status quo. The system allows users to customize their view of the data to focus on the information that is most important to their work.

Using its new information system, EMA was the first to spot the outbreak of H1N1 in the Northeast. Doctors knew that about 6 percent of patients complain of flu-like symptoms on any given day. When the EMA BI system reported that 30 percent of patients were arriving with flu symptoms, the doctors warned the country that H1N1 was on the move. This alert provided medical professionals and citizens the time needed to take action.

Discussion Questions

1. What role did business intelligence software play in catching an H1N1 outbreak in the northeastern United States.?
2. How does a system such as EMA's BI system use human intelligence and machine intelligence to support decision making?

Critical Thinking Questions

1. How do the BI needs of business professionals and medical professionals differ? How are they alike?
2. How does this case study reflect the need for standardized digital medical records systems in the U.S.? How might such standards influence the country's ability to keep its population healthy?

SOURCES: Lai, Eric, "BI helps New York-area hospitals track, fight H1N1," *Computerworld*, October 8, 2009, *www.computerworld.com/s/article/9139121/BI_helps_New_York_area_hospitals_track_ fight_H1N1?source=rss_news*; EMA Web site, accessed November 12, 2009, *www.ema-ed.com*; SAP staff, "Emergency Medical Associates Stays Ahead of Swine Flu Outbreaks This Back-To-School Season with Sap® Software," SAP Press Release, September 14, 2009, *www.sap.com/about/newsroom/topic-rooms/business- objects/press.epx?pressid=11826.*

Case Two

Creativity Moves Up the Value Chain

Creativity Inc. deals in beads, baubles, and stylized paper to "bring crafters' dreams to reality by providing the materials to give life to their ideas and imagination." Creativity owns five well-known brands in the craft industry: Autumn Leaves, Blue Moon Beads, Crop in Style, DND, Hip in a Hurry, and Westrim Crafts. The company is one of the top five wholesale suppliers to national craft chains in the United States with 500 employees at four office and warehouse locations in California and one in Hong Kong.

Creativity outsources the manufacturing of its designs to production facilities across Asia. Crates of assorted beads, scrapbooking supplies, and papercrafting materials flow through Creativity's port-side warehouses to craft stores and department stores across the U.S. In this way, Creativity facilitates the value chain for craft retailers.

In 2007, Creativity found its business model challenged by growing globalization and economic hardships. To save money, some of its customers decided to "do away with the middleman," and purchase crafting materials directly from the Asian manufacturers. Creativity needed to find new ways to provide value to its customers.

Creativity's challenges are not unique. Many businesses are facing growing competition from low-cost manufacturers and service providers in developing countries. To survive, they need to find a way to move up the value chain—that is, to provide valuable services beyond upstream management of the supply chain. Many are turning to information systems to assist in that move.

Creativity turned to IBM's Cognos 8 Business Intelligence suite to identify high-value products that could not be manufactured by its low-cost overseas competitors. The company acquired data about purchase transactions from retailers in craft-related markets and added that data to its data warehouse. Using the Cognos software and Smart Software's SmartForecast program, Creativity determined a need for more "design-oriented, fashion-oriented" products—especially ones associated with popular U.S. media, such as television shows and celebrities.

By shifting its focus to fashion-based craft products, Creativity made up for the business it lost in the low-cost crafting material market. In fact, fashion-oriented products are now the dominant portion of its business, comprising more than 50 percent of its products and a much higher percentage of its profits.

Creativity also uses Cognos to determine which customer segments are most profitable. The company can then focus its efforts in those areas to boost profitability. In addition, Creativity created an "Analytical Center of Excellence" composed of representatives from all of its brands. By improving communication between its brands and sharing its research findings, Creativity elevated the corporate awareness of the entire company and created an environment where everyone is working towards common goals. To further communication, CIO Jim Mulholland used Cognos to develop a software dashboard that provides corporate news and information on the desktops of company managers across its brands. These communication improvements help safeguard against duplication of effort. Each brand is aware of what the other brands are experiencing and working on, allowing brands to learn from each other.

Creativity and other struggling businesses want to create valuable information from low-cost data to learn how to work more intelligently and efficiently. Integrating data from transactions, call centers, Web logs, sales reps, external sources, and elsewhere into data warehouses for analysis allows companies to discover what products are likely to sell, what products return the highest profits, where to cut costs, where to invest for the highest return, and other key information to fuel smart decision making. Many businesses are counting on information systems to provide the knowledge to survive tough economic times.

Discussion Questions

1. Describe the global economic forces that pushed Creativity to move up the value chain.
2. What information did Creativity use to boost its profits and remain solvent?

Critical Thinking Questions

1. What role does communication play in creating savings for a multibrand company like Creative?
2. What lessons does Creative's story provide for U.S. businesses? What does this forecast for the global marketplace in general?

SOURCES: Mitchell, Robert, "Smart and cheap: Business intelligence on a budget," *Computerworld*, May 14, 2009, *www.computerworld.com*; Creativity Inc. Web site, access December 26, 2009, *www.creativityinc.com*; Cognos Web site, accessed December 26, 2009, *www-01.ibm.com/software/data/cognos*.

Questions for Web Case

See the Web site for this book to read about the Altitude Online case for this chapter. The following questions cover this Web case.

Altitude Online: Outgrowing Systems

Discussion Questions

1. Why do you think it's a problem for Altitude Online to use different information systems in its branch locations?
2. What information do you think Jon should collect from the branch offices to plan the new centralized information system?

Critical Thinking Questions

1. With Jon's education and experience, he could design and implement a new information system for Altitude Online himself. What would be the benefits and drawbacks of doing the job himself compared to contracting with an information systems contractor?
2. While Jon is visiting the branch offices, how might he prepare them for the inevitable upheaval caused by the upcoming overhaul to the information system?

Altitude Online: Addressing the Needs of the Organization

Discussion Questions

1. What are the advantages of Altitude Online adopting a new ERP system compared to simply connecting existing corporate systems?
2. Why isn't an out-of-the-box ERP system enough for Altitude Online? What additional needs does the company have? Is this the case for businesses in other industries as well?

Critical Thinking Questions

1. Why do you think Jon is taking weeks to directly communicate with stakeholders about the new system?
2. Why do you think Jon and the system administrators decided to outsource the software for this system to an ERP company rather than developing it from scratch themselves?

NOTES

Sources for the opening vignette: SAP staff, "Braskem - Pursuing Growth and Synergy Through Mergers and Acquisitions," SAP Customer References Web page, accessed November 12, 2009, *www.sap.com/usa/solutions/business-suite/customers*; Braskem Web site, accessed November 12, 2009, *www.braskem.com.br*; Accenture staff, "Braskem: SAP Solutions," Accenture Client Successes Web page, accessed November 12, 2009, *www.accenture.com/Global/Technology/Enterprise_Solutions/SAP_Solutions/Client_Su ccesses/Braskem.htm*.

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CHAPTER

3

Database Systems, Data Centers, and Business Intelligence

PRINCIPLES	LEARNING OBJECTIVES
▪ **Data management and modeling are key aspects of organizing data and information.**	▪ Define general data management concepts and terms, highlighting the advantages of the database approach to data management. ▪ Describe logical and physical database design considerations, the function of data centers, and the relational database model.
▪ **A well-designed and well-managed database is an extremely valuable tool in supporting decision making.**	▪ Identify the common functions performed by all database management systems, and identify popular database management systems.
▪ **The number and types of database applications will continue to evolve and yield real business benefits.**	▪ Identify and briefly discuss business intelligence, data mining, and other database applications.

Information Systems in the Global Economy
Aquent, United States
Leveraging Database Technology to Empower Marketing Professionals

Aquent is a global leader in marketing staffing. The company works with Fortune 500 marketing organizations to fill positions with highly qualified professionals drawn from a pool of thousands of marketing experts worldwide. Aquent works to place brand managers, copywriters, data analysts, Web designers, search-engine optimizers, and other specialists in full-time positions as well as short-term contract positions. According to Aquent, the industry is changing from one in which marketing experts join a company and work their way up the corporate ladder, to one in which marketing projects are hired out to specialists who move from company to company applying unique high-level skills to challenging projects. Aquent believes that it plays a key role in enabling this new era of marketing. It provides challenging projects for marketing professionals to hone their skills and advance in their field, while elevating the quality and effectiveness of marketing efforts within organizations.

Aquent has unique database and information system needs. Its clients are both large corporations and individuals. Although its primary business is staffing, it also provides ancillary services such as project management, translation and localization, and healthcare consulting. Its information systems must produce a wide range of reports to meet a variety of business needs. These needs include staffing levels and requirements, human resource usage, gross profit, pay rates, and many others. Because the company works with many organizations, it must manage diverse payroll schemes and schedules. Aquent also manages systems that allow it to provide insurance and retirement benefits to many of the marketing professional talents that it represents. The databases that support these wide-ranging and diverse systems are about as complicated as a business' databases can be.

To get a handle on all of its data, Aquent uses a database management system that collects operational data from around the world and stores it in a central data mart managed by the SAP Corporation. Each night, the system refreshes the data stored in the data mart with updates from data centers in Sydney, London, and Boston. A backup of the data is stored in Aquent's data center in Boston.

Aquent executives, managers, and personnel access the data through a Web-based system provided by SAP. SAP takes responsibility for storing and managing Aquent's database and providing a robust database management system (DBMS) accessed through a Web browser. This approach to database management, where a company outsources its DBMS to a service provider, is referred to as Database as a Service, or DaaS.

Aquent uses a business intelligence (BI) system to create ad-hoc and annual reports. Aquent regional managers run individual reports for Asia Pacific, Europe, and North America. They also run reports that cover all regions using common criteria to examine. Executives can get a high-level view of trends in corporate data and use BI tools to drill down into the data to discover specific areas of the business that require attention.

Aquent uses SAP data mining technology to examine data in the data mart and discover patterns and anomalies that cue decision makers to examine problems and opportunities. Predictive analysis tools help to provide managers with insight into the future based on an analysis of the past. Using these tools, Aquent can determine future demand for marketing professionals and ensure it can meet that demand. It may also determine a future lack of demand so that Aquent can advise some professionals to consider jobs in other related areas.

Using a central data mart and joining operations around the world, Aquent can more easily view itself as a multinational company. The distances among its global divisions are greatly reduced by its ability to combine corporate data and evaluate it both by region and in its totality.

As you read this chapter, consider the following:

- What role do databases play in the overall effectiveness of information systems?
- What techniques do businesses use to maximize the value of the information provided from databases?

Why Learn About Database Systems, Data Centers, and Business Intelligence?

A huge amount of data is entered into computer systems every day. Where does all this data go, and how is it used? How can it help you on the job? In this chapter, you will learn about database systems and business intelligence tools that can help you make the most effective use of information. If you become a marketing manager, you can access a vast store of data on existing and potential customers from surveys, their Web habits, and their past purchases. This information can help you sell products and services. If you become a corporate lawyer, you will have access to past cases and legal opinions from sophisticated legal databases. This information can help you win cases and protect your organization legally. If you become a human resource (HR) manager, you will be able to use databases and business intelligence tools to analyze the impact of raises, employee insurance benefits, and retirement contributions on long-term costs to your company. Regardless of your field of study in school, using database systems and business intelligence tools will likely be a critical part of your job. In this chapter, you will see how you can use data mining to extract valuable information to help you succeed. This chapter starts by introducing basic concepts of database management systems.

A database is an organized collection of data. Like other components of an information system, a database should help an organization achieve its goals. A database can contribute to organizational success by providing managers and decision makers with timely, accurate, and relevant information based on data. For example, Comic Relief, in London, England, raises money to assist the needy by hosting entertainment events featuring comedians. The organization uses a database to determine which clips in its televised fundraiser generate the highest emotional response from the public to determine whether the clip should be repeated.[1]

Databases also help companies generate information to reduce costs, increase profits, track past business activities, and open new market opportunities. In some cases, organizations collaborate in creating and using international databases. Six organizations, including the Organization of Petroleum Exporting Countries (OPEC), International Energy Agency (IEA), and the United Nations, use a database to monitor the global oil supply.

database management system (DBMS)
A group of programs that manipulate the database and provide an interface between the database and the user of the database and other application programs.

database administrator (DBA)
A skilled IS professional who directs all activities related to an organization's database.

A **database management system** (**DBMS**) consists of a group of programs that manipulate the database and provide an interface between the database and its users and other application programs. Usually purchased from a database company, a DBMS provides a single point of management and control over data resources, which can be critical to maintaining the integrity and security of the data. A database, a DBMS, and the application programs that use the data make up a database environment. A **database administrator** (**DBA**) is a skilled and trained IS professional who directs all activities related to an organization's database, including providing security from intruders. People hack into databases for various reasons. Consider the Latvian computer expert who hacked into a government database to make public the salary information of government officials. He intended to show the people that during the country's severe economic problems, government officials continued receiving high salaries.[2] In 2010, the names, birth dates, and Social Security numbers of 3.3 million students were stolen from a database owned by a student loan company.[3] Such data breaches have become commonplace for organizations because many databases are now

accessible from the Internet. Data quality and accuracy also continue to be important issues for DBAs. For example, in Uckfield, England, government records for Pauline Grant and her farm became jumbled due to a land registry error. The mix-up resulted in a pig named Blossom on Grant's farm receiving mail encouraging her to vote in the upcoming election.[4]

Databases and database management systems are becoming even more important to businesses as they deal with increasing amounts of digital information. A report from IDC called "The Digital Universe Decade – Are you ready," estimates the size of the digital universe to be 1.2 zettabytes, or 1.2 trillion gigabytes.[5] If a tennis ball were one byte of information, a zettabyte-sized ball would be around the size of a million earths. Furthermore, between 2009 and 2020, the amount of information humanity creates will grow by a factor of 44, storage capacity will grow by a factor of 30, and the estimated investment in database infrastructure and administration will grow by only a factor of 1.4. IDC recommends that organizations move now to create policies, tools, and standards to accommodate the approaching tidal wave of digital data and information.

DATA MANAGEMENT

Without data and the ability to process it, an organization could not successfully complete most business activities. It could not pay employees, send out bills, order new inventory, or produce information to assist managers in decision making. As you recall, data consists of raw facts, such as employee numbers and sales figures. For data to be transformed into useful information, it must first be organized in a meaningful way.

The Hierarchy of Data

Data is generally organized in a hierarchy that begins with the smallest piece of data used by computers (a bit) and progresses through the hierarchy to a database. A bit (a binary digit) represents a circuit that is either on or off. Bits can be organized into units called *bytes*. A byte is typically eight bits. Each byte represents a **character**, which is the basic building block of most information. A character can be an uppercase letter (A, B, C… Z), lowercase letter (a, b, c… z), numeric digit (0, 1, 2… 9), or special symbol (., !, +, -, /, …).

character
A basic building block of most information, consisting of uppercase letters, lowercase letters, numeric digits, or special symbols.

Characters are put together to form a field. A **field** is typically a name, number, or combination of characters that describes an aspect of a business object (such as an employee, a location, or a truck) or activity (such as a sale). In addition to being entered into a database, fields can be computed from other fields. *Computed fields* include the total, average, maximum, and minimum value. A collection of data fields all related to one object, activity, or individual is called a **record**. By combining descriptions of the characteristics of an object, activity, or individual, a record can provide a complete description of it. For instance, an employee record is a collection of fields about one employee. One field includes the employee's name, another field contains the address, and still others the phone number, pay rate, earnings made to date, and so forth. A collection of related records is a **file**—for example, an employee file is a collection of all company employee records. Likewise, an inventory file is a collection of all inventory records for a particular company or organization. Some database software refers to files as tables.

field
Typically a name, number, or combination of characters that describes an aspect of a business object or activity.

record
A collection of data fields all related to one object, activity, or individual.

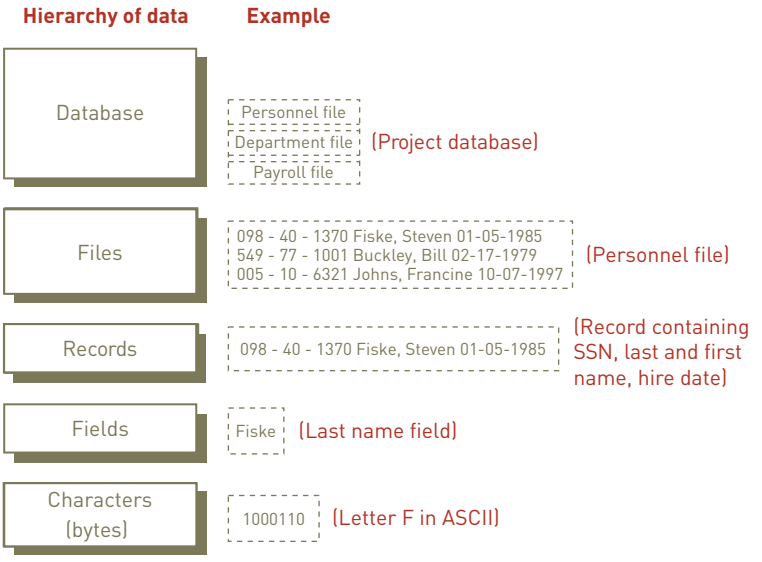
file
A collection of related records.

At the highest level of this hierarchy is a *database*, a collection of integrated and related files. Together, bits, characters, fields, records, files, and databases form the **hierarchy of data**. See Figure 3.1. Characters are combined to make a field, fields are combined to make a record, records are combined to make a file, and files are combined to make a database. A database houses not only all these levels of data but also the relationships among them.

hierarchy of data
Bits, characters, fields, records, files, and databases.

Figure 3.1

The Hierarchy of Data



Data Entities, Attributes, and Keys

entity
A general class of people, places, or things for which data is collected, stored, and maintained.

attribute
A characteristic of an entity.

data item
The specific value of an attribute.

Entities, attributes, and keys are important database concepts. An **entity** is a general class of people, places, or things (objects) for which data is collected, stored, and maintained. Examples of entities include employees, inventory, and customers. Most organizations organize and store data as entities.

An **attribute** is a characteristic of an entity. For example, employee number, last name, first name, hire date, and department number are attributes for an employee. See Figure 3.2. The inventory number, description, number of units on hand, and location of the inventory item in the warehouse are attributes for items in inventory. Customer number, name, address, phone number, credit rating, and contact person are attributes for customers. Attributes are usually selected to reflect the relevant characteristics of entities such as employees or customers. The specific value of an attribute, called a **data item**, can be found in the fields of the record describing an entity.

Figure 3.2

Keys and Attributes

The key field is the employee number. The attributes include last name, first name, hire date, and department number.

Employee #	Last name	First name	Hire date	Dept. number
005-10-6321	Johns	Francine	10-07-1997	257
549-77-1001	Buckley	Bill	02-17-1979	632
098-40-1370	Fiske	Steven	01-05-1985	598

ENTITIES (records)

KEY FIELD

ATTRIBUTES (fields)

Most organizations use attributes and data items. Many governments use attributes and data items to help in criminal investigations. The United States Federal Bureau of Investigation is building a huge database of peoples' physical characteristics or biometrics.[6] At a cost of $1 billion, the database management system named Next Generation Identification will catalog digital images of faces, fingerprints, and palm prints of U.S. citizens and visitors. Each person in the database is an entity, each biometric category is an attribute, and each image is a data item. The information will be used as a forensics tool and to increase homeland security.

As discussed earlier, a collection of fields about a specific object is a record. A **key** is a field or set of fields in a record that identifies the record. A **primary key** is a field or set of fields that uniquely identifies the record. No other record can have the same primary key. For an employee record, such as the one shown in Figure 3.2, the employee number is an example of a primary key. The primary key is used to distinguish records so that they can be accessed, organized, and manipulated. Primary keys ensure that each record in a file is unique. For example, eBay assigns an "Item number" as its primary key for items to make sure that bids are associated with the correct item. See Figure 3.3.

key
A field or set of fields in a record that is used to identify the record.

primary key
A field or set of fields that uniquely identifies the record.

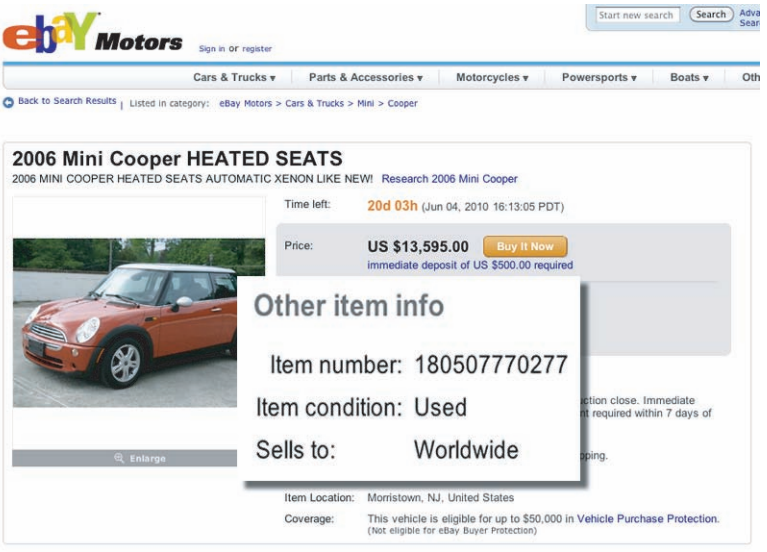


Figure 3.3
Primary Key
eBay assigns an "Item number" as a primary key to keep track of each item in its database.

Locating a particular record that meets a specific set of criteria might be easier and faster using a combination of secondary keys. For example, a customer might call a mail-order company to place an order for clothes. The order clerk can easily access the customer's mailing and billing information by entering the primary key—usually a customer number—but if the customer does not know the correct primary key, a secondary key such as last name can be used. In this case, the order clerk enters the last name, such as Adams. If several customers have a last name of Adams, the clerk can check other fields, such as address, first name, and so on, to find the correct customer record. After locating the correct customer record, the order can be completed and the clothing items shipped to the customer.

The Database Approach

At one time, information systems referenced specific files containing relevant data. For example, a payroll system would use a payroll file. Each distinct operational system used data files dedicated to that system. This approach to data management is called the **traditional approach to data management**.

traditional approach to data management
An approach to data management whereby each distinct operational system used data files dedicated to that system.

Today, most organizations use the **database approach to data management**, whereby multiple information systems share a pool of related data. A database offers the ability to share data and information resources. Federal databases, for example, often include the results of DNA tests as an attribute for convicted criminals. The information can be shared with law enforcement officials around the country.

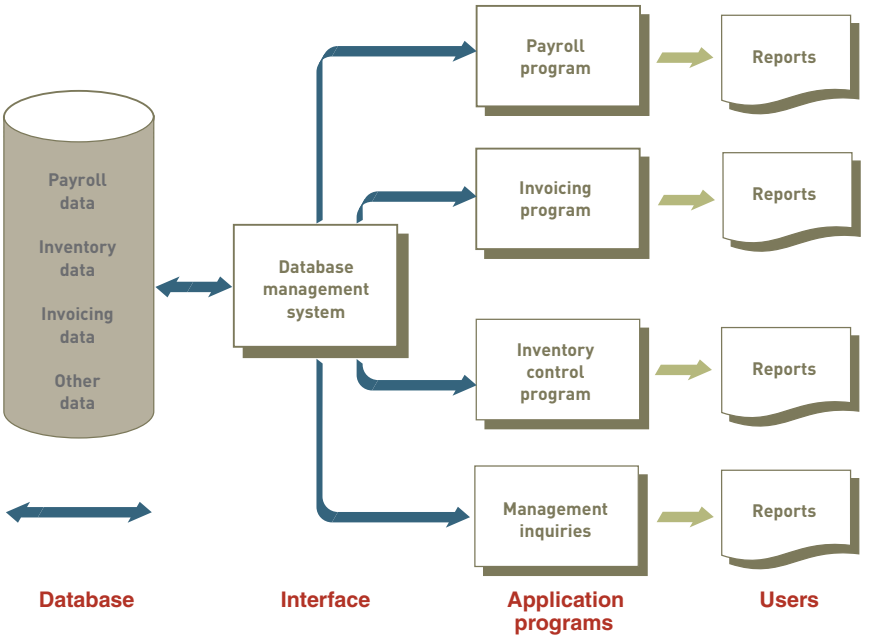
database approach to data management
An approach to data management whereby a pool of related data is shared by multiple information systems.

To use the database approach to data management, additional software—a database management system (DBMS)—is required. As previously discussed, a DBMS consists of a group of programs that can be used as an interface between a database and the user of the database. Typically, this software acts as a buffer between the application programs and the database itself. Figure 3.4 illustrates the database approach.

Table 3.1 lists some of the primary advantages of the database approach, and Table 3.2 lists some disadvantages.

Figure 3.4

The Database Approach to Data Management



Advantages	Explanation
Improved strategic use of corporate data	Accurate, complete, up-to-date data can be made available to decision makers where, when, and in the form they need it. The database approach can also give greater visibility to the organization's data resources.
Reduced data redundancy	Data is organized by the DBMS and stored in only one location. This results in a more efficient use of system storage space.
Improved data integrity	With the traditional approach, some changes to data were not reflected in all copies of the data. The database approach prevents this problem because no separate files exist.
Easier modification and updating	The DBMS coordinates data modifications and updates. Programmers and users do not have to know where the data is physically stored. Data is stored and modified once. Modification and updating is also easier because the data is commonly stored in only one location.
Data and program independence	The DBMS organizes the data independently of the application program, so the application program is not affected by the location or type of data. Introduction of new data types not relevant to a particular application does not require rewriting that application to maintain compatibility with the data file.
Better access to data and information	Most DBMSs have software that makes it easy to access and retrieve data from a database. In most cases, users give simple commands to get important information. Relationships between records can be more easily investigated and exploited, and applications can be more easily combined.
Standardization of data access	A standardized, uniform approach to database access means that all application programs use the same overall procedures to retrieve data and information.
A framework for program development	Standardized database access procedures can mean more standardization of program development. Because programs go through the DBMS to gain access to data in the database, standardized database access can provide a consistent framework for program development. In addition, each application program need address only the DBMS, not the actual data files, reducing application development time.
Better protection of the data	Accessing and using centrally located data is easier to monitor and control. Security codes and passwords can ensure that only authorized people have access to particular data and information in the database, thus ensuring privacy.
Shared data and information resources	The cost of hardware, software, and personnel can be spread over many applications and users. This is a primary feature of a DBMS.

Table 3.1

Advantages of the Database Approach

As you can see from Tables 3.1 and 3.2, the advantages of the database approach far outweigh the disadvantages. For that reason, nearly all businesses use databases of various types and sizes to collect important data that fuels information systems and decision making. Many modern databases serve entire enterprises, encompassing much of the data of the

organization. Often, distinct yet related databases are linked to provide enterprise-wide databases. For example, many Wal-Mart stores include in-store medical clinics for customers. Wal-Mart uses a centralized electronic health records database that stores the information of all patients across all stores.[7] The database is interconnected with the main Wal-Mart database to provide information about customer's interactions with the clinics and stores.

Table 3.2

Disadvantages of the Database Approach

Disadvantages	Explanation
More complexity	DBMSs can be difficult to set up and operate. Many decisions must be made correctly for the DBMS to work effectively. In addition, users have to learn new procedures to take full advantage of a DBMS.
More difficult to recover from a failure	With the traditional approach to file management, a failure of a file affects only a single program. With a DBMS, a failure can shut down the entire database.
More expensive	DBMSs can be more expensive to purchase and operate than traditional file management. The expense includes the cost of the database and specialized personnel, such as a database administrator, who is needed to design and operate the database. Additional hardware might also be required.

DATA MODELING AND DATABASE CHARACTERISTICS

Because today's businesses have so many elements, they must keep data organized so that it can be used effectively. A database should be designed to store all data relevant to the business and provide quick access and easy modification. Moreover, it must reflect the business processes of the organization. When building a database, an organization must carefully consider these questions:

- *Content.* What data should be collected and at what cost?
- *Access.* What data should be provided to which users and when?
- *Logical structure.* How should data be arranged so that it makes sense to a given user?
- *Physical organization.* Where should data be physically located?

The U.S. federal government carefully considers what information it should make accessible and what information should remain private. The Bush administration kept a great deal of information private during the years following the bombing of the Twin Towers in New York City. When President Obama took office, he pledged to run a much more transparent government. He followed through with his promise by providing access to hundreds of government databases through the Web site *www.data.gov*. News agencies, research labs, and analysts can use this Web site to connect databases directly to government records to track government actions and information.[8] See Figure 3.5.

Figure 3.5

The U.S. federal government provides access to numerous data sets at *www.data.gov*.

(Source: *www.data.gov*.)

Data Center

data center
A climate-controlled building or set of buildings that house database servers and the systems that deliver mission-critical information and services.

Databases, and the systems that manipulate them, can be physically stored on computers as small as a PC or as large as mainframes and data centers. A **data center** is a climate-controlled building or set of buildings that house database servers and the systems that deliver mission-critical information and services. Data centers of large organizations are often distributed among several locations, but a recent trend has many organizations consolidating their data centers into a few large facilities. For example, the U.S. federal government is working to save billions of dollars by consolidating 1,100 data centers into a dozen facilities. The project is recognized as the largest data center consolidation in history.[9] The state of Texas is in the midst of a seven-year effort to consolidate its 31 data centers into two facilities in San Angelo and Austin.[10] Microsoft recently constructed a $550 million, 400,000-square-foot data center on 44 acres in San Antonio. Google invested $600 million for a mega data center in Lenoir, North Carolina, and $750 million for another in Goose Creek, South Carolina. Clearly, storing and managing data is a serious business.

Traditional data centers consist of warehouses filled with row upon row of server racks and powerful cooling systems to compensate for the heat generated by the processors. Microsoft,[11] Google,[12] and others have adopted a new modular data center approach, which uses large shipping containers like the ones that transport consumer goods around the world. The huge containers, such as the HP POD, are packed with racks of servers prewired and cooled to easily connect and set up. Microsoft recently constructed a 700,000-square-foot data center in Northlake, Illinois. It is considered to be one of the largest in the world, taking up 16 football fields of space. The mega facility is filled with 220 shipping containers packed with servers. Microsoft says that a new shipping container can be wheeled into place and connected to the Internet within hours.[13] See Figure 3.6.

Figure 3.6

Modular Data Center

Modular data centers, such as the this one from IBM, use large shipping containers to store racks of servers.

(Source: Courtesy of IBM.)

Modular data centers are becoming popular around the world due to their convenience and efficiencies. Taiwan's Technology Research Institute is working to create standards for modular data centers in shipping containers that they say will reduce the costs of these units by half while increasing ease of use and reducing energy demands.[14]

While a company's data sits in large supercooled data centers, the people accessing that data are typically in offices spread across the country or around the world. In fact, the expectation of data center specialists such as Hewlett-Packard CEO Mark Hurd is that in the near future, the only personnel on duty at data centers will be security guards. Data centers

are approaching the point of automation, whereby they can run and manage themselves while being monitored remotely. This is referred to as a "lights out" environment. The State of Vermont recently switched to a lights out approach for nights and weekends, reducing its staff by 40 percent and significantly reducing costs.[15] HP has moved to automated data centers, reducing its IT staffing needs by 3,000.[16]

As data centers continue to expand in terms of the quantity of data that they store and process, their energy demands are becoming an increasingly significant portion of the total energy demands of humanity. Businesses and technology vendors are working to develop green data centers that run more efficiently and require less energy for processing and cooling.

Data Modeling

When organizing a database, key considerations include determining what data to collect, who will have access to it, and how they might want to use it. After determining these details, an organization can create the database. Building a database requires two different types of designs: a logical design and a physical design. The *logical design* of a database is an abstract model of how the data should be structured and arranged to meet an organization's information needs. The logical design involves identifying relationships among the data items and grouping them in an orderly fashion. Because databases provide both input and output for information systems throughout a business, users from all functional areas should assist in creating the logical design to ensure that their needs are identified and addressed. The *physical design* starts from the logical database design and fine-tunes it for performance and cost considerations (such as improved response time, reduced storage space, and lower operating cost). The person who fine-tunes the physical design must have an in-depth knowledge of the DBMS. For example, the logical database design might need to be altered so that certain data entities are combined, summary totals are carried in the data records rather than calculated from elemental data, and some data attributes are repeated in more than one data entity. These are examples of **planned data redundancy**, which is done to improve the system performance so that user reports or queries can be created more quickly.

planned data redundancy
A way of organizing data in which the logical database design is altered so that certain data entities are combined, summary totals are carried in the data records rather than calculated from elemental data, and some data attributes are repeated in more than one data entity to improve database performance.

One of the tools database designers use to show the logical relationships among data is a data model. A **data model** is a diagram of entities and their relationships. Data modeling usually involves understanding a specific business problem and analyzing the data and information needed to deliver a solution. When done at the level of the entire organization, this is called enterprise data modeling. **Enterprise data modeling** is an approach that starts by investigating the general data and information needs of the organization at the strategic level, and then examines more specific data and information needs for the various functional areas and departments within the organization. Various models have been developed to help managers and database designers analyze data and information needs. An entity-relationship diagram is an example of such a data model.

data model
A diagram of data entities and their relationships.

enterprise data modeling
Data modeling done at the level of the entire enterprise.

Entity-relationship (ER) diagrams use basic graphical symbols to show the organization of and relationships between data. In most cases, boxes in ER diagrams indicate data items or entities contained in data tables, and diamonds show relationships between data items and entities. In other words, ER diagrams show data items in tables (entities) and the ways they are related.

entity-relationship (ER) diagrams
Data models that use basic graphical symbols to show the organization of and relationships between data.

ER diagrams help ensure that the relationships among the data entities in a database are correctly structured so that any application programs developed are consistent with business operations and user needs. In addition, ER diagrams can serve as reference documents after a database is in use. If changes are made to the database, ER diagrams help design them. Figure 3.7 shows an ER diagram for an order database. In this database design, one salesperson serves many customers. This is an example of a one-to-many relationship, as indicated by the one-to-many symbol (the "crow's-foot") shown in Figure 3.7. The ER diagram also shows that each customer can place one-to-many orders; each order includes one-to-many line items; and many line items can specify the same product (a many-to-one relationship). This database can also have one-to-one relationships. For example, one order generates one invoice.

ETHICAL AND SOCIETAL ISSUES

Mega Data Centers and Their Environmental Impact

To keep up with the unprecedented amount of information being generated, businesses need to invest in larger and larger data centers. Many businesses find it more economical to outsource their data center needs. Dozens of mega data centers are being constructed around the world for a variety of uses.

Mega data centers typically cost hundreds of millions of dollars and consume acres of property. One of the world's largest was recently constructed for $301 million by Next Generation Data, outside of Newport in South Wales. The 750,000-square-foot (70,000-square-meter) facility has enough space to house 19,000 server racks that each hold a dozen servers. The facility hopes to serve hundreds of businesses, many located in nearby London. Its first two tenants, BT and Logica, signed contracts worth a combined $29 million.

Next Generation Data can provide its customers with certain guarantees of service and data protection. To guard against terrorist attacks, the data center has "triple-skinned walls, bomb-proof glass, prison-grade perimeter fencing, infrared detection, biometric recognition, and ex-special forces security guards." The data center's network is equally protected, and all systems have failback systems to guard against hardware or electrical failure.

The biggest environmental impact of mega data centers is their energy consumption for the processing, storage, and cooling required. The data center for Next Generation Data outside Newport has its own energy substation that provides 90 megavolt-amperes of electrical power. That's roughly equivalent to the requirements of a city of 400,000 people. Multiply this by the dozens of other mega data centers going online, including huge facilities such as Microsoft's new 700,000-square-foot center near Chicago, and the energy requirements increase around the world. Adding the energy needs of mega data centers to the increasing energy demands of developing countries with huge populations such as China and India results in unprecedented worldwide energy consumption.

When coal-burning power plants fulfill these energy demands, they add carbon to the atmosphere, which many scientists argue accelerates climate change. A number of efforts are underway to counteract the growing demand for data centers. Hardware manufacturers are producing servers that are more efficient, requiring half the energy as their predecessors to do twice the work. As new data centers go into operation, they are implementing new energy-efficient technologies. Gradually, as old wasteful systems break down, managers will migrate data to new green systems.

The Newport data center uses fresh air cooling and Energy Star rated equipment to help reduce its impact on the environment. The Environmental Protection Agency has recently released Energy Star standards for servers and is developing standards for enterprise storage as well. Such standards give hardware and software manufacturers targets to shoot for to keep systems running efficiently with less energy.

In light of environmental pressures and public sentiment, many companies are making pledges to reduce the energy requirements of information systems. Disney recently pledged to reduce its electricity consumption by 20 percent by 2013. By measuring Power Usage Effectiveness (PUE), companies can compare IS equipment power requirements to environmental power requirements. A PUE of 2—the industry average—indicates that processing and cooling are requiring equal amounts of energy. Disney and others hope to invest in technologies that have significantly lower energy requirements. Google discovered that adjusting thermostats in its data centers up from the frigid 60s to 80 degrees Fahrenheit helped to lower its PUE to 1.5.

Without a doubt, data centers will continue consuming increasing amounts of real estate. Through a combination of techniques and technologies that include consolidation, more efficient servers, more effective cooling techniques, and alternative energy sources, expanding data centers can reduce their impact on the environment.

Discussion Questions

1. Why is the increase in data center construction a concern for the environment?
2. What efforts can help to minimize the impact of data centers on the environment?

Critical Thinking Questions

1. Companies are finding it necessary to weigh the value of storing information against the value of affecting the environment. Write a few paragraphs outlining the importance of both and describing how companies might financially benefit from protecting both.
2. If you were a systems administrator for a data center, what steps would you take to create and manage a data center to store the maximum amount of valuable data with the minimum impact on the environment?

Sources: Niccolai, James, "750,000-sq.-ft. data center opens in Wales," *Computerworld*, March 15, 2010, *www.computerworld.com*; Lawson, Stephen, "EPA drafting Energy Star standards for enterprise storage," *Computerworld*, May 10, 2010, *www.computerworld.com*; Brodkin, Jon, "Disney, Verizon go green in the data center," *Computerworld*, October 6, 2009, *www.computerworld.com*; Niccolai, James, "Google: Crank up the heat in your data center," *Computerworld*, April 29, 2010, *www.computerworld.com*.

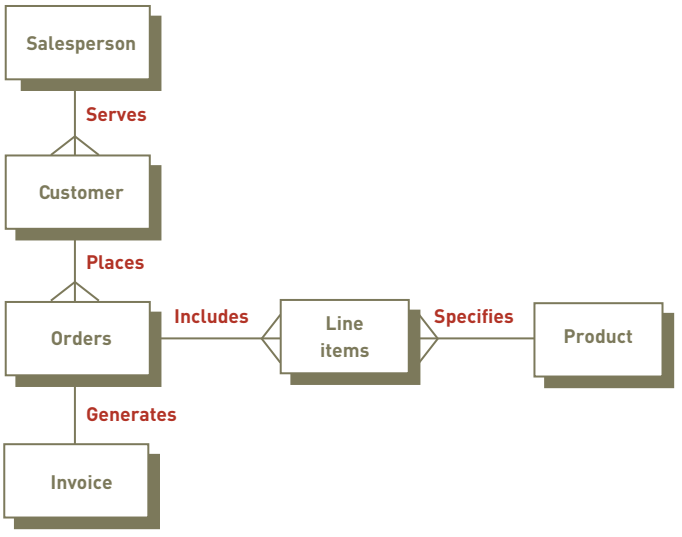


Figure 3.7

An Entity-Relationship (ER) Diagram for a Customer Order Database

Development of ER diagrams helps ensure that the logical structure of application programs is consistent with the data relationships in the database.

The Relational Database Model

Although there are a number of different database models, including flat files, hierarchical, and network models, the relational model has become the most popular, and use of this model will continue to increase. The **relational model** describes data using a standard tabular format; all data elements are placed in two-dimensional tables, called *relations*, which are the logical equivalent of files. The tables in relational databases organize data in rows and columns, simplifying data access and manipulation. It is normally easier for managers to understand the relational model than other database models. See Figure 3.8.

relational model
A database model that describes data in which all data elements are placed in two-dimensional tables, called *relations*, which are the logical equivalent of files.

Data Table 1: Project Table

Project	Description	Dept. number
155	Payroll	257
498	Widgets	632
226	Sales manual	598

Data Table 2: Department Table

Dept.	Dept. name	Manager SSN
257	Accounting	005-10-6321
632	Manufacturing	549-77-1001
598	Marketing	098-40-1370

Data Table 3: Manager Table

SSN	Last name	First name	Hire date	Dept. number
005-10-6321	Johns	Francine	10-07-1997	257
549-77-1001	Buckley	Bill	02-17-1979	632
098-40-1370	Fiske	Steven	01-05-1985	598

Figure 3.8

A Relational Database Model

In the relational model, all data elements are placed in two-dimensional tables, or relations. As long as they share at least one common element, these relations can be linked to output useful information.

Databases based on the relational model include IBM DB2, Oracle, Sybase, Microsoft SQL Server, Microsoft Access, and MySQL. Oracle is currently the market leader in general-purpose databases, with about half of the multibillion dollar database market. Oracle's most recent edition of its relational database, 11g, is highly sophisticated and uses database grids that allow a single database to run across a cluster of computers.[17]

In the relational model, each row of a table represents a data entity—a record—and each column of the table represents an attribute—a field. Each attribute can accept only certain values. The allowable values for these attributes are called the **domain**. The domain for a particular attribute indicates what values can be placed in each column of the relational table. For instance, the domain for an attribute such as gender would be limited to male or female. A domain for pay rate would not include negative numbers. In this way, defining a domain can increase data accuracy.

domain
The allowable values for data attributes.

Manipulating Data

After entering data into a relational database, users can make inquiries and analyze the data. Basic data manipulations include selecting, projecting, and joining. **Selecting** involves eliminating rows according to certain criteria. Suppose a project table contains the project number, description, and department number for all projects a company is performing. The president of the company might want to find the department number for Project 226, a sales manual project. Using selection, the president can eliminate all rows but the one for Project 226 and see that the department number for the department completing the sales manual project is 598.

selecting
Manipulating data to eliminate rows according to certain criteria.

Projecting involves eliminating columns in a table. For example, a department table might contain the department number, department name, and Social Security number (SSN) of the manager in charge of the project. A sales manager might want to create a new table with only the department number and the Social Security number of the manager in charge of the sales manual project. The sales manager can use projection to eliminate the department name column and create a new table containing only the department number and SSN.

projecting
Manipulating data to eliminate columns in a table.

Joining involves combining two or more tables. For example, you can combine the project table and the department table to create a new table with the project number, project description, department number, department name, and Social Security number for the manager in charge of the project.

joining
Manipulating data to combine two or more tables.

As long as the tables share at least one common data attribute, the tables in a relational database can be **linked** to provide useful information and reports. Being able to link tables to each other through common data attributes is one of the keys to the flexibility and power of relational databases. Suppose the president of a company wants to find out the name of the manager of the sales manual project and the length of time the manager has been with the company. Assume that the company has the manager, department, and project tables shown in Figure 3.8. A simplified ER diagram showing the relationship between these tables is shown in Figure 3.9. Note the crow's-foot by the project table. This indicates that a department can have many projects. The president would make the inquiry to the database, perhaps via a personal computer. The DBMS would start with the project description and search the project table to find out the project's department number. It would then use the department number to search the department table for the manager's Social Security number. The department number is also in the department table and is the common element that links the project table to the department table. The DBMS uses the manager's Social Security number to search the manager table for the manager's hire date. The manager's Social Security number is the common element between the department table and the manager table. The final result is that the manager's name and hire date are presented to the president as a response to the inquiry. See Figure 3.10.

linking
Data manipulation that combines two or more tables using common data attributes to form a new table with only the unique data attributes.

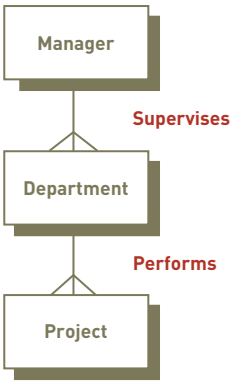
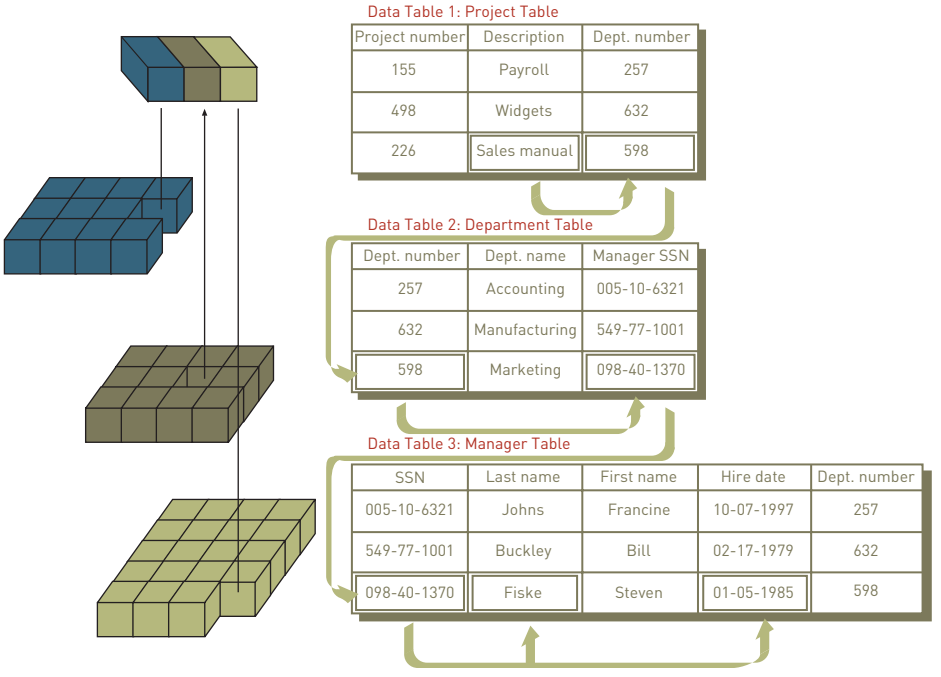


Figure 3.9

A Simplified ER Diagram Showing the Relationship Between the Manager, Department, and Project Tables



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549-77-1001	Buckley	Bill	02-17-1979	632
098-40-1370	Fiske	Steven	01-05-1985	598

Figure 3.10

Linking Data Tables to Answer an Inquiry

In finding the name and hire date of the manager working on the sales manual project, the president needs three tables: project, department, and manager. The project description (Sales manual) leads to the department number (598) in the project table, which leads to the manager's SSN (098-40-1370) in the department table, which leads to the manager's name (Fiske) and hire date (01-05-1985) in the manager table.

One of the primary advantages of a relational database is that it allows tables to be linked, as shown in Figure 3.10. This linkage reduces data redundancy and allows data to be organized more logically. The ability to link to the manager's SSN stored once in the manager table eliminates the need to store it multiple times in the project table.

The relational database model is by far the most widely used. It is easier to control, more flexible, and more intuitive than other approaches because it organizes data in tables. As shown in Figure 3.11, a relational database management system, such as Access, provides tips and tools for building and using database tables. In this figure, the database displays information about data types and indicates that additional help is available. The ability to link relational tables also allows users to relate data in new ways without having to redefine complex relationships. Because of the advantages of the relational model, many companies use it for large corporate databases, such as those for marketing and accounting. The relational model can also be used with personal computers and mainframe systems. A travel reservation company, for example, can develop a fare-pricing system by using relational database technology that can handle millions of daily queries from online travel companies such as Expedia, Travelocity, and Orbitz.

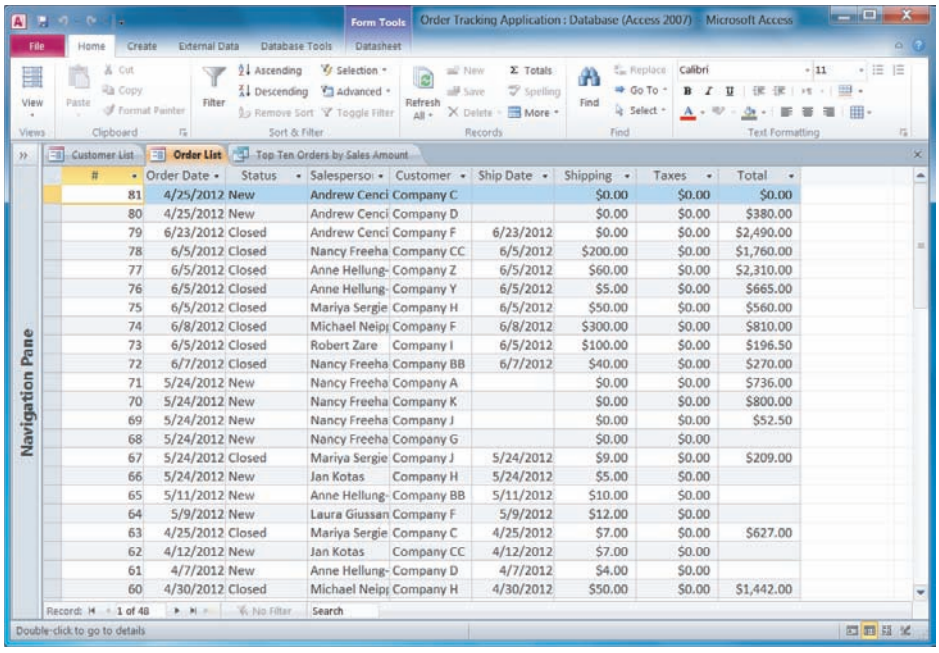


Figure 3.11

Building and Modifying a Relational Database

Relational databases provide many tools, tips, and shortcuts to simplify the process of creating and modifying a database.

(Source: Courtesy of Microsoft Corporation.)

DATABASE MANAGEMENT SYSTEMS

Creating and implementing the right database system ensures that the database will support both business activities and goals. But how do we actually create, implement, use, and update a database? The answer is found in the database management system. As discussed earlier, a DBMS is a group of programs used as an interface between a database and application programs or a database and the user. The capabilities and types of database systems, however, vary considerably. For example, Twitter, Google, Brightkite, and other Internet companies that provide GPS location applications are discussing the creation of a "Unified Database of Places." Rather than each company building proprietary databases of business and attraction locations, they would like to pool resources to build one huge database of places that includes details on every location on earth; such data would fuel applications like Google Street View.[18] Indeed, DBMSs are used to manage all kinds of data for all kinds of purposes.

Overview of Database Types

Database management systems can range from small, inexpensive software packages to sophisticated systems costing hundreds of thousands of dollars. The following sections discuss a few popular alternatives. See Figure 3.12 for one example.

Flat File

A flat file is a simple database program whose records have no relationship to one another. Flat file databases are often used to store and manipulate a single table or file; they do not use any of the database models discussed previously, such as the relational model. Many spreadsheet and word-processing programs have flat file capabilities. These software packages can sort tables and make simple calculations and comparisons. Microsoft OneNote is designed to let people put ideas, thoughts, and notes into a flat file. In OneNote, each note can be placed anywhere on a page or in a box on a page, called a *container*. Pages are organized into sections and subsections that appear as colored tabs. After you enter a note, you can retrieve, copy, and paste it into other applications, such as word-processing and spreadsheet programs. ResMed, a medical firm that manufactures products to assist people with respiratory conditions, uses OneNote to collect new ideas for product improvements and track the status of those ideas through evaluation and implementation.[19] OneNote assists the company in its efforts to increase participation in reducing costs and becoming more efficient.

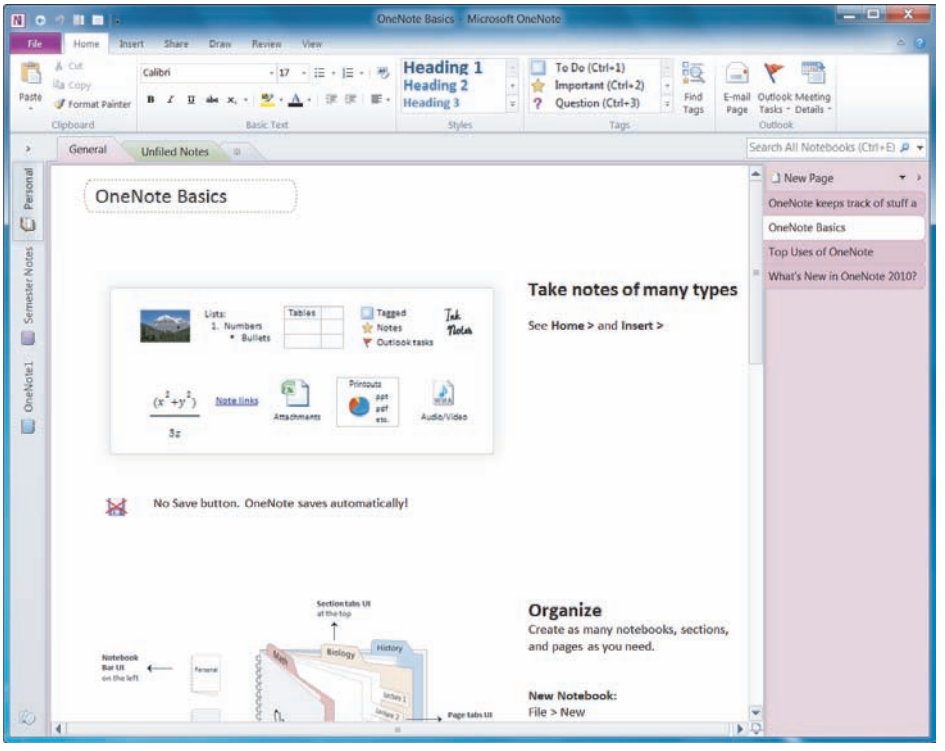


Figure 3.12

Microsoft OneNote

Microsoft OneNote lets you gather any type of information and then retrieve, copy, and paste the information into other applications, such as word-processing and spreadsheet programs.

(Source: Courtesy of Microsoft Corporation.)

Similar to OneNote, EverNote is a free online database service that can store notes and other pieces of information. Considering the amount of information today's high-capacity hard disks can store, the popularity of databases that can handle unstructured data will continue to grow.

Single User

A database installed on a personal computer is typically meant for a single user. Microsoft Office Access and FileMaker Pro are designed to support single-user implementations. Microsoft InfoPath is another example of a database program that supports a single user. This software is part of the Microsoft Office suite, and it helps people collect and organize information from a variety of sources. InfoPath has built-in forms that can be used to enter expense information, timesheet data, and a variety of other information.

Multiple Users

Small, midsize, and large businesses need multiuser DBMSs to share information throughout the organization over a network. These more powerful, expensive systems allow dozens or hundreds of people to access the same database system at the same time. Popular vendors for multiuser database systems include Oracle, Microsoft, Sybase, and IBM. Many single-user databases, such as Microsoft Access, can be implemented for multiuser support over a network, though they often are limited in the number of users they can support.

All DBMSs share some common functions, such as providing a user view, physically storing and retrieving data in a database, allowing for database modification, manipulating data, and generating reports. These DBMSs can handle the most complex data-processing tasks, and because they are accessed over a network, one database can serve many locations around the world. For example, the Linde Group is a global leader in industrial gases and hydrogen production. Its 50,000 employees, spread across 100 countries, all access a central database stored in a data center in Munich, Germany.[20]

Providing a User View

Because the DBMS is responsible for access to a database, one of the first steps in installing and using a large database involves "telling" the DBMS the logical and physical structure of

schema
A description of the entire database.

the data and the relationships among the data for each user. This description is called a **schema** (as in schematic diagram). Large database systems, such as Oracle, typically use schemas to define the tables and other database features associated with a person or user. A schema can be part of the database or a separate schema file. The DBMS can reference a schema to find where to access the requested data in relation to another piece of data.

Creating and Modifying the Database

data definition language (DDL)
A collection of instructions and commands used to define and describe data and relationships in a specific database.

Schemas are entered into the DBMS (usually by database personnel) via a data definition language. A **data definition language** (**DDL**) is a collection of instructions and commands used to define and describe data and relationships in a specific database. A DDL allows the database's creator to describe the data and relationships that are to be contained in the schema. In general, a DDL describes logical access paths and logical records in the database. Figure 3.13 shows a simplified example of a DDL used to develop a general schema. The use of the letter *X* in Figure 3.13 reveals where specific information concerning the database should be entered. File description, area description, record description, and set description are terms the DDL defines and uses in this example. Other terms and commands can be used, depending on the DBMS employed.

Figure 3.13
Using a Data Definition Language to Define a Schema

```
SCHEMA DESCRIPTION
SCHEMA NAME IS XXXX
AUTHOR        XXXX
DATE          XXXX
FILE DESCRIPTION
      FILE NAME IS XXXX
        ASSIGN XXXX
      FILE NAME IS XXXX
        ASSIGN XXXX
AREA DESCRIPTION
      AREA NAME IS XXXX
RECORD DESCRIPTION
      RECORD NAME IS XXXX
      RECORD ID IS XXXX
      LOCATION MODE IS XXXX
      WITHIN XXXX AREA FROM XXXX THRU XXXX
SET DESCRIPTION
      SET NAME IS XXXX
      ORDER IS XXXX
      MODE IS XXXX
      MEMBER IS XXXX
      .
      .
      .
```

data dictionary
A detailed description of all the data used in the database.

Another important step in creating a database is to establish a **data dictionary**, a detailed description of all data used in the database. The data dictionary contains the following information:

- Name of the data item
- Aliases or other names that may be used to describe the item
- Range of values that can be used
- Type of data (such as alphanumeric or numeric)
- Amount of storage needed for the item
- Notation of the person responsible for updating it and the various users who can access it
- List of reports that use the data item

A data dictionary can also include a description of data flows, the way records are organized, and the data-processing requirements. Figure 3.14 shows a typical data dictionary entry.

Figure 3.14
A Typical Data Dictionary Entry

NORTHWESTERN MANUFACTURING

PREPARED BY:	D. BORDWELL
DATE:	04 AUGUST 2010
APPROVED BY:	J. EDWARDS
DATE:	13 OCTOBER 2010
VERSION:	3.1
PAGE:	1 OF 1
DATA ELEMENT NAME:	PARTNO
DESCRIPTION:	INVENTORY PART NUMBER
OTHER NAMES:	PTNO
VALUE RANGE:	100 TO 5000
DATA TYPE:	NUMERIC
POSITIONS:	4 POSITIONS OR COLUMNS

For example, the information in a data dictionary for the part number of an inventory item can include the following information:

- Name of the person who made the data dictionary entry (D. Bordwell)
- Date the entry was made (August 4, 2010)
- Name of the person who approved the entry (J. Edwards)
- Approval date (October 13, 2010)
- Version number (3.1)
- Number of pages used for the entry (1)
- Part name (PARTNO)
- Other part names that might be used (PTNO)
- Range of values (part numbers can range from 100 to 5,000)
- Type of data (numeric)
- Storage required (four positions are required for the part number)

A data dictionary is valuable in maintaining an efficient database that stores reliable information with no redundancy, and it makes it easy to modify the database when necessary. Data dictionaries also help computer and system programmers who require a detailed description of data elements stored in a database to create the code to access the data.

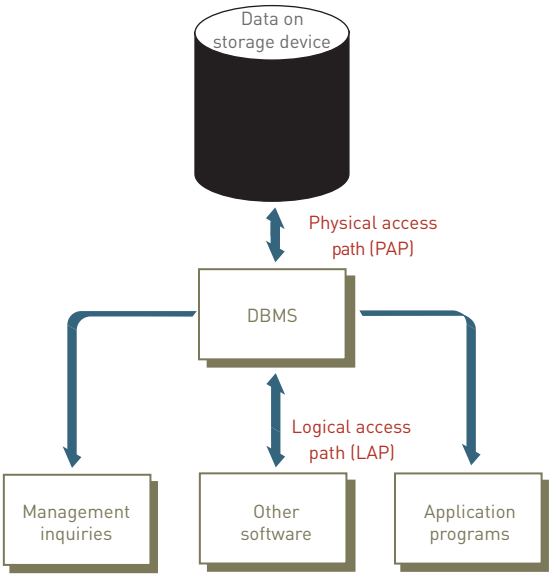
Storing and Retrieving Data

One function of a DBMS is to be an interface between an application program and the database. When an application program needs data, it requests the data through the DBMS. Suppose that to calculate the total price of a new car, a pricing program needs price data on the engine option—six cylinders instead of the standard four cylinders. The application program requests this data from the DBMS. In doing so, the application program follows a logical access path. Next, the DBMS, working with various system programs, accesses a storage device, such as disk drives, where the data is stored. When the DBMS goes to this storage device to retrieve the data, it follows a path to the physical location (physical access path) where the price of this option is stored. In the pricing example, the DBMS might go to a disk drive to retrieve the price data for six-cylinder engines. This relationship is shown in Figure 3.15.

This same process is used if a user wants to get information from the database. First, the user requests the data from the DBMS. For example, a user might give a command, such as LIST ALL OPTIONS FOR WHICH PRICE IS GREATER THAN 200 DOLLARS. This is the logical access path (LAP). Then, the DBMS might go to the options price section of a disk to get the information for the user. This is the physical access path (PAP).

Figure 3.15

Logical and Physical Access Paths



concurrency control
A method of dealing with a situation in which two or more users or applications need to access the same record at the same time.

Two or more people or programs attempting to access the same record at the same time can cause a problem. For example, an inventory control program might attempt to reduce the inventory level for a product by ten units because ten units were just shipped to a customer. At the same time, a purchasing program might attempt to increase the inventory level for the same product by 200 units because inventory was just received. Without proper database control, one of the inventory updates might be incorrect, resulting in an inaccurate inventory level for the product. **Concurrency control** can be used to avoid this potential problem. One approach is to lock out all other application programs from access to a record if the record is being updated or used by another program.

Manipulating Data and Generating Reports

After a DBMS has been installed, employees, managers, and consumers can use it to review reports and obtain important information. For example, the Food Allergen and Consumer Protection Act, effective in 2006, requires that food manufacturing companies generate reports on the ingredients, formulas, and food preparation techniques for the public. Using a DBMS, a company can manage this requirement.

Some databases use *Query by Example (QBE)*, which is a visual approach to developing database queries or requests. Like Windows and other GUI operating systems, you can perform queries and other database tasks by opening windows and clicking the data or features you want. See Figure 3.16.

data manipulation language (DML)
A specific language, provided with a DBMS, which allows users to access and modify the data, to make queries, and to generate reports.

In other cases, database commands can be used in a programming language. For example, C++ commands can be used in simple programs that will access or manipulate certain pieces of data in the database. Here's another example of a DBMS query: SELECT * FROM EMPLOYEE WHERE JOB_CLASSIFICATION = "C2". The asterisk (*) tells the program to include all columns from the EMPLOYEE table. In general, the commands that are used to manipulate the database are part of the **data manipulation language** (**DML**). This specific language, provided with the DBMS, allows managers and other database users to access and modify the data, make queries, and generate reports. Again, the application programs go through schemas and the DBMS before getting to the data stored on a device such as a disk.

In the 1970s, D. D. Chamberlain and others at the IBM Research Laboratory in San Jose, California, developed a standardized data manipulation language called *Structured Query Language (SQL)*, pronounced like the word *sequel* or spelled out as *SQL*. The EMPLOYEE query shown earlier is written in SQL. In 1986, the American National Standards Institute (ANSI) adopted SQL as the standard query language for relational databases. Since ANSI's acceptance of SQL, interest in making SQL an integral part of

relational databases on both mainframe and personal computers has increased. SQL has many built-in functions, such as average (AVG), the largest value (MAX), the smallest value (MIN), and others. Table 3.3 contains examples of SQL commands.

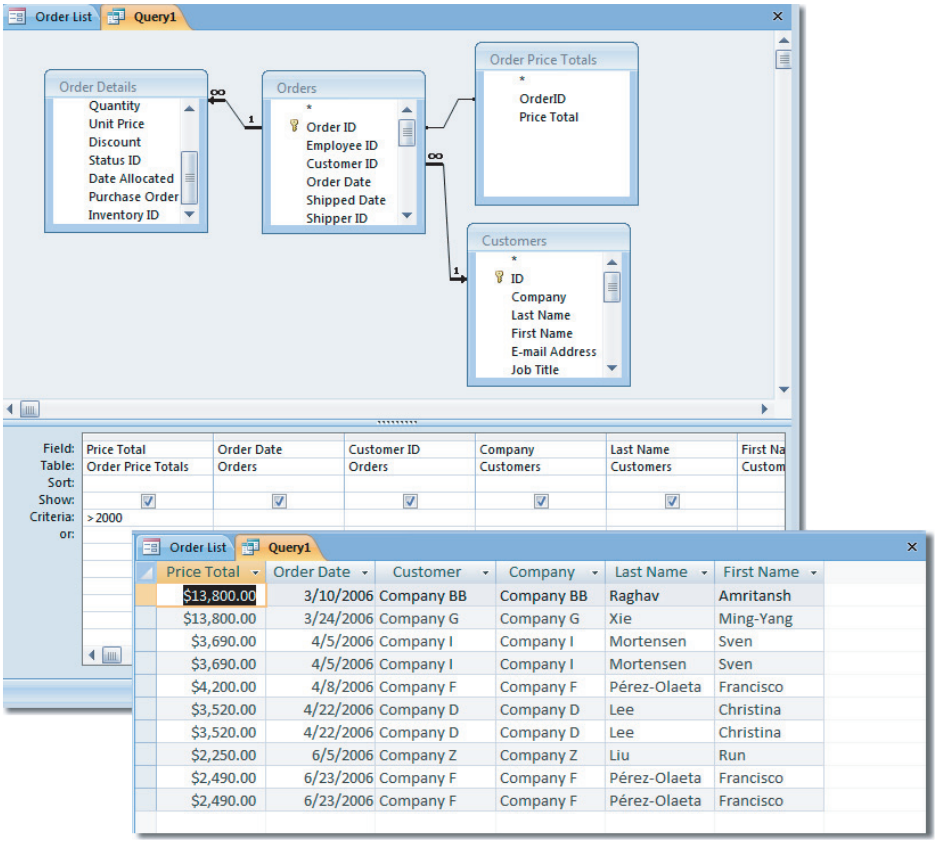


Figure 3.16

Query by Example

Some databases use Query by Example (QBE) to generate reports and information.

Table 3.3

Examples of SQL Commands

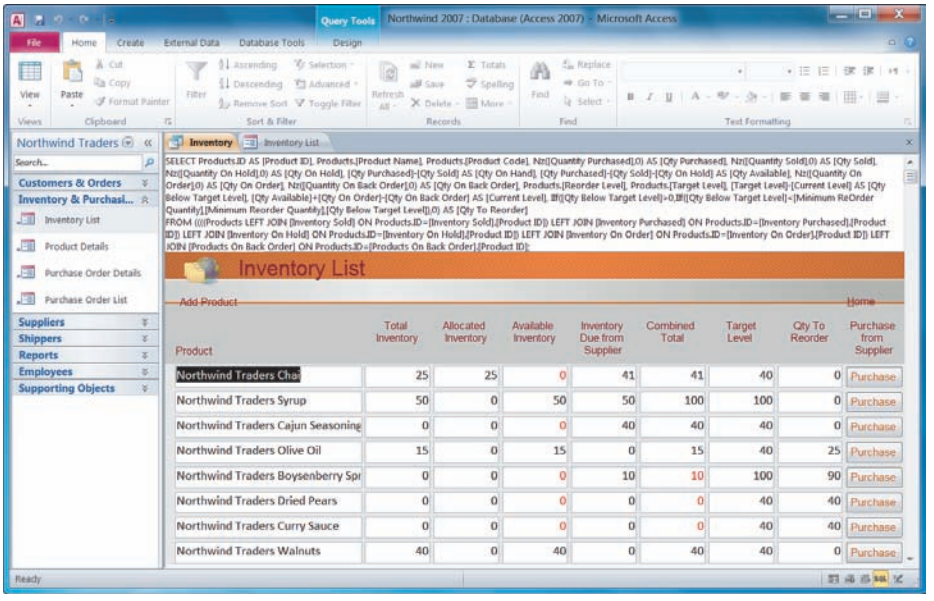
SQL Command	Description
SELECT ClientName, Debt FROM Client WHERE Debt > 1000	This query displays all clients (ClientName) and the amount they owe the company (Debt) from a database table called Client for clients who owe the company more than $1,000 (WHERE Debt > 1000).
SELECT ClientName, ClientNum, OrderNum FROM Client, Order WHERE Client.ClientNum=Order.ClientNum	This command is an example of a join command that combines data from two tables: the client table and the order table (FROM Client, Order). The command creates a new table with the client name, client number, and order number (SELECT ClientName, ClientNum, OrderNum). Both tables include the client number, which allows them to be joined. This is indicated in the WHERE clause, which states that the client number in the client table is the same as (equal to) the client number in the order table (WHERE Client.Client Num= Order.ClientNum).
GRANT INSERT ON Client to Guthrie	This command is an example of a security command. It allows Bob Guthrie to insert new values or rows into the Client table.

SQL lets programmers learn one powerful query language and use it on systems ranging from PCs to the largest mainframe computers. See Figure 3.17. Programmers and database users also find SQL valuable because SQL statements can be embedded into many programming languages, such as the widely used C++, Java, and COBOL languages. Because SQL uses standardized and simplified procedures for retrieving, storing, and manipulating data, the popular database query language can be easy to understand and use.

Figure 3.17

Structured Query Language

Structured Query Language (SQL) has become an integral part of most relational databases, as shown by this screen from Microsoft Access 2010.



After a database has been set up and loaded with data, it can produce desired reports, documents, and other outputs. See Figure 3.18. These outputs usually appear in screen displays or hard-copy printouts. The output-control features of a database program allow you to select the records and fields you want to appear in reports. You can also make calculations specifically for the report by manipulating database fields. Formatting controls and organization options (such as report headings) help you to customize reports and create flexible, convenient, and powerful information-handling tools.

Figure 3.18

Database Output

A database application offers sophisticated formatting and organization options to produce the right information in the right format.

A DBMS can produce a wide variety of documents, reports, and other output that can help organizations achieve their goals. The most common reports select and organize data to present summary information about some aspect of company operations. For example, ac-

counting reports often summarize financial data such as current and past-due accounts. Many companies base their routine operating decisions on regular status reports that show the progress of specific orders toward completion and delivery.

Database Administration

Database systems require a skilled database administrator (DBA), who is expected to have a clear understanding of the fundamental business of the organization, be proficient in the use of selected database management systems, and stay abreast of emerging technologies and new design approaches. The role of the DBA is to plan, design, create, operate, secure, monitor, and maintain databases. Typically, a DBA has a degree in computer science or management information systems and some on-the-job training with a particular database product or more extensive experience with a range of database products. See Figure 3.19.

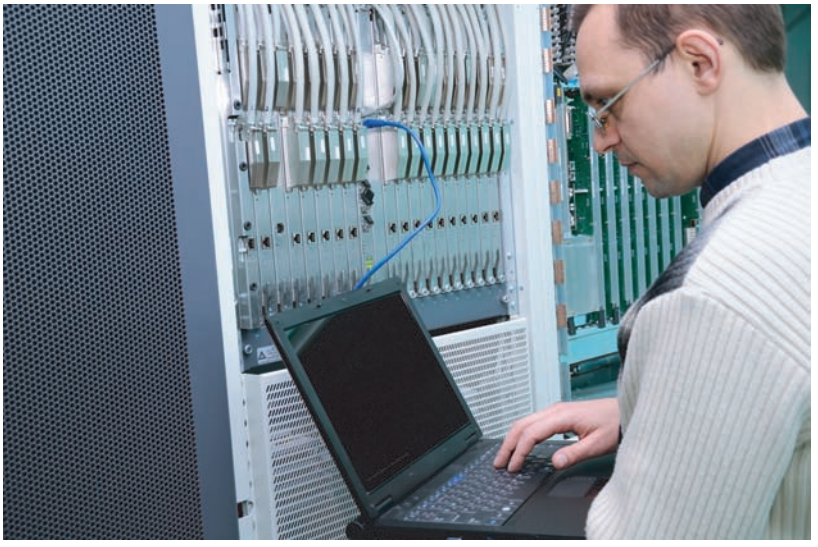


Figure 3.19

Database Administrator

The role of the database administrator (DBA) is to plan, design, create, operate, secure, monitor, and maintain databases.

(Source: Image copyright 2010, Pinchuk Alexey. Used under license from Shutterstock.com.)

The DBA works with users to decide the content of the database—to determine exactly what entities are of interest and what attributes are to be recorded about those entities. Thus, personnel outside of IS must have some idea of what the DBA does and why this function is important. The DBA can play a crucial role in the development of effective information systems to benefit the organization, employees, and managers.

The DBA also works with programmers as they build applications to ensure that their programs comply with database management system standards and conventions. After the database is built and operating, the DBA monitors operations logs for security violations. Database performance is also monitored to ensure that the system's response time meets users' needs and that it operates efficiently. If there is a problem, the DBA attempts to correct it before it becomes serious.

A database failure can cause huge financial losses for a business. A failure due to mechanical problems, controller failures, viruses or attacks, or human failure can cause productivity in an organization to grind to a halt. Databases accessible from the Internet are at a higher level of risk from hackers and viruses than databases stored on private servers. For example, an SQL injection attack uses a Web form to issue SQL commands to a database over the Internet. The SQL command might prompt the database to reveal private data, or it might corrupt the data in the database. SQL injection attacks were used to steal 130 million credit and debit card numbers from databases owned by Heartland Payment Systems, TJX Companies, and other businesses in 2009.[21] In 2010, the Open Web Application Security Project (OWASP) listed injection attacks as the top security threat for Web applications. A large responsibility of a DBA is to protect the database from attack or other forms of failure. DBAs use security software, preventive measures, and redundant systems to keep data safe and accessible.

data administrator
A nontechnical position responsible for defining and implementing consistent principles for a variety of data issues.

Some organizations have also created a position called the **data administrator**, a nontechnical but important position responsible for defining and implementing consistent principles for a variety of data issues, including setting data standards and data definitions that apply across all the databases in an organization. For example, the data administrator would ensure that a term such as "customer" is defined and treated consistently in all corporate databases. This person also works with business managers to identify who should have read or update access to certain databases and to selected attributes within those databases. This information is then communicated to the database administrator for implementation. The data administrator can be a high-level position reporting to top-level managers.

Popular Database Management Systems

Some popular DBMSs for single users include Microsoft Access and FileMaker Pro. The complete DBMS market encompasses software used by professional programmers and that runs on midrange servers, mainframes, and supercomputers. The entire market generates billions of dollars per year in revenue by companies including IBM, Oracle, and Microsoft.

Like other software products, a number of open-source database systems are available, including PostgreSQL and MySQL. Open-source software was described in Chapter 2. In addition, many traditional database programs are now available on open-source operating systems. The popular DB2 relational database from IBM, for example, is available on the Linux operating system. The Sybase IQ database and other databases are also available on the Linux operating system.

A new form of database system is emerging that some refer to as *Database as a Service* (*DaaS*); others call it Database 2.0. DaaS is similar to Software as a Service (SaaS). Recall that a SaaS system is one in which the software is stored on a service provider's servers and is accessed by the client company over a network. In DaaS, the database is stored on a service provider's servers and accessed by the client over a network, typically the Internet. In DaaS, database administration is provided by the service provider. SaaS and DaaS are both part of the larger cloud computing trend. Cloud computing uses a giant cluster of computers that run high-performance applications. In cloud computing, all information systems and data are maintained and managed by service providers and delivered over the Internet. Businesses and individuals are freed from having to install, service, maintain, upgrade, and safeguard their systems.

More than a dozen companies are moving in the DaaS direction. They include Google, Microsoft, Oracle, Amazon, Intuit, MyOwnDB, and Trackvia. Oracle's DaaS combines cloud computing with grid computing and virtualization to provide cost-effective, reliable, and scalable database solutions.[22] Oracle provides both private clouds—accessible only to users on a private network—and public clouds—accessible to the public over the Internet. Razorfish, a digital advertising and marketing firm, uses Amazon's Elastic Cloud service to collect and analyze data (not personally identifiable) from browsing sessions using data mining techniques to develop effective marketing campaigns.[23] Procter and Gamble consolidated hundreds of projects into a single cloud database, which saved operational costs and reduced meeting time and data entry time for employees.[24]

Special-Purpose Database Systems

In addition to the popular database management systems just discussed, some specialized database packages are used for specific purposes or in specific industries. For example, RexBook from Urbanspoon is an iPad App designed for restaurants that utilizes a special-purpose online database to store and manage dining reservations.[25] Another unique special-purpose DBMS for biologists called Morphbank (*www.morphbank.net*) allows researchers from around the world to continually update and expand a library of more than 96,000 biological images to share with the scientific community and the public. Apple's iTunes software uses a special-purpose database system that includes fields for song name, rating, file size, time, artist, album, and genre. When iTunes users go to the iTunes store and search for an artist, they are actually querying the central iTunes database. See Figure 3.20.

Name	Rating	Size	Time	Artist	Album	Genre
Digital Booklet - The ...	★★★★	2.7 MB		Lady GaGa	The Fame Monster (Deluxe V...	Pop
Bad Romance	★★★★★	9.8 MB	4:54	Lady GaGa	The Fame Monster (Deluxe Vers...	Pop
Alejandro	★★★★	9.4 MB	4:34	Lady GaGa	The Fame Monster (Deluxe Vers...	Pop
Monster	★★★★★	8.7 MB	4:09	Lady GaGa	The Fame Monster (Deluxe Vers...	Pop
Speechless	★★	9.1 MB	4:31	Lady GaGa	The Fame Monster (Deluxe Vers...	Pop
Dance In the Dark	★★★	9.6 MB	4:49	Lady GaGa	The Fame Monster (Deluxe Vers...	Pop
Telephone (feat. Beyoncé)	★★★★	7.7 MB	3:41	Lady GaGa	The Fame Monster (Deluxe Vers...	Pop
So Happy I Could Die	★★★★★	7.9 MB	3:55	Lady GaGa	The Fame Monster (Deluxe Vers...	Pop
Teeth	★★★★	7.8 MB	3:41	Lady GaGa	The Fame Monster (Deluxe Vers...	Pop
Just Dance (feat. Colby O'D...	★★★★	8.3 MB	4:02	Lady GaGa	The Fame Monster (Deluxe Vers...	Pop
LoveGame	★★★★★	7.6 MB	3:36	Lady GaGa	The Fame Monster (Deluxe Vers...	Pop
Paparazzi	★★★★	7.1 MB	3:28	Lady GaGa	The Fame Monster (Deluxe Vers...	Pop
Poker Face	★★★★★	8.5 MB	3:57	Lady GaGa	The Fame Monster (Deluxe Vers...	Pop

Figure 3.20

iTunes Database

Apple's iTunes software uses a database to catalog and access music.

(Source: Courtesy of Apple.)

Selecting a Database Management System

The database administrator often selects the best database management system for an organization. The process begins by analyzing database needs and characteristics. The information needs of the organization affect the type of data that is collected and the type of database management system that is used. Important characteristics of databases include the following:

- *Database size*: The number of records or files in the database
- *Database cost*: The purchase or lease costs of the database
- *Concurrent users*: The number of people who need to use the database at the same time
- *Performance*: How fast the database can update records
- *Integration*: The ability to work seamlessly with other applications and databases
- *Vendor*: The reputation and financial stability of the database vendor

Using Databases with Other Software

Database management systems are often used with other software and with the Internet. A DBMS can act as a front-end application or a back-end application. A *front-end application* is one that people interact with directly. Marketing researchers often use a database as a front end to a statistical analysis program. The researchers enter the results of market questionnaires or surveys into a database. The data is then transferred to a statistical analysis program to determine the potential for a new product or the effectiveness of an advertising campaign. A *back-end application* interacts with other programs or applications; it only indirectly interacts with people or users. When people request information from a Web site, the Web site can interact with a database (the back end) that supplies the desired information. For example, you can connect to a university Web site to find out whether the university's library has a book you want to read. The Web site then interacts with a database that contains a catalog of library books and articles to determine whether the book you want is available. See Figure 3.21.

In some situations, front-end systems cannot connect directly to a back-end database due to compatibility issues. Middleware solutions, such as Oracle's Fusion software, are available to connect systems seamlessly, interpreting data from a variety of sources and translating it to a format compatible with the database.

Figure 3.21

Library Web Site

Many university libraries provide Web access to their databases.

(Source: FSU Library Web site, *www.lib.fsu.edu*.)

DATABASE APPLICATIONS

Today's database applications manipulate the content of a database to produce useful information. Common manipulations are searching, filtering, synthesizing, and assimilating the data, using a number of database applications. These applications allow users to link the company databases to the Internet, set up data warehouses and marts, use databases for strategic business intelligence, place data at different locations, use online processing and open connectivity standards for increased productivity, develop databases with the object-oriented approach, and search for and use unstructured data, such as graphics, audio, and video.

Linking the Company Database to the Internet

The ability to link databases to the Internet is one reason the Internet is so popular. A large percentage of corporate databases are accessed over the Internet through a standard Web browser. Being able to access bank account data, student transcripts, credit card bills, product catalogs, and a host of other data online is convenient for individual users and increases effectiveness and efficiency for businesses and organizations. Amazon.com, eHarmony.com, eBay, and many others have made billions of dollars by combining databases, the Internet, and smart business models.

Google, Microsoft, and others have developed Personal Health Record (PHR) systems designed to provide physicians and patients a single storage location for all medical records, accessed through a Web browser.[26] Google Health and Microsoft HealthVault provide "patient-centered" health records that empower patients to more easily participate in their own health care. President Obama is pushing to establish electronic health (e-health) records for all Americans prior to 2015 by making $17 billion available to e-health projects and programs. Database companies will be investing significant effort in developing health and medical databases systems that are accessible on the Internet.

Access to private medical information over the public Web has some privacy advocates concerned. However, the convenience that the system offers by dramatically reducing the number of paper forms to fill out and store, along with the reduction of clerical errors through streamlined data management procedures, has most in the field supporting the move to a centralized system. Encryption and authentication technologies will be used to make the systems as secure as possible.

Developing a seamless integration of databases with the Internet is sometimes called a *semantic Web*. A semantic Web provides metadata with all Web content using technology called the Resource Description Framework (RDF).[27] The result is a more organized Web that acts like one large database system. The World Wide Web Consortium (W3C) has established standards, including an RDF, for a semantic Web in hopes of bringing content providers onboard.

Data Warehouses, Data Marts, and Data Mining

The raw data necessary to make sound business decisions is stored in a variety of locations and formats. This data is initially captured, stored, and managed by transaction processing systems that are designed to support the day-to-day operations of the organization. For decades, organizations have collected operational, sales, and financial data with their online transaction processing (OLTP) systems. The data can be used to support decision making through data warehouses, data marts, and data mining.

Data Warehouses

A **data warehouse** is a database that holds business information from many sources in the enterprise, covering all aspects of the company's processes, products, and customers. The data warehouse provides business users with a multidimensional view of the data they need to analyze business conditions. Data warehouses allow managers to *drill down* to get more detail or *roll up* to take detailed data and generate aggregate or summary reports. A data warehouse is designed specifically to support management decision making, not to meet the needs of transaction processing systems. A data warehouse stores historical data that has been extracted from operational systems and external data sources. See Figure 3.22. This operational and external data is "cleaned up" to remove inconsistencies and integrated to create a new information database that is more suitable for business analysis.

data warehouse
A large database that collects business information from many sources in the enterprise, covering all aspects of the company's processes, products, and customers, in support of management decision making.

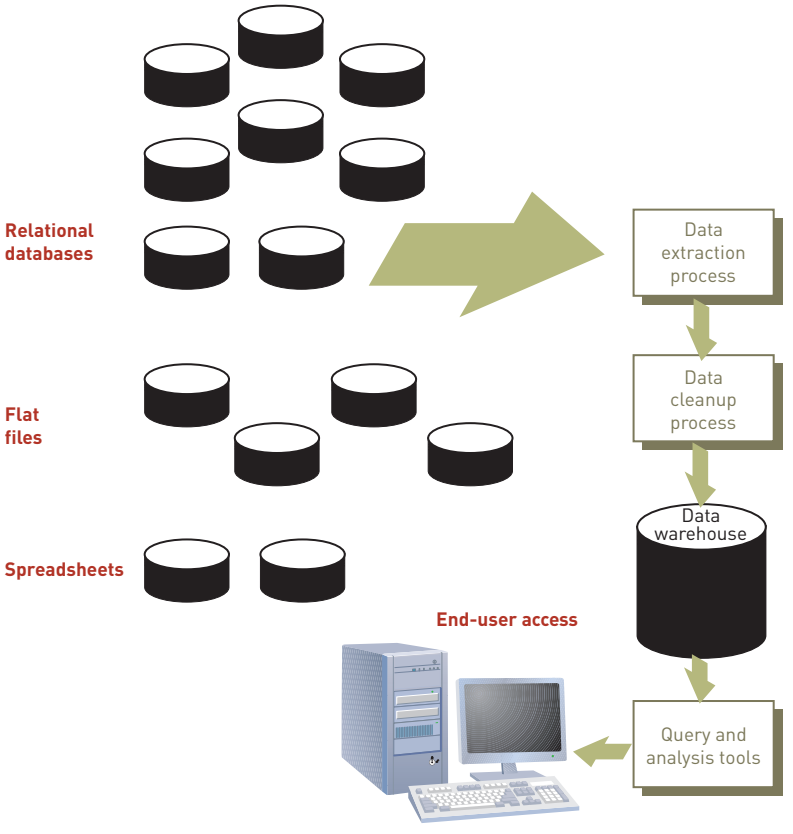


Figure 3.22
Elements of a Data Warehouse

Data warehouses typically start out as very large databases, containing millions and even hundreds of millions of data records. As this data is collected from the various production systems, a historical database is built that business analysts can use to track changes in an organization over time and analyze current conditions. To keep it fresh and accurate, the data warehouse receives regular updates. Old data that is no longer needed is purged from the data warehouse. Updating the data warehouse must be fast, efficient, and automated, or the ultimate value of the data warehouse is sacrificed. It is common for a data warehouse to contain from three to ten years of current and historical data. Data-cleaning tools can merge data from many sources into one database, automate data collection and verification, delete unwanted data, and maintain data in a database management system.

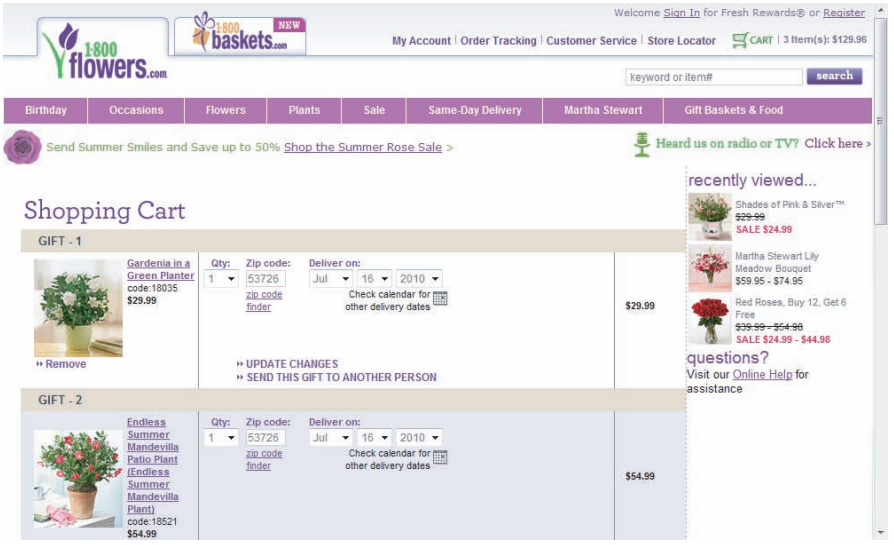
Data warehouses can also acquire data from unique sources. Oracle's Warehouse Management software, for example, can accept information from Radio Frequency Identification (RFID) technology, which is being used to tag products as they are shipped or moved from one location to another. Honda Italia, the world leader in powered two-wheel vehicle manufacturing, uses RFID to feed its data warehouse with information about production. Each vehicle component is tagged with an RFID chip so it can be tracked through the entire production process. The RFID-based system provides highly detailed information to production managers who can tweak production to quickly identify problems and improve supply with little or no wasted effort or resources.[28]

The primary advantage of data warehousing is the ability to relate data in innovative ways. However, a data warehouse for a large organization can be extremely difficult to establish, with the typical cost exceeding $2 million. Table 3.4 compares online transaction processing (OLTP) and data warehousing.

Table 3.4

Comparison of OLTP and Data Warehousing

Characteristic	OLTP Database	Data Warehousing
Purpose	Support transaction processing	Support decision making
Source of data	Business transactions	Multiple files, databases—data internal and external to the firm
Data access allowed users	Read and write	Read only
Primary data access mode	Simple database update and query	Simple and complex database queries with increasing use of data mining to recognize patterns in the data
Primary database model employed	Relational	Relational
Level of detail	Detailed transactions	Often summarized data
Availability of historical data	Very limited—typically a few weeks or months	Multiple years
Update process	Online, ongoing process as transactions are captured	Periodic process, once per week or once per month
Ease of process	Routine and easy	Complex, must combine data from many sources; data must go through a data cleanup process
Data integrity issues	Each transaction must be closely edited	Major effort to "clean" and integrate data from multiple sources



1-800-flowers.com uses a data warehouse to reference customer historical data to determine customer interests based on past interactions.[29]

(Source: 1800flowers.com.)

Data Marts

A **data mart** is a subset of a data warehouse. Data marts bring the data warehouse concept—online analysis of sales, inventory, and other vital business data that has been gathered from transaction processing systems—to small and medium-sized businesses and to departments within larger companies. Rather than store all enterprise data in one monolithic database, data marts contain a subset of the data for a single aspect of a company's business—for example, finance, inventory, or personnel. In fact, a specific area in the data mart might contain more detailed data than the data warehouse.

data mart
A subset of a data warehouse, used by small and medium-sized businesses and departments within large companies to support decision making.

Data marts are most useful for smaller groups who want to access detailed data. A warehouse contains summary data that can be used by an entire company. Because data marts typically contain tens of gigabytes of data, as opposed to the hundreds of gigabytes in data warehouses, they can be deployed on less powerful hardware with smaller secondary storage devices, delivering significant savings to an organization. Although any database software can be used to set up a data mart, some vendors deliver specialized software designed and priced specifically for data marts. Companies such as Sybase, Software AG, Microsoft, and others have products and services that make it easier and cheaper to deploy these scaled-down data warehouses. The selling point: data marts put targeted business information into the hands of more decision makers. For example, the U.S. Department of Defense has created the Defense Health Services Systems' Clinical Data Mart (CDM) to deliver medical information to the more than 9 million military personnel worldwide. The system was developed in response to President Obama's call to "raise health care quality at lower costs."[30]

Data Mining

Data mining is an information-analysis tool that involves the automated discovery of patterns and relationships in a data warehouse. Like gold mining, data mining sifts through mountains of data to find a few nuggets of valuable information. For example, Brooks Brothers, the oldest clothing retailer in the U.S., uses data mining to provide store managers with reports that help improve store performance and customer satisfaction.[31]

data mining
An information-analysis tool that involves the automated discovery of patterns and relationships in a data warehouse.

Data mining's objective is to extract patterns, trends, and rules from data warehouses to evaluate (i.e., predict or score) proposed business strategies, which will improve competitiveness, increase profits, and transform business processes. It is used extensively in marketing to improve customer retention; cross-selling opportunities; campaign management; market, channel, and pricing analysis; and customer segmentation analysis (especially one-to-one marketing). In short, data-mining tools help users find answers to questions they haven't thought to ask.

Amazon uses data mining to recommend products that will entice visitors.

(Source: *www.amazon.com*)

E-commerce presents another major opportunity for effective use of data mining. Attracting customers to Web sites is tough; keeping them there and ensuring they return is even tougher. For example, when retail Web sites launch deep-discount sales, they cannot easily determine how many first-time customers are likely to come back and buy again. Nor do they have a way of understanding which customers acquired during the sale are more likely to jump on future sales. As a result, companies are gathering data on user traffic through their Web sites and storing the data in databases. This data is then analyzed using data-mining techniques to personalize the Web site and develop sales promotions targeted at specific customers. Facebook has angered users on several occasions for sharing member data with commercial partners who then use the information in data mining to fuel targeted marketing campaigns. Some members feel that the practice is a violation of their privacy.[32]

predictive analysis
A form of data mining that combines historical data with assumptions about future conditions to predict outcomes of events, such as future product sales or the probability that a customer will default on a loan.

Predictive analysis is a form of data mining that combines historical data with assumptions about future conditions to predict outcomes of events, such as future product sales or the probability that a customer will default on a loan. Retailers use predictive analysis to upgrade occasional customers into frequent purchasers by predicting what products they will buy if offered an appropriate incentive. Genalytics, Magnify, NCR Teradata, SAS Institute, Sightward, SPSS, and Quadstone have developed predictive analysis tools. Predictive analysis software can be used to analyze a company's customer list and a year's worth of sales data to find new market segments that could be profitable.

American Airlines Consumer Research Department uses predictive analysis to guide its corporate decisions. Passengers on about 100 of the 3,300 flights that American flies each day are asked to fill out a brief survey. The data is loaded into a data warehouse where predictive analytics software processes the information to provide useful statistics. The statistics are analyzed to help determine flight timetables, flight staffing, in-flight services such as food and Internet, and other airline considerations.[33]

Traditional DBMS vendors are well aware of the great potential of data mining. Thus, companies such as Oracle, Sybase, Tandem, and Red Brick Systems are all incorporating data-mining functionality into their products. Table 3.5 summarizes a few of the most frequent applications for data mining.

Application	Description
Branding and positioning of products and services	Enable the strategist to visualize the different positions of competitors in a given market using performance (or other) data on dozens of key features of the product and then to condense all that data into a perceptual map of only two or three dimensions.
Customer churn	Predict current customers who are likely to switch to a competitor.
Direct marketing	Identify prospects most likely to respond to a direct marketing campaign (such as a direct mailing).
Fraud detection	Highlight transactions most likely to be deceptive or illegal.
Market basket analysis	Identify products and services that are most commonly purchased at the same time (e.g., nail polish and lipstick).
Market segmentation	Group customers based on who they are or on what they prefer.
Trend analysis	Analyze how key variables (e.g., sales, spending, promotions) vary over time.

Table 3.5
Common Data-Mining Applications

Business Intelligence

The use of databases for business-intelligence purposes is closely linked to the concept of data mining. **Business intelligence** (**BI**) involves gathering enough of the right information in a timely manner and usable form and analyzing it so that it can have a positive effect on business strategy, tactics, or operations. IMS Health, for example, provides a BI system designed to assist businesses in the pharmaceutical industry with custom marketing to physicians, pharmacists, nurses, consumers, government agencies, and nonprofit healthcare organizations.[34] BI turns data into useful information that is then distributed throughout an enterprise. It provides insight into the causes of problems and, when implemented, can improve business operations. For example, Puma North America, manufacturer of athletic footwear, uses SPSS software to provide business intelligence to its sales consultants. Puma's 70 independent sales consultants depend on SPSS for the information they need to make business decisions regarding orders, shipments, and product availability.[35]

business intelligence (BI)
The process of gathering enough of the right information in a timely manner and usable form and analyzing it to have a positive impact on business strategy, tactics, or operations.

Competitive intelligence is one aspect of business intelligence and is limited to information about competitors and the ways that knowledge affects strategy, tactics, and operations. Competitive intelligence is a critical part of a company's ability to see and respond quickly and appropriately to the changing marketplace. Competitive intelligence is not espionage—the use of illegal means to gather information. In fact, almost all the information a competitive-intelligence professional needs can be collected by examining published information sources, conducting interviews, and using other legal, ethical methods. Using a variety of analytical tools, a skilled competitive-intelligence professional can by deduction fill the gaps in information already gathered.

competitive intelligence
One aspect of business intelligence limited to information about competitors and the ways that knowledge affects strategy, tactics, and operations.

The term **counterintelligence** describes the steps an organization takes to protect information sought by "hostile" intelligence gatherers. One of the most effective counterintelligence measures is to define "trade secret" information relevant to the company and control its dissemination.

counterintelligence
The steps an organization takes to protect information sought by "hostile" intelligence gatherers.

Data loss prevention (**DLP**) refers to systems designed to lock down data within an organization. DLP software from RSA, Symantec, Code Green, Safend, Trend Micro, Sophos, and others are designed to identify, monitor, and protect data wherever it may exist on a system. That includes data stored on disk, passing over a network, in databases, in files, in e-mail, and elsewhere. DLP is a powerful tool for counterintelligence and is a necessity in complying with government regulations that require companies to safeguard private customer data.[36]

data loss prevention (DLP)
Systems designed to lock down—to identify, monitor, and protect—data within an organization.

INFORMATION SYSTEMS @ WORK

The Database that Drives the Austrian Turnpike

ASFINAG Maut Service GmbH is the company responsible for planning, financing, building, maintaining, and operating the Austrian turnpike and highway system—all 2,100 kilometers of it. As with most European countries, Austria has relied on manually collected tolls to finance its highway system. Recently, the country turned to state-of-the-art database-driven systems to transport its highways into the twenty-first century.

Bernd Datler, head of system development for ASFINAG Maut Service GmbH, calls it "the world's first fully automated, free-flowing tolling system for commercial vehicles." ASFINAG hired Austrian IS service provider Raiffeisen Informatik GmbH to implement a system that would tag and track more than 700,000 commercial vehicles across Austrian roads, automatically billing each vehicle according to complicated specifications.

The database that supports this massive system would have to contend with a variety of data formats and high frequency of data input. It would feed numerous systems to serve a variety of needs.

The fully automated, free-flowing tolling system begins with driver registration. Drivers can register online, by phone, or at local sales centers. The registration process collects information about the driver, the vehicle, and the company that employs the driver. This information is fed into the database and is accessed by a customer relationship management (CRM) system as needed. Upon registration, drivers are provided with a radio transceiver box that is mounted to the dashboard of the commercial vehicle.

The 800 tollgates along Austrian highways were fitted with special microwave receivers that connect with the boxes on drivers' dashboards without the drivers needing to stop. As drivers pass a tollgate, data is continuously collected and entered into the database as transactions. Rather than billing a flat rate, the automated system allows for custom rates to be applied. Fees are calculated based on several criteria, including the size of the vehicle, whether it is full or empty, the time of day, and the vehicle's emission class. These last two criteria can be used to motivate drivers to travel at off-peak times and to use vehicles with low emissions.

The database also collects photographic data. Cameras mounted at tollgates photograph every vehicle to catch unregistered vehicles. The photos are used to see vehicle tags and registration to track down the vehicle's owner. The photo system is also used to collect tolls from noncommercial vehicles that use a registration sticker on the windshield.

Drivers can access their toll information online using a Web-based portal that delivers real-time reporting. Data is automatically transferred into a data warehouse, where ASFINAG managers have access to powerful business intelligence (BI) tools that allow them to generate reports on highway usage from multiple perspectives. The system manages 2.5 million transactions per week, without the need for any human intervention. Invoices are automatically generated in the customer's native language and are delivered electronically. The system was designed to be interoperable as well, reading not only Austrian-registered vehicles, but also vehicles registered in Switzerland, Germany, and Italy.

All in all, the project took more than 100 Raiffeisen Informatik IS professionals 18 months to complete. The team met its deadline and hit its goals in terms of quality, functionality, and costs.

Discussion Questions

1. What unique challenges did the ASFINAG project present for database installation, administration, and security?
2. How does the "world's first fully automated, free-flowing tolling system for commercial vehicles" benefit drivers and the highway system?

Critical Thinking Questions

1. What business functions are supported by the database at ASFINAG?
2. What database applications discussed in the chapter are used in conjunction with the ASFINAG database?

Sources: "Raiffeisen Informatik - SAP Software Powers Outsourced Toll-Collection System," SAP Customer Success Story, *www.sap.com/solutions/sap-businessobjects/customers*, accessed May 15, 2010; ASFiNAG Web site, *www.asfinag.at/en*, accessed May 15, 2010.

Distributed Databases

Distributed processing involves placing processing units at different locations and linking them via telecommunications equipment. A **distributed database**—a database in which the data can be spread across several smaller databases connected through telecommunications devices—works on much the same principle. A user in the Milwaukee branch of a clothing manufacturer, for example, might make a request for data that is physically located at corporate headquarters in Milan, Italy. The user does not have to know where the data is physically stored. See Figure 3.23.

distributed database
A database in which the data can be spread across several smaller databases connected via telecommunications devices.

Distributed databases give corporations and other organizations more flexibility in how databases are organized and used. Local offices can create, manage, and use their own databases, and people at other offices can access and share the data in the local databases. Giving local sites more direct access to frequently used data can improve organizational effectiveness and efficiency significantly. The New York City Police Department, for example, has thousands of officers searching for information located on servers in offices around the city.

Despite its advantages, distributed processing creates additional challenges in integrating different databases (information integration), maintaining data security, accuracy, timeliness, and conformance to standards. Distributed databases allow more users direct access at different sites; however, controlling who accesses and changes data is sometimes difficult. Also, because distributed databases rely on telecommunications lines to transport data, access to data can be slower.

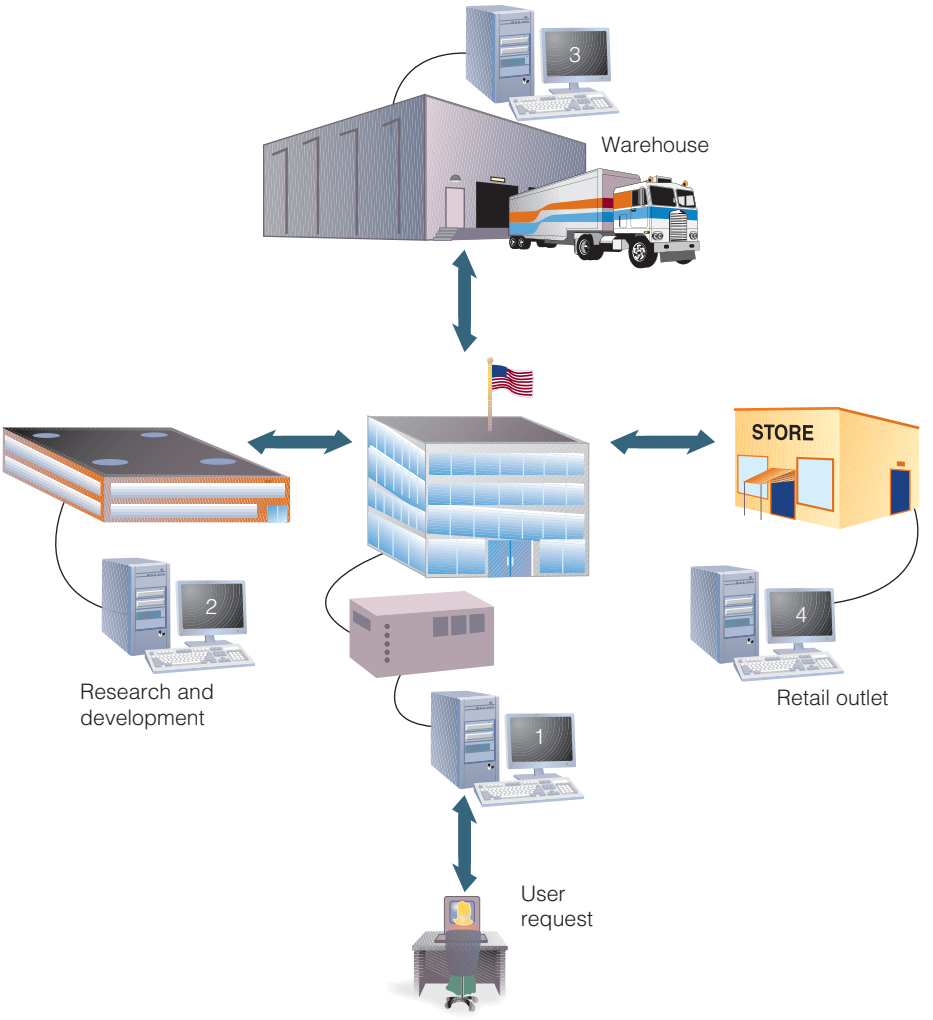
To reduce telecommunications costs, some organizations build a replicated database. A **replicated database** holds a duplicate set of frequently used data. The company sends a copy of important data to each distributed processing location when needed or at predetermined times. Each site sends the changed data back to update the main database on an update cycle that meets the needs of the organization. This process, often called *data synchronization*, is used to make sure that replicated databases are accurate, up to date, and consistent with each other. A railroad, for example, can use a replicated database to increase punctuality, safety, and reliability. The primary database can hold data on fares, routings, and other essential information. The data can be continually replicated and downloaded on a read-only basis from the master database to hundreds of remote servers across the country. The remote locations can send back to the main database the latest figures on ticket sales and reservations.

replicated database
A database that holds a duplicate set of frequently used data.

Figure 3.23

The Use of a Distributed Database

For a clothing manufacturer, computers might be located at corporate headquarters, in the research and development center, in the warehouse, and in a company-owned retail store. Telecommunications systems link the computers so that users at all locations can access the same distributed database, no matter where the data is actually stored.



Online Analytical Processing (OLAP)

online analytical processing (OLAP)
Software that allows users to explore data from a number of perspectives.

For nearly two decades, multidimensional databases and their analytical information display systems have provided flashy sales presentations and trade show demonstrations. All you have to do is ask where a certain product is selling well, for example, and a colorful table showing sales performance by region, product type, and time frame appears on the screen. Called **online analytical processing (OLAP)**, these programs are now being used to store and deliver data warehouse information efficiently. The leading OLAP software vendors include Microsoft, Cognos, SAP, Business Objects, MicroStrategy, Applix, Infor, and Oracle. Blue Mountain, Ontario's largest mountain resort, uses OLAP to allow its analysts, managers, and executives to quickly view and understand large sets of complex data. The resort includes 13 business lines, including restaurants, ski ticketing, call centers, and lodging. Decision makers use the OLAP system to view their data across multiple dimensions and drill down to access specifics.[37]

The value of data ultimately lies in the decisions it enables. Powerful information-analysis tools in areas such as OLAP and data mining, when incorporated into a data warehousing architecture, bring market conditions into sharper focus and help organizations deliver greater competitive value. OLAP provides top-down, query-driven data analysis; data mining provides bottom-up, discovery-driven analysis. OLAP requires repetitive testing of user-originated theories; data mining requires no assumptions and instead identifies facts and conclusions based on patterns discovered. OLAP, or multidimensional analysis, requires a great deal of human ingenuity and interaction with the database to find information in the database. A user of a data-mining tool does not need to figure out what questions to ask;

instead, the approach is, "Here's the data, tell me what interesting patterns emerge." For example, a data-mining tool in a credit card company's customer database can construct a profile of fraudulent activity from historical information. Then, this profile can be applied to all incoming transaction data to identify and stop fraudulent behavior, which might otherwise go undetected. Table 3.6 compares OLAP and data mining.

Table 3.6

Comparison of OLAP and Data Mining

Characteristic	OLAP	Data Mining
Purpose	Supports data analysis and decision making	Supports data analysis and decision making
Type of analysis supported	Top-down, query-driven data analysis	Bottom-up, discovery-driven data analysis
Skills required of user	Must be very knowledgeable of the data and its business context	Must trust in data mining tools to uncover valid and worthwhile hypotheses

Object-Relational Database Management Systems

An **object-oriented database** uses the same overall approach of objected-oriented programming that was discussed in Chapter 2. With this approach, both the data and the processing instructions are stored in the database. For example, an object-oriented database could store monthly expenses and the instructions needed to compute a monthly budget from those expenses. A traditional DBMS might only store the monthly expenses. The popular Internet phone service Skype has been pleased with its object-oriented database from PostgreSQL. The object-oriented nature of the database allowed Skype to develop the database as the company grew and evolved.[38] Object-oriented databases are useful when a database contains complex data that needs to be processed quickly and efficiently.

object-oriented database
A database that stores both data and its processing instructions.

In an object-oriented database, a *method* is a procedure or action. A sales tax method, for example, could be the procedure to compute the appropriate sales tax for an order or sale—for example, multiplying the total amount of an order by 7 percent, if that is the local sales tax. A *message* is a request to execute or run a method. For example, a sales clerk could issue a message to the object-oriented database to compute sales tax for a new order. Many object-oriented databases have their own query language, called *object query language* (*OQL*), which is similar to SQL, discussed previously.

An object-oriented database uses an **object-oriented database management system** (**OODBMS**) to provide a user interface and connections to other programs. Computer vendors who sell or lease OODBMSs include Versant and Objectivity. Many organizations are selecting object-oriented databases for their processing power. Versant's OODBMS, for example, is being used by companies in the telecommunications, defense, online gaming, and healthcare industries and by government agencies. The *Object Data Standard* is a design standard created by the *Object Database Management Group* (*www.odmg.org*) for developing object-oriented database systems.

object-oriented database management system (OODBMS)
A group of programs that manipulate an object-oriented database and provide a user interface and connections to other application programs.

An **object-relational database management system** (**ORDBMS**) provides a complete set of relational database capabilities plus the ability for third parties to add new data types and operations to the database. These new data types can be audio, images, unstructured text, spatial, or time series data that require new indexing, optimization, and retrieval features. Each of the vendors offering ORDBMS facilities provides a set of application programming interfaces to allow users to attach external data definitions and methods associated with those definitions to the database system. They are essentially offering a standard socket into which users can plug special instructions. DataBlades, Cartridges, and Extenders are the names applied by Oracle and IBM to describe the plug-ins to their respective products. Other plug-ins serve as interfaces to Web servers.

object-relational database management system (ORDBMS)
A DBMS capable of manipulating audio, video, and graphical data.

Visual, Audio, and Other Database Systems

In addition to raw data, organizations are finding a need to store large amounts of visual and audio signals in an organized fashion. Credit card companies, for example, enter pictures of charge slips into an image database using a scanner. The images can be stored in the database and later sorted by customer name, printed, and sent to customers along with their monthly statements. Image databases are also used by physicians to store x-rays and transmit them to clinics away from the main hospital. Financial services, insurance companies, and government branches are using image databases to store vital records and replace paper documents. Drug companies often need to analyze many visual images from laboratories. Visual databases can be stored in some object-relational databases or special-purpose database systems. Many relational databases can also store images.

Combining and analyzing data from different databases is an increasingly important challenge. Global businesses, for example, sometimes need to analyze sales and accounting data stored around the world in different database systems. Companies such as IBM have developed *virtual database systems* to allow different databases to work together as a unified database system. The joining of separate databases into one is sometimes referred to as a *federated database system*. World-renowned insurer, Lloyd's of London, joined its database with that of International Underwriting Association (IUA), creating a virtual database that ensured improved customer service at a lower cost.[39]

In addition to visual, audio, and virtual databases, other special-purpose database systems meet particular business needs. *Spatial data technology* involves using a database to store and access data according to the locations it describes and to permit spatial queries and analysis. MapInfo software from Pitney Bowes allows businesses such as Home Depot, Sonic Restaurants, CVS Corporation, and Chico's to choose the optimal location for new stores and restaurants based on geospatial demographics. It also can be used to assist law enforcement agencies and emergency response teams to prepare for emergencies and provide community protection in an efficient manner.[40] The software provides information about local competition, populations, and traffic patterns to predict how a business will fare in a particular location. Builders and insurance companies use spatial data to make decisions related to natural hazards. Spatial data can even be used to improve financial risk management with information stored by investment type, currency type, interest rates, and time. Spatial data technology is a powerful tool that geographic information systems (GIS) use to plot information on a map.

Spatial data technology is used by law enforcement agencies to provide protection where it is most needed.

(Source: © David R. Frazier Photolibrary, Inc./Alamy.)

SUMMARY

Principle

Data management and modeling are key aspects of organizing data and information.

Data is one of the most valuable resources that a firm possesses. It is organized into a hierarchy that builds from the smallest element to the largest. The smallest element is the bit, a binary digit. A byte (a character such as a letter or numeric digit) is made up of eight bits. A group of characters, such as a name or number, is called a field (an object). A collection of related fields is a record; a collection of related records is called a file. The database, at the top of the hierarchy, is an integrated collection of records and files.

An entity is a generalized class of objects for which data is collected, stored, and maintained. An attribute is a characteristic of an entity. Specific values of attributes—called data items—can be found in the fields of the record describing an entity. A data key is a field within a record that is used to identify the record. A primary key uniquely identifies a record, while a secondary key is a field in a record that does not uniquely identify the record.

Traditional file-oriented applications are often characterized by program-data dependence, meaning that they have data organized in a manner that cannot be read by other programs. To address problems of traditional file-based data management, the database approach was developed. Benefits of this approach include reduced data redundancy, improved data consistency and integrity, easier modification and updating, data and program independence, standardization of data access, and more-efficient program development.

When building a database, an organization must consider content, access, logical structure, and physical organization of the database. Many enterprises build a data center to house the servers that physically store databases and the systems that deliver mission-critical information and services. One of the tools that database designers use to show the logical structure and relationships among data is a data model. A data model is a map or diagram of entities and their relationships. Enterprise data modeling involves analyzing the data and information needs of an entire organization. Entity-relationship (ER) diagrams can be used to show the relationships among entities in the organization.

The relational model places data in two-dimensional tables. Tables can be linked by common data elements, which are used to access data when the database is queried. Each row represents a record, and each column represents an attribute (or field). Allowable values for these attributes are called the domain. Basic data manipulations include selecting, projecting, and joining. The relational model is easier to control, more flexible, and more intuitive than the other models because it organizes data in tables.

Principle

A well-designed and well-managed database is an extremely valuable tool in supporting decision making.

A DBMS is a group of programs used as an interface between a database and its users and other application programs. When an application program requests data from the database, it follows a logical access path. The actual retrieval of the data follows a physical access path. Records can be considered in the same way: a logical record is what the record contains; a physical record is where the record is stored on storage devices. Schemas are used to describe the entire database, its record types, and their relationships to the DBMS.

A DBMS provides four basic functions: providing user views, creating and modifying the database, storing and retrieving data, and manipulating data and generating reports. Schemas are entered into the computer via a data definition language, which describes the data and relationships in a specific database. Another tool used in database management is the data dictionary, which contains detailed descriptions of all data in the database.

After a DBMS has been installed, the database can be accessed, modified, and queried via a data manipulation language. A more specialized data manipulation language is the query language, the most common being Structured Query Language (SQL). SQL is used in several popular database packages today and can be installed on PCs and mainframes.

Popular single-user DBMSs include Corel Paradox and Microsoft Access. IBM, Oracle, and Microsoft are the leading DBMS vendors. Database as a Service (DaaS), or Database 2.0, is a new form of database service in which clients lease use of a database on a service provider's site.

A database administrator (DBA) plans, designs, creates, operates, secures, monitors, and maintains databases. Attacks on databases such as SQL injection attacks are an all-too-common threat that DBAs must guard against. Selecting a DBMS begins by analyzing the information needs of the organization. Important characteristics of databases include the size of the database, the number of concurrent users, its performance, the ability of the DBMS to be integrated with other systems, the features of the DBMS, the vendor considerations, and the cost of the database management system.

Principle

The number and types of database applications will continue to evolve and yield real business benefits.

Traditional online transaction processing (OLTP) systems put data into databases very quickly, reliably, and efficiently, but they do not support the types of data analysis that today's businesses and organizations require. To address this need, organizations are building data warehouses, which are relational database management systems specifically designed to support management decision making. Data marts are subdivisions of data warehouses, which are commonly devoted to specific purposes or functional business areas.

Data mining, which is the automated discovery of patterns and relationships in a data warehouse, is a practical approach to generating hypotheses about the data that can be used to predict future behavior.

Predictive analysis is a form of data mining that combines historical data with assumptions about future conditions to forecast outcomes of events such as future product sales or the probability that a customer will default on a loan.

Business intelligence is the process of getting enough of the right information in a timely manner and usable form and analyzing it so that it can have a positive effect on business strategy, tactics, or operations. Competitive intelligence is one aspect of business intelligence limited to information about competitors and the ways that information affects strategy, tactics, and operations. Competitive intelligence is not espionage—the use of illegal means to gather information. Counterintelligence describes the steps an organization takes to protect information sought by "hostile" intelligence gatherers. Data loss prevention (DLP) refers to systems designed to lock down data within an organization.

With the increased use of telecommunications and networks, distributed databases, which allow multiple users and different sites access to data that may be stored in different physical locations, are gaining in popularity. To reduce telecommunications costs, some organizations build replicated databases, which hold a duplicate set of frequently used data.

Multidimensional databases and online analytical processing (OLAP) programs are being used to store data and allow users to explore the data from a number of different perspectives.

An object-oriented database uses the same overall approach of objected-oriented programming, first discussed in Chapter 2. With this approach, both the data and the processing instructions are stored in the database. An object-relational database management system (ORDBMS) provides a complete set of relational database capabilities, plus the ability for third parties to add new data types and operations to the database. These new data types can be audio, video, and graphical data that require new indexing, optimization, and retrieval features.

In addition to raw data, organizations are finding a need to store large amounts of visual and audio signals in an organized fashion. A number of special-purpose database systems are also being used.

CHAPTER 5: SELF-ASSESSMENT TEST

Data management and modeling are key aspects of organizing data and information.

1. A group of programs that manipulate the database and provide an interface between the database and the user of the database and other application programs is called a(n) _____.
   a. GUI
   b. operating system
   c. DBMS
   d. productivity software
2. A(n) _____ is a skilled and trained IS professional who directs all activities related to an organization's database.
3. A field is made up of multiple records. True or False?
4. A(n) _____ is a field or set of fields that uniquely identifies a database record.
   a. attribute
   b. data item
   c. key
   d. primary key
5. The _____ approach provides a pool of related data shared by multiple information systems.
6. Many businesses store their database and related systems in climate-controlled facilities called _____.
7. What database model places data in two-dimensional tables?
   a. relational
   b. network
   c. normalized
   d. hierarchical

A well-designed and well-managed database is an extremely valuable tool in supporting decision making.

8. _____ involves combining two or more database tables.

a. Projecting
b. Joining
c. Selecting
d. Data cleanup

9. Because the DBMS is responsible for providing access to a database, one of the first steps in installing and using a database involves telling the DBMS the logical and physical structure of the data and relationships among the data in the database. This description of an entire database is called a(n) _____.

10. The commands used to access and report information from the database are part of the _____.
    a. data definition language
    b. data manipulation language
    c. data normalization language
    d. schema

11. Access is a popular DBMS for _____.
    a. personal computers
    b. graphics workstations
    c. mainframe computers
    d. supercomputers

12. A trend in database management, known as Database as a Service, places the responsibility of storing and managing a database on a service provider. True or False?

The number and types of database applications will continue to evolve and yield real business benefits.

13. A(n) _____ holds business information from many sources in the enterprise, covering all aspects of the company's processes, products, and customers.

14. An information-analysis tool that involves the automated discovery of patterns and relationships in a data warehouse is called _____.
    a. a data mart
    b. data mining
    c. predictive analysis
    d. business intelligence

15. _____ allows users to predict the future based on database information from the past and present.

16. The process of gathering information in a timely manner and in a usable form so that it positively affects business strategy, tactics, and operations is called _____.

CHAPTER 5: SELF-ASSESSMENT TEST ANSWERS

(1) c (2) database administrator (3) False (4) d (5) database (6) data centers (7) a (8) b (9) schema (10) b (11) a (12) True (13) data warehouse (14) b (15) Predictive analysis (16) business intelligence

REVIEW QUESTIONS

1. What is an attribute? How is it related to an entity?
2. Define the term *database*. How is it different from a database management system?
3. What is the hierarchy of data in a database?
4. What is a relation, and what is its importance to relational databases?
5. What is the purpose of a primary key? How is it useful in controlling data redundancy?
6. What is the purpose of data cleanup?
7. What are the advantages of the database approach over the traditional approach to database management?
8. What is data modeling? What is its purpose? Briefly describe three commonly used data models.
9. What is a data center, and why are they becoming increasingly important?
10. What is a database schema, and what is its purpose?
11. How can a data dictionary be useful to database administrators and DBMS software engineers?
12. Identify important characteristics in selecting a database management system.
13. What is the difference between a data definition language (DDL) and a data manipulation language (DML)?
14. What is the difference between projecting and joining?
15. What is a distributed database system?
16. What is a data warehouse, and how is it different from a traditional database used to support OLTP?
17. What is meant by the "front end" and the "back end" of a DBMS?
18. What is the relationship between the Internet and databases?
19. What is data mining? What is OLAP? How are they different?
20. What is an ORDBMS? What kind of data can it handle?
21. What is business intelligence? How is it used?
22. What is predictive analysis, and how does it assist businesses in gaining competitive advantage?
23. In what circumstances might a database administrator consider using an object-oriented database?

DISCUSSION QUESTIONS

1. You have been selected to represent the student body on a project to develop a new student database for your school. What is the first step in developing the database? What actions might you take to fulfill this responsibility to ensure that the project meets the needs of students and is successful?
2. Your company wants to increase revenues from its existing customers. How can data mining be used to accomplish this objective?
3. You are going to design a database for your school's outdoors club to track its activities. Identify the database characteristics most important to you in choosing a DBMS. Which of the database management systems described in this chapter would you choose? Why? Is it important for you to know what sort of computer the database will run on? Why or why not?
4. Make a list of the databases in which data about you exists. How is the data in each database captured? Who updates each database and how often? Is it possible for you to request a printout of the contents of your data record from each database? What data privacy concerns do you have?
5. If you were the database administrator for the iTunes store, how might you use predictive analysis to determine which artists and movies will sell most next year?
6. You are the vice president of information technology for a large, multinational consumer packaged goods company (such as Procter & Gamble or Unilever). You must make a presentation to persuade the board of directors to invest $5 million to establish a competitive-intelligence organization—including people, data-gathering services, and software tools. What key points do you need to make in favor of this investment? What arguments can you anticipate that the board might make?
7. Identity theft, whereby people steal personal information, continues to be a problem for consumers and businesses. Assume that you are the database administrator for a corporation with a large database that is accessible from the Web. What steps would you implement to prevent people from stealing personal information from the corporate database?
8. What roles do databases play in your most favorite online activities and Web sites?

PROBLEM-SOLVING EXERCISES

1. Develop a simple data model for the music you have on your digital music player or in your CD collection, in which each row is a song. For each row, what attributes should you capture? What will be the primary key for the records in your database? Describe how you might use the database to expand your music exposure and enjoyment.
2. A video movie rental store is using a relational database to store information on movie rentals to answer customer questions. Each entry in the database contains the following items: Movie Number (the primary key), Movie Title, Year Made, Movie Type, MPAA Rating, Number of Copies on Hand, and Quantity Owned. Movie Types are comedy, family, drama, horror, science fiction, and western. MPAA ratings are G, PG, PG-13, R, NC-17, and NR (not rated). Use a single-user database management system to build a data-entry screen to enter this data. Build a small database with at least ten entries.
3. To improve service to their customers, the salespeople at the video rental store have proposed a list of changes being considered for the database in the previous exercise. From this list, choose two database modifications and modify the data-entry screen to capture and store this new information. Proposed changes:
    a. To help store clerks locate the newest releases, add the date that the movie was first available.
    b. Add the director's name.
    c. Add the names of three primary actors in the movie.
    d. Add a rating of one, two, three, or four stars.
    e. Add the number of Academy Award nominations.
4. Your school maintains information about students in several interconnected database files. The student_contact file contains student contact information. The student_grades file contains student grade records, and the student_financial file contains financial records, including tuition and student loans. Draw a diagram of the fields these three files might contain, identify which field is a primary key in each file, and show which fields serve to relate one file to another. Use Figure 3.7 as a guide.

TEAM ACTIVITIES

1. In a group of three or four classmates, communicate with the person at your school who supervises information systems. Find out how many databases are used by your school and for what purpose. Also find out what policies and procedures are in place to protect the data stored from identity thieves and other threats.
2. As a team of three or four classmates, interview business managers from three different businesses that use databases. What data entities and data attributes are contained in each database? What database company did each company select to provide their database, and why? How do they access the database to perform analysis? Have they received training in any query or reporting tools? What do they like about their databases, and what could be improved? Do any of them use data-mining or OLAP techniques? Weighing the information obtained, select one of these databases as being most strategic for the firm and briefly present your selection and the rationale for the selection to the class.
3. Imagine that you and your classmates are a research team developing an improved process for evaluating loan applicants for automobile purchases. The goal of the research is to predict which applicants will become delinquent or forfeit their loan. Those who score well on the application will be accepted, and those who score exceptionally well will be considered for lower-rate loans. Prepare a brief report for your instructor addressing these questions:
    a. What data do you need for each loan applicant?
    b. What data might you need that is not typically requested on a loan application form?
    c. Where might you get this data?
    d. Take a first cut at designing a database for this application. Using the material in this chapter on designing a database, draw the logical structure of the relational tables for this proposed database. In your design, include the data attributes you believe are necessary for this database, and show the primary keys in your tables. Keep the size of the fields and tables as small as possible to minimize required disk drive storage space. Fill in the database tables with the sample data for demonstration purposes (ten records). After your design is complete, implement it using a relational DBMS.

WEB EXERCISES

1. Use a Web search engine to find information on specific products for one of the following topics: business intelligence, object-oriented databases, or Database as a Service. Write a brief report describing what you found, including a description of the database products and the companies that developed them.
2. More information is being produced than can currently be stored in data centers, and yet, existing data centers are consuming huge amounts of energy, putting a strain on the environment and on budgets. Go online to research "Green Data Center" to learn what can be done to store more data using fewer resources. Students with the most unique and useful suggestions may be awarded extra credit.

CAREER EXERCISES

1. What type of data is stored by businesses in a professional field that interests you? How many databases might be used to store that data? How would the data be organized within each database? How can techniques like data loss prevention (DLP) be used to protect critical databases?
2. How could you use business intelligence (BI) to do a better job at work? Give some specific examples of how BI can give you a competitive advantage.

CASE STUDIES

Case One

Managing International Trades with Powerful Database Systems

Internaxx is an international brokerage and banking service that services thousands of expatriates and international clients around the world. Based in Luxembourg, Germany, Internaxx provides international online brokerage services for private investors, companies, monetary and financial markets, and investment and pension funds. Internaxx provides real-time share trading at more than 15 stock exchanges around the world online or by phone.

Working in so many markets and with customers from 155 different countries, Internaxx must deal with large quantities of data. The majority of data collected by Internaxx originates from the many trading operations carried out by its customers. The ability to process that data efficiently is the key to Internaxx's success.

Internaxx uses its database to fuel business intelligence tools that allow it to process data both quantitatively and qualitatively. The company maintains a data warehouse on which it runs queries to provide insight into both its customers and market trends. While this insight helps to make the company more competitive, it is also required by regulations imposed by the European Union. The Market in Financial Instruments Directive (MiFid) requires financial institutions to acquire a detailed knowledge of customer behavior to better protect the customer's interests.

Internaxx's data warehouse provides data that feeds 50 annual reports updated daily, weekly, or monthly. These reports include analysis of trading operations, rate of customer conversion, total commissions received, and assorted financial, commercial, and marketing reports. Reports serve a variety of functions. One report calculates the distribution of customers around the world to enable effective marketing campaigns.

Additionally, the functional databases that feed into the data warehouse can provide real-time information on stock trades, which is essential for making wise trades in a fast-moving market. Customers around the world can watch the rise and fall of stock prices and market conditions as they occur, using powerful forecasting tools to ensure wise investments.

In summary, the Internaxx database fuels both wise investment decision-making for Internaxx customers and wise business decision-making for Internaxx executives. Rodolphe Marck, director information systems at Internaxx, says that due to the power of databases and the systems they fuel, Internaxx can "align our decisions and customer investment and acquisition strategies according to the requirements and trends of the international financial markets in real time."

Discussion Questions

1. What unique challenges do databases that deal with financial markets face?
2. How does Internaxx separate data in its database for annual reports from the data that fuels real-time analytics?

Critical Thinking Questions

1. In what ways does Internaxx use its database to provide the company with a competitive advantage?
2. What unique capabilities must the Internaxx database have in order to support trading in 15 stock exchanges around the world?

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Case Two

Using Databases to Map Human Migration

National Geographic was established in 1888 to advance human understanding of the world's cultural, historical, and natural resources. National Geographic is a nonprofit organization that has contributed greatly to scientific research. One of the most recent examples of its contribution to science is the Genographic Project.

According to the National Geographic Web site, the Genographic Project is a "landmark study of the human journey." Scientists believe that we all descended from a common group of ancestors who lived in Africa some 60,000 years ago. Over the millennia, that group reproduced and migrated to populate the entire globe. The Genographic Project intends to map that migration to allow individuals to trace their ancestry back through time and location using advanced DNA research.

Dozens of researchers around the world have been engaged in genetic research of indigenous cultures. DNA is being collected from select individuals and stored in a database where sequences can be automatically studied. Comparing commonalities between DNA strands allows researchers to draw conclusions about where an individual originated, and where his or her ancestors may have migrated to and from.

Stage 2 of the study brings in the general public. Volunteers from around the world can sign up online to become part of the study and trace their own heritages and family migrations. For $99, anyone can purchase a Genographic Project kit, which includes abundant

information and a swab for gathering DNA from the inside of the mouth. The DNA sample is sent to the Genographic Project by mail. Participants can trace the progress of the research on their DNA online. Once analyzed, the participant is provided with historical information about their ancestors and migration paths dating back to that African community 60,000 years ago.

The same data-mining and business-intelligence tools used by businesses to find correlations between business data are applied to the DNA information stored by the Genographic Project. Advanced trend-mapping and analysis tools provide a deeper understanding of mutation rates and DNA-merging behavior. The participation of more than 300,000 volunteers has created one of the world largest repositories of genetic information, providing new insight into our migratory history and fueling collaboration on new projects.

Without the automation provided by database tools, this research would not be possible. Dr. Spencer Wells, National Geographic Explorer-in-Residence and Scientific Director of the Project, stated that "With hundreds of thousands of samples, researchers could easily become lost in our collected data. But, by working with IBM, we can distill this information into something useful—research breakthroughs and new findings."

Discussion Questions

1. What role do database and DBMS play in assisting with the Genographic Project?
2. What types of data are stored in the Genographic database, and how might it be organized into the data hierarchy discussed in this chapter?

Critical Thinking Questions

1. How is the manipulation of Genographic data similar to the manipulation of business data? What DBMS tools and techniques are shared by both?
2. How does National Geographics investment in this DBMS assist other researchers? How might this data be shared using the database concepts taught in this chapter?

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Questions for Web Case

See the Web site for this book to read about the Altitude Online case for this chapter. Following are questions concerning this Web case.

Altitude Online: Using Databases and Business Intelligence

Discussion Questions

1. What work is involved in merging multiple databases into one central database, as Altitude Online is doing?
2. Why do you think Altitude Online found it necessary to hire a database administrator? How will the ERP affect the responsibilities of IS personnel across the organization?

Critical Thinking Questions

1. In a major move such as this, what opportunities can Altitude Online take advantage of as it totally revamps its database system that it perhaps wouldn't consider before?
2. Why do you think Altitude Online is beginning work on its database prior to selecting an ERP vendor?

NOTES

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