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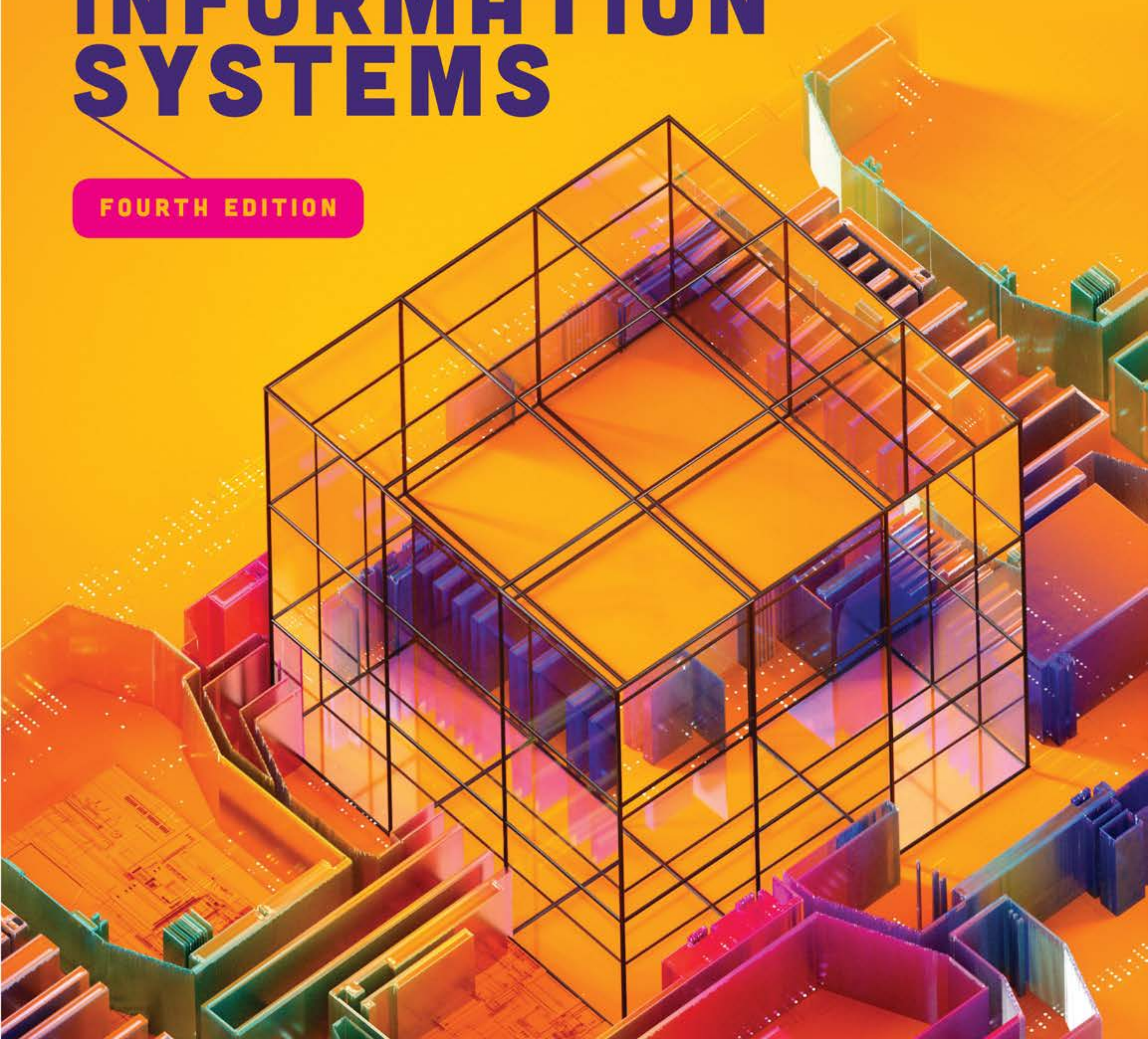
PRINCIPLES OF BUSINESS INFORMATION SYSTEMS

FOURTH EDITION



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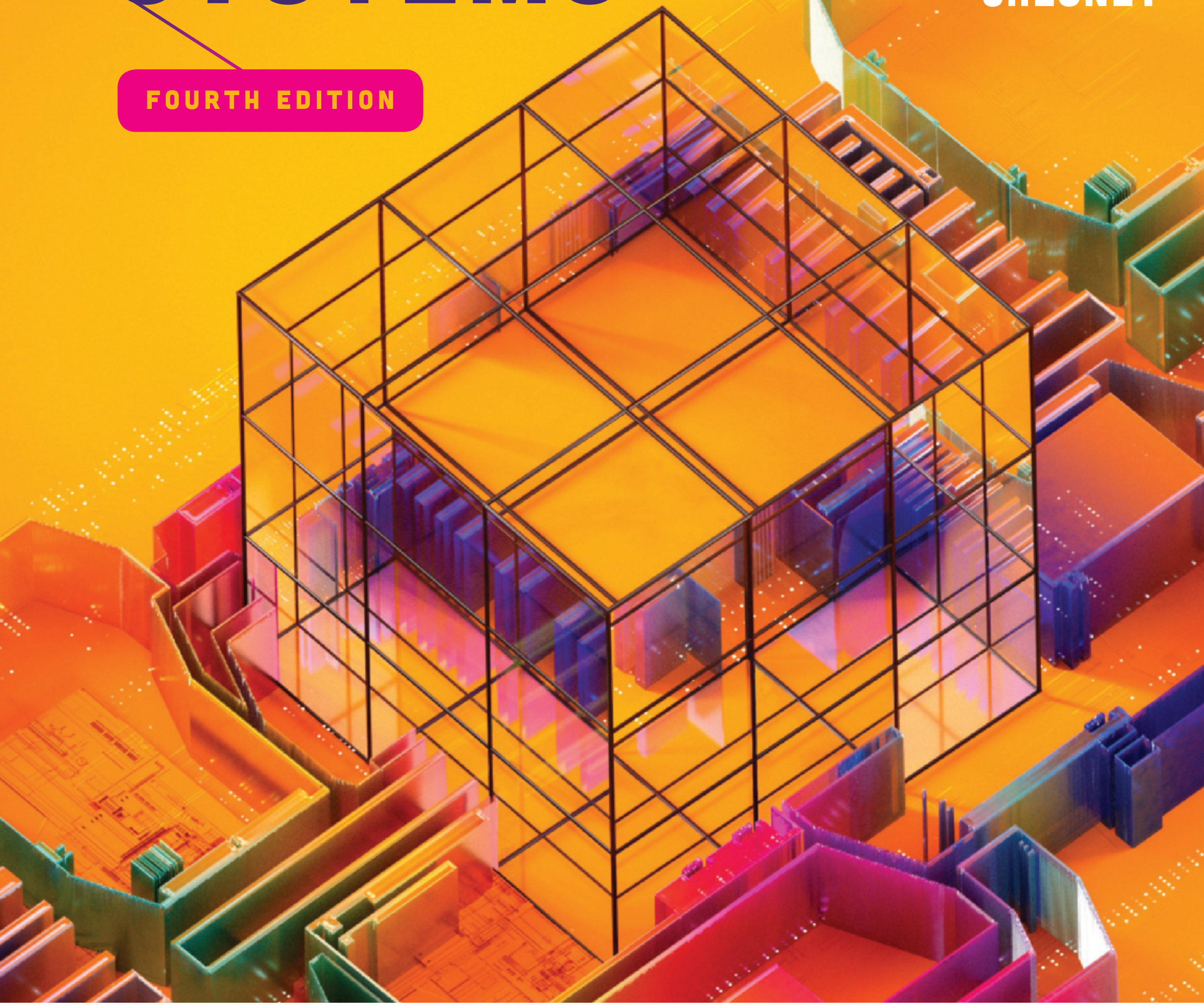

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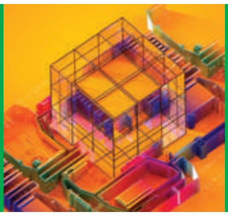
Brief Contents



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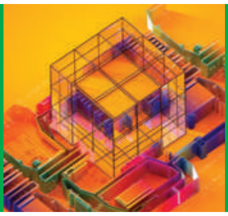
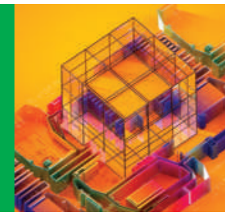


Preface



As organizations continue to operate in an increasingly competitive and global marketplace, workers in all areas of business including accounting, finance, human resources, marketing, operations management and production must be well prepared to make the significant contributions required for success. Regardless of your future role, you will need to understand what information systems can and cannot do and be able to use them to help you accomplish your work. You will be expected to discover opportunities to use information systems and to participate in the design of solutions to business problems employing information systems. You will be challenged to identify and evaluate information systems options. To be successful, you must be able to view information systems from the perspective of business and organizational needs. For your solutions to be accepted, you must recognize and address their impact on fellow workers, customers, suppliers and other key business partners. For these reasons, a course in information systems is essential for students in today's high-tech world.

The primary objective of *Principles of Business Information Systems fourth edition* is to provide the best information systems text and accompanying materials for the first information technology course required of all business students. We want you to learn to use information technology to ensure your personal success in your current or future job and to improve the success of your organization. *Principles of Business Information Systems* stands proudly at the beginning of the information systems (IS) curriculum and remains unchallenged in its position as the only IS principles text offering the basic IS concepts that every business student must learn to be successful.

This text has been written specifically for the introductory course in the IS curriculum. *Principles of Business Information Systems* treats the appropriate computer and IS concepts together with a strong managerial emphasis on meeting business and organizational needs.

Approach of the Text

Principles of Business Information Systems offers the traditional coverage of computer concepts, but it places the material within the context of meeting business and organizational needs. Placing IS concepts in this context and taking a general management perspective sets the text apart from general computer books thus making it appealing not only to those studying for IS degrees but also to students from other fields of study. The text isn't overly technical, but rather deals with the role that information systems play in an organization and the key principles a manager needs to grasp to be successful. These principles of IS are brought together and presented in a way that is both understandable and relevant. In addition, this book offers an overview of the entire IS discipline, while giving students a solid foundation for further study in advanced IS courses such as programming, systems analysis and design, project management, database management, data communications, website and systems development, electronic commerce and mobile commerce applications, and decision support. As such, it serves the needs of both general business students and those who will become IS professionals.

IS Principles First, Where They Belong

Exposing students to fundamental IS principles is an advantage for students who do not later return to the discipline for advanced courses. Since most functional areas in business rely on information systems, an understanding of IS principles helps students in other course work. In addition, introducing students to the principles of IS helps future business function managers employ information systems successfully and avoid mishaps that often result in unfortunate consequences. Furthermore, presenting IS concepts at the introductory level creates interest among general business students who may later choose IS as a field of concentration.

Goals of this Text

Principles of Business Information Systems has four main goals:

1. To provide a core of IS principles with which every business student should be familiar.
2. To offer a survey of the IS discipline that will enable all business students to understand the relationship of IS courses to their curriculum as a whole.
3. To present the changing role of the IS professional.
4. To show the value of the discipline as an attractive field of specialization.

By achieving these goals, *Principles of Business Information Systems* will enable students to understand and use fundamental IS principles so that they can function more efficiently and effectively as workers, managers, decision makers and organizational leaders.

IS Principles

Principles of Business Information Systems, although comprehensive, cannot cover every aspect of the rapidly changing IS discipline. The authors, having recognized this, provide students with an essential core of guiding IS principles to use as they face career challenges ahead. Think of principles as basic truths or rules that remain constant regardless of the situation. As such, they provide strong guidance in the face of tough decisions. A set of IS principles is highlighted at the beginning of each chapter. The ultimate goal of *Principles of Business Information Systems* is to develop effective, thinking, action-oriented employees by instilling them with principles to help guide their decision making and actions.

Survey of the IS Discipline

This text not only offers the traditional coverage of computer concepts but also provides a broad framework to impart students with a solid grounding in the business uses of technology. In addition to serving general business students, this book offers an overview of the entire IS discipline and solidly prepares future IS professionals for advanced IS courses and their careers in the rapidly changing IS discipline.

Changing Role of the IS Professional

As business and the IS discipline have changed, so too has the role of the IS professional. Once considered a technical specialist, today the IS professional operates as an internal consultant to all functional areas of the organization, being knowledgeable about their needs and competent in bringing the power of IS to bear throughout the organization. The IS professional views issues through a global perspective that encompasses the entire organization and the broader industry and business environment in which it operates.

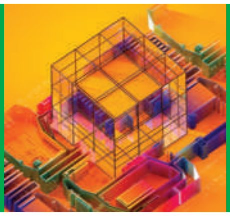
The scope of responsibilities of an IS professional today is not confined to just his or her employer but encompasses the entire interconnected network of employees, suppliers, customers, competitors, regulatory agencies and other entities, no matter where they are located. This broad scope of responsibilities creates a new challenge: how to help an organization survive in a highly interconnected, highly competitive global environment. In accepting that challenge, the IS professional plays a pivotal role in shaping the business itself and ensuring its success. To survive, businesses must now strive for the highest level of customer satisfaction and loyalty through competitive prices and ever-improving product and service quality. The IS professional assumes the critical responsibility of determining the organization's approach to both overall cost and quality performance and therefore plays an important role in the ongoing survival of the organization. This new duality in the role of the IS employee – a professional who exercises a specialist's skills with a generalist's perspective – is reflected throughout the book.

IS as a Field for Further Study

Employment of computer and IS managers is expected to grow much faster than the average for all occupations. Technological advancements will boost the employment of computer-related workers; in turn, this will boost the demand for managers to direct these workers. In addition, job openings will result from the need to replace managers who retire or move into other occupations.

A career in IS can be exciting, challenging and rewarding! It is important to show the value of the discipline as an appealing field of study and that the IS graduate is no longer a technical recluse. Today, perhaps more than ever before, the IS professional must be able to align IS and organizational goals and ensure that IS investments are justified from a business perspective. The need to draw bright and interested students into the IS discipline is part of our ongoing responsibility. Upon graduation, IS graduates at many schools are among the highest paid of all business graduates. Throughout this text, the many challenges and opportunities available to IS professionals are highlighted and emphasized.

Changes to the Fourth Edition



Principles of Business Information Systems is an adaptation of the popular US textbook *Principles of Information Systems*, now in its fourteenth edition. With a more international outlook, this book is suitable for students in the UK, Europe, the Middle East and South Africa on introductory BIS or MIS courses. The new edition reflects the fact that this book has boosted its business emphasis but retained its technology focus.

Continuing to present IS concepts with a managerial emphasis, this edition retains the overall vision, framework and pedagogy that made the previous US editions so popular:

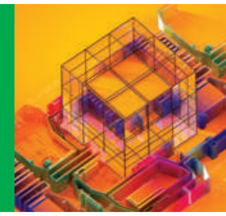
- *Principles of Business Information Systems* keeps the same five-part structure, is packed with new real world examples and business cases, and highlights ethical issues throughout.
- It is still an IS text aimed at those studying business and management.

However, in order to increase its international relevance, we have made a number of changes. The main improvements are:

- Cases are more international in flavour, including examples from South Africa, Australia and Europe, and have a broader sector spread reflecting a wider variety of business types (including SMEs).
- The book has been brought completely up to date in terms of innovations in IT.
- Legal and ethical issues in IT have been made more international.
- A chapter on pervasive computing reflects the move of the computer away from the desktop to enter almost every aspect of our lives.
- Separate information systems are still discussed in Chapters 7, 8, 9 and 10 (all of Part 3) but we recognize that many large – and some small – companies take a more integrated approach and this is covered at the start of Part 3.

We want to note that at the time of this fourth EMEA edition going to press, the global COVID-19 pandemic is still at large worldwide. For the past few months governments across the world have introduced a range of social distancing, isolation and quarantine methods to help control the pandemic which has impacted businesses and their information systems worldwide. It is too early to tell what the full effects of this pandemic will be on business information systems, but references to and examples of effects there have been to date, are included in the new edition.

Structure of the Text



Principles of Business Information Systems is organized into five parts – an overview of information systems, an introduction to information technology concepts, an examination of different classes of business information systems, a study of systems development and a focus on information systems in business and the wider society.

The content of each chapter is as follows:

Chapter 1 An Introduction to Information Systems

Chapter 1 creates a framework for the entire book. Major sections in this chapter become entire chapters in the text. This chapter describes the components of an information system and introduces major classes of business information systems. It offers an overview of systems development and outlines some major challenges that IS professionals face.

Chapter 2 Information Systems in Organizations

Chapter 2 gives an overview of business organizations and presents a foundation for the effective and efficient use of IS in a business environment. We have stressed that the traditional mission of IS is to deliver the right information to the right person at the right time. In the section on virtual organizational structure, we discuss that virtual organizational structures allow work to be separated from location and time. Work can be done anywhere, anytime. The concept of business process reengineering (BPR) is introduced and competitive advantage is examined – higher quality products, better customer service and lower costs.

Chapter 3 Hardware: Input, Processing, Output and Storage Devices

This chapter concentrates on the hardware component of a computer-based information system (CBIS) and reflects the latest equipment and computer capabilities. Computer memory is explained and a variety of hardware platforms are discussed including mobile technology.

Chapter 4 Software: Systems and Application Software

You cannot come into contact with a computer without coming into contact with software. This chapter examines a wide range of software and related issues including operating systems and application software, open-source and proprietary software, software for mobile devices and copyrights and licenses.

Chapter 5 Organizing and Storing Data

Databases are the heart of almost all IS. A huge amount of data is entered into computer systems every day. Chapter 5 examines database management systems and how they can help businesses. The chapter includes a brief overview of how to organize data in a database, a look at database administration and discusses how data can be used competitively by examining both data mining and business intelligence.

Chapter 6 Computer Networks

The power of information technology greatly increases when devices are linked or networked, which is the subject of this chapter. Today's decision makers need to access data wherever it resides. They must be able to establish fast, reliable connections to exchange messages, upload and download data and software, route business transactions to processors, connect to databases and network services, and send output to printers. This chapter examines the hardware involved and examines the world's biggest computer network, the Internet.

Chapter 7 Operational Systems
Operational systems, such as transaction processing systems, allow firms to buy and sell. Without systems to perform these functions, firms could not operate. Organizations today are moving from a collection of non-integrated transaction processing systems to highly integrated enterprise resource planning systems to perform routine business processes and maintain records about them. These systems support a wide range of business activities associated with supply chain management and customer relationship management. This chapter examines transaction processing systems and enterprise resource planning systems.

Chapter 8 Management Information and Decision Support Systems
This chapter begins with a discussion of decision making and examines the decision-making process. Both management information systems and decision support systems are examined in detail. Their ability to help managers make better decisions is emphasized.

Chapter 9 Knowledge Management and Specialized Information Systems
A discussion of knowledge management leads onto a discussion of some of the special-purpose systems discussed in the chapter, including expert and knowledge-based systems. The other topics discussed include robotics, vision systems, virtual reality and a variety of other special-purpose systems. We discuss embedded artificial intelligence, where artificial intelligence capabilities and applications are placed inside products and services.

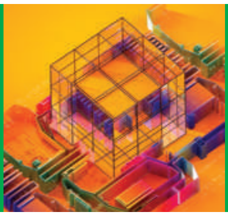
Chapter 10 Pervasive Computing
The move of information systems to leave the office desktop and enter every aspect of our lives is well underway. Many businesses are exploiting this to their advantage, as are their customers. This chapter examines some of the technologies that are enabling all of this to happen. New ones are being introduced almost every month. It is important that businesses understand the potential benefits they can bring.

Chapter 11 Systems Analysis
This chapter and the next examine where information systems come from. Systems investigation and systems analysis, the first two steps of the systems development, are discussed. This chapter provides specific examples of how new or modified systems are initiated and analyzed in a number of industries. This chapter emphasizes how a project can be planned, aligned with corporate goals and rapidly developed.

Chapter 12 Systems Design and Implementation
This chapter looks at how the analysis discussed in Chapter 11 can be used to design and build IT solutions. The chapter mainly looks at developing a new system but also examines solving a problem by buying an existing IS that has already been developed.

Chapter 13 Security, Privacy and Ethical Issues in Information Systems
This last chapter looks at security, privacy and ethical issues, something that is in the background throughout the text. A wide range of non-technical issues associated with the use of IS provide both opportunities and threats to modern organizations. The issues span the full spectrum – from preventing computer waste and mistakes, to avoiding violations of privacy, to complying with laws on collecting data about customers, to monitoring employees.

About the Authors



Ralph Stair received a BS in Chemical Engineering from Purdue University, an MBA from Tulane University, and a PhD from the University of Oregon. He has taught information systems at many universities. He has published numerous articles and books, including *Succeeding With Technology, Programming in BASIC* and many more.

George Reynolds is an assistant professor in the Information Systems department of the College of Business at the University of Cincinnati. He received a BS in Aerospace Engineering from the University of Cincinnati and an MS in Systems Engineering from West Coast University. He taught part-time at Xavier University, the University of Cincinnati, Miami University and the College of Mount Saint Joseph while working full-time in the information systems industry, including positions at the Manned Spacecraft Center in Houston, Texas; the Jet Propulsion Lab in Pasadena, California; and Procter and Gamble in Cincinnati, Ohio.

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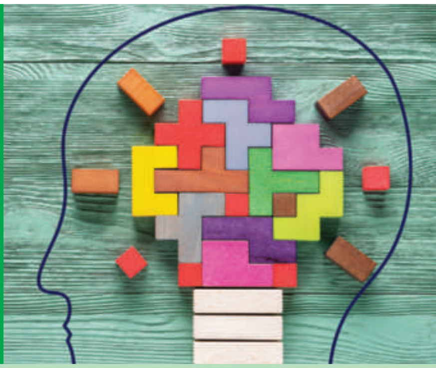
PART 1

Overview

01

An Introduction to Information Systems



Principles	Learning Objectives
The value of information is directly linked to how it helps decision makers achieve organizational goals.	■ Discuss why it is important to study and understand information systems. ■ Describe the characteristics used to evaluate the quality of data.
Computers and information systems are constantly making it possible for organizations to improve the way they conduct business.	■ Name the components of an information system and describe several system characteristics.
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.
Information systems must be applied thoughtfully and carefully so that society, business and industry can reap their enormous benefits.	■ Describe some of the threats to security and privacy that information systems and the Internet can pose. ■ Discuss the expanding role and benefits of information systems in business and industry.

1

Why Learn About Information Systems?

Information systems are used in almost every imaginable profession. Sales representatives use information systems to advertise products, communicate with customers and analyze sales trends. Managers use them to make major decisions, such as whether to build a manufacturing plant or research a cancer drug. 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 chosen career, you will use information systems to help you achieve goals.

This chapter presents an overview of information systems. The sections on hardware, software, databases, telecommunications, e-commerce and m-commerce, transaction processing and enterprise resource planning, information and decision support, special purpose systems, systems development, and ethical and societal issues are expanded to full chapters in the rest of the book. We will start by exploring the basics of information systems.

1.1 What is an Information System?

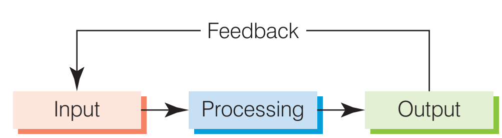
People and organizations use information every day. Many retail chains, for example, collect data from their shops to help them stock what customers want and to reduce costs. Businesses use information systems to increase revenues and reduce costs. We use automated teller machines outside banks and access information over the Internet. Information systems usually involve computers, and together they are constantly changing the way organizations conduct business. Today we live in an information economy. 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-euro decisions, financial institutions transfer billions of euros 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 define an information system, we will start by examining what a system is.

What is a System?

system A set of elements or components that interact to accomplish goals.

A central concept of this book is that of a **system**. A system is a set of elements or components that interact to accomplish goals. The elements themselves and the relationships between them determine how the system works. Systems have inputs, processing mechanisms, outputs and feedback (see Figure 1.1). A system processes the input to create the output. For example, consider an automatic car wash. Tangible inputs for the process are a dirty car, water and various cleaning ingredients. Time, energy, skill and knowledge also serve as inputs to the system because they are needed to operate it.

Figure 1.1 Components of a System *A system's four components consist of input, processing, output and feedback.*



The processing mechanisms consist of first selecting which cleaning option you want (wash only, wash with wax, wash with wax and hand dry, etc.) and communicating that to the operator of the car wash. Liquid sprayers shoot clean water, liquid soap or car wax depending on where your car is in the process and which options you selected. The output is a clean car. As in all systems, independent elements or components (the liquid sprayer, foaming brush and air dryer) interact to create a clean car. A feedback mechanism is your assessment of how clean the car is.

System performance can be measured in various ways. **Efficiency** is a measure of what is produced divided by what is consumed. For example, the efficiency of a motor is the energy produced (in terms of work done) divided by the energy consumed (in terms of electricity or fuel). Some motors have an efficiency of 50 per cent or less because of the energy lost to friction and heat generation.

efficiency A measure of what is produced divided by what is consumed.

Effectiveness is a measure of the extent to which a system achieves its goals. It can be computed by dividing the goals actually achieved by the total of the stated goals. For example, a company might want to achieve a net profit of €100 million for the year with a new information system. Actual profits, however, might only be €85 million for the year. In this case, the effectiveness is 85 per cent (85/100 = 85 per cent).

effectiveness A measure of the extent to which a system achieves its goals; it can be computed by dividing the goals actually achieved by the total of the stated goals.

Evaluating system performance also calls for using performance standards. A **system performance standard** is a specific objective of the system. For example, a system performance standard for a marketing campaign might be to have each sales representative sell €100,000 of a certain type of product each year (see Figure 1.2a). A system performance standard for a manufacturing process might be to produce no more than 1 per cent defective parts (see Figure 1.2b). After standards are established, system performance is measured and compared with the standard. Variances from the standard are determinants of system performance.

system performance standard A specific objective of the system.

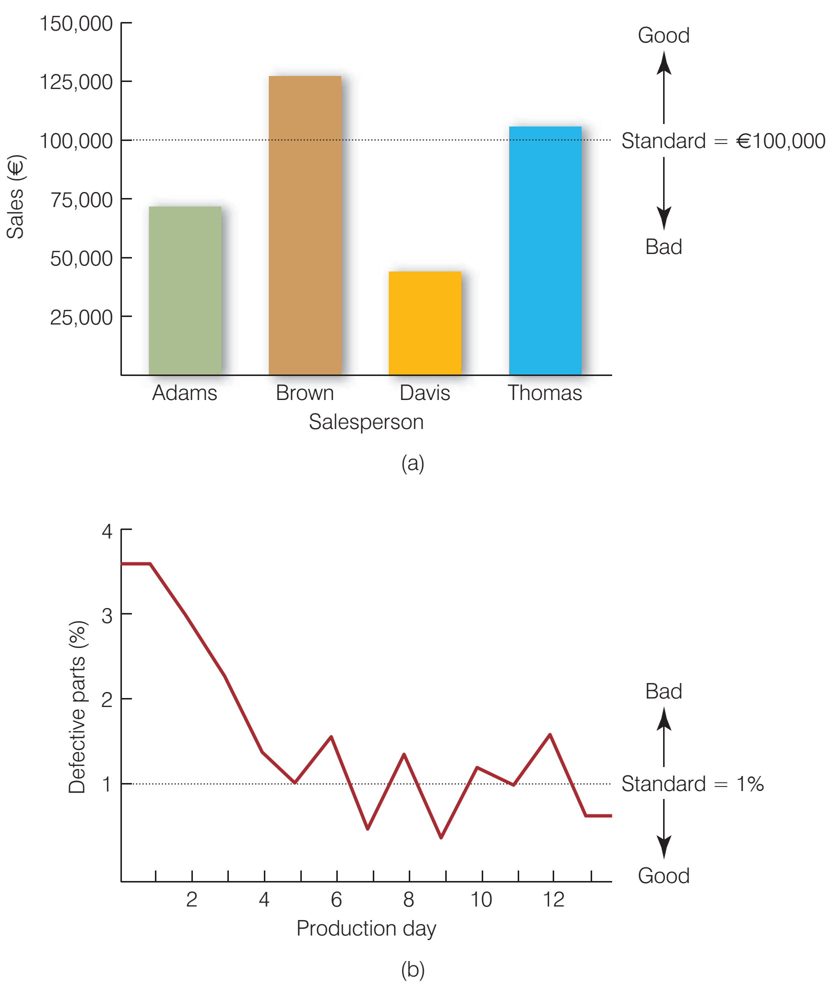


Figure 1.2 System Performance Standards

(a) Sales broken down by salesperson.
(b) Percentage of defective parts.

What is Information?

Information is one of those concepts that we all seem intuitively able to grasp but find tricky to define. In the 1940s, mathematician Claude Shannon defined it as: information is that which reduces uncertainty. Shannon was working on the technical problems involved in sending messages over communication networks, and his concept of information is actually quite different from what we in business information systems mean by 'information'. Nevertheless, we can use his definition as a starting point. Imagine you are unsure of what today's weather will be like. Getting out of bed you open the curtains to see that the sun is shining. You now know a bit more about what it's going to be like: your uncertainty about the weather has been reduced. Therefore looking out of the window gave you information. When you turn on your radio and hear a detailed weather report, your uncertainty has been reduced further. When you look at the temperature gauge in your car, again your uncertainty has gone down. According to Shannon's definition, each of these events has therefore given you information.

However, his definition does not really capture what we would think of when we consider the information in, say, a management report. Therefore we simply define information as a collection of facts. These facts can take many forms. The temperature gauge in the car gives information in the form of a number. The radio gives audio information. Looking out of the window gives visual information. Other forms of information include text, images and video clips.

Another term that is closely related to information is 'data'. It's not intuitive but a philosopher might define data as 'variation'. To explain this: a blank page contains no data, but as soon as there is a mark on the page, that is, as soon as there is variation in the blankness, then data exist. Again this doesn't really capture what we mean by data in the context of business information systems. The traditional information systems view is that the input to an information system is data, and the output from the system is information. This means therefore that the difference between them is to do with how much processing has been done: unprocessed facts are data; processed facts are information. Unfortunately, however, this distinction is of little practical use. Therefore we will simply use the terms 'information' and 'data' interchangeably and define them as a collection of facts which can come in a variety of formats. (Incidentally, strictly speaking, the term data is plural, so we would say 'data are used' rather than 'data is used'. However, this is often not adhered to and we won't worry too much about it here.)

What is an Information System?

information system (IS) A set of interrelated components that collect, manipulate, store and disseminate information and provide a feedback mechanism to meet an objective.

input The activity of gathering and capturing data.

processing Converting or transforming input into useful outputs.

Now that we have defined the terms 'system' and 'information', we can define an information system: an **information system (IS)** is a set of interrelated components that collect, manipulate, store and disseminate information and provide a feedback mechanism to meet an objective. It is the feedback mechanism that helps organizations achieve their goals, such as increasing profits or improving customer service.

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

Processing means converting or transforming this input into useful outputs. Processing can involve making calculations, comparing data and taking alternative actions, and storing data for future use. 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 required 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 basic hours, overtime pay might also be included. Then tax must be deducted along with contributions to health and life insurance or savings plans 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. **Output** involves producing useful information, usually in the form of documents and reports. Outputs can include paycheques for employees, reports for managers, and information supplied to stockholders, banks, government agencies and other groups. In addition, 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. Computers typically produce output on printers and display screens. Output can also be handwritten or manually produced reports, although this is not common.

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

Lastly, **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 hours. 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 hours 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.

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 manufacturing 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. Forecasting is also used to predict the strength of hurricanes and where they will reach land, future stock-market values and who will win a political election.

forecasting Predicting future events.

The Characteristics of Valuable Information

To be valuable to managers and decision makers, information should have some and possibly all of the characteristics described in Table 1.1. 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 euros. Many claim, for example, that the collapse and bankruptcy of some companies, such as drug companies and energy-trading firms, was a result of inaccurate accounting and reporting information, which led investors and employees alike to misjudge the actual state of these companies' finances and suffer huge personal losses. As another example, 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 euros 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.

The value of information is directly linked to how it helps decision makers achieve their organization's goals. For example, the value of information might be measured in the time required to make a decision or in increased profits to the company. 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.

Table 1.1 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
Complete	Complete information contains all the important facts, but not more facts than are necessary (see the Simple characteristic below)
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
Reliable	Reliable information can be depended on. 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 rumour from an unknown source that oil prices might go up soon may not be reliable (even though it might be useful)
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 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

Manual and Computerized Information Systems

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 in graphical form (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 euros 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 to take advantage of market discrepancies.

The components of a **computer-based information system (CBIS)** are illustrated in Figure 1.3. Information technology (IT) refers to hardware, software, databases and telecommunications. 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.

computer-based information system (CBIS) A single set of hardware, software, databases, telecommunications, people and procedures that is 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.

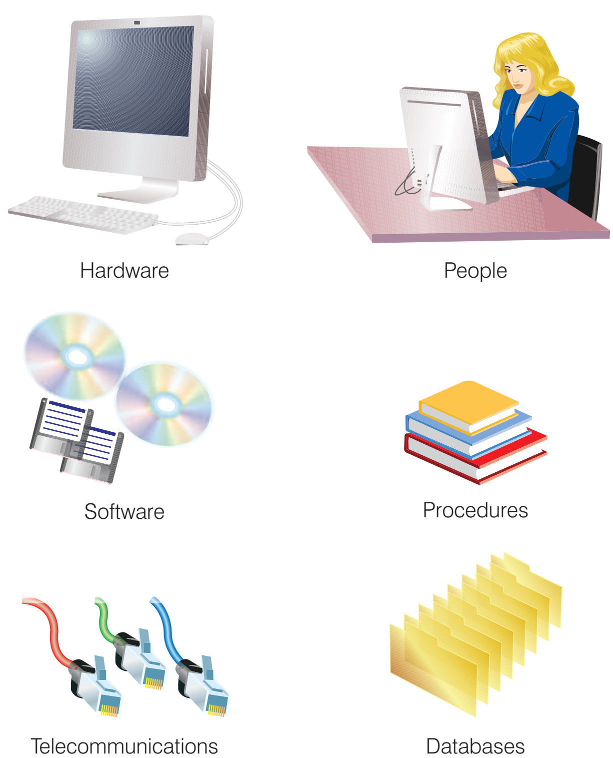


Figure 1.3 The Components of a Computer-Based Information System

Hardware

Hardware consists of computer equipment used to perform input, processing and output activities. Input devices include keyboards, mice and other pointing devices, automatic scanning devices and equipment that can read magnetic ink characters. Investment firms often use voice-response technology to allow customers to access their balances and other information with spoken commands. Processing devices include computer chips that contain the central processing unit and main memory. One processor chip, called the 'Bunny Chip' by some, mimics living organisms and can be used by the drug industry to test drugs instead of using animals, such as rats or bunnies.[1] The experimental chip could save millions of euros and months of time in drug research costs, as well as having a positive impact by reducing animal testing. Speed is an important part of assessing hardware. The TOP500 project (www.top500.org) has collected statistics on the world's fastest computers since 1993. Currently the fastest is the Summit computer at the Oak Ridge National Laboratory in Tennessee, USA. Summit is providing

hardware Any machinery (most of which uses digital circuits) that assists in the input, processing, storage and output activities of an information system.

scientists with computing power to research problems in energy, artificial intelligence and human health. It is able to perform up to 143.5 petaflops; a petaflop is one thousand million million calculations per second.[2,3]

The many types of output devices include printers and computer screens. Bond traders, for example, often use an array of six or more computer screens to monitor bond prices and make split-second trades throughout each day. Another type of output device is a printer to print photos from a digital camera. Such printers accept the memory card direct from the camera. There are also many special-purpose hardware devices. Computerized event data recorders (EDRs) are now being placed into vehicles. Like an aeroplane black box, EDRs record a vehicle's speed, possible engine problems, a driver's performance and more. The technology is being used to monitor vehicle operation, determine the cause of accidents and investigate whether truck drivers are taking required breaks.

Software

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

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. With software, people can work anytime at any place. Software, along with manufacturing tools, for example, can be used to fabricate parts almost anywhere in the world.[4] Software called 'Fab Lab' controls tools, such as cutters, milling machines and other devices. A Fab Lab system, which costs about €15,000, 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.

The two types of software are system software, such as Microsoft Windows, which controls basic computer operations, including start-up and printing; and applications software, such as Microsoft Office, which allows you to accomplish specific tasks, including word processing and drawing charts. Sophisticated application software, such as Adobe Creative Suite, can be used to design, develop, print and place professional-quality advertising, brochures, posters, prints and videos on the Internet.

Databases

database An organized collection of electronic 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 information on customers, employees, inventory, competitors' sales, online purchases and much more. Most managers and executives consider a database to be one of the most valuable parts of a computer-based information system. One California real estate development company uses databases to search for homes that are undervalued and purchase them at bargain prices.[5] It uses the database to analyze crime statistics, prices, local weather reports, school districts and more to find homes whose values are likely to increase. The database has helped the company realize an average 50 per cent return on investment. Increasingly, organizations are placing important databases on the Internet, which makes them accessible to many, including unauthorized users.

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.

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

Telecommunications is the electronic transmission of signals for communications, which enables organizations to carry out their processes and tasks through computer networks. Large restaurant chains, for example, can use telecommunications systems and satellites to link hundreds of restaurants to plants and headquarters to speed credit card authorization and report sales and payroll data. **Networks** connect computers and equipment in a building, around the country or around the world to enable electronic communication. Investment firms can use wireless networks to connect thousands of investors with brokers or traders. Many hotels use wireless telecommunications to allow guests to connect to the Internet, retrieve voice messages and exchange email without plugging their computers or mobile devices into a phone socket. Wireless transmission also allows drones, such as Boeing's Scan Eagle, to fly using a remote control system and monitor buildings and other areas.

The **Internet** is the world's largest computer network, actually consisting of thousands of interconnected networks, all freely exchanging information. Research firms, colleges, universities, schools and businesses are just a few examples of organizations using the Internet. People use the Internet to research information, buy and sell products and services, make travel arrangements, conduct banking, and download music and videos, among other activities. After downloading music, you can use audio software to change a song's tempo, create mixes of your favourite tunes and modify sound tracks to suit your personal taste. You can even mix two or more songs simultaneously, which is called 'mashing'. You can also use many of today's mobile phones to connect to the Internet from around the world and at high speeds.[6] This not only speeds communications but allows you to conduct business electronically. Some airline companies are providing Internet service on their flights so that travellers can send and receive email, check investments and browse the Internet. Internet users can create blogs (weblogs) to store and share their thoughts and ideas with others around the world.[7] You can also record and store TV programmes on computers or special viewing devices and watch them later.[8] Often called 'place shifting', this technology allows you to record TV programmes at home and watch them at a different place when it's convenient.

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

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 many hundreds of millions of documents. Widely available Internet access has allowed the development of **cloud computing**, where software and data storage are provided as an Internet service and are accessed via a web browser.

cloud computing A computing environment where software and storage are provided as an Internet service and are accessed via a web browser.

The technology used to create the Internet is also being applied within companies and organizations to create **intranets**, which allow people within an organization to exchange information and work on projects. One company, for example, uses an intranet to connect its 200 global operating companies and 20,000 employees. 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. Companies can move all or most of their business activities to an extranet site for corporate customers. 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. 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.

intranets An internal company network built using Internet and World Wide Web standards and products 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, suppliers or customers, to access authorized resources of a company's intranet.

People

People are the most important element in most computer-based information systems. The people involved include users of the system and information systems personnel, including all the people who manage, run, program and maintain the system.

Procedures

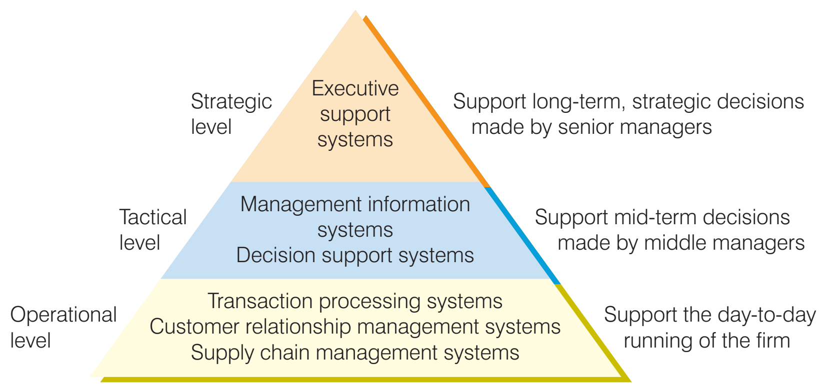
Procedures include the strategies, policies, methods and rules for using the CBIS, including the operation, maintenance and security of the computer. For example, some procedures describe when each program should be run. Others describe who can access facts in the database, or what to do if a disaster, 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.

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

1.2 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. Together, these systems help employees in organizations accomplish routine and special tasks – from recording sales, processing payrolls and supporting decisions in various departments, to examining alternatives for large-scale projects and opportunities. Often in large organizations one information system is used to accomplish all of these tasks. In others, separate systems are used. When one system is used it is called an Enterprise Resource Planning System, and it does most if not all of the tasks of the other systems shown in Figure 1.4.

Figure 1.4 **Business Information Systems**
The triangle shows the main types of information system used in businesses and the level within the business where they tend to be used.



Information Systems @ Work

Translating Shakespeare into Xhosa

Xhosa is an official language in South Africa and Zimbabwe, spoken by Bantu people. It uses three click-consonant sounds for X, Q and C. So the name Xhosa is pronounced by making a clicking or TCHICK sound for the X, resulting in TCHICK-hosa. A way of writing Xhosa using the Latin alphabet was developed in the early 19th century and the language is available as an option on Google Translate.

Many people using Google Translate for the first time are amazed by its abilities. If you haven't tried it, visit your local site (it's www.translate.google.co.uk in the UK), enter some text, choose a language and hit translate. If you actually speak the language you translated into, how did it do? Does the translation make sense and does it say what you meant it to say? If you don't speak that language, copy the translated text and translate it back into the first language – it probably won't be exactly the same, but does it still mean roughly what you said in the first place? Try translating the text through several other languages – English to German to French to Chinese and then back to English – what does it say now? This game is actually popular fodder for YouTube videos – YouTubers translate the lyrics of a popular song into another language, then back into the first language, and record themselves singing exactly what they ended up with. However, this technology has more serious applications.

So how does it work? It relies on the one thing that Google is extremely good at – processing lots and lots of data, very, very quickly. Sorry to disappoint you if you thought the computer could actually understand what you are saying, but in fact it's just doing some statistics. There are many books that have been translated by a human from one language into another, say Victor Hugo's *Notre Dame de Paris*, which was written in French. To translate a French phrase, all the computer has to do is find the phrase in *Notre Dame de Paris*, or some other French book that has been translated, then go to the corresponding page and line in the translation, and return that to the user. But how does the computer know that the page and line are the exact words that translate the exact phrase that the user wrote? That's where the statistics and data processing come in. The computer doesn't just search for the phrase in one book, it looks in say 100 books (the actual figure Google uses is difficult to track down and probably varies) and finds roughly where the phrase will be in each. This will give 100 samples of text that contain the translation somewhere within them. It then chooses the phrase that appears most often in the sample of 100.

For example, the line 'igubu lokukhaphela ingoma endiyivuma ngesingqala' in a Xhosa poem by Ncumisa Garishe MaMiya gets translated as 'the drum of song that I sing in a thunderstorm'. This sequence of words probably only appears in that one poem and nowhere else, so to translate it Google might look for three phrases 'the drum of song', 'that I sing' and 'in a thunderstorm' in its source material to find a translation for each. Then it will put all three together, perhaps also applying some rules it has been taught about grammar.

Taking just the word 'ingoma', which means 'song', if the computer finds 100 sources where this word appears, and in 97 of the translations at around about the right point in the text the word 'song' appears, then that would seem to be a correct translation with 97 per cent confidence. The computer doesn't have to understand anything about language to do this. Given enough sample text, the computer could translate all of Shakespeare. (Trying this, you get 'ngoku kubusika kokunganeliseki kwethu' for 'now is the winter of our discontent'.)

Google Translate was developed under the leadership of computer scientist Franz Och and originally used documents created by the United Nations. The UN has a need to create a lot of written material accurately in a number of languages, and all of this material is freely available, which made it a good source to use. (We should point out that Google did not invent statistical translation.)

Questions

1 Try the exercises suggested in the case – how did Google Translate do?

2 Could this technology be used by a global firm or is the need for absolute accuracy so great that a human translator would always be needed?

3 What are some of the problems with using Google Translate to translate a web page?

4 What would the computer need in order to translate 'Shakespeare into Xhosa'?

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Enterprise Systems: Transaction Processing Systems and Enterprise Resource Planning

Enterprise systems help organizations perform and integrate important tasks, such as paying employees and suppliers, controlling inventory, sending out 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. For example, Whirlpool Corporation, the large appliance maker, used enterprise resource planning to reduce inventory levels by 20 per cent and cut about 5 per cent from its freight and warehousing

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costs by providing managers with information about inventory levels and costs.[9] The new system may have also helped the company increase its revenues by about €0.7 billion.

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, labour-intensive business transactions. A **transaction** is any business-related exchange, such as payments to employees, sales to customers or payments to suppliers. Thus, 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 record completed 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 record completed business transactions.

One of the first business systems to be computerized was the payroll system. 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 paycheques. Early payroll systems produced employee paycheques and related reports required by tax authorities. Other routine applications include sales ordering, customer billing and customer relationship management, and inventory control. Some car companies, for example, use their TPSs to buy billions of euros of needed parts each year through websites. Because these systems handle and process daily business exchanges or transactions, they are all classified as TPSs.

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. An ERP system can replace many applications with one unified set of programs, making the system easier to use and more effective.

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.

Although the scope of an ERP system might vary from company to company, most ERP systems provide integrated software to support manufacturing and finance. In such an environment, a forecast is prepared that estimates customer demand for several weeks. The ERP system checks what is already available in finished product inventory to meet the projected demand. Manufacturing must then produce inventory to eliminate any shortfalls. In developing the production schedule, the ERP system checks the raw material and packing material inventories and determines what needs to be ordered to meet the schedule. Most ERP systems also have a purchasing subsystem that orders the needed items. In addition to these core business processes, some ERP systems can support functions such as human resources, sales and distribution. The primary benefits of implementing an ERP system include easing adoption of improved work processes and increasing access to timely data for decision making.

An important type of transaction processing system handles transactions made electronically over the web. **E-commerce** involves any business transaction executed electronically between companies (business-to-business, 'B2B'), companies and consumers (business-to-consumer, 'B2C'), consumers and other consumers (consumer-to-consumer, 'C2C'), business and the public sector, and consumers and the public sector. You might assume that e-commerce is reserved mainly for consumers visiting websites for online shopping, but web shopping is only a small part of the e-commerce picture; the major volume of e-commerce – and its fastest growing segment – is business-to-business (B2B) transactions that make purchasing easier for corporations. This growth is being stimulated by increased Internet access, growing user confidence, better payment systems and rapidly improving Internet and web security. E-commerce also offers opportunities for small businesses to market and sell at a low cost worldwide, allowing them to enter the global

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

market. **Mobile commerce (m-commerce)** refers to transactions conducted anywhere, anytime. 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 (see Figure 1.5, which shows a mobile phone being used to make a contactless payment).

mobile commerce (m-commerce) Conducting business transactions electronically using mobile devices such as smartphones.

Figure 1.5 Contactless Payment *M-commerce means that it is possible to pay for items using a smartphone or other mobile device.*

E-commerce offers many advantages for streamlining work activities. Figure 1.6 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 website, find the item in a catalogue and order what they need at a price set by their company. If approval is required, the approver 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.

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 website 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 with traditional business strategy, e-business strategy is flexible and adaptable.

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

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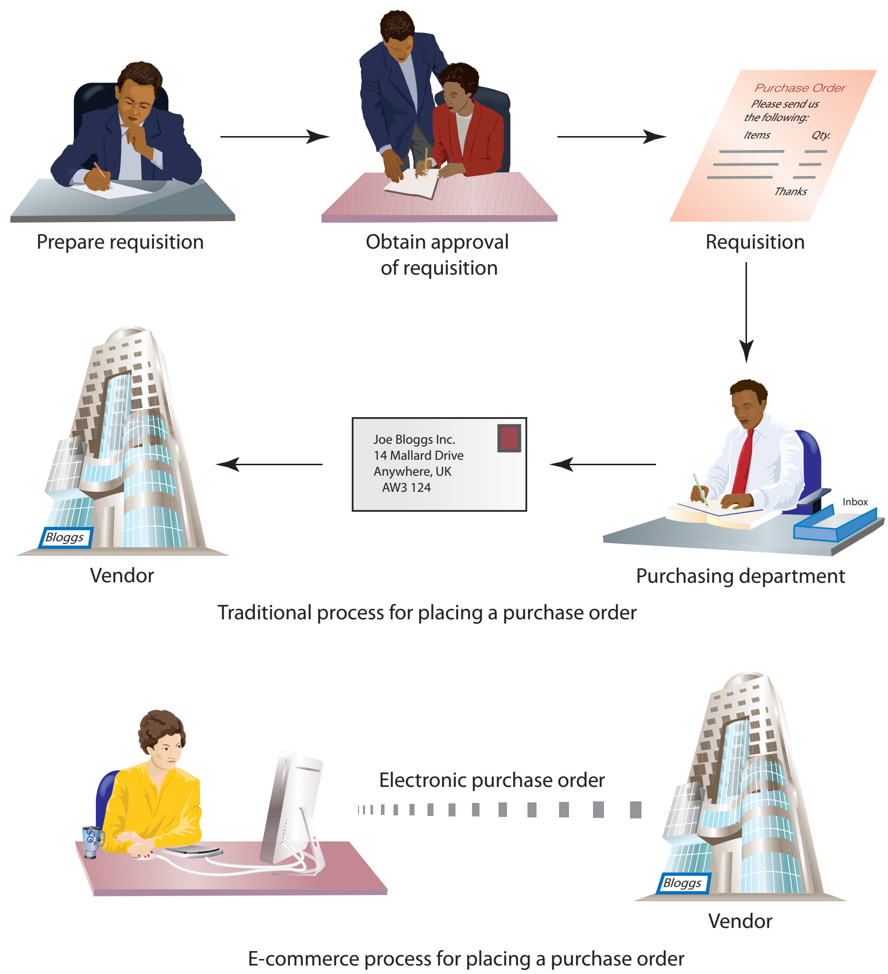
Figure 1.6
E-Commerce Greatly Simplifies Purchasing



MIS and DSS

The benefits provided by an effective TPS are tangible and justify their associated costs in computing equipment, computer programs, and specialized personnel and supplies. A TPS can speed business activities and reduce clerical costs. Although early accounting and financial TPSs were already valuable, 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.

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. 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, meaning the output of a TPS is the input to an MIS. Producing a report that describes inventory that should be ordered is an example of an MIS.

MISs were first developed in the 1960s and typically used 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. For instance, the total payroll summary report produced initially for an accounting manager might also be useful to a production manager to help monitor and control labour and job costs.

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 at all levels of organizations began using personal computers to do a variety of tasks; they were no longer solely dependent on the IS department for all their information needs. 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'.

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

In addition to assisting in all aspects of problem-specific decision making, a DSS can support customers by rapidly responding to their phone and email enquiries. A DSS goes beyond a traditional MIS by providing immediate assistance in solving problems. Many of these problems are unique and complex, and information is often difficult to obtain. For instance, a car manufacturer might try to determine the layout for its new manufacturing facility. Traditional MISs are seldom used to solve these types of problems; a DSS can help by suggesting alternatives and assisting in final decision making.

DSSs are used when the problem is complex and the information needed to make the best decision is difficult to obtain and use. So a DSS also involves managerial judgement and perspective. Managers often play an active role in developing and implementing the DSS. A DSS recognizes that different managerial styles and decision types require different systems. For example, two production managers in the same position trying to solve the same problem might require different information and support. The overall emphasis is to support, rather than replace, managerial decision making.

The essential elements of a DSS 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 (dialogue manager or user interface) that help decision makers and other users interact with the DSS. Software is often used to manage the database – the database management system (DBMS) – and the model base – the model management system (MMS).

In addition to DSSs for managers, group decision support systems and executive support systems use the same approach to support groups and executives.[10] A group decision support system, also called a group support system, includes the DSS elements just described, and software, called groupware, to help groups make effective decisions. An executive support system, also called an executive information system, helps top-level managers, including a firm's CEO, divisional directors and members of the board of directors, make better decisions. An executive support system can assist with strategic planning, top-level organizing and staffing, strategic control and crisis management.

Knowledge Management, Artificial Intelligence, Expert Systems and Virtual Reality

Also, 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. According to a survey of CEOs, firms that use KMSs are more likely to innovate and perform better.[11]

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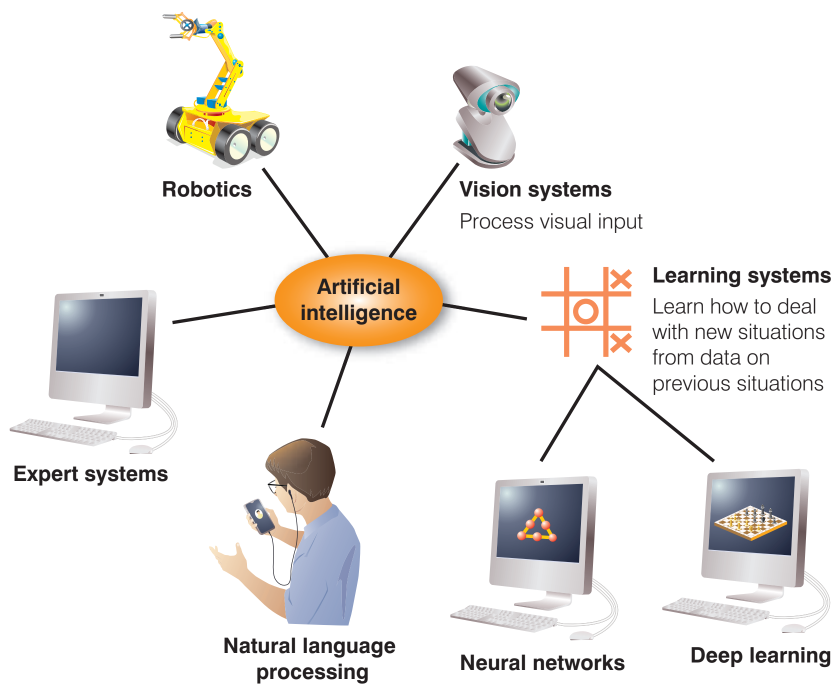
In addition to knowledge management, companies use other types of specialized systems. The Nissan Motor Company, for example, has developed a specialized system for its vehicles called 'Lane Departure Prevention' that nudges a car back into the correct lane if it veers off course.[12,13] The system uses cameras and computers to adjust braking to get the vehicle back on course. The system switches off when the driver uses turn signals to change lanes. Other 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 1.7). Computer scientists are predicting that deep learning will play a massive role in healthcare: computers will be used to analyze medical images, process health records and will fully automate certain teleoperated manipulation tasks of the surgical procedure (which means they will improve robot assisted surgery).[14]

artificial intelligence (AI) The ability of computer systems to mimic or duplicate the functions or characteristics of the human brain or intelligence.

Figure 1.7 The Major Elements of Artificial Intelligence



Learning Systems

Robotics is an area of AI in which machines take over complex, dangerous, routine or boring tasks, such as welding car frames or assembling computer systems and components. 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, and neural networks is a branch of AI that allows computers to recognize and act on patterns or trends. Some successful stock, options and futures traders use neural networks to spot trends and make them more profitable with their investments. State of the art AI is impressive. In 2011 the IBM supercomputer Watson competed against and beat two human champions in the game show *Jeopardy*. In December 2018, Google's Waymo company launched driverless taxis in four suburbs of Phoenix, Arizona in the USA. Riders use an app similar to the Uber app and, for the time being, the cars all have a human driver present to intervene in case of an emergency.[15]

Expert Systems

Expert systems give the computer the ability to make suggestions and act like an expert in a particular field. It can help the novice user perform at the level of an expert. The unique value of expert systems is that they allow organizations to capture and use the wisdom of experts and specialists. Therefore, years of experience and specific skills are not completely lost when a human expert dies, retires or leaves for another job. Expert systems can be applied to almost any field or discipline. They have been used to monitor nuclear reactors, perform medical diagnoses, locate possible repair problems, design and configure IS components, perform credit evaluations and develop marketing plans for a new product or new investment strategy. 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 systems A system that gives a computer the ability to make suggestions and act like an expert in a particular field (or) hardware and software that stores knowledge and makes inferences, similar to a human expert.

knowledge base A component of an expert system that stores all relevant information, data, rules, cases and relationships used by the expert system.

Virtual Reality

Virtual reality is the simulation of a real or imagined environment that can be experienced visually in three dimensions. 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. It can represent any 3D setting, real or abstract, such as a building, an archaeological excavation site, the human anatomy, a sculpture or a crime scene reconstruction. Virtual worlds can be animated, interactive and shared. Through immersion, the user can gain a deeper understanding of the virtual world's behaviour and functionality. 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.

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

A variety of input devices, such as head-mounted displays, 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.

It is difficult to predict where information systems and technology will be in 10 to 20 years. It seems, however, that we are just beginning to discover the full range of their usefulness. Technology has been improving and expanding at an increasing rate; dramatic growth and change are expected for years to come. Without question, a knowledge of the effective use of information systems will be critical for managers both now and in the long term. But how are these information systems created?

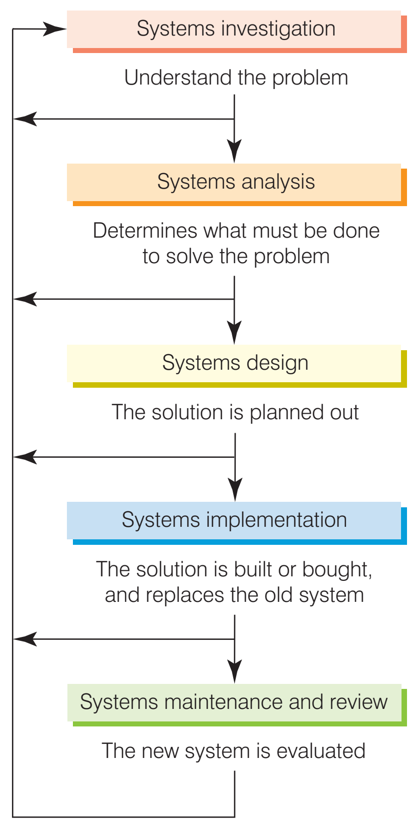
1.3 Systems Development

Systems development is the activity of creating or modifying business systems. Systems development projects can range from small to very large in fields as diverse as stock analysis and video game development. 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. Outsourcing, however, is not the best alternative for all companies. An alternative is agile systems development where systems are developed rapidly in close partnership with users. Working together, parts of the system are developed, tested, modified and refined over and over again until a usable system emerges.

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

Developing information systems to meet business needs is highly complex and difficult – so much so that it is common for IS projects to overrun budgets and exceed scheduled completion dates. Her Majesty's Revenue and Customs (HMRC), which collects taxes in the UK, settled out of court with an outsourcing company to recover funds lost due to a tax-related mistake caused by a failed systems development project.[16] The failed project overpaid about €2.5 billion to some families with children or taxpayers in a low-income tax bracket. 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 1.8). These steps are summarized next.

Figure 1.8 An Overview of Systems Development



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. A cruise line company, for example, might launch a systems investigation to determine whether a development project is feasible to automate purchasing at ports around the world. 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.[17]

Systems Design, Implementation, and Maintenance and Review

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.

1.4 Information Systems in Society, Business and Industry

Information systems have been developed to meet the needs of all types of organizations and people, and their use is spreading throughout the world to improve the lives and business activities of many citizens. To provide their enormous benefits, however, information systems must be implemented with thought and care. The speed and widespread use of information systems opens users to a variety of threats from unethical people.

Ethical and Societal Issues

Ethical Robots

'A robot may not injure a human being or, through inaction, allow a human being to come to harm.'

This is Isaac Asimov's famous first law of robotics and means that a robot must never harm a human being. But what if a robot had to choose between one of two actions, both of which would cause harm? Believe it or not, there are devices interacting with humans right now that at any time could be required to make such a decision. Driverless vehicles are a good example and are currently being tested and used on roads all over the world. What would happen if a child ran out in front of a driverless car and the car could swerve, but if it did swerve it would hit another child standing by the side of the road? According to *Nature* magazine, people often respond that the child at the side is more innocent than the one who ran out and therefore the robot should not swerve. But what if two children ran out and only one stood at the side? Or if it was an adult at the side? What if the adult looked strong and healthy and the robot calculated that they were more likely than the child to survive being hit by the car?

Answers to such questions often rely on what is known to philosophers as the doctrine of double effect: sometimes it is permissible to cause a harm as a side effect (or 'double effect') of bringing about a good result. Analyzing these situations is difficult for a decision-making program. The robot must predict two futures and assess whether the actions in each is not allowed because it causes harm, or permissible because the harm is only a side effect of causing good.

One question is whether this should be programmed into the robot or if the robot should be allowed to learn it for itself? Some computer scientists, like Michael Fisher from the University of Liverpool in the UK, think that rule-based systems could reassure the public. He told *Nature* magazine, 'People are going to be scared of robots if they're not sure what it's doing', he says. 'But if we can analyse and prove the reasons for their actions, we are more likely to surmount that trust issue.' On the other hand, the machine-learning approach (where the robot has to learn what is best for itself) would create robots that can learn from experience, which might ultimately make them more useful than a robot that must follow pre-programmed rules. According to *Nature*, many roboticists say that the best way forward will be a combination of the two approaches. The challenge is to make them work together.

Recently a series of researchers at MIT created the Moral Machine, an online platform to collect data from people all over the world about human opinions on how machines should make decisions when faced with moral dilemmas like these. The site presents participants with scenarios such as brake failure resulting in the deaths of two elderly pedestrians or four young passengers.

(continued)

1

For each scenario, two possibilities are given and participants must choose which one is preferable. For its first major publication, the site was able to gather 40 million decisions from millions of people in over 230 countries and territories. Findings show that humans have a preference to spare humans over animals, spare more lives, and spare young lives, and that both male and female respondents have a preference for sparing female lives.

Questions

1. Should the robot swerve or not in each of the examples given? Can you justify your answer?
2. Would you be comfortable taking a robotic taxi? What about a driverless car?
3. Could a robot ever learn whether or not to swerve? Wouldn't it need to be in the situations many times in order to learn that?
4. View the Moral Machine at www.moralmachine.mit.edu and judge a few of the scenarios. Are there any where you are unable to make a choice?

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Security, Privacy and Ethical Issues in Information Systems and the Internet

Although information systems can provide enormous benefits, they do have some drawbacks.[18] Computer-related mistakes are also a concern. In Japan, a financial services firm had trading losses of ¥245 million due to a typing mistake in entering a trade. In another case, criminals stole carbon credits worth about £30 million from a European carbon credit market.[19]

Increasingly, the ethical use of systems has been highlighted in the news. Ethical issues concern what is generally considered right or wrong. Some IS professionals believe that computers may create new opportunities for unethical behaviour. For example, a faculty member of a medical school falsified computerized research results to get a promotion – and a higher salary. In another case, a company was charged with using a human resource information system to time employee layoffs and firings to avoid paying pensions. More and more, the Internet is also associated with unethical behaviour. Unethical investors have placed false rumours or incorrect information about a company on the Internet and tried to influence its stock price to make money. Information theft, such as stealing credit card numbers and other personal information, is another issue.

To protect against these threats, you can install security and control measures. For example, many software products can detect and remove viruses and spam, or unwanted email, from computer systems. Information systems can help reduce other types of crime as well. In a New Zealand city, a free computer centre has cut vandalism by keeping young people off the street and giving residents a sense of pride. When a pair of headphones disappeared from the centre, the community rallied to make sure that they were promptly returned.

You can install firewalls (software and hardware that protect a computer system or network from outside attacks) to avoid viruses and prevent unauthorized people from gaining access to your computer system. You can also use identification numbers and passwords. Some security experts propose installing web cameras and hiring 'citizen spotters' to monitor them. Use of information systems also raises work concerns, including job loss through increased efficiency and some potential health problems from making repetitive motions. Ergonomics, the study of designing and positioning workplace equipment, can help you avoid health-related problems of using computer systems.

Computer and Information Systems Literacy

In the twenty-first century, business survival and prosperity have continued to become more difficult. For example, increased mergers among former competitors to create global conglomerates, continued downsizing of corporations to focus on their core businesses and to improve efficiencies, efforts to reduce trade barriers, and the globalization of capital all point to the increased internationalization of business organizations and markets. In addition, business issues and decisions are becoming more complex and must be made faster. Whatever career path you take, understanding information systems will help you cope, adapt and prosper in this challenging environment.

A knowledge of information systems will help you make a significant contribution to the job. It will also help you advance in your chosen career or field. Managers are expected to identify opportunities to implement information systems to improve their business. They are also expected to lead IS projects in their areas of expertise. To meet these personal and organizational goals, you must acquire both computer literacy and information systems literacy. **Computer literacy** is a knowledge of computer systems and equipment and the ways they function. It stresses equipment and devices (hardware), programs and instructions (software), databases and telecommunications.

computer literacy Knowledge of computer systems and equipment and the ways they function; it stresses equipment and devices (hardware), programs and instructions (software), databases and telecommunications.

information systems literacy Knowledge of how data and information are used by individuals, groups and organizations.

Information systems literacy goes beyond knowing the fundamentals of computer systems and equipment. **Information systems literacy** is the knowledge of how data and information are used by individuals, groups and organizations. It includes knowledge of computer technology and the broader range of information systems. Most importantly, however, it encompasses how and why this technology is applied in business. Knowing about various types of hardware and software is an example of computer literacy. Knowing how to use hardware and software to increase profits, cut costs, improve productivity and increase customer satisfaction is an example of information systems literacy. Information systems literacy can involve recognizing how and why people (managers, employees, stockholders and others) use information systems; being familiar with organizations, decision-making approaches, management levels and information needs; and understanding how organizations can use computers and information systems to achieve their goals. Knowing how to deploy transaction processing, management information, decision support and expert systems to help an organization achieve its goals is a key aspect of information systems literacy.

Information Systems in the Functional Areas of Business

Information systems are used in all functional areas and operating divisions of business. In finance and accounting, information systems forecast revenues and business activity, determine the best sources and uses of funds, manage cash and other financial resources, analyze investments and perform audits to make sure that the organization is financially sound and that all financial reports and documents are accurate. Sales and marketing use information systems to develop new goods and services (product analysis), select the best location for production and distribution facilities (place or site analysis), determine the best advertising and sales approaches (promotion analysis) and set product prices to get the highest total revenues (price analysis).

In manufacturing, information systems process customer orders, develop production schedules, control inventory levels and monitor product quality. In addition, information systems help to design products (computer-assisted design or CAD), manufacture items (computer-assisted manufacturing or CAM), and integrate machines or pieces of equipment (computer-integrated manufacturing or CIM). Human resource management uses information systems to screen applicants, administer performance tests to employees, monitor employee productivity and more. Legal information systems analyze product liability and warranties and help to develop important legal documents and reports.

Information Systems in Industry

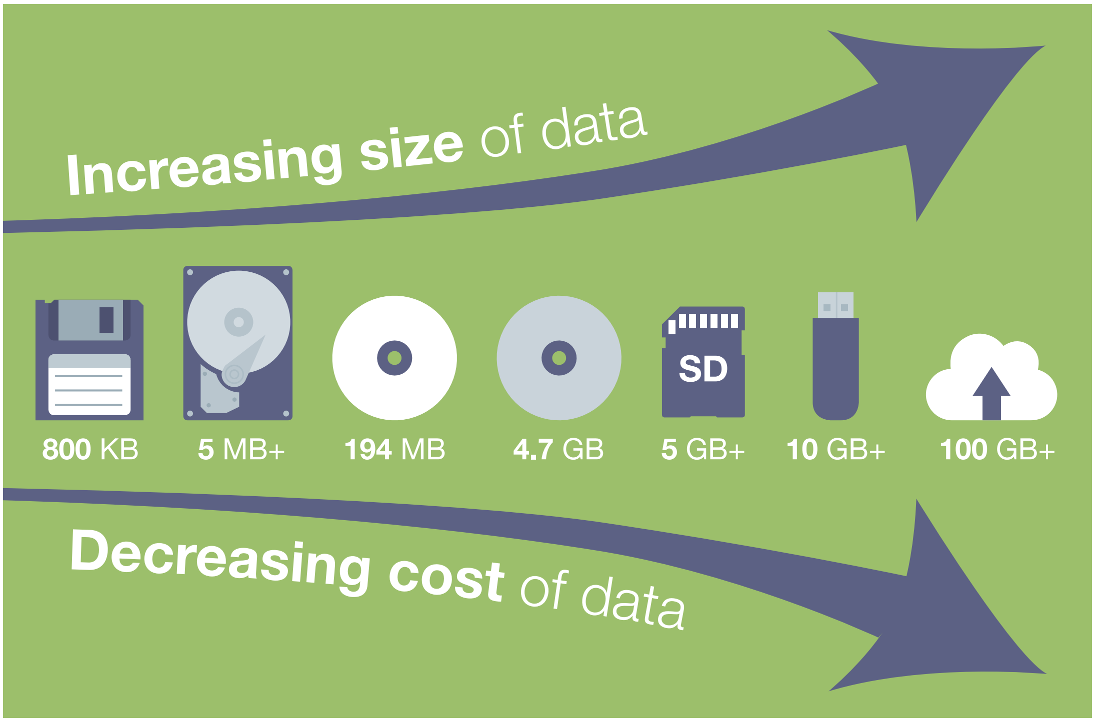
In addition to being used in every department in a company, information systems are used in almost every industry or field in business. The airline industry develops Internet auction sites to offer discount fares and increase revenue. Investment firms use information systems to analyze stocks, bonds, options, the futures market and other financial instruments, and provide improved services to their customers. Banks use information systems to help make sound loans and good investments, as well as to provide online payment for account holders. The transportation industry uses information systems to schedule trucks and trains to deliver goods and services at the lowest cost. Publishing companies use information systems to analyze markets and to develop and publish newspapers, magazines and books. Private healthcare organizations use information systems to diagnose illnesses, plan medical treatment, track patient records and bill patients. Retail companies are using the web to take orders and provide customer service support. Retail companies also use information systems to help market products and services, manage inventory levels, control the supply chain and forecast demand. Power management and utility companies use information systems to monitor and control power generation and usage. Professional services firms employ information systems to improve the speed and quality of services they provide to customers. Management consulting firms use intranets and extranets to offer information on products, services, skill levels and past engagements to their consultants. These industries are discussed in more detail as we continue through the book.

1.5 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 big impact on organizations and their information systems. In his book *The World Is Flat*, Thomas Friedman describes three eras of globalization (see Table 1.2).[20] 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 seem smaller and effectively levelling the global playing field. In the Globalization 3 era, designing a new aeroplane 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.

Table 1.2 Eras of Globalization

Era	Dates	Characterized by
Globalization 1	Late 1400–1800	Countries with the power to explore and influence the world
Globalization 2	1800–2000	Multinational corporations that have plants, warehouses and offices around the world
Globalization 3	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



Increasing size of data: *As the cost of storing data has fallen, the world's need for data storage has increased.*

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.

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These opportunities, however, introduce numerous obstacles and issues, including challenges involving culture, language and many others.

- *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 a car 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 help and advice can all be delivered over the Internet.
- *Technology transfer issues.* Most governments don't allow certain military-related equipment and systems to be sold to some countries. Also, some believe that foreign companies are stealing the intellectual property, trade secrets, copyrighted materials, and counterfeiting products and services.[21, 22]
- *National laws.* Every 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 'trans-border data-flow laws'. Keeping track of these laws and incorporating them into the procedures and computer systems of multinational and trans-national organizations can be very difficult and time consuming, requiring expert legal advice.
- *Trade agreements.* Countries often enter into trade agreements with each other. The EU has trade agreements among its members.[23] The North American Free Trade Agreement (NAFTA) and the Central American Free Trade Agreement (CAFTA) are other examples.[24] Others include the Australia–United States Free Trade Agreement and agreements between Bolivia and Mexico, Canada and Costa Rica, Canada and Israel, Chile and Korea, Mexico and Japan, the USA and Jordan and many others.[25]

Summary

The value of information is directly linked to how it helps decision makers achieve the organizational goals. Information systems are used in almost every imaginable career area. Regardless of your chosen career, you will find that information systems are indispensable tools to help you achieve your goals. Learning about information systems can help you get your first job, earn promotions and advance your career.

Information is a collection of facts. 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.

Computers and information systems are constantly making it possible for organizations to improve the way they conduct business. A system is a set of elements that interact to accomplish a goal or set of objectives. The components of a system include inputs, processing mechanisms and outputs. A system uses feedback to monitor and control its operation to make sure that it continues to meet its goals and objectives.

System performance is measured by its efficiency and effectiveness. Efficiency is a measure of what is produced divided by what is consumed; effectiveness measures the extent to which a system achieves its goals. A system's performance standard is a specific objective.

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 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.

The components of a computer-based information system (CBIS) include hardware, software, databases, telecommunications and the Internet, people and procedures. The types of CBISs that organizations use can be classified into: (1) e-commerce and m-commerce, TPS and ERP systems; (2) MIS and DSS; and (3) specialized business information systems. The key to understanding these types of systems begins with learning their fundamentals.

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 also offers opportunities for small businesses to market and sell at a low cost worldwide, thus allowing them to enter the global market right from start-up. M-commerce involves 'anytime, anywhere' computing that relies on wireless networks and systems.

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. An enterprise resource planning (ERP) system is a set of integrated programs that can manage the vital business operations for an entire multisite, global organization. A management information system (MIS) uses the information from a TPS to generate information useful for management decision making.

A decision support system (DSS) is an organized collection of people, procedures, databases and devices that help make problem-specific decisions. A DSS differs from an MIS in the support given to users, the emphasis on decisions, the development and approach, and the system components, speed and output.

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Specialized business information systems include knowledge management, artificial intelligence, expert 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. Artificial intelligence (AI) includes a wide range of systems in which the computer takes on the characteristics of human intelligence. Robotics is an area of AI in which machines perform complex, dangerous, routine or boring tasks, such as welding car frames or assembling computer systems and components. Vision systems allow robots and other devices to have 'sight' and to store and process visual images. Natural language processing involves computers interpreting and acting on verbal or written commands in English, Spanish or other human languages. Learning systems let computers learn from past mistakes or experiences, such as playing games or making business decisions, while neural networks is a branch of AI that allows computers to recognize and act on patterns or trends. An expert system (ES) is designed to act as an expert consultant to a user who is seeking advice about a specific situation. Originally, the term 'virtual reality' referred to immersive virtual reality, in which the user becomes fully immersed in an artificial, computer-generated 3D world. 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.

System users, business managers and information systems professionals must work together to build a successful information system. Systems development involves creating or modifying existing business systems. The major steps of this process and their goals include systems investigation (gain a clear understanding of what the problem is), systems analysis (define what the system must do to solve the problem), systems design (determine exactly how the system will work to meet the business needs), systems implementation (create or acquire the various system components defined in the design step), and systems maintenance and review (maintain and then modify the system so that it continues to meet changing business needs).

Information systems must be applied thoughtfully and carefully so that society, business and industry can reap their enormous benefits. Information systems play a fundamental and ever-expanding role in society, business and industry. But their use can also raise serious security, privacy and ethical issues. Effective information systems can have a major impact on corporate strategy and organizational success. Businesses around the globe are enjoying better safety and service, greater efficiency and effectiveness, reduced expenses, and improved decision making and control because of information systems. Individuals who can help their businesses realize these benefits will be in demand well into the future.

Computer and information systems literacy are prerequisites for numerous job opportunities, and not only in the IS field. Computer literacy is knowledge of computer systems and equipment, and information systems literacy is knowledge of how data and information are used by individuals, groups and organizations. Today, information systems are used in all the functional areas of business, including accounting, finance, sales, marketing, manufacturing, human resource management and legal information systems. Information systems are also used in every industry, such as airlines, investment firms, banks, transportation companies, publishing companies, healthcare, retail, power management, professional services and more.

Self-Assessment Test

1 Input is __________ to produce output.

2 A __________ is a specific objective of a system.

3 __________ is information from a system that is used to make changes to the input.

4 Providing software and data storage via a web browser is usually called __________.

5 The most important element in an information system is the __________.

6 An __________ supports long-term strategic decision making.

7 A business related exchange is known as a __________.

8 M-commerce involves paying for goods and services using a __________.

9 The activity of creating an information system is called __________.

10 When a person has the ability to use a computer they are known as being __________.

Review Questions

1 Describe what an information system is. What are its main elements?

2 Define the word 'system'.

3 What are the main components of a system? What does each of them do?

4 What are the characteristics of good quality information?

5 Describe what a TPS does.

6 What is m-commerce?

7 Define telecommunications.

8 What is virtual reality and how could it be used in an organization?

9 What are the main steps in systems development?

10 What are some of the global challenges in the field of information systems?

Discussion Questions

1 List the areas of your life that are impacted by information systems. Select a few of these and describe how things would be different without IS.

2 If driverless technology was perfected, how would you organize the country's daily commute to work? Would we all own a car or would you take a different approach?

Web Exercises

1 Search for information about a system that you interact with (it doesn't have to be a software system). Describe the main input, processing and output.

2 Find examples of software that allows working from home including perhaps during the coronavirus (COVID-19) pandemic. What are the features that each example offers that facilitate home working?

1

Case One

Boaty McBoatface: The Online Survey That Went Viral

Oh dear. It has happened before and it will happen again. A serious organization naively assumes that the Internet-using public will take its survey seriously.

Having just spent over €300 million on a new Arctic-going research vessel, the Natural Environment Research Council (NERC) thought it would stir up interest in its work by running an online poll to decide what to name it. Perhaps the public would suggest naming it after a famous explorer. Or maybe Sir David Attenborough, a name synonymous in the UK with TV nature programmes. A few weeks later and the results were in. The winning suggestion? 'Boaty McBoatface'.

The suggestion received 124,109 votes, a massive four times as many as the runner up, Poppy-Mai, named after a 16-month-old girl with incurable cancer. The chief executive of the NERC, Duncan Wingham, was then faced with the dilemma of choosing between a credible name and overwhelming public opinion.

As mentioned, this is not the first time this sort of thing has happened. In 2012, soft drinks maker PepsiCo ran a survey to 'Dub the Dew' and give their new flavour a brand name. Unfortunately pranksters from the online community 4Chan stepped in and the name 'Hitler Did Nothing Wrong' rose to the top of the suggestions (although other communities were also blamed for this).

The UK government was quick to put the breaks on Boaty McBoatface. Jo Johnson, the then science minister said, 'The new royal research ship will be sailing into the world's iciest waters to address global challenges that affect the lives of hundreds of millions of people, including global warming, the melting of polar ice and rising sea levels. That's why we want a name that lasts longer than a social media news cycle and reflects the serious nature of the science it will be doing. There are many excellent suggestions among the 7,000 names put forward by members of the public and we'll make a decision as to which one should be put forward for the royal warrant when we've had a chance to review them all'.

There was even more to answer for. A parliamentary inquiry into the affair criticized NERC and its partners in the British government for not having sufficiently planned for what would happen after the naming contest ended. NERC had invited the public to engage with their new research ship but didn't specify what engagement they were looking for and how to proceed if and when people actually engaged. *The Atlantic* magazine asked 'What's the point of getting people involved if their involvement stops at voting in an online poll? It's a bit like asking someone on a date without gaming out what you'll do if you get a "yes"'.

Some people thought the NERC could compromise and use Boaty McBoatface in some way without actually giving that name to the ship (perhaps by using the name for a raft or life vessel).

In fact, NERC did indeed announce that Boaty McBoatface would be the name of the ship's remote submarine and the ship itself would be called *The Sir David Attenborough*.

Questions

1 If you were chief executive of the NERC, what would your decision be?

2 Are online surveys of this kind just too dangerous for an organization?

3 What are the advantages of this sort of survey?

4 Is there no such thing as bad publicity? Who would have heard of this €300m ship if it had not been for the Boaty McBoatface suggestion?

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Case Two

Health Information Systems in South Africa

Hospitals and health workers have long recognized the importance of good information. A knowledge of diagnoses made by doctors in the past, and a record of treatments that were given to patients along with the outcomes, all help to create the most promising treatment plans for future patients. Information on the geography of health problems also helps to create a national strategy that can be used to make health-related decisions and plan responses to disease outbreaks. The data may even be used to predict and prevent those outbreaks.

South Africa’s Health Information Systems Program is a not-for-profit non-governmental organization that aims to empower healthcare workers and decision makers to improve the coverage, quality and efficiency of health services through the use of open standards and data exchange mechanisms. They subscribe to an open source philosophy, freely sharing their training materials and software solutions.

Their staff members include nine software developers and ten database administrators who create web-based and mobile solutions. This use of web standards means that their software will run on most operating systems and on most devices, which means there will be few, if any, access problems. One of their main systems, called DHIS2, is used to collect a range of data. This includes case-based data from in-patient admissions, essentially recording the who, what, when and where of patients being seen. Data is also stored on disease outbreaks and responses. New mothers and young children are seen as being particularly vulnerable, and so data is stored to improve their care. The results of lab tests and information on stocks of drugs and other treatments in hospitals are also recorded, as is data on patient deaths. The system includes a variety of ways to view all of this including charts and graphs. Geographic features that allow users to view maps of hospitals and to visualize the catchment areas for each are also available. All of this is seen through a clear, easy to navigate, information dashboard. The COVID-19 pandemic has also highlighted how important it is to have information and systems in place to deal with health crisis situations.

One important but previously often overlooked feature that is included in DHIS2 is social networking. In other words, DHIS2 allows for communication between users. This often encourages knowledge sharing and means that health professionals do not have to work in isolation. Patients too are realizing the importance of sharing their data. For instance, in a case unrelated to the HIS program, South African members of PatientsLikeMe recently contributed to an online survey of drug use which gave health professionals vital information. PatientsLikeMe is a web-based community of patients who compare the treatments they receive, and discuss their symptoms and experiences. The goal is for patients to support each other and to use the data generated to develop new treatment plans using cutting edge analytics. Towards that goal, in 2016 the NHS in the UK gave a company owned by Google access to 1.6 million patients from three hospitals. One of the goals is to develop software to alert staff to patients at risk of deterioration and death through kidney failure. However, local papers have reported that some patients are concerned about privacy and sharing sensitive data with a private company.

1

Questions

1 What devices could be used to collect health information and what are the advantages and disadvantages of each?

2 What are the advantages of health professionals discussing patients with each other online? Are there any disadvantages?

3 Why do you think the Health Information Systems Program uses an open source philosophy?

4 Why are patients concerned with sharing sensitive data with a private company?

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Case Three

Australian Drones Join The Postal Service

Australia's national postal service occassionally uses drones to make deliveries. Testing has begun that may in the near future see some customers receiving parcels from the sky. This could be good news for those who live in more remote areas and for people whose mailboxes are a distance from their doors, such as farmers, some of whom have to drive many miles to the gates of their property where deliveries are usually left.

The drones are remote controlled by an operator and have been built by Australian company ARI Labs. They feature a parachute in case of engine failure and have a camera at the front giving the operator a real-time view of what is ahead of the drone. The customer lays out a landing grid that the operator can see (essentially a brightly coloured picnic blanket) when they get close to the delivery address.

Some operators use a headset to immerse themselves in the experience of flying. This involves wearing goggles that display the feed from the camera and give them the sense that they are actually on board the drone. Doing this often makes people physically sick when they start to use it, and even after that initial period, some people will never enjoy the sensation. It's like sea sickness and can last for several hours. There are several explanations for it but the most likely seems to be that the body is getting signals through the eyes that it is moving, but nothing from the rest of the senses.

When the drone is nearing its destination, a message is sent to the receiver that it is about to land and to put out the landing grid. What happens next is being tested, but it's likely to be that the drone lands, drops the parcel on the ground and then takes off again, allowing the receiver to then go safely in and pick up their package, having never interacted directly with the drone.

Others are interested in this technology. Drones have been used to deliver contraband into prisons and to smuggle drugs across borders. In the UK, there were 33 incidents of smuggling contraband into prisons involving devices in 2015. This has caused some police forces to train up eagles to grab them in mid flight!

Australia's Civil Aviation Safety Authority is monitoring the tests carefully and will decide whether to allow the postal service to go ahead with the scheme. Australia Post CEO Ahmed Favour said that although the company hoped to get the drones delivering soon, they would only start shipping parcels 'once we are 100 percent sure that it's safe and reliable'. As yet, no details have been released about the cost of the service to customers.

Questions

1 What precautions would have to be taken to get this technology off the ground?

2 What other uses can you think of for this technology?

3 What alternatives are there to the use of a headset for drone operators?

4 Will all police forces need to start training eagles?

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02

Information Systems in Organizations

Principles

The use of information systems to add value to the organization is strongly influenced by organizational structure and the organization's attitude and ability to change.

Learning Objectives

- Identify the value-adding processes in the supply chain and describe the role of information systems within them.
- Provide a clear definition of 'organizational structure' and 'organizational change' and discuss how these affect the implementation of information systems.

Because information systems are so important, businesses need to be sure that improvements to existing systems or completely new systems help lower costs, increase profits, improve service or achieve a competitive advantage.

- 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 achieve such an advantage.
- Discuss how organizations justify the need for information systems.

Cooperation between business managers and IS personnel is the key to unlocking the potential of any new or modified system.

- Define the types of roles, functions and careers available in information systems.

Why Learn About Information Systems in Organizations?

The impact that computers have in organizations cannot be overstated. Office work has been transformed almost beyond all recognition, and many workers could not operate without their computer. All of this happened before the rise in popularity of the Internet as a channel for sharing information. When that happened, the Internet changed everything all over again! No matter what path your career takes, you will almost certainly come into contact with information systems every day. Marketing departments, accounts departments, order processing, shipping and logistics all rely on information systems. Researchers, medical doctors, mechanics – it is difficult to think of a profession where the computer does not play a central role. Even musicians use information systems to get the sound they want. In this chapter, you will see how the use of information systems in every part of organizations can help produce higher-quality products and increase their returns on investment.

2.1 An Introduction to Organizations

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. Non-profit organizations include social groups, religious groups, universities, charities and other organizations that do not have profit as their goal.

An organization is a system, which, as you will recall from Chapter 1, means that it has inputs, processing mechanisms, outputs and feedback. 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 achieve their goals.

How does the organizational system increase the value of resources? In the transformation mechanism, subsystems contain processes that help turn inputs into goods or services of increasing value. These processes increase the relative worth of the combined inputs on their way to becoming final outputs. Consider a car maker. Its inputs are the staff it has hired, the assembly equipment it has bought, raw materials such as metal and plastic, and pre-assembled components such car radios. The processing that it does is turning the materials into finished vehicles, which are the output. The finished product is worth more than the cost of the components. This amount is the value that has been added.

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.

The **value chain**, popularized by Michael Porter in his book, *Competitive Strategy*,[1] is a useful tool for analyzing where and how this value gets added. The value chain is a series (chain) of activities that includes inbound logistics, warehouse and storage, production, finished product storage, outbound logistics, marketing and sales, and customer service. The value chain of a manufacturing company is shown in Figure 2.1.

Analyzing value chains when developing information systems often results in efficient transaction processing systems (explained fully in a later chapter), an expanding market and the sharing of information.[2] The value chain is used to examine what happens to raw materials to add value to them before the finished product is sold to customers. Information systems can be focused on those activities that add the most value. The value chain can also reveal linkages between different activites (say marketing and production) which can be exploited using IS (to increase communication between the two for instance).

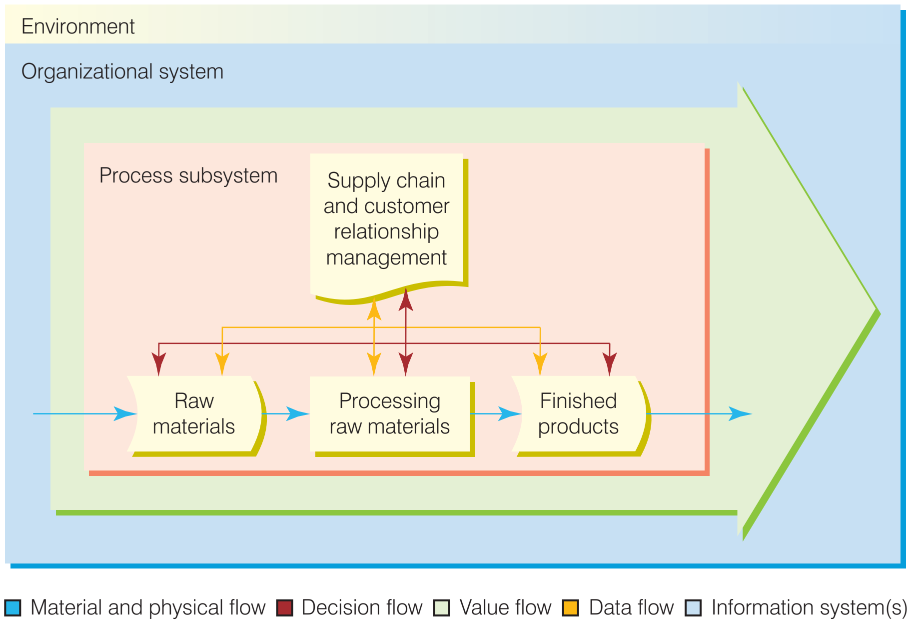


Figure 2.1 The Value Chain of a Manufacturing Company *Managing raw materials, inbound logistics, and warehouse and storage facilities is called 'upstream management', and managing finished product storage, outbound logistics, marketing and sales, and customer service is called 'downstream management'.*

The value chain is just as important (although it can be a little more difficult to apply) to companies that don't manufacture products but provide services, such as tax preparers and legal firms. By adding a significant amount of value to their products and services, companies ensure success.

Supply chain management (SCM) and customer relationship management (CRM) are two key parts of managing the value chain. 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.[3] For example, in the car manufacturing company mentioned previously, SCM can identify key suppliers and parts, negotiate with vendors for the best prices and support, make sure that all supplies and parts are available to manufacture cars and send finished products to dealerships around the country when they are needed. Increasingly, SCM is accomplished using the Internet and electronic marketplaces (e-marketplaces).[4] When an organization has many suppliers, it can use business-to-business exchanges. Zoodel, for example, facilitates international trade in the Middle East and elsewhere including Kazakhstan, Lebanon, Iran, China, Afghanistan, Iraq, Oman, Turkey and Russia. Their web portal can help buyers find the products they are looking for and facilitate communication between buyer and seller to allow them to negotiate, place orders and arrange delivery. Zoodel checks all sellers through a verification and inspection process and guarantees payment using an escrow system.[5]

CRM programs help a company manage all aspects of customer encounters, including marketing and advertising, sales, customer service after the sale and help to retain loyal customers. CRM can assist a company with collecting data on customers, contacting customers, informing them about new products and actively selling products to existing and new customers. Often, CRM software uses a variety of information sources, including sales from retail stores, surveys, email and Internet browsing habits, to compile comprehensive customer profiles. CRM systems can also collect customer feedback which can be used to design new products and services. Tesco, the UK's largest retail operation,[6] encourages its customers to use its Clubcard, which allows it to collect information on customer transactions. It uses this information to provide outstanding customer service and deliver loyalty rewards and perks to valued customers.[7] In return, customers are rewarded with discounts on Tesco products, holidays and other deals. Figure 2.2 shows the Tesco website which the company uses to help with CRM.

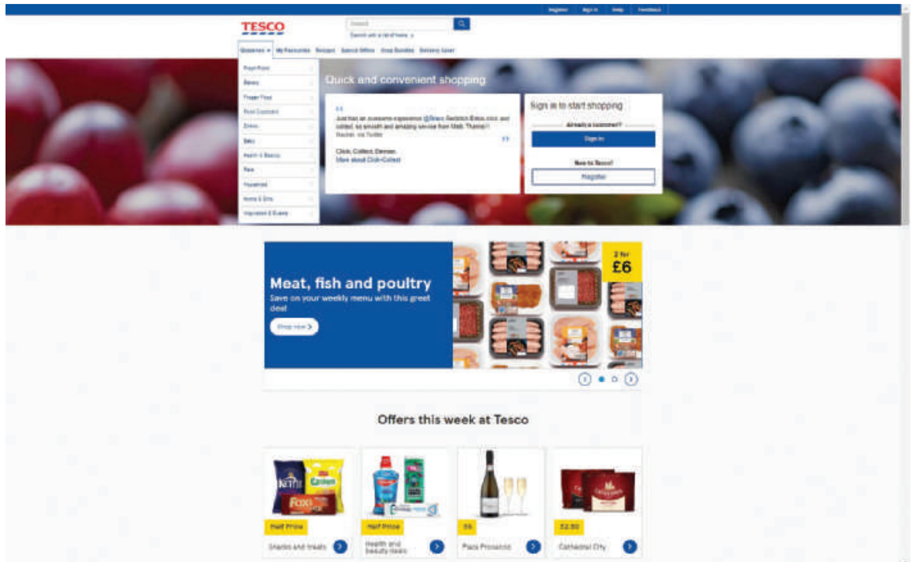


Figure 2.2 Tesco Website *Tesco uses its website to help with customer relationship management.*

What role does an information system play in these processes? A traditional view of information systems holds that organizations use them to control and monitor processes and ensure effectiveness and efficiency. Under this view, the output from a company's information systems is used to make changes to company processes. These changes could involve using different raw materials (inputs), designing new assembly-line procedures (product transformation) or developing new products and services (outputs). Here, the information system is external to the process and serves to monitor or control it.

A more contemporary view, however, holds that information systems are often so intimately involved that they are part of the process itself. From this perspective, the information system plays an integral role in the process, whether providing input, aiding product transformation or producing output. Consider a telephone directory business that creates telephone books for international businesses. A customer requests a telephone directory listing all steel suppliers in Western Europe. Using its information system, the directory business can sort files to find the suppliers' names and telephone numbers and organize them into an alphabetical list. The information system itself is an inseparable part of this process. It does not just monitor the process externally but works as part of the process to transform raw data into a product. In this example, the information system turns input (names and telephone numbers) into a sellable output (a telephone directory). The same system might also provide the input (the files storing the data) and output (printed pages for the directory).

This latter view provides a new perspective on how and why businesses can use information systems. Rather than attempting to understand information systems independently of the organization, we must consider the potential role of information systems within the process itself, often leading to the discovery of new and better ways to accomplish the process.

Organizational Structures

organizational structure Organizational subunits and the way they relate to the overall organization.

Organizational structure refers to organizational subunits and the way they relate to each other. An organization's structure depends on its approach to management and can affect how it views and uses information systems. The types of organizational structures typically include traditional, project, team and virtual.

Traditional Organizational Structure

A **traditional organizational structure**, also called a hierarchical structure, is like a managerial pyramid where the hierarchy of decision making and authority flows from the strategic management at the top, down to operational management and non-management employees. Compared to lower levels, the strategic level, including the managing director of the company and directors, has a higher degree of decision authority, more impact on business goals and more unique problems to solve (see Figure 2.3).

traditional organizational structure An organizational structure similar to a managerial pyramid, where the hierarchy of decision making and authority flows from strategic management at the top, down to operational management and non-management employees. Also called a hierarchical structure.

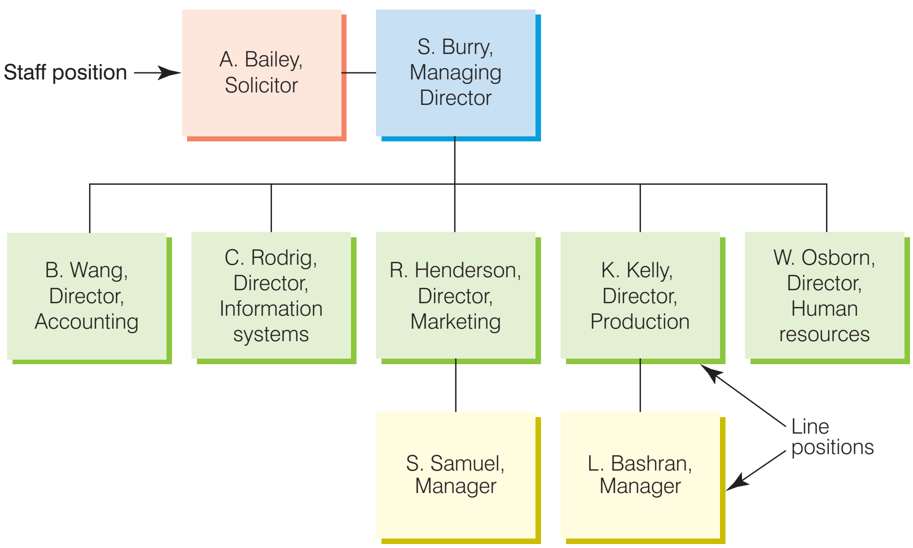


Figure 2.3 A Traditional Organizational Structure

In most cases, department heads report to a managing director or top-level manager. The departments are usually divided according to function and can include marketing, production, information systems, finance and accounting, research and development, and so on. The positions or departments that are directly associated with making, packing, or shipping goods are called line positions. A production manager who reports to a director of production is an example of a line position. Other positions might not be directly involved with the formal chain of command but instead assist a department or area. These are staff positions, such as a solicitor, reporting to the managing director.

Today, the trend is to reduce the number of management levels, or layers, in the traditional organizational structure. This type of structure, often called a **flat organizational structure**, empowers employees at lower levels to make decisions and solve problems without needing permission from mid-level managers. **Empowerment** gives employees and their managers more responsibility and authority to make decisions, take action and have more control over their jobs. For example, an empowered shop assistant can respond to customer requests and problems without needing permission from a manager. In a factory, empowerment might mean that an assembly-line worker can stop production to correct a problem before the product is passed to the next station.

flat organizational structure An organizational structure with a reduced number of management layers.

empowerment Giving employees and their managers more responsibility and the authority to make decisions, take certain actions and have more control over their jobs.

Information systems can be a key element in empowering employees because they provide the information employees need to make decisions. The employees might also be empowered to develop or use their own personal information systems, such as a simple forecasting model or spreadsheet.

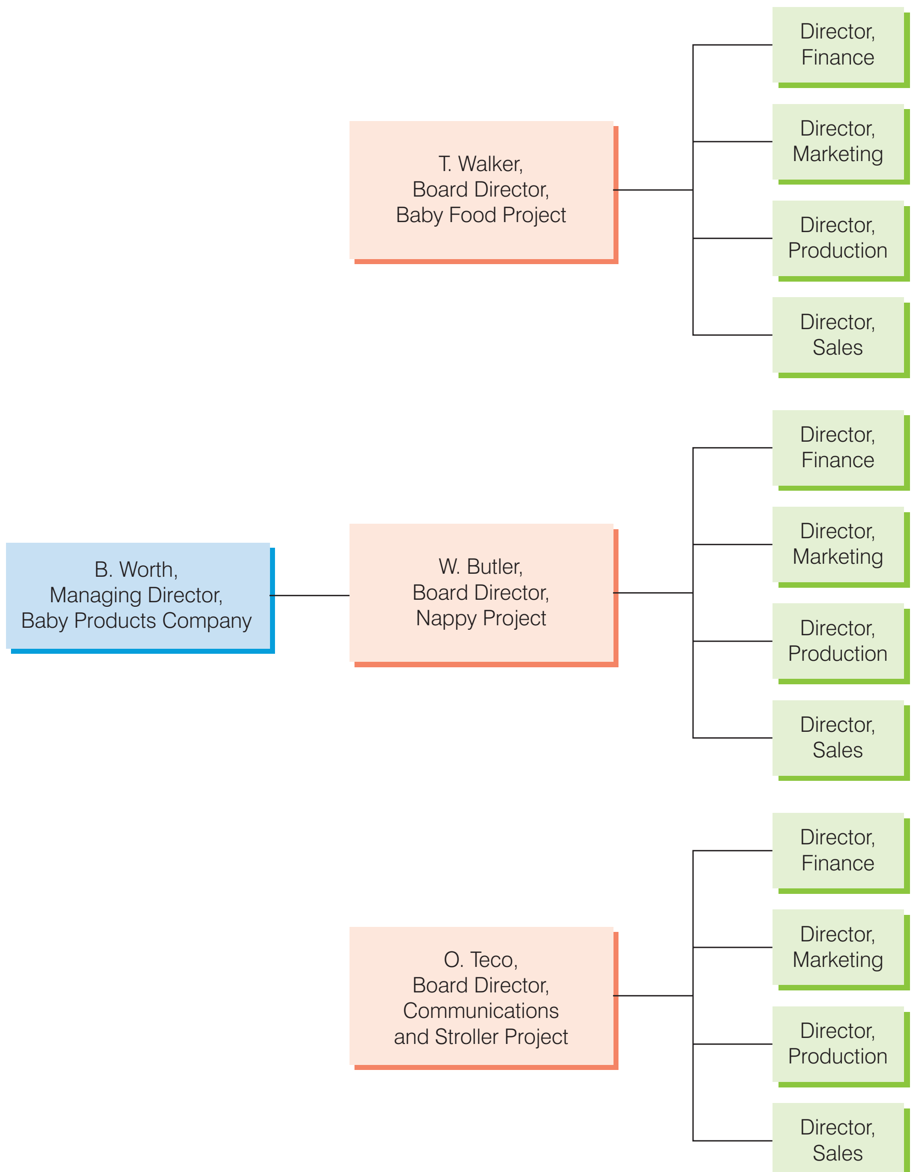
Project and Team Organizational Structures

project organizational structure A structure centred on major products or services.

A **project organizational structure** is centred on major products or services. For example, in a manufacturing firm that produces baby food and other baby products, each line is produced by a separate unit. Traditional functions such as marketing, finance and production are positioned within these major units (see Figure 2.4). Many project teams are temporary – when the project is complete, the members go on to new teams formed for another project.

2

Figure 2.4 A Project Organizational Structure



team organizational structure A structure centred on work teams or groups.

The **team organizational structure** is centred on work teams or groups. In some cases, these teams are small; in others, they are very large. Typically, each team has a leader who reports to an upper-level manager. Depending on its tasks, the team can be temporary or permanent. A healthcare company, for example, can form small teams to organize its administrators, physicians and others to work with individual patients.

Virtual Organizational Structure

A **virtual organizational structure** is made up of individuals, teams or complete business units that work with other individuals, teams or complete business units in different geographic locations. This almost always requires the use of the Internet (or other telecommunications), and the teams can exist for a few weeks or years. The people involved might be in different countries and operating in different time zones. In other words, virtual organizational structures allow people who work together to be separated by location and time. The people might never meet physically, which explains the use of the word 'virtual'. In Chapter 10 we will examine some of the technologies that make this form of collaborative work possible. Despite their physical separation, members of a virtual organization can collaborate on any aspect of a project, such as supplying raw materials, producing goods and services, and delivering goods and services to the marketplace.

virtual organizational structure A structure that employs individuals, groups or complete business units in geographically dispersed areas that can last for a few weeks or years, often requiring telecommunications or the Internet.

A company can use a virtual organizational structure with its own dispersed workers who have distinct skills and abilities to reduce costs. PwC, a global accounting giant, uses virtual teams of 5 to 50 people in the learning and education department.[8] According to Peter Nicolas, the company's Learning Solutions manager, 'Virtual teaming is the norm for us'. The company takes advantage of software and technology, including Microsoft Live Meeting, Centra Software's Virtual-Classroom Application and Lotus Notes from IBM, to help the teams work from distant locations.

In addition to reducing costs or increasing revenues, a virtual organizational structure can provide an extra level of security. For instance, dispersing employees and using a virtual structure can provide an ability to deal with a disaster at the primary location. If this happened, the company would still have sufficient employees at other locations to keep the business running. Today's workers are performing company work at home, at a customer's location, in coffee shops, on pleasure boats and at convenient work centres in suburbia. People can work at any time. Using the Internet and email, workers can put the finishing touches to a new business proposal in Europe or Asia, while co-workers in North America are sleeping.

Successful virtual organizational structures share key characteristics. One strategy is to have in-house employees concentrate on the firm's core businesses and use virtual employees, groups or businesses to do everything else. Using information systems to manage the activities of a virtual structure is essential, often requiring specialized software to coordinate joint work. Even with sophisticated IS tools though, teams may still need face-to-face meetings, especially at the beginning of new projects.

Organizational Change

Most organizations are constantly undergoing change, both minor and major. The need for **organizational change** can be caused by internal factors, such as those initiated by employees at all levels, or external factors, such as activities wrought by competitors, stockholders, new laws, community regulations, natural occurrences (such as hurricanes) and general economic conditions. In the 1990s, the Internet caused massive changes in the way millions of organizations did business. The COVID-19 pandemic “lockdowns” and a rapid transition to homeworking in many countries throughout the world has changed work practices, certainly on a temporary level and possibly more permanently – an unforeseen environmental change.

organizational change The responses that are necessary so that for-profit and non-profit organizations can plan for, implement and handle change.

Change can be sustaining or disruptive. Sustaining change such as new or cheaper production equipment can help an organization improve its operations. For example, many factories are now able to use robots because prices for robots are falling and their useful lifetime is increasing, leading to a big market in second-hand robots.[9] Global Robots, for example, based in the UK, buys and sells industrial robots in large numbers from big manufacturers including ABB, Fanuc, Motoman and Kuka with the aim of making robots affordable to a wide market. They have agents in the USA, Scandinavia, Russia and Eastern Europe.[10]

Disruptive change, on the other hand, often harms an organization's performance or even puts 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 good, stable companies to fail when they don't change or adopt the new technology. Voice Over IP (VoIP) telephone technology is currently disrupting the business models of established companies such as BT (www.bt.com) who, in response, are moving towards providing broadband Internet connections as their main product.

Overcoming resistance to change, especially disruptive change, can be the hardest part of bringing information systems into a business. Occasionally, employees even attempt to sabotage a new information system because they do not want to learn the new procedures and commands. The best way to avoid this resistance is to involve the employees in the decision to implement the change, and consult them on the development or purchase of the information system.

When a company introduces a new information system, a few members of the organization must become agents of change – champions of the new system and its benefits. Understanding the dynamics of change can help them confront and overcome resistance so that the new system can be used to maximum efficiency and effectiveness.

A significant portion of an organization's expenses are used to hire, train and compensate talented staff. So organizations try to control costs by determining the number of employees they need to maintain high-quality goods and services. Strategies to contain costs are outsourcing, on-demand computing and downsizing.

outsourcing Contracting with outside professional services to meet specific business needs.

Outsourcing involves contracting with outside professional services to meet specific business needs. Often, companies outsource a specific business process, such as recruiting and hiring employees, developing advertising materials, promoting product sales or setting up a global telecommunications network. Organizations often outsource a process to focus more closely on their core business and target limited resources to meet strategic goals. South Africa has a sophisticated manufacturing and service-based economy, and many small businesses from the UK and Australia are outsourcing their services to that country. In addition to a highly skilled workforce, there are time zone advantages too (everyone is awake at the same time for at least part of the day), and potential cost savings. The Shopper Collective in Australia, which helps its clients to understand their customers better, outsources its data analytics to South Africa.[11, 12]

Other reasons for outsourcing are to trim expenses or benefit from the expertise of a service provider. A growing number of organizations, however, are finding that outsourcing does not necessarily lead to reduced costs. One of the primary reasons for cost increases is poorly written contracts that tack on charges from the outsourcing vendor for each additional task. Other potential drawbacks of outsourcing include loss of control and flexibility, overlooked opportunities to strengthen core competency and low employee morale.

on-demand computing Contracting for computer resources to rapidly respond to an organization's varying workflow. Also called on-demand business and utility computing.

On-demand computing is an extension of the outsourcing approach, and many companies offer on-demand computing to business clients and customers. On-demand computing, also called on-demand business and utility computing, involves rapidly responding to the organization's flow of work as the need for computer resources varies. It is often called 'utility computing' because the organization pays for computing resources from a computer or consulting company just as it pays for electricity from a utility company. This approach treats the information system – including hardware, software, databases, telecommunications, personnel and other components – more as a service than as separate products. In other words, instead of purchasing hardware, software and database systems, the organization only pays a fee for the systems it needs at peak times. The approach can save money because the organization does not pay for systems that it doesn't routinely need. It also allows the organization's IS staff to concentrate on more strategic issues.

Downsizing involves reducing the number of employees to cut costs. The term 'rightsizing' is also used. Rather than pick a specific business process to downsize, companies usually look to downsize across the entire company. Downsizing clearly reduces total payroll costs, although employee morale can suffer.

downsizing Reducing the number of employees to cut costs.

Employers need to be open to alternatives to reducing the number of employees and use layoffs as the last resort. It's simpler to encourage people to leave voluntarily through early retirement or other incentives. Voluntary downsizing programmes often include a buyout package offered to certain classes of employees (for example, those over 50 years old). The buyout package offers employees certain benefits and cash incentives if they voluntarily retire from the company. Other options are job sharing and transfers.

Organizational learning is closely related to organizational change. According to the concept of organizational learning, organizations adapt to new conditions or alter their practices over time. Assembly-line workers, secretaries, shop assistants, managers and executives all learn better ways of doing business and incorporate them into their day-to-day activities. Collectively, these adjustments based on experience and ideas are called 'organizational learning'. In some cases, the adjustments can be a radical redesign of business processes, often called 'reengineering'. In other cases, these adjustments can be more incremental, a concept called 'continuous improvement'. Both adjustments reflect an organization's strategy: the long-term plan of action for achieving their goals.

organizational learning The adaptations to new conditions or alterations of organizational practices over time.

Ethical and Societal Issues

Customers Out of Pocket After Direct Transfer Error

A Direct Debit is an instruction from a customer to their bank giving permission for a third party to collect varying amounts from their account, usually in order to pay regular bills. In the UK, the Direct Debit Guarantee applies to all banks and building societies and protects customers in the event of errors made in payments such as an incorrect amount being taken or a payment being made on the wrong date. The guarantee says that, 'If an error is made in the payment of your Direct Debit, by the organisation or your bank or building society, you are entitled to a full and immediate refund of the amount paid from your bank or building society'. Many Internet banking customers assume that the guarantee applies to online transfers that they have made, but in fact this is not the case.

At the end of 2014, a record label manager and her husband fell victim to a sophisticated email scam. The couple had some work done to their house and received an email from what they thought was their builder giving them instructions on how to pay. The email asked for over £25,000 to be transferred and gave the account number and sort code of the bank it was to be paid into. Later that day, they arranged payment and thought no more of it, until they received a second email chasing payment. At that point they looked into it and realized the first email had been sent by a scammer. The email address had been slightly different: 'development' instead of 'developments' in the company name.

The money had been sent from Lloyds Bank to Barclays Bank. Contacting Lloyds, they were told that the bank had simply followed their instructions. So they turned to Barclays. Initially, the bank refused to give them any information, citing that they had to protect the identity of the fraudster in line with data protection legislation. They did learn something though. 'Our own questioning with the banks had traced our money to an account in the north [of England] owned by a man called "Harry". It, of course, had been immediately fully withdrawn and closed', said Sarah Fisher, the victim. Eventually, Barclays said that by the time it was alerted, the couple's £25,000 had been 'utilized' by the account holder, so it was unable to return any of their cash.

(*continued*)

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Its letter added: 'We do not report scam claims to the police because the bank is not the victim'. However, they also said they would cooperate fully with the police as part of a criminal investigation.

Following up on this story, *The Guardian* newspaper sent one of their journalists to open an account at Barclays. 'It was impossible without giving the bank my full name, date of birth, addresses for the past three years, email address, phone number, income and employment details, including my full company address. It also required permission from me to make checks on everything I submitted'.

When the couple reported the incident to the police, they did not pursue an investigation but instead referred the case to Action Fraud, the UK's national fraud and cybercrime reporting centre. 'The reason the police are citing for not pursuing an investigation is that this type of crime is so rife they haven't got the resources – they say that compared to some of the cases they are dealing with, it's small scale', says Mrs Fisher. City of London Police Commander Chris Greany concedes that this type of 'invoicing fraud', where people are fooled into transferring funds, is an emerging threat. 'Those with viable lines of inquiry have been sent to local police forces to investigate', he says. The name for this kind of fraud is an Authorised Push Payment Scam, and has become common. The story above has been repeated many times, eventually causing UK banks to act. In February 2018, the Payment Systems Regulator created a steering committee to develop a code of practice to guide how the financial sector should respond to reported cases. In May 2019 the new code of practice was published, recommending that victims should be reimbursed unless they ignored their bank's warnings or were grossly negligent in transferring the money. While signing up to the code is voluntary, many of the main high street players joined immediately. If one of their customers is scammed, the bank will have to decide whether or not to refund them within 15 working days, and then make the refund as soon as possible. Banks should also be proactive, identifying customers whom they feel are at a high risk of being scammed and warning them in advance. They should also delay payments while they investigate potential scams, and freeze accounts they believe might belong to scammers.

All of this comes too late to help Sarah Fisher though.

Questions

1 How could banks identify customers who are likely to be victims?

2 How could delayed payments be a problem for banks?

3 What additional controls could banks offer their customers?

4 How should you assess emails that ask for money transfers?

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Reengineering and Continuous Improvement

To stay competitive, organizations must occasionally make fundamental changes to the way they do business. In other words, they must change the activities, tasks or processes they use to achieve their goals. **Reengineering**, also called 'process redesign' and 'business process reengineering' (BPR), involves the radical redesign of business processes, organizational structures, information systems and values of the organization to achieve a breakthrough in business results. Reengineering can reduce delivery times, increase product and service quality, enhance customer satisfaction, and increase revenues and profitability. When the Mittal Steel plant in Vanderbijlpark, South Africa, reengineered its steelmaking operations, introducing new automated systems, it was able to reduce the amount of raw materials used in its processes and increase its output of steel, which was of a higher quality than before. It was also able to reduce processing time and improve plant availability.[13]

reengineering Also known as 'process redesign' and 'business process reengineering' (BPR). The radical redesign of business processes, organizational structures, information systems and values of the organization to achieve a breakthrough in business results.

In contrast to simply automating the existing work process, reengineering challenges the fundamental assumptions governing its design. It requires finding and vigorously challenging old rules blocking major business process changes. These rules are like anchors weighing down a firm and keeping it from competing effectively. Table 2.1 provides some examples of such rules.

Table 2.1 Selected Business Rules that Affect Business Processes

Rule	Original Rationale	Potential Problem
Hold small orders until full lorry load shipments can be assembled	Reduce delivery costs	Customer delivery is slow
Do not accept an order until customer credit is approved	Reduce potential for bad debt	Customer service is poor
Let headquarters make all merchandizing decisions	Reduce number of items carried in inventory	Customers perceive organization has limited product selection

In contrast to reengineering, the idea of **continuous improvement** is to constantly seek ways to improve business processes and add value to products and services. This continual change will increase customer satisfaction and loyalty and ensure long-term profitability. Manufacturing companies make continual product changes and improvements. Service organizations regularly find ways to provide faster and more effective assistance to customers. By doing so, these companies increase customer loyalty, minimize the chance of customer dissatisfaction and diminish the opportunity for competitive inroads. Table 2.2 compares these two strategies.

continuous improvement Constantly seeking ways to improve business processes to add value to products and services.

Table 2.2 Comparing Business Process Reengineering and Continuous Improvement

Business Process Reengineering	Continuous Improvement
Strong action taken to solve serious problems	Routine action taken to make minor improvements
Top-down change driven by senior executives	Bottom-up change driven by workers
Broad in scope; cuts across departments	Narrow in scope; focus is on tasks in a given area
Goal is to achieve a major breakthrough	Goal is continuous, gradual improvements
Often led by outsiders	Usually led by workers close to the business
Information system integral to the solution	Information systems provide data to guide the improvement team

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

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

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. 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.[14]

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

An active research area in IS involves identifying why people accept and use one system but dislike and therefore don't use another. One early model, the Technology Acceptance Model (TAM), shows that people will use a system if it is easy to use and useful to them. This in itself is unhelpful to IS developers; however, TAM has been the basis for a large body of research that is ongoing and which hopes to produce more practical results.

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.

Information Systems @ Work

Neto Helps Australian Small Businesses Get Online

In 2011, Australian entrepreneur Ryan Murtagh saw an opportunity to help get small businesses online. Having been an e-retailer, he realized the struggle involved in scaling up an e-commerce store efficiently. This set him on the path to developing an end-to-end e-commerce platform designed to automate and streamline online trading for small to medium sized businesses. By focusing on the 'pain points' he had experienced himself, he assembled a team and set about solving these problems through software, using a company called Neto. Five years later, thousands of businesses use their platform to run online stores, and cumulatively they have turned over more than €1 billion through the service. One of these companies is Bicycles Online.

Founded by Jonathon Allara and James van Rooyen, Bicycles Online is an Australian owned, online speciality retailer of road bikes, mountain bikes, bike parts, accessories and clothing. As the business began to grow, the two were faced with a number of business obstacles. They sold their products through multiple channels: their own website, eBay, a number of shopping comparison websites and industry specific marketplaces. They also had just expanded from one to two warehouses. They needed an e-commerce solution that allowed them to accurately and effectively manage stock and fulfil orders across multiple warehouse locations and multiple sales channels, preferably one that integrated well with freight providers and Australia Post. Searching online they stumbled across Neto.

'With Neto, all integrations that we need are built into the system and we also have the ability to build custom integrations with Neto to other marketplaces if need be. The in-built shipping labelling and manifesting as well as the real-time shipping quotes and multi-carrier support have had a significant impact on our business. The time taken for us to fulfil orders has halved and we have also experienced significant cost savings with our freight charges by being able to have the option to choose the most cost effective freight option on an order by order basis', said Mr Allara.

Bicycles Online prides itself on offering the same level of services that customers would get in a brick-and-mortar store, or better, combined with competitive pricing. These services include free shipping, 14-day test rides and a national network of centres where bikes can be serviced. By using Neto, Bicycles Online gets to focus on what it knows – bikes – and uses Neto to focus on what it knows – online platforms.

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Using Neto, netohq.com, they were able to create and customize what Neto refers to as their 'e-commerce ecosystem', which means their entire online presence. Using a combination of eBay, accounting software Xero, Australia Post and help desk software Zendesk, they were able to streamline their business processes and increase sales.

'By moving over our platform to Neto we have been able to seamlessly manage our order fulfilment and inventory management across two warehouses', said Mr Allara. 'Neto has provided us with a solution that centralises our sales channel management – we can sell bikes online, whether it is on our main website, eBay or other marketplaces. When we were operating on our previous e-commerce system, integration with eBay and other marketplaces was very difficult and required linking up with third-party systems to try and do so – which can be costly and sometimes unreliable.'

Australia's largest telecommunications and media company Telstra Corporation Limited has taken notice and recently invested in Neto. Speaking in 2015, Telstra Business Group Managing Director, Will Irving, said, 'We estimate that by 2020, 82 per cent of SMEs will have a web presence, rising from 58 per cent today. The role of e-commerce will only become more important in the competitive retail environment. The Neto platform allows businesses to meet the needs of customers at their convenience: where they want and when they want'. Mr Murtagh said, 'With the technical expertise and scale that Telstra brings, I believe that this partnership will allow us to accelerate our development plans and to provide Australian SMEs with an even better product and a higher level of service and support'.

Questions

1. Why is it important for Bicycles Online to integrate with freight providers?
2. How can a company's social media presence integrate well with its retail website?
3. Why would Telstra be interested in Neto?
4. Why would Bicycles Online sell through so many channels?

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The Applications Portfolio

In Chapter 1 we looked at how information systems can be classified by the management level of the user. The **applications portfolio** is perhaps a more useful classification scheme. It sorts information systems according to the contribution they make to the business. According to the applications portfolio, there are four types of system:

applications portfolio A scheme for classifying information systems according to the contribution they make to the organization.

1. Support: **Support applications** are nice to have, but are not essential. They include things that are convenient, but without them the organization can still conduct business. Typical support applications include electronic diaries and instant messaging software, used to let employees in an office communicate with each other.
2. Key operational: **Key operational applications** are essential. Without them the organization would not be able to do business. Transaction processing systems, mentioned in Chapter 1 and discussed fully in Chapter 8, are an example. If the checkout system at a Tesco shop malfunctions, Tesco would be unable to sell goods until it was repaired. The website of every e-commerce business is key operational.

support applications Support applications make work more convenient but are not essential.

key operational applications Key operational applications are essential. Without them the organization could not conduct business.

3. Strategic: A **strategic application** is an information system that gives a business an advantage over some or all of its competitors. Some ideas for what this advantage might be are discussed later in this chapter in the section on Competitive Advantage. The term 'strategic' should not be confused with the same term used to describe senior management in a business. A strategic system could appear anywhere in the company hierarchy.

strategic application A strategic application gives a firm a competitive advantage.

4. Future strategic: A **future strategic application** (also known as a 'potential strategic' or 'high potential' application) is an idea for, or a prototype of, an information system which, if developed, might one day become a strategic system. A company may have ten future strategic systems and decide to invest in only one. This decision is often a judgement call made by senior management. It may be that the technology to develop a future strategic system is currently too expensive and the company is waiting for prices to fall.

future strategic application Future strategic applications are ideas for systems which, if fully developed and deployed, might one day become strategic applications.

There is an endless cycle at work with systems starting life in one part of the portfolio and finishing in another. Typically an innovative, leading company will come up with an idea for a potential strategic system. If they invest in it and it is successful, it becomes a strategic system. Their competitors see that they have an advantage and so create their own versions of the system. Eventually, the system will become industry standard and then be key operational. In the meantime, the innovative company will have had more ideas for future strategic systems, and so the cycle starts again. Companies that see themselves as industry followers rather than industry leaders will not have strategic or future strategic systems in their portfolio.

Success Factors

Many writers have suggested reasons why some information systems are implemented successfully and others are not. It is of vital importance that a company's information systems are aligned with the company's goals. Misalignment is a frequently cited reason for information systems failure. The main way of achieving **alignment** is for senior managers to consider the business processes they have in place to achieve company goals, and ask what information systems are needed to support these business processes. Less frequently, a business, typically a small business or even a single entrepreneur, will consider what technology is available and ask what business goals can be achieved using it. In this case, information technology is dictating business strategy instead of business strategy dictating what information technology is used. Both are valid paths to alignment.

alignment When the output from an information system is exactly what is needed to help a company achieve its strategic goals, the two are said to be in alignment.

Other common success factors are:

- Senior management must be committed to the development or purchase of the information system and support it fully.
- End-users of the system should be involved as early and as much as possible in the development or purchase of the system.
- Time must be taken to carefully determine what the system must do, something known as **requirements engineering**. Requirements must be clearly stated and understood and accepted by everyone involved.
- Strong project management in the development or purchase of the information system.

requirements engineering Also known as 'requirements analysis' and 'requirements capture'. Identifying what an information system is needed (required) to do. Once the requirements have been identified, a solution can then be designed.

Later on in this text we will examine Joint Application Development, a method for creating IS which places users at the centre of the development.

2.2 Competitive Advantage

competitive advantage The ability of a firm to outperform its industry; that is, to earn a higher rate of profit than the industry norm.

A **competitive advantage** is the ability of a firm to outperform its industry, that is, to earn a higher rate of profit than the industry norm[15] and can result from higher-quality products, better customer service and lower costs. Establishing and maintaining a competitive advantage is complex. An organization often uses its information system to help it do this. 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.

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 a company to seek to attain a competitive advantage. Michael Porter, a prominent management theorist, suggested a simple but widely accepted model of the competitive forces in an industry, also called the **five-forces model**. A strong force can put a business at a disadvantage and lead it to invest in technology that can weaken it. The five forces are: (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.

Given the five market forces just 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.[16] 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 needs be.

Cost Leadership

The intent of a cost leadership strategy is to deliver the lowest possible products and services cost. In the UK, supermarket Asda has 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

The intent of differentiation as a strategy is to deliver different products and services. This strategy can involve producing a variety of products, giving customers more choice, 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. Some consumers are willing to pay higher prices for vehicles that differentiate on higher quality or better safety.

Niche Strategy

A niche strategy will deliver to only a small, niche market. Porsche, for example, doesn't produce inexpensive estate cars or saloons. It makes high-performance sports cars and four-wheel drives. Rolex only makes high-quality, expensive watches. It doesn't make inexpensive, plastic watches that can be purchased for €20 or less.

Altering the Industry Structure

Changing the industry to become more favourable to the company or organization is another strategy companies use. The introduction of low-fare airline carriers, such as easyJet, has forever changed the airline industry, making it difficult for traditional airlines to make high profit margins. To fight back, airlines such as British Airways cut their flight prices and started to emphasize their strengths over low-cost airlines in their advertising. These include landing in central airports rather than airports many miles out of the city they supposedly serve, and extra staff and resources to cope if there is a fault with an aircraft, or adverse weather grounds all planes. 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.

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

Creating New Products and Services

Some companies introduce new products and services periodically or frequently as part of their strategy. This strategy can help a firm gain a competitive advantage, especially in 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.

Improving Existing Product Lines and Services

Making real or perceived improvements to existing product lines and services is another strategy. Manufacturers of household products are always advertising 'new and improved' products. In some cases, the improvements are more perceived than real refinements; usually, only minor changes are made to the existing product, such as reducing the amount of sugar in a breakfast cereal. Some mail order companies are improving their service by using Radio Frequency Identification (RFID) tags to identify and track the location of their products as they are shipped from one location to another. Customers and managers can instantly locate products as they are shipped from suppliers to the company, to warehouses and finally to customers.

Other potentially successful strategies include being the first to market, offering customized products and services, and hiring talented staff, the assumption being 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. Companies can also combine one or more of these strategies.

2.3 Evaluating IS

Once an information system has been implemented, management will want to assess how successful it has been in achieving its goals. Often this is a difficult thing to do, and many businesses do not attempt to take anything more than an informal approach to evaluation.[17] Businesses can use measurements of productivity, return on investment (ROI), net present value and other measures of performance to evaluate the contributions their information systems make to their businesses.

Productivity

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

productivity A measure of the output achieved divided by the input required. Productivity = (Output ÷ Input) × 100%.

always based on labour 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.

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. 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.

In the late 1980s and early 1990s, overall productivity did not seem to improve as a company increased its 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 to be on the rise.

Return on Investment and the Value of Information Systems

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.

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 per cent (€20,000/€100,000). In many cases, however, it can be difficult to accurately measure ROI.[18]

Earnings Growth

Another measure of IS value is the increase in profit or earnings growth it brings. For instance, a mail-order company might install an order-processing system that generates a 7 per cent earnings growth compared with the previous year.

Market Share

Market share is the percentage of sales that a product or service has in relation to the total market. If installing a new online catalogue increases sales, it might help a company to increase its market share by 20 per cent.

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 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 measurement of the total cost of owning computer equipment, including desktop computers, networks and large computers.

Another way to measure the value of information systems was developed by the Gartner Group and is called the **total cost of ownership (TCO)**. This approach breaks down total costs into areas such as the cost to acquire the technology, technical support, administrative costs and end-user operations. Other costs in TCO include retooling and training costs. TCO can help to develop a more accurate estimate of the total costs for systems that range from desktop computers to large mainframe systems. Market research groups often use TCO to compare products and services.

ROI, 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 technology and personnel are too important to leave to chance.

Risk

In addition to the ROI measures of a new or modified information system, managers should also consider the risks of designing, developing and implementing these systems. Information systems can sometimes be costly failures. Some companies, for example, have attempted to implement enterprise resource planning (ERP) systems (see Chapter 7) and failed, costing them millions of euros. In other cases, e-commerce applications have been implemented with little success. The costs of development and implementation can be greater than the returns from the new system.

2.4 Careers in Information Systems

Realizing the benefits of any information system requires competent and motivated IS personnel, and many companies offer excellent job opportunities. Professionals with careers in information systems typically work in an IS department as web developers, computer programmers, systems analysts, database developers and administrators, computer operators, technical support or in other positions. In addition to technical skills, they 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.

It is not uncommon for IS personnel to undertake remote working, where colleagues are not co-located but are in separated geographical areas, using many of the information technologies described in this book to facilitate this. Contract work, where IS professionals complete short-term contracts, maybe for six months, are also not unusual.

In general, IS professionals are charged with maintaining the broadest perspective on organizational goals. 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. As shown in Figure 2.5, the IS department has three primary responsibilities: operations, systems development and support.

Operations

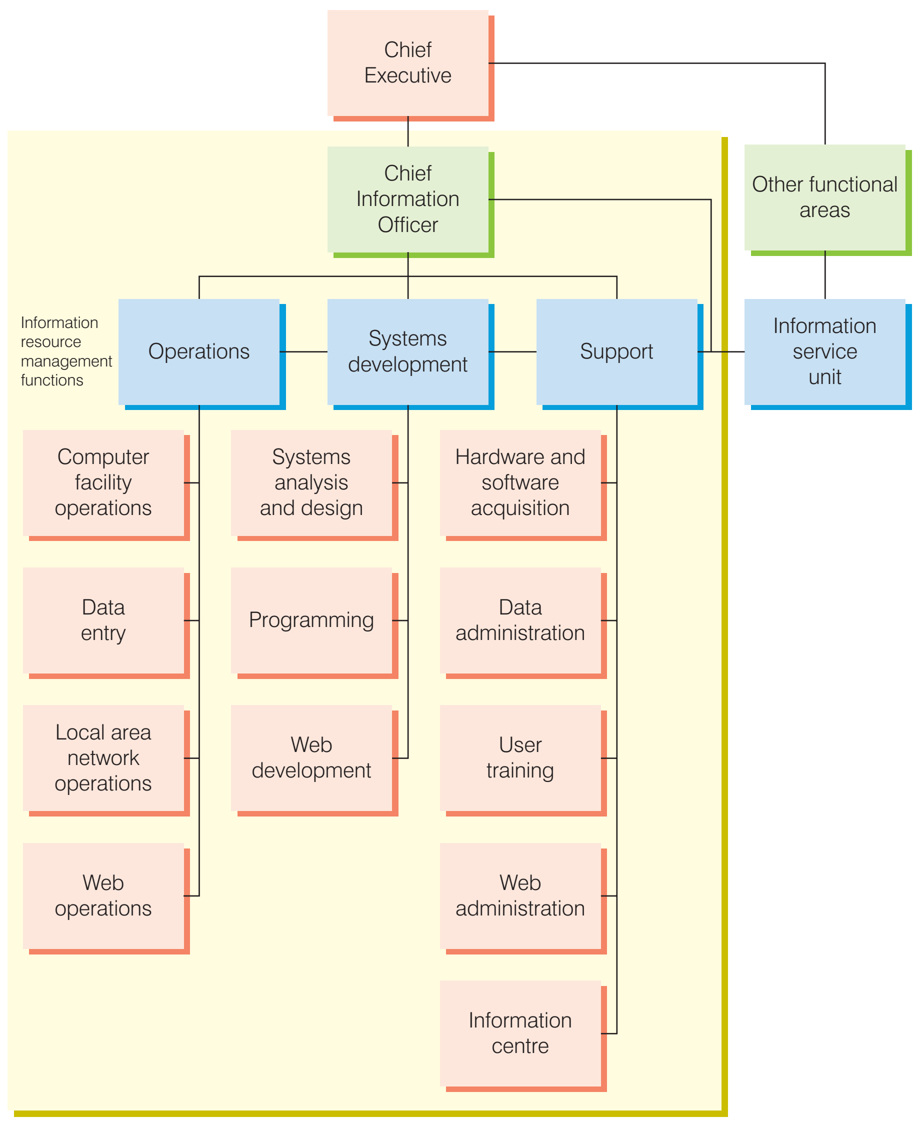
People in the operations component of a typical IS department work with information systems in corporate or business unit computer facilities. They tend to focus more on the efficiency of IS functions rather than their effectiveness.

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 starting, stopping and correctly operating mainframe systems, networks, back-up drives, disc 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. They can use terminals or other devices to enter business transactions, such as sales orders and payroll data. Increasingly, data entry is being automated – captured at the source of the transaction rather than entered later. In addition, companies might have local area network (LAN) and web operators who run the local network and any websites the company has.

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 the systems analyst has created to develop or adapt one or more computer programs that produce the desired outputs. Often, analysts will be using an agile approach to software development, where software is written rapidly and then continuously improved. One such approach is called Scrum where small teams intensively work together on small tasks that can be completed within one month.

Figure 2.5 The IS Department *Not all businesses will have all of these divisions, and in many firms people will take on multiple roles.*



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 websites 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. In many cases, support is delivered through an information centre.

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. It must gain and maintain an understanding of available technology and develop good relationships with vendors.

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 organization's databases for developers of IS applications. In addition, the database administrator monitors and controls database use.

User training is key to getting 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. For example, internal support staff can train managers and employees in the best way to enter sales orders, to receive computerized inventory reports and to submit expense reports electronically. Companies also hire outside firms to help train users in other areas, including the use of word processing, spreadsheets and database programs.

Web administration is another key area for support staff. With the increased use of the Internet, web administrators are sometimes asked to regulate and monitor Internet use by employees and managers to make sure that it is authorized and appropriate. Web administrators also maintain the organization's website to keep it accurate and current, which can require substantial resources.

The support component typically operates the helpdesk. A helpdesk provides users with assistance, training, application development, documentation, equipment selection and setup, standards, technical assistance and troubleshooting.

Information Service Units

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 2.5. 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 2.5 is a simplified model of an IS department in a typical medium 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 2.5 into fewer formal positions.

The 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. The CIO is a senior manager concerned with the overall needs of the organization who sets organization-wide policies, and plans, manages and acquires information systems. Some of the CIO's top concerns include integrating IS operations with business strategies, keeping up with the rapid pace of technology, and defining and assessing the value of systems development projects. The high level of the CIO position reflects that information is one of the organization's most important resources. A CIO works with other high-level officers in an organization, including the finance director and the chief executive officer, in managing and controlling total corporate resources. CIOs must also work closely with advisory committees, stressing effectiveness and teamwork and viewing information systems as an integral part of the organization's business processes – not an adjunct to the organization. Thus, CIOs need both technical and business skills.

Administrators

local area network (LAN) A computer network that connects computer systems and devices within a small area, such as an office, home or several floors in a building.

2

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 operational problems. LAN administrators are in high demand and often solve both technical and non-technical problems. Database administrators manage the use, maintenance and security of a company's databases. Often a database administrator will help users extract the data they need in the format they require.

Internet Careers

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 website operators.

Systems Developers

Systems developers design and write software. Typically, developers will be graduates with degrees in technical subjects such as computer science, mathematics or engineering. However, many big employers have graduate recruitment schemes where degree subject is less important than an ability to learn. On such schemes, graduates are taught the skills they need. The skills needed by developers include the ability to design solutions to problems and communicate these solutions to other developers and to users, and the technical skill to create these solutions. Software development can be extremely challenging and exciting.

Often, systems developers are employed to create software to support business goals, such as developing the organization's transaction processing system. Alternatively, systems developers may work in a software house, where the software they write is the product the organization sells. One of the fastest growing areas of software development is the games industry, with many universities now offering degrees in games development.

Other IS Careers

Other IS career opportunities include technical writing (creating technical manuals and user guides) and user interface design.

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

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 and many others.

Summary

The use of information systems to add value to the organization is strongly influenced by organizational structure and the organization's attitude and ability to change. 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. Non-profit 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 include (1) inbound logistics, (2) warehouse and storage, (3) production, (4) finished product storage, (5) outbound logistics, (6) marketing and sales, and (7) customer service.

Organizational structure refers to how organizational subunits relate to the overall organization. Several basic organizational structures include traditional, project, team and a virtual one. A virtual organizational structure employs individuals, groups or complete business units in geographically dispersed areas. These can involve people in different countries operating in different time zones and different cultures. Organizational change deals with how profit and non-profit organizations plan for, implement and handle change. Change can be caused by internal or external factors. According to the concept of organizational learning, organizations adapt to new conditions or alter practices over time.

Because information systems are so important, businesses need to be sure that improvements to existing systems, or completely new systems, help lower costs, increase profits, improve service or achieve a competitive advantage. Business process reengineering involves the radical redesign of business processes, organizational structures, information systems and values of the organization, to achieve a breakthrough in results. Continuous improvement to business processes can add value to products and services.

The extent to which technology is used throughout an organization can be 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. User satisfaction with a computer system and the information it generates depends on the quality of the system and the resulting information.

Outsourcing involves contracting with outside professional services to meet specific business needs. This approach allows the company to focus more closely on its core business and to target its limited resources to meet strategic goals. Downsizing involves reducing the number of employees to reduce payroll costs; however, it can lead to unwanted side effects.

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 explains factors that lead firms to seek competitive advantage: the 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. Strategies to address these factors and to attain competitive advantage include cost leadership, differentiation, niche strategy, altering the industry structure, creating new products and services, improving existing product lines and services, and other strategies.

Cooperation between business managers and IS personnel is the key to unlocking the potential of any new or modified system. Information systems personnel typically work in an IS department. The chief information officer (CIO) employs an IS department's equipment and personnel to help the organization attain its goals. Systems analysts help users determine what outputs they need from the system and construct the plans needed to develop the necessary programs that produce these outputs. Systems analysts then work with one or more system developers 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 build 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, disc devices, printers and so on. LAN administrators set up and manage the network hardware, software and security processes. Trained personnel are also needed to set up and manage a company's Internet site, including Internet strategists, Internet systems developers, Internet programmers and website operators. Information systems personnel can also support other functional departments or areas.

In addition to technical skills, IS personnel 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.

Self-Assessment Test

1. A minimum number of management layers results in a ___________ organization structure.
2. Giving employees and their managers more responsibility and authority is known as ___________.
3. Outsourcing computing resources to a third party is known as ___________.
4. The radical redesign of business processes is known as ___________.
5. ___________ are information systems that an organization could not operate without.
6. Productivity equals ___________.
7. If a firm can outperform its industry it has a ___________.
8. ___________ is the percentage of sales that a product or service has in relation to the total market.
9. An agreement between two or more companies is known as a ___________.
10. The head of the information systems department is the ___________.

Review Questions

1. What is the value chain?
2. Describe a virtual organization structure.
3. What is technology diffusion?
4. Describe on-demand computing.
5. Define continuous improvement and compare it with reengineering.
6. What is a support application?
7. Describe some of the ways in which IS can be evaluated.
8. Why would a company constantly develop new products?

Discussion Questions

1. Search on www.indeed.com or similar for some current information systems job opportunities for recent graduates. What skills are required? Which are the areas that interest you the most?
2. How would you help an employee cope with rapid organizational change?

Web Exercises

1. Search for information about the career of a CIO in a top organization. What skills must they have displayed at each stage?
2. Select an object on the desk in front of you. Sketch out its value chain. How were the raw materials that it is made of processed in a way that made them more valuable?

2

Case One

Nailed it! Instagram and Cloud Computing Ensure Success

After her graduation in fashion, New Zealand born Anna Ross found herself working in Melbourne in the clothing industry, putting in 90 hour weeks for little money. 'I just couldn't do it anymore', she says. 'I decided I hated working in fashion.' Looking for a way out, she soon started designing and selling her own silver jewellery. With little start-up capital, it took two years but eventually she noticed a gap in the market and started to manufacture nail polish. 'Nail polish is something I have enjoyed from a young age', she says. 'It's fun and there is something almost cathartic about painting your nails.' The gap she spotted was an unmet demand for ethically produced, professional quality polish. 'I was really just testing the waters, but there turned out to be so much demand.' It took a year to perfect the product, which is vegan accredited, not tested on animals and made in Australia. She hired a chemist to help her get the colours right, without the need for any unpleasant chemicals. She called her brand Kester Black.

To market her product, Ms Ross used social media, carefully crafting an online presence that made her company seem much larger than it actually was. By publishing beautifully shot photos on Instagram, Ms Ross turned her brand into a lifestyle product that attracted customers who desired the lifestyle she portrayed in the photos. Nick Bez, a director at Australian market research group Mobium Group, told business reporter Kate Stanton that, 'Being savvy with social media and using the online environment to talk to a wider audience, means you can be a little brand and have a persona of something much bigger'.

In an interview with online magazine The Design Files, Ms Ross explained her use of cloud computing. When Kester Black got big enough that an additional employee was needed, she used the cloud to hand over responsibilities to her new administrator. Using Google Docs meant that they could both be working on the same document at the same time, from anywhere with an Internet connection. They used Gmail to communicate and Google calendar to coordinate manufacturing, accounting, pay reminders, marketing and event listings. They also used Dropbox for storage of all important documents that they both had to access. All of this software is available for free and offers basic functionality (although users must agree to having some of their data used for targeted advertising), yet it is powerful enough to have helped a young company get off the ground.

Questions

1. How can social media change people's perception of a company?
2. Are there any dangers with using social media as a platform for promotion?
3. What are some of the advantages of using Google Docs?
4. What other cloud-based services could small businesses benefit from?

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Case Two

Crosswords and Cybersecurity

In the 2014 film *The Imitation Game*, Alan Turing is shown recruiting code breakers by publishing a crossword in the *Daily Telegraph* with a message asking people who could solve it in ten minutes or fewer to get in touch. This is based on a real event. The actual crossword used was published on 13 January 1942 and gave readers 12 minutes not 10. Clues included 'when hammering take care not to hit this (5,4)' and 'those well brought up help these over stiles (4,4)'. It might seem like a strange way to apply for a job, but puzzles are still used by the intelligence community.

The current 'coding challenge' issued by the British security service MI5 is an image showing pink and blue lines with the instructions: 'Intelligence isn't always obvious and our engineers and analysts work hard to unlock it. There's a clue in the image file below, if you can find it'.

Opening the file in a text editor reveals a further Shakespearian sounding clue hidden in a comment: 'As I read, numbers I see. Twould be a shame not to count this art among the great texts of our time.' You can use a search engine to find the image using this line if you want to see it. The important part of the message seems to be 'count this art'. The challenge is to count the number of pink pixels followed by the number of blue pixels repeatedly. For that you'll need software that can pick apart an image file (you could try the 'png' package in the programming language R if you want to give it a go). Spoiler alert: to give it away, the numbers refer to letters using ASCII character coding (the American Standard Code for Information Interchange gives each character a numerical representation) to reveal the message, 'Congratulations, you solved the puzzle! Why don't you apply to join our team?' There's probably a new puzzle on the MI5 website by now if you want a fresh challenge.

In November 2016, UK Chancellor Philip Hammond said that the country must develop the capability to launch a counter cyber-attack. He said, 'The UK must strike back at hostile states in cyberspace and be capable of mounting sophisticated cyber-attacks of its own in place of military strikes'. With information technology having such a rapid pace of change, it is not an easy thing to recruit people with the skillset to deal with problems from technology that hasn't even been invented yet. 'Sometimes when you are screening [new recruits], you don't even know what kind of technology or problems they are going to be dealing with by the time they actually sit there and have the responsibility upon their shoulders', says Nadav Zafrir, an ex-member of Israel's famous Unit 8200 which runs electronic surveillance and other cyber activities.

Mr Zafrir left Unit 8200 in 2013 to found Team 8, which aims to build successful companies that can transform cybersecurity. Team 8 says that they work 'with innovative leaders and entrepreneurs to address the biggest problems in cybersecurity and create differentiated, independent leaders in the cybersecurity market. Our mission is to initiate and build long-term, innovative cybersecurity companies that can truly make the world a safer place and assist enterprises in coping with the most daunting cyber challenges'. The skills that Team 8 are developing are exactly what the UK will need if it is to develop its cyber-war capabilities.

'We literally had to redefine [a] control hierarchy as otherwise we wouldn't be able to create the magic that these kids can bring with them. I think a lot of them are more agile, better prepared, speak languages that we didn't even know existed in terms of coding and stuff like that', Mr Zafrir says. 'We had to adapt not only the recruiting process, but also the day-to-day control systems in many ways in order to create this magic.'

And the answers to Alan Turing's puzzle? 'Right nail' and 'Lame dogs'. Don't be too surprised if you didn't get them. Apparently, Telegraph readers in the 1940s had very different ideas about how crossword clues work from what we have today.

Questions

1. How could children at school be encouraged to consider a career in cybersecurity?
2. How could job recruitment be made to be 'future proof'?
3. Should governments rely on private firms for their nation's cybersecurity?
4. How could this same approach be used by organizations to hire IT professionals?

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Case Three

Raining Wine from the Cloud

Baacco is a search engine which helps customers find and buy premium yet affordable wines. It describes itself as a 'cloud first business' and uses over 20 cloud-based tools to reach customers in the UK, France, Germany, Spain and Belgium. The idea came when founder Tai Alegbe was trying to find a wine he had seen on a London restaurant's menu. He felt it should be possible to buy it somewhere but couldn't find it in a store. Sensing a challenge, he set about searching for a UK distributor who supplied it and found that it was difficult but not impossible to buy. He then realized there was a gap in the marketplace, so he and four friends founded Baacco, 'the ultimate new way to search, discover and shop for top-quality and affordable wines; whilst connecting with specialist wine merchants'. The Baacco website allows customers to search for wines from distributors and new sellers who are not represented in the supermarket chains and high street wine stores. Crucially, Baacco facilitates communication between sellers and customers to create an open discussion between wine experts and consumers who don't really understand grapes yet know what they like.

Baacco uses the cloud to process payments in different regions and currencies and to analyze their customers' experience. For instance, they use Crazy Egg to see how people are using their website. Crazy Egg can create maps of the most visited pages in a website from customer clicks, and a map of how far down a web page customers tend to scroll. The idea is to ferret out the parts of the site that aren't viewed so that they can be changed. Baacco uses Mixpanel to do something similar for users of their mobile app. Mixpanel will help predict which app users are most likely to use to make a purchase and when.

These tools have been essential. 'They allow us to build, measure and learn about our customers far quicker than any other method', Mr Alegbe says. One warning raised by Crazy Egg was that customers in France and Spain were getting to the checkout and then leaving the website. Investigating this, Baacco found that those customers were being put off by unfamiliar payment logos.

The cloud tools helped the business to grow. 'We scaled up our business by gaining an early understanding of which marketing channels had proven to be most successful, and then making sure the unit economics for that channel made sense for the business', said Mr Alegbe. They also helped the business appear much bigger to customers than it really was, which is a recurring theme in case studies of small businesses who access the cloud. 'The cloud provides a more affordable, flexible and scaleable platform that greatly enhances small retailers' opportunities to manage, share and control its data – and function like a globally integrated enterprise', says Vish Ganapathy, vice president and chief technology officer at IBM.

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Questions

1 What were the advantages to Baacco in using cloud computing?

2 How would knowing where people stop scrolling down a web page help to redesign that page?

3 How could a company decide between two possible changes they are considering making to their website?

4 Investigate and list some other cloud services Baacco could potentially use.

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2

World Views Case

ABAZONG Training and Consulting (Pty) Ltd Helps Organizations and Users With Information Security Consultation and Training Awareness

Paul Abanda
Damelin College, South Africa

ABAZONG Training and Consulting is run by individuals that collectively have decades of experience working within businesses. Their team focuses on helping organizations implement working solutions to information security management standard. Their staff ensure that there is a business-wide solution to organizational security data, which can take the form of physical and logical infrastructures.

The organization has established relationships in order to support businesses and enable them to offer services in the areas of information security corporate training, penetration testing and information security auditing, software project development and security management. Their staff members are knowledge leaders in the industry and are among the most active Sub Sahara African participants in industry conferences, blogs and podcasts.

Furthermore, the team has addressed security problems in South Africa and several other African countries, and they have a good understanding of information security and the standards that govern security. The ISO 27001 information security management systems audit (ISMSA) standard considers every risk critical in identifying potential dangers and disruption in the quality, quantity and distribution or relevance of data that can put a business at risk.

ISO 27001 improves business reliability and demonstrates the integrity of data, systems and the obligation to information security. This helps to transform organizational culture, opening up new venture opportunities with security conscious customers and thereby improving employee ethics and strengthening the notion of workplace confidentiality.

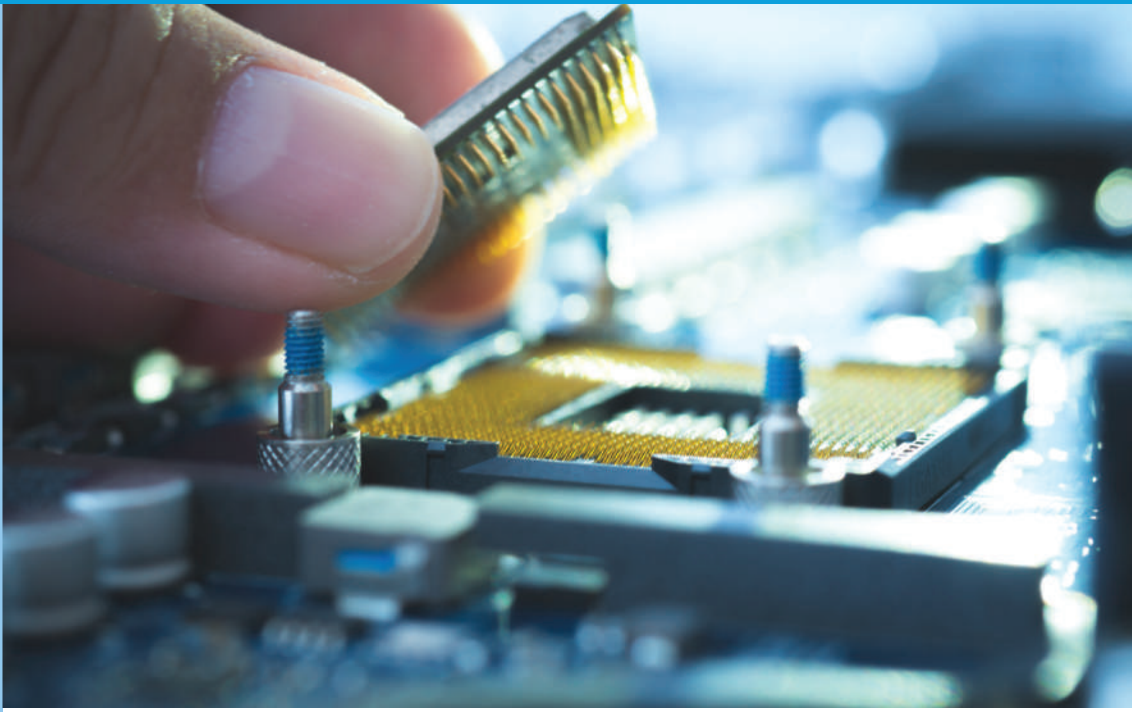
The precision of ABAZONG Training and Consulting's technical competence is guaranteed to ensure that businesses operate at optimal levels in their requirements, which are data loss prevention, vulnerability management, logical access, anti-virus protection, system integration, software integration, or any other specialized IT security services. Their dedicated technical professionals ensure that businesses receive the most appropriate solution that is aligned to meet the objectives of ISO 27001's information security management systems standard.

Questions

1. What are the advantages and disadvantages of creating awareness of the ISO 27001 information security management systems standard?
2. Identify the dangers that are associated with lack of training on the protection of organizational information systems.
3. What is a code of ethics and why should employees be ethical?
4. How does ABAZONG Training and Consulting assist organization security awareness?
5. Why should IS professionals become certified in ISOs?

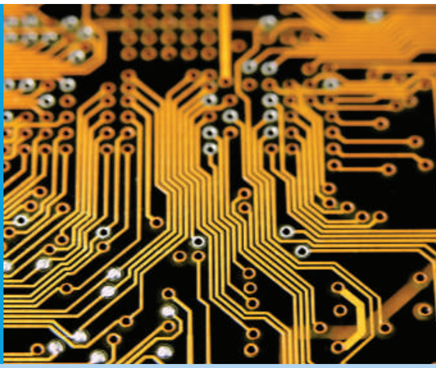
PART 2

Information Technology Concepts



03

Hardware: Input, Processing, Output and Storage Devices



Principles	Learning Objectives
Computer hardware must be carefully selected to meet the evolving needs of the organization and its supporting information systems.	■ Describe the role of the central processing unit and main memory. ■ State the advantages of multiprocessing and parallel computing systems and provide examples of the types of problems they address. ■ Describe the access methods, capacity and portability of various secondary storage devices. ■ Identify and discuss the speed, functionality and importance of various input and output devices. ■ Identify the characteristics and discuss the usage of various classes of single-user and multiuser computer systems.
The computer hardware industry is rapidly changing and highly competitive, creating an environment ripe for technological breakthroughs.	■ Describe Moore's Law and discuss its implications for future computer hardware developments. ■ Give an example of recent innovations in computer CPU chips, memory devices and input/output devices.
The computer hardware industry and users are implementing green computing designs and products.	■ Define the term green computing and identify the primary goals of this program. ■ Identify several benefits of green computing initiatives that have been broadly adopted.

Why Learn About Hardware?

Organizations invest in computer hardware to improve worker productivity, increase revenue, reduce costs, provide better customer service, speed up time-to-market and enable collaboration among employees. Organizations that don't make wise hardware investments are often stuck with outdated equipment that is unreliable and that cannot take advantage of the latest software advances. Such obsolete hardware can place an organization at a competitive disadvantage. Managers, no matter what their career field and educational background, are expected to help define the business needs that the hardware must support. In addition, managers must be able to ask good questions and evaluate options when considering hardware investments for their areas of the business. This need is especially true in small organizations which might not have information system specialists. Managers in marketing, sales and human resources often help IS specialists assess opportunities to apply computer hardware and evaluate the options and features specified for the hardware. Managers in finance and accounting especially must keep an eye on the bottom line, guarding against overspending, yet be willing to invest in computer hardware when and where business conditions warrant it.

Today's use of technology is practical – it's intended to yield real business benefits. Using the latest information technology and providing additional processing capabilities can increase employee productivity, expand business opportunities and allow for more flexibility. This chapter concentrates on the hardware component of a computer-based information system (CBIS). Recall that hardware refers to the physical components of a computer that perform the input, processing, output and storage activities of the computer. When making hardware decisions, the overriding consideration of a business should be how hardware can support the objectives of the information system and the goals of the organization.

3.1 Computer Systems: Integrating the Power of Technology

People involved in selecting their organization's computer hardware must clearly understand current and future business requirements so that they can make informed acquisition decisions. Consider the following examples illustrating the range of hardware challenges and opportunities that exist:

- The Large Hadron Collider (LHC), built to gain a better understanding of what our universe is made of and how it began, captures about 3 gigabytes of data per second. The mission of the LHC Computing Grid is to store and analyze all this data using 132,922 physical processors, 300 petabytes of online disk storage and 230 petabytes of magnetic tape storage. For perspective, one gigabyte can store seven minutes of HD-TV while one petabyte is equivalent to 13.3 years of HD-TV.
- Biomedical engineers are exploring a process called bioprinting, which uses 3D printers to create living tissue capable of naturally integrating into the body. This will eventually enable the construction of fully functional human organs.
- At the other end of the scale, rather than providing laptops, tablets or smartphones, some businesses are allowing their employees to choose their own technology. Sometimes funds are given for the employee to buy their own hardware, the idea being that the employee will get something that they are comfortable with – the right screen

size, resolution and weight for them, for example. With Internet standards and other standard protocols, the company should be reassured that there won't be accessibility problems. This is called Bring Your Own Technology.[1]

As these examples demonstrate, choosing the right computer hardware requires understanding its relationship to the information systems and the needs of an organization.

Hardware Components

Computer system hardware components include devices that perform input, processing, data storage and output, as shown in Figure 3.1.

Recall that any system must be able to process (organize and manipulate) data, and a computer system does so through an interplay between one or more central processing units and primary storage. Each **central processing unit (CPU)** consists of three associated elements: the arithmetic/logic unit, the control unit and the register areas. The **arithmetic/logic unit (ALU)** performs mathematical calculations and makes logical comparisons. The **control unit** sequentially accesses program instructions, decodes them and coordinates the flow of data in and out of the ALU, the registers, the primary storage and even secondary storage and various output devices. **Registers** are high-speed storage areas used to temporarily hold small units of program instructions and data immediately before, during and after execution by the CPU.

Primary storage, also called **main memory** or **memory**, is closely associated with the CPU. Memory holds program instructions and data immediately before or after the registers. To understand the function of processing and the interplay between the CPU and memory, let's examine the way a typical computer executes a program instruction.

central processing unit (CPU) The part of the computer that consists of three associated elements: the arithmetic/logic unit, the control unit and the register areas.

arithmetic/logic unit (ALU) The part of the CPU that performs mathematical calculations and makes logical comparisons.

control unit The part of the CPU that sequentially accesses program instructions, decodes them and coordinates the flow of data in and out of the ALU, the registers, the primary storage and even secondary storage and various output devices.

registers A high-speed storage area in the CPU used to temporarily hold small units of program instructions and data immediately before, during and after execution by the CPU.

primary storage (main memory; memory) The part of the computer that holds program instructions and data.

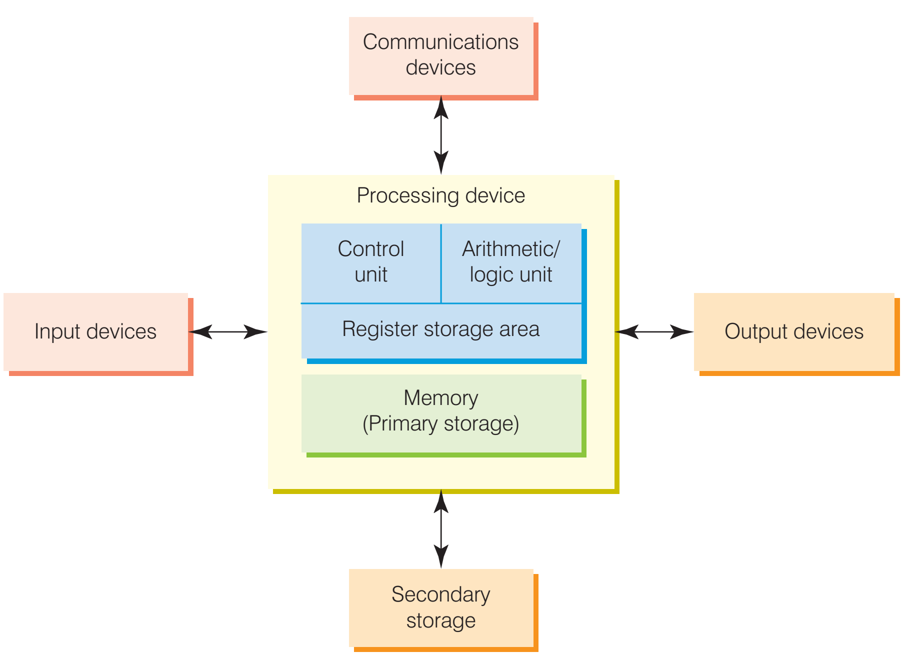


Figure 3.1 Hardware Components *These components include the input devices, output devices, communications devices, primary and secondary storage devices and the central processing unit (CPU). The control unit, the arithmetic/logic unit (ALU) and the register storage areas constitute the CPU.*

Hardware Components in Action

Executing any machine-level instruction involves two phases: instruction and execution. During the instruction phase, a computer performs the following steps:

- Step 1: Fetch instruction. The computer reads the next program instruction to be executed and any necessary data into the processor.
- Step 2: Decode instruction. The instruction is decoded and passed to the appropriate processor execution unit. Each execution unit plays a different role. The arithmetic/logic unit performs all arithmetic operations; the floating-point unit deals with noninteger operations; the load/store unit manages the instructions that read or write to memory; the branch processing unit predicts the outcome of a branch instruction in an attempt to reduce disruptions in the flow of instructions and data into the processor; the memory-management unit translates an application's addresses into physical memory addresses; and the vector-processing unit handles vector-based instructions that accelerate graphics operations.

instruction time (i-time) The time it takes to perform the fetch instruction and decode instruction steps of the instruction phase.

The time it takes to perform the instruction phase (Steps 1 and 2) is called the **instruction time (i-time)**.

The second phase is execution. During the execution phase, a computer performs the following steps:

- Step 3: Execute instruction. The hardware element, now freshly fed with an instruction and data, carries out the instruction. This process could involve making an arithmetic computation, logical comparison, bit shift or vector operation.
- Step 4: Store results. The results are stored in registers or memory.

execution time (e-time) The time it takes to execute an instruction and store the results.

machine cycle The instruction phase followed by the execution phase.

pipelining A form of CPU operation in which multiple execution phases are performed in a single machine cycle.

The time it takes to complete the execution phase (Steps 3 and 4) is called the **execution time (e-time)**.

After both phases have been completed for one instruction, they are performed again for the second instruction and so on. Completing the instruction phase followed by the execution phase is called a **machine cycle**, as shown in Figure 3.2. Some processing units can speed up processing by using **pipelining**, whereby the processing unit gets one instruction, decodes another and executes a third at the same time. Modern desktop and laptop processors are capable of handling up to 20 stages at the same time. When doing this, essentially the fetch-execute cycle is split up into more, smaller stages. In addition to these 20 stages happening at the same time, since each stage is smaller than each of the traditional fetch, decode, execute, store stages, they should run quicker.

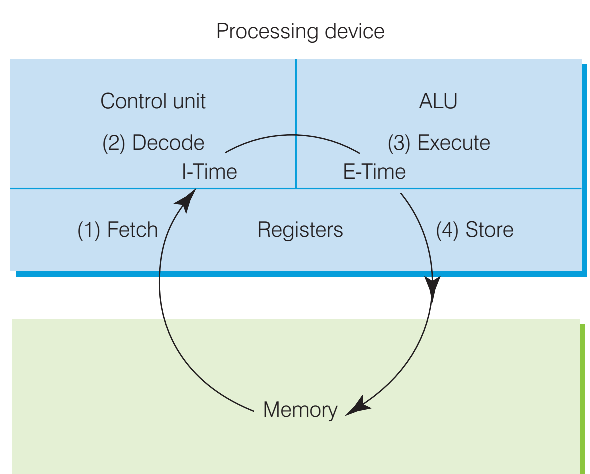


Figure 3.2 Execution of an Instruction *In the instruction phase, a program's instructions and any necessary data are read into the processor (1). Then the instruction is decoded so that the central processor can understand what to do (2). In the execution phase, the ALU does what it is instructed to do, making either an arithmetic computation or a logical comparison (3). Then the results are stored in the registers or in memory (4). The instruction and execution phases together make up one machine cycle.*

3.2 Processing and Memory Devices: Power, Speed and Capacity

The components responsible for processing – the CPU and memory – are housed together in the same box or cabinet, called the *system unit*. All other computer system devices, such as the monitor, secondary storage and keyboard, are linked directly or indirectly into the system unit housing. In this section we investigate the characteristics of these important devices.

Processing Characteristics and Functions

Because organizations want efficient processing and timely output, they use a variety of measures to gauge processing speed. These measures include the time it takes to complete a machine cycle and clock speed.

Machine Cycle Time

As you've seen, a computer executes an instruction during a machine cycle. The time in which a machine cycle occurs is measured in *nanoseconds* (one-billionth of one second) and *picoseconds* (one-trillionth of one second). Machine cycle time also can be measured by how many instructions are executed in one second. This measure, called **MIPS**, stands for millions of instructions per second. MIPS is another measure of speed for computer systems of all sizes.

MIPS Millions of instructions per second, a measure of machine cycle time.

Clock Speed

Each CPU produces a series of electronic pulses at a predetermined rate, called the **clock speed**, which affects machine cycle time. The control unit executes instructions in accordance with the electronic cycle or pulses of the CPU 'clock'. Each instruction takes at least the same amount of time as the interval between pulses. The shorter the interval between pulses, the faster each instruction can be executed.

clock speed A series of electronic pulses produced at a predetermined rate that affects machine cycle time.

Clock speed is often measured in **megahertz** (MHz, millions of cycles per second) or **gigahertz** (GHz, billions of cycles per second). Unfortunately, the faster the clock speed of the CPU, the more heat the processor generates. This heat must be dissipated to avoid corrupting the data and instructions the computer is trying to process. Also, chips that run at higher temperatures need bigger heat sinks, fans and other components to eliminate the excess heat. This increases the size of the computing device whether it is a desktop computer, tablet computer or smartphone, which increases the cost of materials and makes the device heavier – counter to what manufacturers and customers desire.

megahertz (MHz) Millions of cycles per second, a measure of clock speed.

gigahertz (GHz) Billions of cycles per second, a measure of clock speed.

Chip designers and manufacturers are exploring various means to avoid heat problems in their new designs. ARM is a computer chip design company whose energy-efficient chip architecture is broadly used in smartphones and tablet computers. Its Cortex-A7 chip design is expected to lead to much cheaper smartphones with a battery life five times longer than in current devices. Its more powerful Cortex-A15 processor can be used for processing-intensive tasks such as navigation or video playback.[2]

Manufacturers are also seeking more effective sources of energy as portable devices grow increasingly power hungry. A number of companies are exploring the substitution of fuel cells for lithium ion batteries to provide additional, longer-lasting power. Fuel cells generate electricity by consuming fuel (often methanol), while traditional batteries store electricity and release it through a chemical reaction. A spent fuel cell is replenished in moments by simply refilling its reservoir or by replacing the spent fuel cartridge with a fresh one.

Physical Characteristics of the CPU

Most CPUs are collections of digital circuits imprinted on silicon wafers or chips, each no bigger than the tip of a pencil eraser. To turn a digital circuit on or off within the CPU, electrical current must flow through a medium (usually silicon) from point A to point B. The speed the current travels between points can be increased by either reducing the distance between the points or reducing the resistance of the medium to the electrical current.

Reducing the distance between points has resulted in ever smaller chips, with the circuits packed closer together. Gordon Moore, who would cofound Intel (the largest maker of microprocessor chips) and become its chairman of the board, hypothesized that progress in chip manufacturing ought to make it possible to double the number of transistors (the microscopic on/off switches) on a single chip every two years. The hypothesis became known as **Moore's Law**, and this 'rule of thumb' has become a goal that chip manufacturers have met more or less for more than four decades.

Moore's Law A hypothesis stating that transistor densities on a single chip will double every two years.

Chip manufacturers have been able to improve productivity and performance by putting more transistors on the same size chip while reducing the amount of power required to perform tasks. Furthermore, because the chips are smaller, chip manufacturers can cut more chips from a single silicon wafer and thus reduce the cost per chip. As silicon-based components and computers perform better, they become cheaper to produce and therefore more plentiful, more powerful and more a part of our everyday lives. This process makes computing devices affordable for an increasing number of people around the world and makes it practical to pack tremendous computing power into the tiniest of devices.

Memory Characteristics and Functions

Main memory is located physically close to the CPU, although not on the CPU chip itself. It provides the CPU with a working storage area for program instructions and data. The chief feature of memory is that it rapidly provides the data and instructions to the CPU.

Storage Capacity

Like the CPU, memory devices contain thousands of circuits imprinted on a silicon chip. Each circuit is either conducting electrical current (on) or not conducting current (off). Data is stored in memory as a combination of on or off circuit states. Usually, 8 bits are used to represent a character, such as the letter *A*. Eight bits together form a **byte (B)**. In most cases, storage capacity is measured in bytes, with 1 byte equivalent to one character of data. The contents of the Library of Congress, with over 126 million items and 530 miles of bookshelves, would require about 20 petabytes of digital storage. It is estimated that all the words ever spoken represented in text form would equal about 5 exabytes of information.[3] Table 3.1 lists units for measuring computer storage.

byte (B) Eight bits that together represent a single character of data.

Table 3.1 Computer Storage Units

Name	Abbreviation	Number of Bytes
Byte	B	1
Kilobyte	KB	2^{10} or approximately 1024 bytes (exactly 1024 bytes is called a kibibyte)
Megabyte	MB	2^{20} or 1024 kilobytes (about 1 million)
Gigabyte	GB	2^{30} or 1024 megabytes (about 1 billion)
Terabyte	TB	2^{40} or 1024 gigabytes (about 1 trillion)
Petabyte	PB	2^{50} or 1024 terabytes (about 1 quadrillion)
Exabyte	EB	2^{60} or 1024 petabytes (about 1 quintillion)

Types of Memory

Computer memory can take several forms. Instructions or data can be temporarily stored in and read from **random access memory (RAM)**. As currently designed, RAM chips are volatile storage devices, meaning they lose their contents if the current is turned off or disrupted (as happens in a power surge, blackout or electrical noise generated by lightning or nearby machines). RAM chips are mounted directly on the computer's main circuit board or in other chips mounted on peripheral cards that plug into the main circuit board. These RAM chips consist of millions of switches that are sensitive to changes in electrical current.

random access memory (RAM) A form of memory in which instructions or data can be temporarily stored.

RAM comes in many varieties: static random access memory (SRAM) is byte-addressable storage used for high-speed registers and caches; dynamic random access memory (DRAM) is byte-addressable storage used for the main memory in a computer; and double data rate synchronous dynamic random access memory (DDR SDRAM) is an improved form of DRAM that effectively doubles the rate at which data can be moved in and out of main memory. Other forms of RAM memory include DDR2 SDRAM and DDR3 SDRAM.

Read-only memory (ROM), another type of memory, is nonvolatile, meaning that its contents are not lost if the power is turned off or interrupted. ROM provides permanent storage for data and instructions that do not change, such as programs and data from the computer manufacturer, including the instructions that tell the computer how to start up when power is turned on. ROM memory also comes in many varieties: programmable read-only memory (PROM), which is used to hold data and instructions that can never be changed; erasable programmable read-only memory (EPROM), which is programmable ROM that can be erased and reused; and electrically erasable programmable read-only memory (EEPROM), which is user-modifiable read-only memory that can be erased and reprogrammed repeatedly through the application of higher than normal electrical voltage.

read-only memory (ROM) A nonvolatile form of memory.

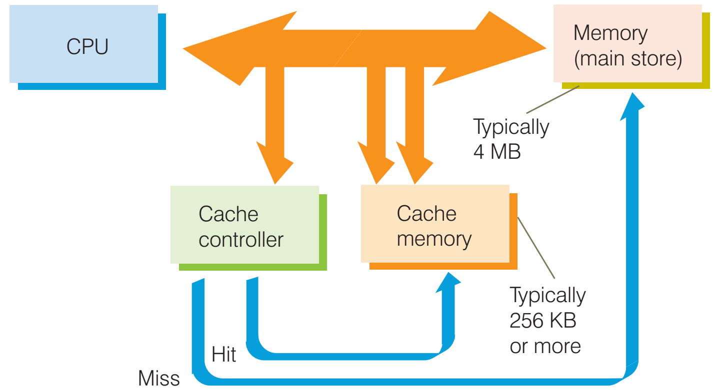
Chip manufacturers are competing to develop a nonvolatile memory chip that requires minimal power, offers extremely fast write speed and can store data accurately even after a large number of write-erase cycles. Such a chip could eliminate the need for RAM and simplify and speed up memory processing. Phase change memory (PCM) is one potential approach to provide such a memory device. PCM employs a specialized glass-like material that can change its physical state, shifting between a low-resistance crystalline state to a high-resistance gaseous state by applying voltage to rearrange the atoms of the material.

Although microprocessor speed has roughly doubled every 24 months over the past decades, memory performance has not kept pace. In effect, memory has become the principal bottleneck to system performance. **Cache memory** is a type of high-speed memory that a processor can access more rapidly than main memory to help ease this bottleneck (see Figure 3.3). Frequently used data is stored in easily accessible cache memory instead of slower memory such as RAM. Because cache memory holds less data, the CPU can access the desired data and instructions more quickly than when selecting from the larger set in main memory. Thus, the CPU can execute instructions faster, improving the overall performance of the computer system. Cache memory is available in three forms. The level 1 (L1) cache is on the CPU chip. The level 2 (L2) cache memory can be accessed by the CPU over a high-speed dedicated interface. The latest processors go a step further and place the L2 cache directly on the CPU chip itself and provide high-speed support for a tertiary level 3 (L3) external cache.

cache memory A type of high-speed memory that a processor can access more rapidly than main memory.

Memory capacity contributes to the effectiveness of a computer. For example, complex processing problems, such as computer-assisted product design, require more memory than simpler tasks such as word processing. Also, because computer systems have different types of memory, they might need other programs to control how memory is accessed and used. In other cases, the computer system can be configured to maximize memory usage. Before purchasing additional memory, an organization should address all these considerations.

Figure 3.3 Cache Memory *Processors can access this type of high-speed memory faster than main memory. Located on or near the CPU chip, cache memory works with main memory. A cache controller determines how often the data is used, transfers frequently used data to cache memory and then deletes the data when it goes out of use.*



Multiprocessing

multiprocessing The simultaneous execution of two or more instructions at the same time.

coprocessor The part of the computer that speeds processing by executing specific types of instructions while the CPU works on another processing activity.

multicore microprocessor A microprocessor that combines two or more independent processors into a single computer so that they share the workload and improve processing capacity.

Generally, **multiprocessing** involves the simultaneous execution of two or more instructions at the same time. One form of multiprocessing uses coprocessors. A **coprocessor** speeds processing by executing specific types of instructions while the CPU works on another processing activity. Coprocessors can be internal or external to the CPU and may have different clock speeds than the CPU. Each type of coprocessor performs a specific function. For example, a maths coprocessor chip speeds up mathematical calculations, while a graphics coprocessor chip decreases the time it takes to manipulate graphics.

A **multicore microprocessor** combines two or more independent processors into a single computer so that they share the workload and boost processing capacity. In addition, a dual-core processor enables people to perform multiple tasks simultaneously, such as playing a game and burning a CD.

When selecting a CPU, organizations must balance the benefits of processing speed with energy requirements and cost. CPUs with faster clock speeds and shorter machine cycle times require more energy to dissipate the heat generated by the CPU, and are bulkier and more expensive than slower ones.

Parallel Computing

parallel computing The simultaneous execution of the same task on multiple processors to obtain results faster.

massively parallel processing systems A form of multiprocessing that speeds processing by linking hundreds or thousands of processors to operate at the same time, or in parallel, with each processor having its own bus, memory, discs, copy of the operating system and applications.

bus A bus is a connection between components within a computer, or devices connected to a computer.

Parallel computing is the simultaneous execution of the same task on multiple processors to obtain results faster. Systems with thousands of such processors are known as **massively parallel processing systems**, a form of multiprocessing that speeds processing by linking hundreds or thousands of processors to operate at the same time, or in parallel, with each processor having its own **bus**, memory, discs, copy of the operating system and applications. The processors might communicate with one another to coordinate when executing a computer program, or they might run independently of one another but under the direction of another processor that distributes the work to the other processors and collects their results. The dual-core processors mentioned earlier are a simple form of parallel computing.

The most frequent uses for parallel computing include modelling, simulation and analyzing large amounts of data. Parallel computing is used in medicine to develop new imaging systems to complete ultrasound scans in less time with greater accuracy, enabling doctors to provide better diagnoses to patients, for example. Instead of building physical models of new products, engineers can create a virtual model of them and use parallel computing to test how the products work and then change design elements and materials as needed. The European Space Agency is using parallel computing to solve aerospace problems, such as calculating interplanetary trajectories. They use open source software to optimize how their algorithms are distributed between multiple processors so that they run as fast as possible.[4] They have made the software they use to do this open source so that anyone can use it, although not everyone has access to parallel systems.

grid computing The use of a collection of computers, often owned by multiple individuals or organizations, to work in a coordinated manner to solve a common problem.

Grid computing is the use of a collection of computers, often owned by multiple individuals or organizations, to work in a coordinated manner to solve a common problem. Grid computing is a low-cost approach to parallel computing. The grid can include dozens, hundreds or even thousands of computers that run collectively to solve extremely large processing problems. Key to the success of grid computing is a central server that acts as the grid leader and traffic monitor. This controlling server divides the computing task into subtasks and assigns the work to computers on the grid that have (at least temporarily) surplus processing power. The central server also monitors the processing and, if a member of the grid fails to complete a subtask, it restarts or reassigns the task. When all the subtasks are completed, the controlling server combines the results and advances to the next task until the whole job is completed.

CERN is the European Organization for Nuclear Research and its main area of research is the study of the fundamental constituents of matter and the forces acting between them.[5] CERN uses grid computing with the processing power of over 300,000 high-end personal computers. This computing power is needed to process some 25 petabytes of data generated each year by the Large Hadron Collider (LHC) particle accelerator looking for evidence of new particles that can provide clues to the origins of our universe.[6]

3.3 Secondary Storage

Storing data safely and effectively is critical to an organization's success. Driven by many factors such as needing to retain more data longer to meet government regulatory concerns, storing new forms of digital data such as audio and video, and keeping systems running under the onslaught of increasing volumes of email, the world's information is more than doubling every two years. IBM, which is investing heavily in technologies (such as Watson, its cognitive computer system) that can help organizations manage all that unstructured data, estimates that more than 80 per cent of the 2.5 billion gigabytes of data created every day comes in the form of unstructured data such as video, audio and image objects.[7]

The Indian government has undertaken a massive effort to register its 1.3 billion residents in a universal citizen ID system. Called Aadhaar, the result is the world's largest database of biometric data including retina scans, fingerprints and multiple facial images of each individual. The database has applications at India's borders to recognize travellers and to identify people who should not be in controlled areas such as the hangar area of an airport. The system can also be used in crowd control to recognize the gender and age of a crowd of people and identify where security personnel might be most needed. The system has massive ethical issues but its legality has been upheld by the Indian courts.[8]

secondary storage Devices that store large amounts of data, instructions and information more permanently than allowed with main memory.

For most organizations, the best overall data storage solution is probably a combination of different **secondary storage** options that can store large amounts of data, instructions and information more permanently than allowed with main memory. Compared with memory, secondary storage offers the advantages of nonvolatility, greater capacity and greater economy. On a cost-per-megabyte basis, secondary storage is considerably less expensive than primary memory (see Table 3.2). The selection of secondary storage media and devices requires understanding their primary characteristics: access method, capacity and portability.

Table 3.2 Cost Comparison for Various Forms of Storage

All forms of secondary storage cost considerably less per gigabyte of capacity than SDRAM, although they have slower access times. A 25 GB Blu-ray disc costs about €0.03 per gigabyte, while an industrial strength SD card can cost around €15 per gigabyte – 500 times more expensive.

Description	Cost	Storage Capacity (GB)	Cost Per GB
1.6 TB 4 mm back-up data tape cartridge	€30.00	1,600	€0.02
1 TB desktop external hard drive	€50.00	50,000	€0.001
50 GB rewritable Blu-ray disc	€6.00	50	€0.12
64 GB flash drive	€8.00	64	€0.13
Industrial strength SD (Secure Digital) card able to support extreme temperatures	€30.00	32	€0.94
SD Card	€9	32	€0.28
Cloud storage	Cost varies depending on use	Unlimited storage	~€10/month

An objective of a credit card company's information system might be to rapidly retrieve stored customer data to approve customer purchases. In this case, a fast access method is critical. In other cases, such as equipping the Coca-Cola field sales force with pocket-sized personal computers, portability and storage capacity might be major considerations in selecting and using secondary storage media and devices.

In addition to cost, capacity and portability, organizations must address security issues to allow only authorized people to access sensitive data and critical programs. Because the data and programs kept on secondary storage devices are so critical to most organizations, all of these issues merit careful consideration.

Access Methods

sequential access A retrieval method in which data must be accessed in the order in which it was stored.

direct access A retrieval method in which data can be retrieved without the need to read and discard other data.

sequential access storage device (SASDs) A device used to sequentially access secondary storage data.

direct access storage device (DASDs) A device used for direct access of secondary storage data.

Data and information access can be either sequential or direct. **Sequential access** means that data must be accessed in the order in which it is stored. For example, inventory data might be stored sequentially by part number, such as 100, 101, 102 and so on. If you want to retrieve information on part number 125, you must read and discard all the data relating to parts 001 to 124.

Direct access means that data can be retrieved directly without the need to pass by other data in sequence. With direct access, it is possible to go directly to and access the needed data – for example, part number 125 – without having to read through parts 001 to 124. For this reason, direct access is usually faster than sequential access. The devices used only to access secondary storage data sequentially are called **sequential access storage devices (SASDs)**; those used for direct access are called **direct access storage devices (DASDs)**.

Secondary Storage Devices

Secondary data storage is not directly accessible by the CPU. Instead, computers usually use input/output channels to access secondary storage and transfer the desired data using intermediate areas in primary storage. The most common forms of secondary storage devices are magnetic, optical and solid state.

Magnetic Secondary Storage Devices

Magnetic storage uses tape or disc devices covered with a thin magnetic coating that enables data to be stored as magnetic particles. **Magnetic tape** is a type of sequential secondary storage medium, which is now used primarily for storing backups of critical organizational data in the event of a disaster. Examples of tape storage devices include cassettes and cartridges measuring a few millimetres in diameter, requiring very little storage space. Magnetic tape has been used as storage media since the time of the earliest computers, such as the 1951 Univac computer.[9]

magnetic tape A type of sequential secondary storage medium, now used primarily for storing backups of critical organizational data in the event of a disaster.

Continuing advancements have kept magnetic tape as a viable storage medium. For example, IBM and FUJIFILM Corporation of Japan recently achieved a recording density of 123 billion bits per square inch on low-cost magnetic tape. While still in development, this innovation represents the equivalent of a 220-terabyte tape cartridge (enough to hold the text of approximately 220 million books) that could fit into the palm of your hand.[10]

Australia Wide IT offers clients a range of backup options including magnetic tape.[11]

A **magnetic disc** is a direct access storage device that represents bits using small magnetized areas and uses a read/write head to go directly to the desired piece of data. Because direct access allows fast data retrieval, this type of storage is ideal for companies that need to respond quickly to customer requests, such as airlines and credit card firms. For example, if a manager needs information on the credit history of a customer or the seat availability on a particular flight, the information can be obtained in seconds if the data is stored on a direct access storage device. Magnetic disc storage varies widely in capacity and portability. Hard discs, though more costly and less portable, are more popular because of their greater storage capacity and quicker access time.

magnetic disc A direct access storage device with bits represented by magnetized areas.

Putting an organization's data online involves a serious business risk – the loss of critical data can put a corporation out of business. The concern is that the most critical mechanical components inside a magnetic disc storage device – the disc drives, the fans and other input/output devices – can fail. Thus organizations now require that their data storage devices be fault tolerant; that is, they can continue with little or no loss of performance if one or more key components fail.

A **redundant array of independent/inexpensive discs (RAID)** is a method of storing data that generates extra bits of data from existing data, allowing the system to create a 'reconstruction map' so that if a hard drive fails, it can rebuild lost data. With this approach, data is split and stored on different physical disc drives using a technique called *striping* to evenly distribute the data. RAID technology has been applied to storage systems to improve system performance and reliability.

redundant array of independent/inexpensive discs (RAID) A method of storing data that generates extra bits of data from existing data, allowing the system to create a 'reconstruction map' so that, if a hard drive fails, the system can rebuild lost data.

RAID can be implemented in several ways. In the simplest form, RAID subsystems duplicate data on drives. This process, called **disc mirroring**, provides an exact copy that protects users fully in the event of data loss. However, to keep complete duplicates of current backups, organizations need to double the amount of their storage capacity. Other RAID methods are less expensive because they only duplicate part of the data, allowing storage managers to minimize the amount of extra disc space they must purchase to protect data. Optional second drives for personal computer users who need to mirror critical data are available for less than €75.

disc mirroring A process of storing data that provides an exact copy that protects users fully in the event of data loss.

RAID technology is often used by universities and colleges to mirror their learning environment, such as Moodle. That way if a problem occurs before exam time, all materials can be made available quickly and accurately.

Virtual tape is a storage technology for less frequently needed data so that it appears to be stored entirely on tape cartridges, although some parts might actually be located on faster hard discs. The software associated with a virtual tape system is sometimes called a *virtual tape server*. Virtual tape can be used with a sophisticated storage-management system that moves data to slower but less costly forms of storage media as people use the data less

virtual tape A storage device for less frequently needed data so that it appears to be stored entirely on tape cartridges, although some parts of it might actually be located on faster hard discs.

often. Virtual tape technology can decrease data access time, lower the total cost of ownership and reduce the amount of floor space consumed by tape operations.

Baldor Electric Company designs, manufactures and markets industrial electric motors, transmission products, drives and generators. The firm implemented a virtual tape system to replace its tape-based storage system consisting of thousands of magnetic tapes. Baldor uses the new virtual tape system to back up its five production databases twice a day and stores the data for 14 days. The time to create backups has been cut by 40 per cent, and the new system takes up about 100 square feet less of data-centre floor space.[12]

Optical Secondary Storage Devices

optical storage device A form of data storage that uses lasers to read and write data.

An **optical storage device** uses special lasers to read and write data. The lasers record data by physically burning pits into the disc. Data is directly accessed from the disc by an optical disc device. This optical disc device uses a low-power laser that measures the difference in reflected light caused by a pit (or lack thereof) on the disc.

compact disc read-only memory (CD-ROM) A common form of optical disc on which data cannot be modified once it has been recorded.

A common optical storage device is the **compact disc read-only memory (CD-ROM)**, with a storage capacity of 740 megabytes of data. After data is recorded on a CD-ROM, it cannot be modified because the disc is read-only. A CD burner, the informal name for a CD recorder, is a device that can record data to a compact disc. CD-recordable (CD-R) and CD-rewritable (CD-RW) are the two most common types of drives that can write CDs, either once (in the case of CD-R) or repeatedly (in the case of CD-RW). CD-rewritable (CD-RW) technology allows PC users to back up data on CDs.

digital video disc (DVD) A storage medium used to store software, video games and movies.

A **digital video disc (DVD)** looks like a CD, but it can store about 135 minutes of digital video or several gigabytes of data. At a data transfer rate of 1.352 megabytes per second, the access speed of a DVD drive is also faster than that of the typical CD-ROM drive. Software, video games and movies are often stored and distributed on DVDs.

The Blu-ray high-definition video disc format based on blue laser technology stores at least three times as much data as a DVD. DVD and Blu-ray discs were used for storing movies for home entertainment, but this is less popular now given the rise of streaming services. In addition, the discs can become unreliable over time as they are exposed to light, humidity and chemical changes inside the disc itself. As a result, the data stored on such discs can become unreadable over time. Thus, disc manufacturers are focused on developing longer-lasting DVD and Blu-ray technology.

Solid State Secondary Storage Devices

A solid state storage device (SSD) stores data in memory chips rather than on hard disk drives or optical media. These memory chips require less power and provide much faster data access than magnetic data storage devices. In addition, SSDs have no moving parts, so they are less fragile than hard disk drives. All these factors make the SSD a preferred choice over hard disk drives for portable computers.

A universal serial bus (USB) flash drive is one example of a commonly used SSD. USB flash drives are external to the computer and are removable and rewritable. They are very popular for moving data between different computers (a laptop and a desktop for example). Most weigh less than 30g and can provide a wide range of storage capacity. Samsung has developed a 15.36-terabyte solid state storage device based on 48-layer 3D chip technology. This technology allows for vertical stacking of flash cells, thus requiring less space to store data. It also improves performance and requires less power.

Enterprise Storage Options

Businesses need to store large amounts of data created throughout an organization. Such large secondary storage is called *enterprise storage* and comes in three forms: attached storage, network-attached storage (NAS) and storage area networks (SANs).

Attached Storage

Attached storage methods include the tape, hard discs and optical devices discussed previously, which are connected directly to a single computer. Attached storage methods, though simple and cost effective for single users and small groups, do not allow systems to share storage, and they make it difficult to back-up data.

Because of the limitations of attached storage, firms are turning to network-attached storage (NAS) and storage area networks (SANs). These alternatives enable an organization to share data storage resources among a much larger number of computers and users, resulting in improved storage efficiency and greater cost effectiveness. In addition, they simplify data back-up and reduce the risk of downtime. Nearly one-third of system downtime is a direct result of data storage failures, so eliminating storage problems as a cause of downtime is a major advantage.

Network-Attached Storage

Network-attached storage (NAS) is hard disc storage that is set up with its own network address rather than being attached to a computer. Figure 3.4 shows a NAS storage device. NAS includes software to manage storage access and file management, relieving the users' computers of those tasks. The result is that both application software and files can be served faster because they are not competing for the same processor resources. Computer users can share and access the same information, even if they are using different types of computers. Common applications for NAS include consolidated storage, Internet and e-commerce applications, and digital media.

network-attached storage (NAS) Hard disc storage that is set up with its own network address rather than being attached to a computer.

Figure 3.4 **NAS Storage Device** *a network-attached storage device with six disks.*

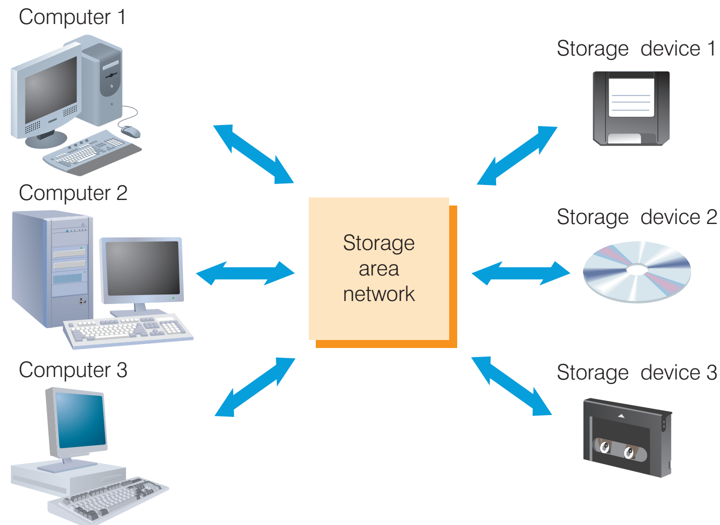
One of the most popular Swiss skiing destinations is the Davos Klosters resort with more than 300 kilometres of ski slopes, 5 mountain railways, and 22 hotels with 1,700 beds. Resort guests expect hassle-free hotel check-ins, an always available online ticket shop, reliable information display boards, and efficient and on-time mountain railways. It takes powerful information systems to meet these expectations. The resort decided to implement NAS storage devices to make sure its information systems are reliable and provide fast access to data, dependable backups of operational data and easy expansion of storage capacity.[13]

storage area network (SAN) A special-purpose, high-speed network that provides high-speed connections between data storage devices and computers over a network.

Storage Area Network

A **storage area network (SAN)** is a special-purpose, high-speed network that provides direct connections between data storage devices and computers across the enterprise (see Figure 3.5). A SAN also integrates different types of storage subsystems, such as multiple RAID storage devices and magnetic tape back-up systems, into a single storage system. Use of a SAN offloads the network traffic associated with storage onto a separate network. The data can then be copied to a remote location, making it easier for companies to create backups and implement disaster recovery policies.

Figure 3.5 Storage Area Network *A SAN provides high-speed connections between data-storage devices and computers over a network.*



Using a SAN, an organization can centralize the people, policies, procedures and practices for managing storage, and a data storage manager can apply the data consistently across an enterprise. This centralization eliminates inconsistent treatment of data by different system administrators and users, providing efficient and cost-effective data storage practices.

NorthgateArinso is a global human resources services provider that equips its clients with HR solutions using advanced technology, outsourcing and consulting. The firm's systems support multicountry payroll, training, recruiting and talent management.[14] NorthgateArinso implemented two integrated data centres, one in London and one in Brussels, with an information systems architecture based on standard servers from a single supplier and data storage provided by SAN hardware and software. The SAN makes the total data stored available to all users. The company's prior collection of separate servers, applications and databases is now integrated into an infrastructure that is easier to manage and can more flexibly meet the challenges of a highly fluctuating workload.[15]

A fundamental difference between NAS and SAN is that NAS uses file input/output, which defines data as complete containers of information, while SAN deals with block input/output, which is based on subsets of data smaller than a file. SAN manufacturers include EMC, Hitachi Data Systems Corporation, Xiotech and IBM.

As organizations set up large-scale SANs, they use more computers and network connections than in a NAS environment and, consequently, the network becomes difficult to manage. In response, software tools designed to automate storage using previously defined policies are finding a place in the enterprise. Known as **policy-based storage management**, the software products from industry leaders such as Veritas Software Corporation, Legato Systems, EMC and IBM automatically allocate storage space to users, balance the loads on servers and discs, and reroute network traffic when systems go down – all based on policies set up by system administrators.

policy-based storage management Automation of storage using previously defined policies.

The trend in secondary storage is towards higher capacity, increased portability and automated storage management. Organizations should select a type of storage based on their needs and resources. In general, storing large amounts of data and information and providing users with quick access make an organization more efficient.

Storage as a Service

Storage as a service is a data storage model in which a data storage service provider rents space to people and organizations. Users access their rented data storage via the Internet. Such a service enables the users to store and back-up their data without requiring a major investment to create and maintain their own data storage infrastructure. Businesses can also choose pay-per-use services where they rent space on massive storage devices housed either at a service provider (such as Hewlett-Packard or IBM) or on the customers' premises, paying only for the amount of storage they use. This approach is sensible for organizations with wildly fluctuating storage needs, such as those involved in the testing of new drugs or in developing software.

storage as a service A data storage model where a data storage service provider rents space to individuals and organizations.

Amazon, Google, Microsoft, Stortech based in South Africa, HP and IBM are a few of the storage-as-a-service providers used by organizations. Amazon.com's Simple Storage Service (S3) provides storage as a service with a monthly cost of roughly €0.10 per GB stored and €0.075 per GB of data transferred into the Amazon.com storage.

Box.net, Carbonite, SugarSynch, Symantec and Mozy are a few of the storage-as-a-service providers used by individuals. This set of providers all charge less than €6 per month for up to 5 GB of storage.

A Mozy customer who had his laptop stolen was able to provide police with photos of the thief because Mozy continued to back-up data after the laptop was stolen, including the thief's photos and documents. The customer accessed the photos from his online storage site, and police captured the thief and returned the laptop. Mozy is now owned by Dell and offers a number of solutions for clients if an item of technology has been stolen.[16]

Storing Data in DNA

Scientists are currently experimenting with even more advanced storage technologies, including the use of DNA molecules to store vast amounts of data for long periods of time. DNA molecules consist of four chemicals connected end-to-end, similar to the sequences of ones and zeros that computers use to represent data. One gram of DNA is capable of holding 455 exabytes (one exabyte is equivalent to a billion gigabytes).[17] In addition, data could be stored in DNA for thousands of years. By comparison, today's most powerful desktop hard drives hold around 6 terabytes of data and might last 50 years.[18] At this time, the cost of synthesizing DNA to store data and the cost of decoding the data stored in DNA are prohibitively expensive, unless the data needs to be archived for at least 600 years. It will likely be a decade or more before the technology evolves to the point where DNA data storage is practical.[19] Startup company Catalog is working to reduce the cost of 'printing' to DNA.[20]

3.4 Input and Output Devices: The Gateway to Computer Systems

Your first experience with computers is usually through input and output devices. These devices are the gateways to the computer system – you use them to provide data and instructions to the computer and receive results from it. Input and output devices are part of a computer's user interface, which includes other hardware devices and software that allow you to interact with a computer system.

As with other computer system components, an organization should keep its business goals in mind when selecting input and output devices. For example, many restaurant chains use handheld input devices or computerized terminals that let food servers enter orders efficiently and accurately. These systems have also cut costs by helping to track inventory and market to customers.

Characteristics and Functionality

In general, businesses want input devices that let them rapidly enter data into a computer system, and they want output devices that let them produce timely results. When selecting input and output devices, businesses also need to consider the form of the output they want, the nature of the data required to generate this output, and the speed and accuracy they need for both. Some organizations have very specific needs for output and input, requiring devices that perform specific functions. The more specialized the application, the more specialized the associated system input and output devices.

The speed and functions of input and output devices should be balanced with their cost, control and complexity. More specialized devices might make it easier to enter data or output information, but they are generally more costly, less flexible and more susceptible to malfunction.

The Nature of Data

Getting data into the computer – input – often requires transferring human-readable data, such as a sales order, into the computer system. 'Human-readable' means data that people can read and understand. A sheet of paper containing inventory adjustments is an example of human-readable data. In contrast, machine-readable data can be read by computer devices (such as the universal barcode on many grocery and retail items) and is typically stored as bits or bytes. Inventory changes stored on a disc is an example of machine-readable data.

Some data can be read by people and machines, such as magnetic ink on bank cheques. Usually, people begin the input process by organizing human-readable data and transforming it into machine-readable data. Every keystroke on a keyboard, for example, turns a letter symbol of a human language into a digital code that the machine can manipulate.

Data Entry and Input

Getting data into the computer system is a two-stage process. First, the human-readable data is converted into a machine-readable form through **data entry**. The second stage involves transferring the machine-readable data into the system. This is **data input**.

data entry Converting human-readable data into a machine-readable form.

data input Transferring machine-readable data into the system.

Today, many companies are using online data entry and input: they communicate and transfer data to computer devices directly connected to the computer system. Online data entry and input place data into the computer system in a matter of seconds. Organizations in many industries require the instantaneous updating offered by this approach. For example, when ticket agents enter a request for concert tickets, they can use online data entry and input to record the request as soon as it is made. Ticket agents at other terminals can then access this data to make a seating check before they process another request.

Source Data Automation

Regardless of how data gets into the computer, it should be captured and edited at its source. **Source data automation** involves capturing and editing data where it is originally created and in a form that can be directly entered into a computer, thus ensuring accuracy and timeliness. For example, using source data automation, salespeople enter sales orders into the computer at the time and place they take the orders. Any errors can be detected and corrected immediately. If an

source data automation Capturing and editing data where it is initially created and in a form that can be directly entered into a computer, thus ensuring accuracy and timeliness.

item is temporarily out of stock, the salesperson can discuss options with the customer. Prior to source data automation, orders were written on paper and entered into the computer later (usually by a clerk, not by the person who took the order). Often the handwritten information wasn't legible or, worse still, got lost. If problems occurred during data entry, the clerk had to contact the salesperson or the customer to 'recapture' the data needed for order entry, leading to further delays and customer dissatisfaction.

Input Devices

Data entry and input devices come in many forms. They range from special-purpose devices that capture specific types of data to more general-purpose input devices. Some of the special-purpose data entry and input devices are discussed later in this chapter. First, we focus on devices used to enter and input general types of data, including text, audio, images and video for personal computers.

Personal Computer Input Devices

A keyboard and a computer mouse are the most common devices used for entry and input of data such as characters, text and basic commands. Some companies are developing keyboards that are more comfortable, more easily adjusted and faster to use than standard keyboards. These ergonomic keyboards, such as the split keyboard offered by Microsoft and others, are designed to avoid wrist and hand injuries caused by hours of typing. Other keyboards include touchpads that let you enter sketches on the touchpad while still using keys to enter text. Wireless mice and keyboards keep a physical desktop free from clutter.

You use a computer mouse to point to and click symbols, icons, menus and commands on the screen. The computer makes a number of actions in response, such as placing data into the computer system.

Speech-Recognition Technology

Using **speech-recognition technology**, a computer equipped with a source of speech input, such as a microphone, can interpret human speech as an alternative means of providing data or instructions to the computer. The most basic systems require you to train the system to recognize your speech patterns or are limited to a small vocabulary of words. More advanced systems can recognize continuous speech without requiring you to break your speech into discrete words. Interactive voice response (IVR) systems allow a computer to recognize both voice and keypad inputs.

speech-recognition technology Input devices that recognize human speech.

Companies that must constantly interact with customers are eager to reduce their customer support costs while improving the quality of their service. For example, Time Warner implemented a speech-recognition application as part of its customer call centre. Subscribers who call customer service can speak commands to begin simple processes such as 'pay my bill' or 'add ShowTime'. The voice recognition system saves time and money even though most people would prefer to speak to a live person. 'We have roughly 13 million customers, and a few seconds or minutes here or there for each customer can really add up to longer hold times and higher staffing costs – which makes cable rates climb', says Time Warner spokesman Matthew Tremblay.[21]

Digital Cameras

Digital cameras record and store images or video in digital form, so when you take pictures, the images are electronically stored in the camera. You can download the images to a computer either directly or by using a flash memory card. After you store the images on the computer's hard disc, you can then edit and print them, send them to another location or paste them into another application. This digital format saves time and money by eliminating the need to process film in order to share photos. For

digital cameras An input device used with a PC to record and store images and video in digital form.

example, you can download a photo of your project team captured by a digital camera and then post it on a website or paste it into a project status report. Digital cameras have eclipsed film cameras used by professional photographers for photo quality and features such as zoom, flash, exposure controls, special effects and even video-capture capabilities. With the right software, you can add sound and handwriting to the photo. Many computers and smartphones come equipped with a digital camera to enable their users to place video calls and take pictures and videos.

Canon, Casio, Nikon, Olympus, Panasonic, Pentax, Sony and other camera manufacturers offer full-featured, high-resolution digital camera models at prices ranging from €200 to over €3,000. Some manufacturers offer pocket-sized camcorders for less than €100.

The police department in Wallis, Mississippi, consists of only five officers but is one of the first departments in the USA to use tiny digital cameras that clip onto the front pocket of the officers' uniforms. The cameras are the size of a pack of chewing gum and come with a memory card capable of holding hours of evidence. The cameras record each police stop in its entirety and provide evidence that supports prosecution of suspects.[22]

Scanning Devices

Scanning devices capture image and character data. A page scanner is like a photocopier. You either insert a page into the scanner or place it face down on the glass plate of the scanner and then scan it. With a handheld scanner, you manually move or roll the scanning device over the image you want to scan. Both page and handheld scanners can convert monochrome or colour pictures, forms, text and other images into machine-readable digits. Considering that US enterprises generate an estimated 1 billion pieces of paper daily, many companies are looking to scanning devices to help them manage their documents and reduce the high cost of using and processing paper.

Silicon Valley Bank (SVB) Financial Group is headquartered in Santa Clara, California, and is surrounded by hundreds of high-tech companies and start-up ventures in the life science, clean technology, venture capital, private equity and premium wine markets.[23] SVB used to store loan and deposit documents for some 4,000 clients in paper files at its headquarters. The firm received more than 75 requests per day from branches for copies of documents, with each request taking about 15 minutes to process. SVB implemented document-scanning hardware and software that can create a digital, online copy of all documents.

Optical Data Readers

You can also use a special scanning device called an *optical data reader* to scan documents. The two categories of optical data readers are for optical mark recognition (OMR) and optical character recognition (OCR). You use OMR readers for grading tests and other purposes such as forms. With this technology, you use pencils to fill in bubbles or check boxes on OMR paper, which is also called a 'mark sense form'. OMR systems are used in standardized tests, including the USA's SAT and GMAT tests, and on Lotto tickets in the UK. In contrast, most OCR readers use reflected light to recognize and scan various machine-generated characters. With special software, OCR readers can also convert handwritten or typed documents into digital data. After being entered, this data can be shared, modified and distributed over computer networks to hundreds or thousands of people.

Magnetic Ink Character Recognition (MICR) Devices

In the 1950s, the banking industry became swamped with paper cheques, loan applications, bank statements and so on. The result was the development of magnetic ink character recognition (MICR), a system for reading banking data quickly. With MICR, data is placed on the bottom of a cheque or other form using a special magnetic ink. Using a special character set, data printed with this ink is readable by people and computers (see Figure 3.6).

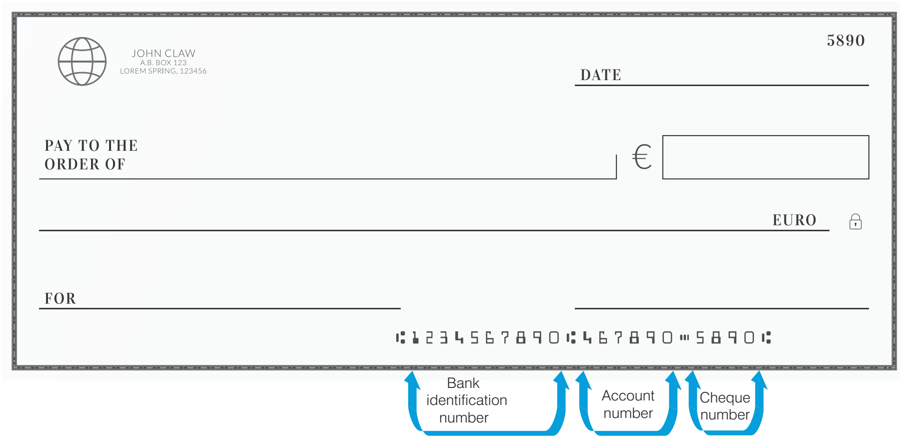


Figure 3.6 MICR Device *Magnetic ink character recognition technology codes data on the bottom of a cheque or other form using special magnetic ink, which is readable by people and computers. For an example, look at the bottom of a bank cheque. Although cheques are not used as much now, they are still the most likely place you will see MICR. Previously MICR was used on airline tickets and it is sometime used in creating durable shelf tags and coupon books.*

Magnetic Strip Cards

A **magnetic strip card** stores a limited amount of data by modifying the magnetism of tiny iron-based particles contained in a band on the card. The magnetic strip is read by physically swiping the card at a terminal. For this reason, such cards are called a contact card. Magnetic strip cards are commonly used in credit and debit cards, transportation tickets and ID cards.

magnetic strip card A type of card that stores a limited amount of data by modifying the magnetism of tiny iron-based particles contained in a band on the card.

Chip-and-PIN Cards

Most European countries as well as many countries in Asia and South America have converted to chip-and-PIN (personal identification number) technology, which uses 'smart card technology.[24] This technology employs a computer chip that communicates with a card reader using radio frequencies, which means the cards do not need to be swiped at a terminal. **Chip-and-PIN cards** require different terminals from those used for magnetic stripe cards. For security, the card holder is also required to enter a PIN at the point of sale, making such cards more effective at preventing fraud. Although credit card fraud is a problem, credit card issuers cannot force merchants to invest in the new terminals required for chip-and-PIN cards. As a result, deployment of this technology is lagging.

chip-and-PIN card A type of card that employs a computer chip that communicates with a card reader using radio frequencies; it does not need to be swiped at a terminal.

Contactless Cards

A **contactless card** has an embedded chip that only needs to be held close to a terminal to transfer its data; no PIN needs to be entered. Contactless credit card payments are common now in many parts of the world, and these areas are rapidly becoming 'cashless', something that is a problem for buskers, beggars, charity collectors and others who rely on the availability of small change. Many locations have moved towards mobile contactless payments using a service such as Apple Pay instead, although the effect is the same. For example, mobile payment is more common in China than contactless card payment.

contactless card A card with an embedded chip that only needs to be held close to a terminal to transfer its data; no PIN needs to be entered.

Point-of-Sale Devices

Point-of-sale (POS) devices are terminals used to capture data for data entry. They are frequently used in retail operations to enter sales information into the computer system. The POS device then computes the total charges, including any tax. In medical settings, POS devices are often used for remote monitoring in

point-of-sale (POS) devices A terminal used to enter data into the computer system.

hospitals, clinics, laboratories, doctors' offices and patients' homes. With network-enabled POS equipment, medical professionals can instantly get an update on the patient's condition from anywhere at any time via a network or the Internet. POS devices use various types of input and output devices, such as keyboards, barcode readers, scanning devices, printers and screens. Much of the money that businesses spend on computer technology involves POS devices.

Special input devices can be attached to smartphones and computers to accept payments from credit and debit cards for goods and services. Intuit Go Payment and Square can provide a small credit card scanner that plugs into your smartphone.[25]

Automated Teller Machine (ATM) Devices

Another type of special-purpose input/output device, the automated teller machine (ATM), is a terminal that bank customers use to perform transactions with their bank accounts. Companies use various ATM devices, sometimes called *kiosks*, to support their business processes. Some can dispense tickets, such as for airlines, concerts and football games. Some colleges use them to produce transcripts.

Pen Input Devices

By touching the screen with a pen input device, you can activate a command or cause the computer to perform a task, enter handwritten notes, and draw objects and figures. Pen input requires special software and hardware. Handwriting recognition software, for example, converts handwriting on the screen into text. The Tablet PC from Microsoft and its hardware partners can transform handwriting into typed text and store the 'digital ink' in the same way in which a person writes it. People can use a pen to write and send an email, add comments to Word documents, mark up PowerPoint presentations and even hand-draw charts in a document. The data can then be moved, highlighted, searched and converted into text. Pen input is especially attractive if you are uncomfortable using a keyboard. The success of pen input depends on how accurately and at what cost handwriting can be read and translated into digital form.

Audi AG installed interactive white boards at its five technical training locations in Germany. PowerPoint presentations can be projected onto the screen, and trainers can draw over the image and highlight features by circling or underlining. Consequently, static presentations have become more interactive.[26]

Touch-Sensitive Screens

Advances in screen technology allow display screens to function as input as well as output devices. By touching certain parts of a touch-sensitive screen, you can start a program or trigger other types of action. Touch-sensitive screens can remove the need for a keyboard, which conserves space and increases portability. Touchscreens are frequently used at petrol stations to allow customers to select grades of petrol and request a receipt; on photocopy machines for selecting options; at fast-food restaurants for entering customer choices; at information centres for finding facts about local eating and drinking establishments; and at amusement parks to provide directions to patrons. They are also used in kiosks at airports and department stores. Touch-sensitive screens are also being considered for gathering votes in elections in some countries.

As touchscreens get smaller, the user's fingers begin to block the information on the display. Nanotouch technology is being explored as a means of overcoming this problem. Using this technology, users control the touchscreen from its backside so that fingers do not block the display. As the user's finger moves on the back of the display, a tiny graphical finger is projected onto the touchscreen. Such displays are useful for mobile audio players the size of a coin.

Barcode Scanners and QR Readers

A barcode scanner employs a laser scanner to read a barcoded label and pass the data to a computer. The barcode reader may be stationary or hand-held to support a wide variety of uses. This form of input is used widely in store checkouts and warehouse inventory control. Barcodes are also used in hospitals, where a nurse first scans a patient's wristband and then a barcode on the medication about to be administered to prevent medication errors. A QR or Quick Response code is a way of representing text as an image that can be interpreted through a digital camera. A QR code typically contains a webpage URL. The three large squares in the corners allow a computer to tell 'which way up' the code is.

Radio Frequency Identification

Radio frequency identification (RFID) is a technology that employs a microchip with an antenna to broadcast its unique identifier and location to receivers. The purpose of an RFID system is to transmit data via a mobile device called a tag (see Figure 3.7), which is read by an RFID reader and processed according to the needs of a computer program. One popular application of RFID is to place microchips on retail items and install in-store readers that track the inventory on the shelves to determine when shelves should be restocked. The RFID tag chip includes a special form of EPROM memory that holds data about the item to which the tag is attached. A radio frequency signal can update this memory as the status of the item changes. The data transmitted by the tag might provide identification, location information or details about the product tagged, such as date manufactured, retail price, colour or date of purchase.

radio frequency identification (RFID) A technology that employs a microchip with an antenna to broadcast its unique identifier and location to receivers.

Farmers in Australia use RFID tags to keep track on their sheep to help trace food from farm to fork.[27]

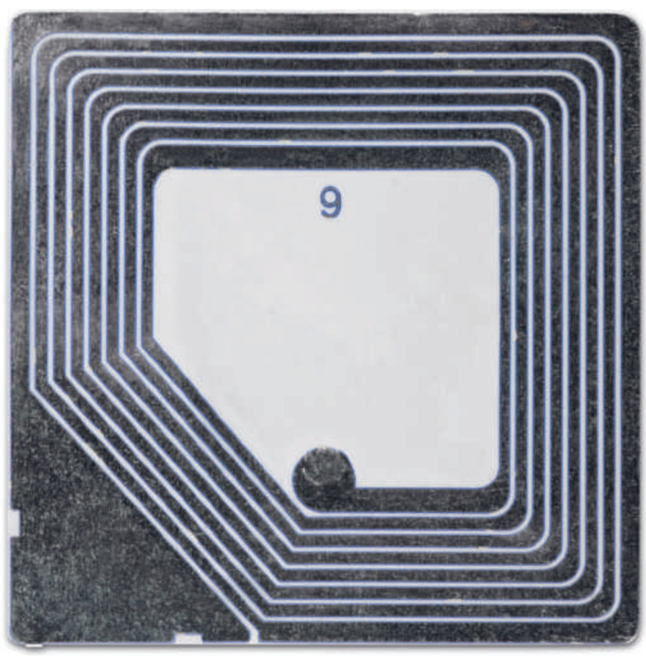


Figure 3.7 **RFID Tag**
An RFID tag is small compared to current barcode labels used to identify items.

Output Devices

Computer systems provide output to decision makers at all levels of an organization so they can solve a business problem or capitalize on a competitive opportunity. In addition, output from one computer system can provide input into another computer system. The desired form of this output might be visual, audio or even digital. Whatever the output's content or form, output devices are designed to provide the right information to the right person in the right format at the right time.

Display Monitors

The display monitor is a device used to display the output from the computer. Because early monitors used a cathode-ray tube to display images, they were sometimes called *CRTs*. The cathode-ray tubes generate one or more electron beams. As the beams strike a phosphorescent compound (phosphor) coated on the inside of the screen, a dot on the screen called a pixel lights up. A **pixel** is a dot of colour on a photo image or a point of light on a display screen. It appears in one of two modes: on or off. The electron beam sweeps across the screen so that as the phosphor starts to fade, it is struck and lights up again.

pixel A dot of colour on a photo image or a point of light on a display screen.

A **plasma display** uses thousands of smart cells (pixels) consisting of electrodes and neon and xenon gases that are electrically turned into plasma (electrically charged atoms and negatively charged particles) to emit light. The plasma display lights up the pixels to form an image based on the information in the video signal. Each pixel is made up of three types of light – red, green and blue – with the plasma display varying the intensities of the lights to produce a full range of colours. Plasma displays can produce high resolution and accurate representation of colours to create a high-quality image.

plasma display A type of display using thousands of smart cells (pixels) consisting of electrodes and neon and xenon gases that are electrically turned into plasma (electrically charged atoms and negatively charged particles) to emit light.

LCD displays are flat displays that use liquid crystals – organic, oil-like material placed between two polarizers – to form characters and graphic images on a backlit screen. These displays are easier on your eyes than CRTs because they are flicker-free, brighter and do not emit the type of radiation that concerns some CRT users. In addition, LCD monitors take up less space and use less than half of the electricity required to operate a comparably sized CRT monitor. *Thin-film transistor (TFT) LCDs* are a type of liquid crystal display that assigns a transistor to control each pixel, resulting in higher resolution and quicker response to changes on the screen. TFT LCD monitors have displaced the older CRT technology and are available in sizes from 12 to 30 inches. Many companies now provide multimonitor solutions that enable users to see a wealth of related information at a single glance.

LCD displays Flat display that uses liquid crystals – organic, oil-like material placed between two polarizers – to form characters and graphic images on a backlit screen.

Organic light-emitting diode (OLED) display uses a layer of organic material sandwiched between two conductors, which in turn are sandwiched between a glass top plate and a glass bottom plate. When electric current is applied to the two conductors, a bright, electroluminescent light is produced directly from the organic material. OLEDs can provide sharper and brighter colours than LCDs and CRTs, and, because they do not require a backlight, the displays can be half as thick as LCDs and are flexible. Another big advantage is that OLEDs do not break when dropped. OLED technology can also create 3D video displays by taking a traditional LCD monitor and then adding layers of transparent OLED films to create the perception of depth without the need for 3D glasses or laser optics. The iZ3D monitor is capable of displaying in both 2D and 3D modes.

organic light-emitting diode (OLED) display Flat display that uses a layer of organic material sandwiched between two conductors, which in turn are sandwiched between a glass top plate and a glass bottom plate so that when electric current is applied to the two conductors, a bright, electroluminescent light is produced directly from the organic material.

Because most users leave their computers on for hours at a time, power usage is an important factor when deciding which type of monitor to purchase. Energy efficiency ratings for these displays are very high as LEDs produce light with very little power.[28] OLED monitors use even less power than LCD monitors.

Aspect ratio and screen size describe the size of the display screen. Aspect ratio is the ratio of the width of the display to its height. An aspect ratio of 4 to 3 is common. For widescreen LCD monitors used for viewing DVD movies in widescreen format, playing games or displaying multiple screens side-by-side, an aspect ratio of 16 to 10 or 15 to 9 is preferred. The screen size is measured diagonally from the outside of the screen casing for CRT monitors and from the inside of the screen casing for LCD displays.

With today's wide selection of monitors, price and overall quality can vary tremendously. The quality of a screen image is measured by the number of horizontal and vertical pixels used to create it. Resolution is the total number of pixels contained in the display; the more pixels, the clearer and sharper the image. The size of the display monitor also affects the quality of the viewing. The same pixel resolution on a small screen is sharper than on a larger screen, where the same number of pixels is spread out over a larger area. Over the years, display monitor sizes have increased and display standards and resolutions have changed, as shown in Table 3.3.

Table 3.3 Common Display Monitor Standards and Associated Resolutions

Standard	Resolution (number of horizontal pixels × vertical pixels)
WSXGA (Wide SGXA plus)	1680 × 1050
UXGA (Ultra XGA)	1600 × 1200
WUXGA (Wide Ultra XGA)	1920 × 1200
QXGA (Quad XGA)	2048 × 1536

Another way to measure image quality is the distance between one pixel on the screen and the next nearest pixel, which is known as *dot pitch*. The common range of dot pitch is from 0.25 mm to 0.31 mm. The smaller the dot pitch, the better the picture. A dot pitch of 0.28 mm or smaller is considered good. Greater pixel densities and smaller dot pitches yield sharper images of higher resolution.

The characteristics of screen colour depend on the quality of the monitor, the amount of RAM in the computer system and the monitor's graphics adapter card. Digital Video Interface (DVI) is a video interface standard designed to maximize the visual quality of digital display devices such as flat-panel LCD computer displays.

Companies are competing on the innovation frontier to create thinner display devices for computers, mobile phones and other mobile devices. In its effort to gain an edge, LG Philips has developed an extremely thin display that is only 0.15 mm thick, or roughly as thick as a human hair. The display is also so flexible that it can be bent or rolled without damage. Nokia has demonstrated a flexible portable computer that you can actually twist and bend to change a music track or adjust the volume. As of May 2020, Nokia is still working on a foldable screen.[29] Such screens open possibilities for manufacturers to make mobile phones and laptops with significantly larger displays but without increasing the size of the device itself, as the screen could be rolled up or folded and tucked away into a pocket.

The Microsoft Surface platform is designed to help people learn, collaborate and make decisions. The Surface can be used as a tablet, mounted on the wall, or embedded in furniture or fixtures. Its large 40-inch screen is an effective way to share photos, maps, modelling and simulations. The Surface allows a single user or multiple users to manipulate digital content by motion of their hands.

In 2011, the Bank of Canada implemented the Surface as a component of its Discovery Zone, a unique and digitally interactive approach to engage customers to learn more about the bank, its services and its employees. Arbie, an animated character, guided people through various applications with the results displayed on the Surface screen. Other banks took notice. In 2019, the Royal Bank of Canada launched a digitally enhanced "branch of the future" where clients can get hands-on demonstrations of RBC's product offerings through its digital and mobile platforms.[30]

Printers and Plotters

One of the most useful and common forms of output is called hard copy, which is simply paper output from a printer. The two main types of printers are laser printers and inkjet printers, and they are available with different speeds, features and capabilities. Some can be set up to accommodate paper forms, such as blank cheque forms and invoice forms. Specialist printers allow businesses to create full-colour, customized and individualized printed output using standard paper and data input. Ticket-receipt printers, such as those used in restaurants, ATMs and point-of-sale systems, are also widely used.

The speed of a printer is typically measured by the number of pages printed per minute (ppm). Similar to a display screen, the quality, or resolution, of a printer's output depends on the number of dots printed per inch (dpi). A 600-dpi printer prints more clearly than a 300-dpi printer. A recurring cost of using a printer is the inkjet or laser cartridge that must be replaced periodically every few thousand pages for laser printers and every 500 to 900 pages for inkjet printers.

Inkjet printers that can print 10 to 40 ppm for black-and-white output and 5 to 20 ppm for colour output are available for less than €150. With an initial cost much less than colour laser printers, inkjet printers can print vivid hues and can produce high-quality banners, graphics, greeting cards, letters, text and photo prints. However, the cost of ink over time can be very expensive. Laser printers are generally faster than inkjet printers and can handle a heavier print load volume.

Mobile print solutions enable users to wirelessly send documents, email messages and attachments, presentations and even boarding passes from any smartphone, tablet or laptop to any mobile-enabled printer in the world. For example, PrinterOn Enterprise enables any print requests from any mobile or fixed device to be routed to any of over 10,000 printers worldwide that are configured with the PrinterOn Enterprise service. Mobile users who use the service only need to access a directory of PrinterOn printers and locations and then send an email with the attachment to be printed to the email address of the printer. American Airlines Admiral Club, Delta Sky Club, Embassy Suites and DoubleTree by Hilton have installed PrinterOn printers at many of their locations.[31]

Plotters are a type of hard-copy output device used for general design work. Businesses typically use plotters to generate paper or acetate blueprints, schematics and drawings of buildings or new products. Standard plot widths are 24 inches and 36 inches (the widths are always measured in inches), and the length can be whatever meets the need from a few inches to many feet.

Given environmental concerns, many users are trying to reduce the amount they print. E-readers, described in a later section, are a potential solution to this with users copying files to their e-reader to read rather than printing them to read, although material on an e-reader cannot as easily be annotated as paper.

3D Printers

3D printers have created a major breakthrough in how many items will be manufactured (see the Information Systems @ Work section). 3D printing technology takes a three-dimensional model of an object stored on a computer and sends it to a 3D printer to create the object using strands of a plastic filament or synthetic powder. The filament comes in spools of various colours and is fed through a heated extruder that moves in several directions to place super thin layers on top of each other. The stacks are then bonded together, often using ultraviolet light, to create a 3D object. 3D printers come with a wide range of capabilities in terms of how fast they can build objects and how large an object they can build. 3D printers for home use typically cost upwards of €300 while commercial 3D printers can cost tens of thousands of euros.[32]

3D printing is commonly used by aerospace firms, auto manufacturers and other design-intensive companies. It is especially valuable during the conceptual stage of engineering design when the exact dimensions and material strength of the prototype are not critical. Some architectural design firms are using 3D printers to create full colour models of their projects to show clients.

3D printing can cut costs and reduce the waste and carbon footprint associated with traditional manufacturing. With 3D printing, production and assembly can be local, with no need to ship products thousands of miles to their destination. Only the raw materials needed to create the object, be it carbon fibre, metal powder, plastic filament, or some other substance, are used. Product parts can be replaced using parts manufactured with 3D printing so the entire product doesn't have to be disposed of and replaced each time it malfunctions.[33]

Digital Audio Players

A **digital audio player** is a device that can store, organize and play digital music files. **MP3** (MPEG-1 Audio Layer-3) is a popular format for compressing a sound sequence into a very small file, while preserving most of the original sound quality when it is played. By compressing the sound file, it requires less time to download the file and less storage space on a hard drive.

digital audio player A device that can store, organize and play digital music files.

MP3 A standard format for compressing a sound sequence into a small file.

You can use many different music devices smaller than a pack of cards to download music from the Internet and other sources. These devices have no moving parts and can store hours of music. Apple expanded into the digital music market with an MP3 player (the iPod) and the iTunes Music Store, which allows you to find music online, preview it and download it in a way that is safe, legal and affordable. Many music streaming services now exist such as Spotify and Deezer. Other MP3 manufacturers include Dell, Sony, Samsung, Iomega, Creative and Motorola, whose Rokr product was the first iTunes-compatible phone.

The Apple iPod Touch, with a 3.5-inch widescreen, is a music player that also plays movies and TV shows, displays photos and connects to the Internet. You can, therefore, use it to view YouTube videos, buy music online, check emails and more. The display automatically adjusts the view when it is rotated from portrait to landscape. An ambient light sensor adjusts brightness to match the current lighting conditions.

E-book Readers

The digital media equivalent of a conventional printed book is called an e-book (short for electronic book). The Project Gutenberg Online Book Catalog lists over 36,000 free e-books and a total of over 100,000 e-books available. E-books can be downloaded from Project Gutenberg (www.gutenberg.org) or many other sites onto personal computers or dedicated hardware devices known as e-book readers. The devices themselves cost from around €70 to €170, and downloads of the bestselling books and new releases cost less than €9.99. The e-book reader has the capacity to store thousands of books. The Amazon Paperwhite uses tiny LEDs at the bottom of the device that point toward the display. The light is dispersed across the entire screen making the device very easy on the eyes.[34] E-book readers are lighter than most books and the screen is the same size as a novel. Thus, these readers are more compact than most paperbacks and can be easily held in one hand. Recent e-book readers display content in 16 million colours and high resolution. On most e-readers, the size of the text can be magnified for readers with poor vision.

3.5 Computer System Types

In general, computers can be classified as either special purpose or general purpose. *Special-purpose computers* are used for limited applications, for example by military, government and scientific research groups such as the CIA and NASA. Other applications include specialized processors found in appliances, cars and other products. For example, mechanics connect special-purpose computers to your car's engine to identify specific performance problems. As another example, IBM is developing a new generation of computer chips to develop so-called cognitive computers that are designed to mimic the way the human brain works. Rather than being programmed as today's computers are, cognitive computers will be able to learn through experiences and outcomes and mimic human learning patterns.[35]

General-purpose computers are used for a variety of applications and to execute the business applications discussed in this text. General-purpose computer systems can be divided into two major groups: systems used by one user at a time and systems used by multiple concurrent users. Table 3.4 shows the general ranges of capabilities for various types of computer systems. General-purpose computer systems can range from small handheld computers to massive supercomputers that fill an entire room. We will first cover single-user computer systems.

Table 3.4 Types of Computer Systems

Single-user computer systems can be divided into two groups: portable computers and nonportable computers.

Factor	Single-User Computers				
Portable Computers					
	Handheld	Laptop	Notebook	Netbook	Tablet
Cost	€100–€300	€350–€2,000	€500–€2,000	€150–€600	€150–€400
Weight (pounds)	<0.30	4.0–7.0	<4	<2.5	0.75–2.0
Screen size (inches)	2.4–3.6	11.5–15.5	11.6–14.0	7.0–11.0	5.0–14.0
Typical use	Organize personal data	Improve worker productivity	Improve productivity of mobile worker	Access the Internet and email	Capture data via pen or finger input, improve worker productivity

Nonportable Computers				
	Thin Client	Desktop	Nettop	Workstation
Cost	€150–€400	€400–€2,000	€100–€300	€600–€4,000
Weight (pounds)	1–3	<30	<5	<35
Screen size (inches)	10.0–15.0	13.0–27.0	Comes with or without attached screen	13.0–27.0
Typical use	Enter data and access applications via the Internet	Improve worker productivity	Replace desktop with small, low-cost, low-energy computer	Perform engineering, CAD and software development

Multiple-user computer systems include servers, mainframes and supercomputers.

Factor	Multiple-User Computers		
	Server	Mainframe	Supercomputer
Cost	€400–€40,000	>€75,000	>€200,000
Weight (pounds)	>25	>100	>100
Screen size (inches)	n/a	n/a	n/a
Typical use	Perform network and Internet applications	Perform computing tasks for large organizations and provide massive data storage	Run scientific applications; perform intensive number crunching

Portable Computers

Many computer manufacturers offer a variety of **portable computers**, those that are small enough to carry easily. Portable computers include handheld computers, laptop computers, notebook computers, netbook computers and tablet computers.

portable computers A computer small enough to carry easily.

Handheld computers are single-user computers that provide ease of portability because of their small size – some are as small as a credit card. These systems often include a variety of software and communications capabilities. Most can communicate with desktop computers over wireless networks. Some even add a built-in GPS receiver with software that can integrate location data into the application. For example, if you click an entry in an electronic address book, the device displays a map and directions from your current location. Such a computer can also be mounted in your car and serve as a navigation system. One of the shortcomings of handheld computers is that they require a lot of power relative to their size.

handheld computers A single-user computer that provides ease of portability because of its small size.

A **smartphone** is a handheld computer that combines the functionality of a mobile phone, camera, web browser, email tool, MP3 player and other devices into a single device. BlackBerry was one of the earliest smartphone devices, developed by the Canadian company Research in Motion in 1999.

smartphone A handheld computer that combines the functionality of a mobile phone, camera, web browser, email tool, MP3 player and other devices into a single device.

While Apple with its iPhone dominated the smartphone market for several years, it is now facing stiff competition from Amazon, Samsung, HTC, Motorola, Nokia, Samsung and others. Apple has sued many of its competitors for allegedly violating its patents and trademarks used in mobile devices. In return, many of these competitors have countersued Apple, with Samsung and Apple eventually settling their dipute in 2018.[36] Industry observers point out that such patent wars stifle innovation and competition, but unfortunately they have become a common tactic in dealing with the competition.[37]

Increasingly, consumers and workers alike will perform data processing, email, web surfing and database lookup tasks on smartphone-like devices. The number of business applications for smartphones is increasing rapidly to meet this need, especially in the medical field. Similar digital support was utilized in the COVID-19 pandemic, by assisting with an influx of patients and also facilitating normal patients to have access to advice and prescriptions remotely.

AccessReflex is software that enables users to view Microsoft Access databases from a smartphone.[38] EBSCOhost Mobile offers mobile access to a broad range of full text and bibliographic databases for research.[39] Mobile police officers can use their smartphones to connect to national crime databases, and emergency first responders can use theirs to connect to hazardous materials databases to find out advice on how to deal with dangerous spills or fires involving such materials.

Laptop Computers

A **laptop computer** is a personal computer designed for use by mobile users, being small and light enough to sit comfortably on a user's lap. Laptop computers use a variety of flat panel technologies to produce a lightweight and thin display screen with good resolution. In terms of computing power, laptop computers can match most desktop computers as they come with powerful CPUs as well as large-capacity primary memory. This type of computer is highly popular among students and mobile workers who carry their laptops on trips and to meetings and classes. Many personal computer users now prefer a laptop computer to a desktop because of its portability, lower energy usage and smaller space requirements.

laptop computer A personal computer designed for use by mobile users, being small and light enough to sit comfortably on a user's lap.

Notebook Computers

notebook computers Smaller than a laptop computer, an extremely lightweight computer that weighs less than 2 kilogrammes and can easily fit in a briefcase.

Many highly mobile users prefer **notebook computers** that weigh less than 2 kilogrammes compared to larger laptops that weigh up to around 3 kilogrammes. However, there are limitations to these small, lighter laptops. Because they are thinner, they have less room for larger, longer-life batteries. Their thin profile also does not allow for heat sinks and fans to dissipate the heat generated by fast processors, so they typically have less processing power. Finally, few come with a high-power graphics card, so these machines are less popular with gamers.

Netbook Computers

netbook computers A small, light, inexpensive member of the laptop computer family.

Netbook computers are small, light and inexpensive members of the laptop computer family that are great for tasks that do not require a lot of computing power, such as sending and receiving email, viewing DVDs, playing games or accessing the Internet. However, netbook computers are not good for users who want to run demanding applications, have many applications open at one time or need lots of data storage capacity.

Many netbooks use the Intel Atom CPU (the N450), which is specially designed to run on minimal power so that the computer can use small, lightweight batteries and avoid potential overheating problems without the need for fans and large heat sinks. Battery life is a key distinguishing feature when comparing various netbooks, with expected operating times varying from 4 hours to nearly 12 hours depending on the manufacturer and model.

All 320 high school students in Bloomingdale, Michigan, have been provided with their own netbook computers and free wireless Internet access. The goal of this program is to provide students with additional learning resources and improve the level of instruction. This is important for a community where nearly half of the households are without Internet access. Teachers update the system each day to notify students and parents about missing assignments; they can also attach a worksheet if applicable. Students appreciate the ability to track their homework and to watch online videos covering many topics and providing step-by-step directions on how to complete homework assignments.[40] Google's Chromebook netbook computer is a low-cost machine that runs the operating system Chrome OS. A Chromebook starts up in 8 seconds and does not require any virus protection software. It is among the most secure computers available for the home.[41]

Tablet Computers

tablet computers A portable, lightweight computer with no keyboard that allows you to roam the office, home or factory floor, carrying the device like a clipboard.

Tablet computers are portable, lightweight computers with no keyboard that allow you to roam the office, home or factory floor, carrying the device like a clipboard. You can enter text with a writing stylus or finger directly on the screen thanks to built-in handwriting recognition software. Other input methods include an optional keyboard or speech recognition. Tablet PCs that support input only via a writing stylus are called *slate computers*. The *convertible tablet PC* comes with a swivel screen and can be used as a traditional notebook or as a pen-based tablet PC. Most new tablets come with a front-facing camera for videoconferencing and a second camera for snapshot photos and video.[42]

Tablets do not yet have the processing power of desktop computers. They also are limited in displaying some videos because the Flash software does not run at all on an iPad, neither does it run reliably on Android tablets.[43] Further, tablet screens of most manufacturers need better antiglare protection before they can be used outside in full sunlight.

Tablet computers are especially popular with students and gamers. They are also frequently used in the healthcare, retail, insurance and manufacturing industries because of their versatility. M&D Oral Care and Maxillofacial Surgery is an oral surgery practice in Connecticut that installed iPads and a Motorola Xoom tablet at five patient chairs in its office so that patients can view their CT scans and X-rays as well as educational videos.[44]

De Santos is a high-end Italian-American restaurant in New York's West Village. Its waiters use tablet computers to take orders and swipe credit cards. In addition to displaying the full menu, the tablet displays the restaurant's table and seating chart. Accordingly, the tablets make the whole process of seating customers, taking orders, sending orders to the kitchen and paying the bill simpler and more time efficient. By using tablets, waiters can serve more tables and provide improved customer service. 'Nowadays in New York City, the menus don't list the entire specifications of each dish', says Sebastian Gonella, one of the owners and cofounders of the restaurant. 'With this software, you can show them exactly the dish itself and all the specifications for each dish, so people are really buying what they're seeing and there's no more confusion. It's pretty important.'[45]

The Apple iPad is a tablet computer capable of running the same software that runs on the older Apple iPhone and iPod Touch devices, giving it a library of over 300,000 applications.[46] It also runs software developed specifically for it.

Tablets are popular in education as devices on which to take notes in class and read through materials. The materials can be annotated too, although not as easily as paper, which many students find extremely useful. Tablets can be especially liked by international students who do not want to carry paper notes with them on flights home just before their exams.

Nonportable Single-User Computers

Nonportable single-user computers include thin client computers, desktop computers, nettop computers and workstations.

Thin Clients

A **thin client** is a low-cost, centrally managed computer with no extra drives (such as CD or DVD drives) or expansion slots. These computers have limited capabilities and perform only essential applications, so they remain 'thin' in terms of the client applications they include. As stripped-down computers, they do not have the storage capacity or computing power of typical desktop computers, neither do they need it for the role they play. With no hard disc, they never pick up viruses or suffer a hard disc crash. Unlike personal computers, thin clients download data and software from a network when needed, making support, distribution and updating of software applications much easier and less expensive.[47] Thin clients work well in a cloud-computing environment to enable users to access the computing and data resources available within the cloud.

thin client A low-cost, centrally managed computer with essential but limited capabilities and no extra drives (such as CD or DVD drives) or expansion slots.

Desktop Computers

Desktop computers are single-user computer systems that are highly versatile. Named for their size, desktop computers can provide sufficient computing power, memory and storage for most business computing tasks.

The Apple iMac is a family of Macintosh desktop computers first introduced in 1998 in which all the components (including the CPU, disc drives and so on) fit behind the display screen. The Intel iMac is available with Intel's new core i5 or i7 processors making such machines the first quad-core iMacs.

desktop computers A nonportable computer that fits on a desktop and provides sufficient computing power, memory and storage for most business computing tasks.

Nettop Computers

A **nettop computer** is an inexpensive (less than €200) desktop computer designed to be smaller and lighter and to consume 10 per cent of the power of a traditional desktop computer.[48] A nettop is designed to perform basic processing tasks such as exchanging email, Internet surfing and accessing web-based applications. This computer can also be used for home theatre activities such

nettop computer An inexpensive desktop computer designed to be smaller, lighter and consume much less power than a traditional desktop computer.

as watching video, viewing pictures, listening to music and playing games. Unlike netbook computers, nettop computers are not designed to be portable, and they come with or without an attached screen. (Nettops with attached screens are called all-in-ones.) A nettop without an attached screen can be connected to an existing monitor or even a TV screen. They also may include an optical drive (CD/DVD). The CPU is typically an Intel Atom or AMD Geode, with a single-core or dual-core processor. Choosing a single-core processor CPU reduces the cost and power consumption but limits the processing power of the computer. A dual-core processor nettop has sufficient processing power to enable you to watch video and do limited processing tasks. Businesses are considering using nettops because they are inexpensive to buy and run, and therefore these computers can improve an organization's profitability.

Workstations

workstations A more powerful personal computer used for mathematical computing, computer-assisted design and other high-end processing, but still small enough to fit on a desktop.

Workstations are more powerful than personal computers but still small enough to fit on a desktop. They are used to support engineering and technical users who perform heavy mathematical computing, computer-assisted design (CAD), video editing and other applications requiring a high-end processor. Such users need very powerful CPUs, large amounts of main memory and extremely high-resolution graphic displays. Workstations are typically more expensive than the average desktop computer. Some computer manufacturers are now providing laptop versions of their powerful desktop workstations.

Multiple-User Computer Systems

Multiple-user computers are designed to support workgroups from a small department of two or three workers, to large organizations with tens of thousands of employees and millions of customers. Multiple-user systems include servers, mainframe computers and supercomputers.

Servers

server A computer employed by many users to perform a specific task, such as running network or Internet applications.

A **server** is a computer employed by many users to perform a specific task, such as running network or Internet applications. Servers typically have large memory and storage capacities, along with fast and efficient communications abilities. A web server handles Internet traffic and communications. An enterprise server stores and provides access to programs that meet the needs of an entire organization. A file server stores and coordinates program and data files. Server systems consist of multiuser computers, including supercomputers, mainframes and other servers. Often an organization will house a large number of servers in the same room where access to the machines can be controlled, and authorized support personnel can more easily manage and maintain the servers from this single location. Such a facility is called a *server farm*.

Google runs a server farm in Finland, using wind to power it and sea water to cool it. Google buys electricity from a wind farm in Northern Sweden, and brings in water from the Bay of Finland. The farm is based in an old paper mill which already had massive quarter-mile-long sea water tunnels, which had been used to cool the paper mill's manufacturing systems.[49]

scalability The ability to increase the processing capability of a computer system so that it can handle more users, more data or more transactions in a given period.

Servers offer great **scalability**, the ability to increase the processing capability of a computer system so that it can handle more users, more data or more transactions in a given period. Scalability is increased by adding more, or more powerful, processors. *Scaling up* adds more powerful processors, and *scaling out* adds many more equal (or even less powerful) processors to increase the total data-processing capacity.

Information Systems @ Work

3D Printers Arrive in the Operating Theatre

3D printing involves creating objects by adding together very thin layers of material. 3D printers can create objects from plastic, metal and even wood (this last one involves powdered woodchips being melted together during the process). We've seen the creation of a wide variety of objects from 3D printers including guns, engines, replacement parts for NASA's spacecraft for repairs during missions in space, and we've even heard talk of 3D printers being used to print more 3D printers as experiments in machine replication. Dr Anthony Atala from the Wake Forest Institute for Regenerative Medicine has now printed functional, living body parts.

The idea of printing with individual human cells has been around for a while, but there have been problems scaling up the technology. Previous research showed that 3D-printed tissue structures without pre-existing blood vessel systems would need to be smaller than 0.2 millimetres in order to survive in the human body. Atala's technique is to print a plastic scaffold full of holes ('microchannels') which is filled with a gel that contains tissue cells. The gel encourages the cells to grow. Over time, the structure forms more tissue and a system of blood vessels while the plastic itself degrades in the host body, which for testing has been mice. The whole thing works a bit like a sponge, soaking up nutrients. The system is called Integrated Tissue and Organ Printing.

The printing itself happens inside a closed acrylic chamber which has its own temperature controller and humidifier. A series of nozzles shoot the materials out in such a way that they are layered together properly. One nozzle is filled with the plastic needed to make the scaffold. The others contain different cell-laden hydrogels – that's the gels that contain the tissue. Each nozzle is connected to an air pressure controller which precisely controls the dispensing volume, and each is mounted on a three-axis motorized stage system which enables the nozzles to be directed precisely where they need to be. The patient is scanned using an existing technology such as MRI, and the scan is used as input to some computer aided design software. This then creates a custom nozzle motion program – instructions that will tell the nozzles where to point, how much to 'squirt' and the order in which everything has to happen.

Dr Atala told the BBC News website: 'Let's say a patient presented with an injury to their jaw bone and there's a segment missing. We'd bring the patient in, do the imaging and then we would take the imaging data and transfer it through our software to drive the printer to create a piece of jawbone that would fit precisely in the patient'. The team expects that surgeons will be using 3D printed body parts in less than a decade.

Questions

1. How do you think 3D printing will change medicine?
2. Are there any ethical challenges with this technology?
3. Do you think that technologies like these should be controlled by patent law?
4. Can you come up with a business model that involves you, in your student accommodation, manufacturing your own products using a 3D printer?

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The latest Intel Core vPro processors support hyperthreading technology, which enables each core to conduct two sets of instructions, called threads. Hyperthreading gives each processor the ability to run up to 20 threads simultaneously. [50]

Less powerful servers are often used on a smaller scale to support the needs of many users. For example, the Gashora Girls Academy located in the Republic of Rwanda deployed server computers to ensure that its 270 students and 12 teachers could have access to the latest technology. Each server computer supports multiple students, each working independently using their own basic workstation that allows them to run word processing and spreadsheet software, use computer science applications, stream videos and listen to audio programs. This solution minimized the school's investment in hardware and reduced ongoing power and maintenance costs, making it feasible for students to access computing technology to gain the work skills necessary to be successful in the twenty-first century.[51]

Server manufacturers are also competing heavily to reduce the power required to operate their servers and making 'performance per watt' a key part of their product differentiation strategy. Low power usage is a critical factor for organizations that run server farms of hundreds or even thousands of servers. Typical servers draw up to 220 watts, while new servers based on Intel's Atom microprocessor draw 8 or fewer watts. The annual power savings from such low-energy usage servers can amount to tens of thousands of euros for operators of a large server farm.

A virtual server is a method of logically dividing the resources of a single physical server to create multiple logical servers, each acting as its own dedicated machine. The server administrator uses software to divide one physical server into multiple isolated virtual environments. For example, a single physical web server might be divided into two virtual private servers. One of the virtual servers hosts the organization's live website, while the other hosts a copy of the website. The second private virtual server is used to test and verify updates to software before changes are made to the live website. The use of virtual servers is growing rapidly. In a typical data centre deployment of several hundred servers, companies using virtualization can build 12 virtual machines for every actual server with resulting savings in capital and operating expenses (including energy costs) of millions of euros per year.

EZZI.net is a web hosting service provider for many companies including some of the largest *Fortune* 500 companies. It has data centres located in New York City and Los Angeles that employ virtual servers because they are easy to use, can be supported around the clock, and operate with a 99.7 per cent uptime to meet the needs of its many customers.[52]

blade server A server that houses many individual computer motherboards that include one or more processors, computer memory, computer storage and computer network connections.

A **blade server** houses many computer motherboards that include one or more processors, computer memory, computer storage and computer network connections. These all share a common power supply and air-cooling source within a single chassis. By placing many blades into a single chassis and then mounting multiple chassis in a single rack, the blade server is more powerful but less expensive than traditional systems based on mainframes or server farms of individual computers. In addition, the blade server approach requires much less physical space than traditional server farms.

Norddeutsche Landesbank (NORD/LB) is a major financial institution with headquarters in Hanover, Germany. The bank was suffering from slow response time for its key systems while trying to meet new business needs. New blade server computers were installed to improve system response time by 40 per cent and provide the bank's departments with the data they needed on a timely basis so they could operate efficiently.[53]

mainframe computer A large, powerful computer often shared by hundreds of concurrent users connected to the machine over a network.

Mainframe Computers

A **mainframe computer** is a large, powerful computer shared by dozens or even hundreds of concurrent users connected to the machine over a network. The mainframe computer must reside in a data centre with special HVAC equipment to control temperature, humidity and dust levels. In addition, most mainframes are kept in a secure data centre with limited access. The construction and maintenance of a controlled-access room with HVAC can add hundreds of thousands of euros to the cost of owning and operating a mainframe computer.

The role of the mainframe is undergoing some remarkable changes as lower-cost, single-user computers become increasingly powerful. Many computer jobs that used to run on mainframe computers have migrated onto these smaller, less expensive computers. This information-processing migration is called *computer downsizing*.

The new role of the mainframe is as a large information-processing and data storage utility for a corporation – running jobs too large for other computers, storing files and databases too large to be stored elsewhere, and storing backups of files and databases created elsewhere. For example, the mainframe can handle the millions of daily transactions associated with airline, car and hotel reservation systems. It can process the tens of thousands of daily queries necessary to provide data to decision support systems. Its massive storage and input/output capabilities enable it to play the role of a video computer, providing full-motion video to multiple, concurrent users.

Payment Solution Providers (PSP) is a Canadian corporation specializing in e-payment networks and the integration of financial transaction processing systems. PSP selected an IBM system z mainframe computer on which to run its credit card processing business. Other alternatives examined lacked the security PSP requires and would make it difficult to meet the banking industry's compliance standards for increasing controls around cardholder data to reduce credit card fraud. In addition, consolidation of operations onto a single mainframe provides a compact, efficient infrastructure that minimizes space requirements and reduces costs for IT management, power and cooling, and software licences by 35 per cent.[54]

Supercomputers

Supercomputers are the most powerful computers with the fastest processing speeds and highest performance. They are special-purpose machines designed for applications that require extensive and rapid computational capabilities. Originally, supercomputers were used primarily by government agencies around the world to perform the high-speed number crunching needed in weather forecasting, earthquake simulations, climate modelling, nuclear research, study of the origin of matter and the universe, and weapons development and testing. They are now used more broadly for commercial purposes in the life sciences and the manufacture of drugs and new materials. For example, Procter & Gamble uses supercomputers in the research, design and development of many of its products, including its paper products.[55]

supercomputers The most powerful computer systems with the fastest processing speeds.

Supercomputers are based on a new architecture that employs **graphics processing unit (GPU)** chips to perform high-speed processing. The GPU chip is a specialized circuit that is very efficient at manipulating computer graphics and is much faster than the typical CPU chip at performing floating point operations and executing algorithms for which processing of large blocks of data is done in parallel. This maths is precisely the type performed by supercomputers.[56]

graphics processing unit (GPU) A specialized circuit that is very efficient at manipulating computer graphics and is much faster than the typical CPU chip at performing floating point operations and executing algorithms for which the processing of large blocks of data is done in parallel.

At the time of writing, according to the TOP500 list (www.top500.org), the world's top three supercomputers are 3) the Sunway TaihuLight in use at the National Supercomputing Center in Wuxi, China; 2) the Sierra at the Lawrence Livermore National Laboratory, USA; and 1) the Summit in use at the Oak Ridge National Laboratory, USA. All are used for basic research such as studying climate and weather modelling. The Summit can perform 150,000 trillion floating point operations per second, nearly 60 per cent faster than the Sierra computer in the number two spot. Amazingly, it also draws less power. Table 3.5 lists the three most powerful supercomputers in use as of February 2020.

Table 3.5 The Three Most Powerful Operational Supercomputers (February 2020)

Rank	System	Manufacturer	Research Centre	Location	Speed (teraflops)
1	Summit	IBM	Oak Ridge National Laboratory	USA	150,000
2	Sierra	IBM	Lawrence Livermore National Laboratory	USA	95,000
3	Sunway TaihuLight	NRCPC	National Supercomputing Center	China	93,000

Source: www.top500.org/lists/2019/11/. Accessed 11 February 2020.

Watson, an IBM supercomputer, is best known for defeating former *Jeopardy!* quiz champions. The contest was a means to demonstrate the various systems, data management and analytics technology that can be applied in business and across different industries.[57] Watson is being 'trained' by the medical insurance company WellPoint to diagnose treatment options for patients.[58]

Table 3.6 lists the processing speeds of supercomputers.

Table 3.6 Supercomputer Processing Speeds

Speed	Meaning
GigaFLOPS	1×10^{9} FLOPS
TeraFLOPS	1×10^{12} FLOPS
PetaFLOPS	1×10^{15} FLOPS
ExaFLOPS	1×10^{18} FLOPS

3.6 Green Computing

green computing A program concerned with the efficient and environmentally responsible design, manufacture, operation and disposal of IS-related products.

Green computing is concerned with the efficient and environmentally responsible design, manufacture, operation and disposal of IS-related products, including all types of computers, printers and printer materials such as cartridges and toner. Business organizations recognize that going green is in their best interests in terms of public relations, safety of employees and the community at large. They also recognize that green computing presents an opportunity to substantially reduce total costs over the lifecycle of their IS equipment. Green computing has three goals: reduce the use of hazardous material, allow companies to lower their power-related costs, and enable the safe disposal or recycling of computers and computer-related equipment. According to Greenpeace, 50 million tons of computers, monitors, laptops, printers, disc drives, mobile phones, DVDs and CDs are discarded worldwide each year.[59]

Computers contain many toxic substances including beryllium, brominated flame retardants, cadmium, lead, mercury, polyvinyl chloride and selenium. As a result, electronic manufacturing employees and suppliers at all steps along the supply chain and in the manufacturing process are at risk of unhealthy exposure. Computer users can also be exposed to these substances when using poorly designed or damaged devices.

Because it is impossible to ensure safe recycling or disposal, the best practice is to eliminate the use of toxic substances, particularly since recycling of used computers, monitors and printers has raised concerns about toxicity and carcinogenicity of some of the substances. Safe disposal and reclamation operations must be extremely careful to avoid exposure in recycling operations and leaching of materials such as heavy metals from landfills and incinerator ashes. In many cases, recycling companies export large quantities of used electronics to companies in developing countries. Unfortunately, many of these countries do not have strong environmental laws, and they sometimes fail to recognize the potential dangers of dealing with hazardous materials. In their defence, these countries point out that the USA and other developed countries were allowed to grow robust economies and rise up out of poverty without the restrictions of strict environmental policies.

One of the earliest initiatives towards green computing in the USA was the voluntary labelling programme known as Energy Star. It was conceived by the Environmental Protection Agency in 1992 to promote energy efficiency in hardware of all kinds. This programme resulted in the widespread adoption of sleep mode for electronic products.

The European Union Directive 2002/95/EC required that as of July 2006 new electrical and electronic equipment cannot contain any of six banned substances in quantities exceeding certain maximum concentration values. The six banned substances are lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls and polybrominated diphenylethers. The Directive was modified in September 2011 to exclude lead and cadmium because of the impracticality of finding suitable substitutes for these materials.[60] This Directive applies to US organizations selling equipment to members of the European Union (EU) and has encouraged US manufacturers to meet the standards as well.

The Green Electronics Council manages the Electronic Product Environment Assessment Tool (EPEAT) to assist in the evaluation and purchase of green computing systems. The EPEAT assesses products against 51 lifecycle environmental criteria developed by representatives of the environmental community, manufacturers, private and public purchasers, resellers, recyclers and other interested parties. These criteria are documented in IEEE Standard 1680 and are concerned with the reduction of hazardous materials, the use of recycled materials, the design for recovery through recycling systems, product longevity, energy conservation, end of life management, the manufacturer's corporate environmental policy and packaging.[61] The products evaluated against the EPEAT criteria are placed into one of three tiers based on their rating, as shown in Table 3.7.

Table 3.7 EPEAT Product Tiers

Tier	Number of Required Criteria That Must Be Met	Number of Optional Criteria That Must Be Met
Bronze	All 23	None
Silver	All 23	At least 50%
Gold	All 23	At least 75%

Computer manufacturers such as Apple, Dell and Hewlett-Packard have long competed on the basis of price and performance. As the difference between the manufacturers in these two arenas narrows, support for green computing is emerging as a new business strategy for these companies to distinguish themselves from the competition. Apple claims to have the 'greenest lineup of notebooks' and is making progress at removing toxic chemicals. Dell's new mantra is to become 'the greenest technology company on Earth'. Hewlett-Packard highlights its long tradition of environmentalism and is improving its packaging to reduce the use of materials. It is also urging computer users around the world to shut down their computers at the end of the day to save energy and reduce carbon emissions.

Ethical and Societal Issues

Mobile Technology Fighting Human Trafficking

Sadly the following is all too common. A young girl in the Philippines is promised work in Malaysia. Seeing an opportunity to earn some money for her and her family, she readily agrees. She is put in touch with a recruiter. He tells her that documents will be arranged for her and that an employer has been in contact and is expecting her. Plane tickets are booked, but when the big day comes, the recruiter tells her that the plans have changed. Instead of a flight, she is put on a boat for a one-week crossing of the Sulu Sea. Arriving in Malaysia, she is bundled into a van with other girls. Their passports and phones are taken. They are isolated and frightened and put to work in the sex industry. They are told they will be arrested if they try to escape as they are in the country illegally.

In fact, if they only but knew it, arrest may be their best hope of escape, as other girls more lucky than the first have found out. In another van, in the same part of the world, a different girl was apprehended by police while travelling to a similar job. Interrogated and imprisoned, she managed to sneak her phone into jail and made one last call. The friend she called contacted the Philippine government and they intervened. After a month in prison she was repatriated and placed in a rehabilitation shelter in Manila.

The Center on Communication Leadership & Policy at the University of Southern California is researching the use of mobile phones and related technology to fight this sort of human trafficking. They are investigating three primary themes: (1) the role of technology in facilitating trafficking; (2) the potential for technological tools to prevent, expose and monitor trafficking; and (3) the capacity for trafficking victims, survivors and at-risk groups to use network technology for assistance and information.

This is important, ongoing work. So far, they have demonstrated that mobile technology provides both positive and negative social interactions around human trafficking. Workers use the Internet to find legitimate jobs, which is extremely empowering, but they may also instead find illegal recruiters like the one above. Social isolation is exacerbated when mobile phones are confiscated or online access is restricted by illegal employers. However, the same technology can offer solutions, interventions to help vulnerable people employ different technologies, from cloud-based web interfaces to mobile phone apps. The private sector is developing technologies to gather business intelligence on legitimate contractors and suppliers that make up modern supply chains. Charities are examining how data on global supply chains can reveal human trafficking risks to corporations and governments. NGOs and Internet companies have begun coordinating to train migrant workers in the use of social media to connect with family, friends and support networks.

The Center's report says that 'the growing role of technology in global disaster response hints at a new avenue for intervention in trafficking situations.

(*continued*)

The rapid deployment of technology that follows such disasters might provide the information or infrastructure needed for data-driven anti-trafficking projects. Whether addressing supply chain monitoring, online recruitment, social media, or humanitarian relief, special care must be given to human rights, exposure, and privacy concerns for those populations most vulnerable to labor trafficking'.

Questions

1 In what ways does deploying technology after a disaster (an earthquake, for instance) resemble deploying technology in a community which is vulnerable to human trafficking?

2 Using a search engine, can you find suitable technologies for establishing communication after a disaster?

3 How would you counsel vulnerable women on their use of a mobile phone to minimize their risk of being trafficked? What would you teach them to do?

4 The traffickers themselves will use mobile phones to communicate with each other. How could this be used against them?

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Summary

Computer hardware must be carefully selected to meet the evolving needs of the organization and its supporting information systems. Computer hardware should be selected to meet specific user and business requirements. These requirements can evolve and change over time.

The central processing unit (CPU) and memory cooperate to execute data processing. The CPU has three main components: the arithmetic/logic unit (ALU), the control unit and the register areas. Instructions are executed in a two-phase process called a machine cycle, which includes the instruction phase and the execution phase.

Computer system processing speed is affected by clock speed, which is measured in gigahertz (GHz). As the clock speed of the CPU increases, heat is generated that can corrupt the data and instructions the computer is trying to process. Bigger heat sinks, fans and other components are required to eliminate the excess heat. This excess heat can also raise safety issues. Chip designers and manufacturers are exploring various means to avoid heat problems in their new designs.

Primary storage or memory provides working storage for program instructions and data to be processed and provides them to the CPU. Storage capacity is measured in bytes.

A common form of memory is random access memory (RAM). RAM is volatile; loss of power to the computer erases its contents. RAM comes in many different varieties including dynamic RAM (DRAM), synchronous DRAM (SDRAM), double data rate SDRAM and DDR2 SDRAM.

Read-only memory (ROM) is nonvolatile and contains permanent program instructions for execution by the CPU. Other nonvolatile memory types include programmable read-only memory (PROM), erasable programmable read-only memory (EPROM), electrically erasable PROM (EEPROM) and flash memory.

Cache memory is a type of high-speed memory that CPUs can access more rapidly than RAM.

A multicore microprocessor is one that combines two or more independent processors into a single computer so that they can share the workload. Intel and AMD have introduced eight-core processors that are effective in working on problems involving large databases and multimedia.

Parallel computing is the simultaneous execution of the same task on multiple processors to obtain results faster. Massively parallel processing involves linking many processors to work together to solve complex problems.

Grid computing is the use of a collection of computers, often owned by multiple individuals or organizations, to work in a coordinated manner to solve a common problem.

Computer systems can store larger amounts of data and instructions in secondary storage, which is less volatile and has greater capacity than memory. The primary characteristics of secondary storage media and devices include access method, capacity, portability and cost. Storage media can implement either sequential access or direct access. Common forms of secondary storage include magnetic storage devices such as tape, magnetic disc and virtual tape; optical storage devices such as optical disc, digital video disc (DVD) and holographic versatile disc (HVD); and solid state storage devices such as flash drives.

Redundant array of independent/inexpensive discs (RAID) is a method of storing data that generates extra bits of data from existing data, allowing the system to more easily recover data in the event of a hardware failure.

Network-attached storage (NAS) and storage area networks (SAN) are alternative forms of data storage that enable an organization to share data resources among a much larger number of computers and users for improved storage efficiency and greater cost effectiveness.

Storage as a service is a data storage model in which a data storage service provider rents space to people and organizations.

Input and output devices allow users to provide data and instructions to the computer for processing, and allow subsequent storage and output. These devices are part of a user interface through which human beings interact with computer systems.

Data is placed in a computer system in a two-stage process: data entry converts human-readable data into machine-readable form; data input then transfers it to the computer. Common input devices include a keyboard, a mouse, speech recognition, digital cameras, terminals, scanning devices, optical data readers, magnetic ink character recognition devices, magnetic stripe cards, chip-and-PIN cards, contactless cards, point-of-sale devices, automated teller machines, pen input devices, touch-sensitive screens, barcode scanners and radio frequency identification tags.

Display monitor quality is determined by aspect ratio, size, colour and resolution. Liquid crystal display and organic light-emitting diode technology are enabling improvements in the resolution and size of computer monitors. Other output devices include printers, plotters, Surface touch tablets, digital audio players and e-book readers.

Computer systems are generally divided into two categories: single user and multiple users. Single-user systems include portable computers such as handheld, laptop, notebook, netbook and tablet computers. Nonportable single-user systems include thin client, desktop, nettop and workstation computers.

Multiuser systems include servers, blade servers, mainframes and supercomputers.

The computer hardware industry is rapidly changing and is highly competitive, creating an environment ripe for technological breakthroughs. CPU processing speed is limited by physical constraints such as the distance between circuitry points and circuitry materials. Moore's Law is a hypothesis stating that the number of transistors on a single chip doubles every two years. This hypothesis has been accurate since it was introduced in 1970.

Manufacturers are competing to develop a nonvolatile memory chip that requires minimal power, offers extremely fast write speeds and can store data accurately even after it has been stored and written over many times. Such a chip could eliminate the need for RAM forms of memory.

The computer hardware industry and users are implementing green computing designs and products. Green computing is concerned with the efficient and environmentally responsible design, manufacture, operation and disposal of IS-related products.

Business organizations recognize that going green can reduce costs and is in their best interests in terms of public relations, safety of employees and the community at large.

Three specific goals of green computing are: reduce the use of hazardous material, lower power-related costs and enable the safe disposal and/or recycling of IT products.

Three key green computing initiatives are the Energy Star programme to promote energy efficiency, the European Union Directive 2002/95/EC to reduce the use of hazardous materials and the use of the EPEAT tool to evaluate and purchase green computing systems.

Self-Assessment Test

1. The ______________ computer hardware component performs mathematical calculations.
2. A ______________ holds small units of program instructions and data immediately before, during and after execution by the computer.
3. ______________ is a measure of machine cycle time.
4. A terabyte is 2 to the power of ______________ bytes.
5. Magnetic tape is an example of ______________.
6. A ______________ is a low-cost computer with no extra drives or expansion slots.
7. Project Gutenberg is a source of _________.
8. The ability to increase processing in order to handle more users is called ______________.
9. Google uses ______________ to cool its servers in Finland.
10. EPEAT assists with the assessment of ______________.

Review Questions

1. Describe the function of the main components of a CPU.
2. Explain storage capacity.
3. What is parallel computing?
4. List some secondary storage devices.
5. Describe a SAN.
6. What is a pixel?
7. Describe the main functionality of a smartphone.
8. Explain the role of a mainframe computer in a business.
9. What is the goal of green computing?
10. Who would use a supercomputer?

Discussion Questions

1. List the types of information you need to store and state how long you think you will need them for. Include entertainment, work data, finances and family memories. Describe what you think the best options are for keeping and accessing each.
2. Describe how voice input using speech recognition technology could be used in an organization.

Web Exercises

1. Search for examples of technologies that could be used by a mobile sales force. What are the pros and cons of each?
2. Investigate alternatives to printing in a university or college. Write a short report detailing your findings.

3

Case One

Moore's Law About to be Overturned

In the 1930s, British mathematician Alan Turing was writing a paper about the limits of what can be calculated. In one section he wrote a single paragraph that started with the line: 'imagine a machine that can…'. What followed described in English what became the basic design for all modern computers.

The actual text he wrote was: 'We may compare a man in the process of computing a real number to a machine which is only capable of a finite number of conditions q1: q2... ql; which will be called "m-configurations". The machine is supplied with a "tape" (the analogue of paper) running through it, and divided into sections (called "squares") each capable of bearing a "symbol". At any moment there is just one square ... which is "in the machine". We may call this square the "scanned square". The symbol on the scanned square may be called the "scanned symbol". The "scanned symbol" is the only one of which the machine is, so to speak, "directly aware"'.

The device he sketched had a ream of tape that could move forwards and backwards, reading and writing numbers from and to sections on the tape. The device had what we would now call an 'instruction set' and Turing realized that anything that could possibly be computed, could be written using commands in his instruction set and run on his machine.

But what is the smallest set of instructions that could be used to create such a 'Universal Turing Machine'? It turns out to be ridiculously small. In fact, researchers have proved that a creature on a 2D surface covered in white squares that obeys the following two instructions could in principle be used to compute anything:

- At a white square, turn 90° right, colour the square black and move forward one unit.
- At a black square, turn 90° left, turn the square white and move forward one unit.

This is probably as small as it gets. Modern computer chips have over 200 instructions. These are the basic things that the computer hardware can do. The only things it can do in fact. Everything else a computer does has to be assembled by software out of those 200 instructions. Computer chips are densely packed with tiny electronic switches called transistors. Since the 1960s, the number of transistors on computer chips has roughly doubled every two years, a phenomenon known as Moore's Law, after the cofounder of Intel, Gordon Moore. This has meant that chip performance has doubled every two years too.

Moore's Law has held ever since then, but this was not inevitable and chip manufacturers have collaborated to keep to it. In fact, since the 1990s, every two years they get together to release a research road map for the industry to make sure they stay on track. But this is coming to an end. The physics involved in packing transistors into tiny spaces generates heat, and this has put a limit on how many of them can be squeezed in. This means that Moore's Law is breaking down. Within ten years, devices will be so small that they will no longer be governed by physics as we know it, but by the different physical processes (called quantum mechanics) that happen at the atomic scale. Quantum mechanics comes with strange uncertainties that will make chips unreliable.

Some people who work in the industry think that the real limit to Moore's Law is not physical at all, but economic. The cost of creating new fabrication plants is prohibitively expensive. Bill Bottoms, president of equipment manufacturer Third Millennium Test Solutions says, 'The end of Moore's Law is not a technical issue, it is an economic issue. My bet is that we run out of money before we run out of physics'.

The latest road map therefore does not concentrate on Moore's Law but is instead centred on applications that users want, and working down from those asking: what chips do those applications need? Energy efficiency is an urgent priority, and in the future chips may have to work without batteries by harvesting energy from radio waves and ambient heat. Connectivity is essential to allow millions of devices to communicate with one another, and security is crucial. There is certainly plenty of work for chip researchers.

Questions

1 Do you think the industry's research road map is anti-competitive?

2 Is computing power in your device really that important anymore, given the rise of cloud computers that can do any 'heavy lifting' that you need?

3 Hardware performance may have doubled every two years, but software performance certainly has not. Do you think engineers should now concentrate on software efficiency rather than hardware?

4 The (theoretical) creature on the black and white surface is called Langton's Ant. Do a Google search to try to explain how it could be used to 'compute anything'.

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Case Two

Sen.Se is Helping to Create the Internet of Things

Sen.se was an early player in the Internet of Things and their products are still available. They wanted to impact on everything from walking your dog to brushing your teeth. Their flagship product is called Mother. Technology publication CNET describes Mother as 'a data-tracker with a ton of built-in flexibility'. The basic Mother kit comes with a base unit called a hub, which is designed to look like a friendly Japanese style cartoon character, and a set of four sensors which Sen.Se calls 'cookies'. An app is downloaded separately.

The cookies are remote sensors that are used to monitor location, motion and temperature. The cookies spend all day storing and sharing data with the hub. They can be attached to just about anything, and once they are attached to an object they spend their time monitoring it. As CNET points out, this system is extremely flexible.

For instance, a parent might put a cookie on a child's toothbrush to make sure they are brushing twice a day. Unless the cookie detects the proper movement at the right times of day, it will send an alert. Another cookie might go on the dog's collar. If poochie hasn't been for a walk, the app will send a reminder. A cookie might go on the car keys to make sure they never get lost again. Sen.Se suggest the following ideas:

- Manage coffee consumption. Place a motion cookie on your coffee machine so it can register all the coffees you make throughout your day. The Coffee app will register the number of capsules, doses or pods you use and will also notify you if you are running out.
- Keep track of exercise. Keep track of the number of steps walked and the amount of calories consumed. Maintain or boost the level of activity.
- Make sure medication is never forgotten. The system will remind you when it is time to take any pills.

Mother is an attempt to build the Internet of Things. The Internet of Things involves connecting objects to the Internet. Whether or not you like the idea of Mother, the Internet of Things is on its way. Utility providers are installing smart meters in homes that send information on your energy use every 30 minutes. The only TV you can now buy for your living room is a smart TV that needs to connect to your broadband. This means you can watch YouTube

3

and other streaming services in comfort, but it also means that information on your viewing habits can be collected. Soon your fridge and oven will want to connect. Modern cars are all already connected and one team of researchers has shown that it is possible for hackers to turn off a car engine while it is travelling.

Sen.Se says that 'the time has come for devices to learn to live with us instead of us learning to live with them. Sensors that understand things without needing to be told. Batteries that last for more than a year. Simple, buttonless devices. Mother and its sensors have been designed to blend into your life and adapt to your behaviour without requiring any effort, training or care from you'. It is indeed a brave new world.

Questions

1. Does anyone ever need to be reminded to buy more coffee or walk the dog? Should a parent ever delegate tooth brushing monitoring to the Mother hub?
2. What are some more serious applications for the Internet of Things?
3. What are some of the concerns users of this technology may have and how could Sen.Se overcome them?
4. What use could a third party make of data from a smart meter?

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Case Three

The €30 computer

In the 1970s and early 1980s, many children in the UK got their first taste of computing when their parents brought home a BBC Micro or one of its variants or competitors. These computers looked a lot like a larger version of today's desktop keyboards and they had to be connected to a television for visual output. For input, disk drives were available but expensive. Alternatively, children could hook up their tape recorder and 'play' programs into their computer exactly as they would play pop songs. The programs they were inputting were invariably computer games.

Games launched the home computing revolution, but for the more curious children their computer allowed them to learn how to program. For many people at that time, their first experience of programming was typing in code that had been published in a computer magazine, which would usually create a simple game. The programs were written in a language called BASIC.

Children today typically have access to much more powerful computer technology, but the programming languages that are in them are often hidden within the operating system and most kids never go near them. Some popular applications are challenging this. The popular game Roblox, for instance, has tools which allow children to create their own worlds and many are doing so. However, some people in the computer industry have seen a need for specialist hardware to encourage children to tinker with programs again.

David Braben was one of those children who played with BASIC in the 1970s. In fact he co-wrote one of the most popular BBC Micro games ever (Elite), which to this day still has a huge following and is still influencing modern games. Braben cofounded the Raspberry Pi Foundation to develop and sell a credit card sized computer that costs less than €30, which will hopefully encourage a new generation of children to learn to program.

The Pi's user base has grown quickly and while its use is mostly educational, a few other applications have sprung up. Pocket FM enables people in crisis regions to communicate without Internet, mobile phones or television. The makers explain that 'despite technological innovation, local radio continues to be a vital source of information and entertainment in many regions. Throughout the developed world, people use television, newspapers and the internet to stay up-to-date but these sources are not an option in rural areas of developing countries. At times of disaster, war, and population displacement, local radio can provide updates which help save lives'.

Pocket FM is currently running beta-tests in crisis regions and developing countries such as Syria. The devices have a range of between 4 and 6 km, which is enough to cover a town. At the heart of each device is a Raspberry Pi. The designer says they are as easy to set up as a piece of flat-pack furniture. The devices pick up a satellite feed from a radio station and rebroadcast it on an FM frequency, so that people can listen on ordinary radios. This can make a big difference in oppressed areas.

As for educational applications, the University of Cambridge Computer Laboratory is using the Pi to teach a range of computer fundamentals. If you ever wanted to know how a computer processor creates output on a monitor, the tutorials they produce are probably the best and most entertaining way to find out.

Questions

1 Why was gaming so important in the launch of home computing?

2 Do children no longer have any interest in programming? Explain your answer.

3 How does the Raspberry Pi encourage programming?

4 What applications for the Pi can you think of?

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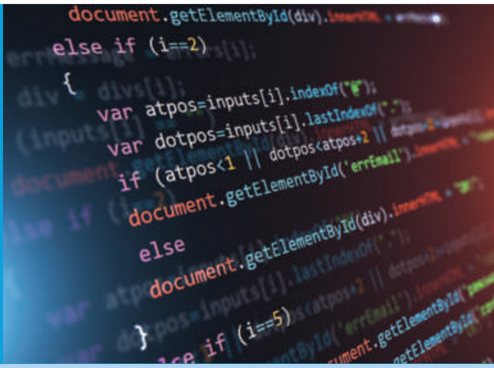
04

Software: Systems and Application Software



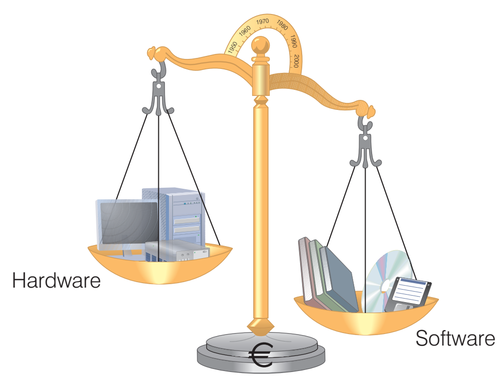
Principles	Learning Objectives
Systems and application software are critical in helping individuals and organizations achieve their goals.	■ Identify and briefly describe the functions of the two basic kinds of software. ■ Outline the role of the operating system and identify the features of several popular operating systems.
Organizations use off-the-shelf application software for common business needs and proprietary application software to meet unique business needs and provide a competitive advantage.	■ Discuss how application software can support personal, workgroup and enterprise business objectives. ■ Identify three basic approaches to developing application software and discuss the pros and cons of each.
Organizations should choose programming languages with functional characteristics that are appropriate for the task at hand and well suited to the skills and experience of the programming staff.	■ Outline the overall evolution and importance of programming languages and clearly differentiate between the generations of programming languages.
The software industry continues to undergo constant change; users need to be aware of recent trends and issues to be effective in their business and personal life.	■ Identify several key software issues and trends that have an impact on organizations and individuals.

Why Learn About Systems and Application Software?

Software is indispensable for any computer system and the people using it. In this chapter you will learn about systems and application software. Without systems software, computers would not be able to accept data input from a keyboard, process data or display results. Application software is one of the keys to helping you achieve your career goals. Sales representatives use software on their smartphones and tablet computers to enter sales orders and help their customers get what they want. Stock and bond traders use software to make split-second decisions involving millions of euros. Scientists use software to analyze the threat of climate change. Regardless of your job, you will most likely use software to help you advance in your career and earn higher wages. You can also use software to help you prepare your tax return, keep a budget and keep in contact with friends and family online. Software can truly advance your career and enrich your life. We begin with an overview of software.

Software has a profound impact on individuals and organizations. It can make the difference between profits and losses and between financial health and bankruptcy. As Figure 4.1 shows, companies recognize this impact, spending more on software than on computer hardware.

Figure 4.1 Importance of Software in Business
Since the 1950s, businesses have greatly increased their expenditures on software compared with hardware.



4.1 An Overview of Software

computer programs Sequences of instructions for the computer.

documentation Text that describes a program's functions to help the user operate the computer system.

As you learned in Chapter 1, software consists of computer programs that control the workings of computer hardware. **Computer programs** are sequences of instructions for the computer. **Documentation** describes the program functions to help the user operate the computer system. Some documentation is given on-screen or online, while other forms appear in external resources, such as printed manuals. Software is a growing and dynamic industry. Some believe that software development and sales have more growth potential than hardware.[1]

Systems Software

Systems software is the set of programs that coordinates the activities and functions of the hardware and other programs throughout the computer system. Each type of systems software is designed for a specific CPU and class of hardware. The combination of a hardware configuration and systems software is known as a computer system platform.

Application Software

Application software consists of programs that help users solve particular computing problems.[2] An architectural firm in Boise, Idaho, for example, used ProjectDox software to streamline the paperwork required to get approval and permits for building projects.[3] According to one architect from the firm, 'The nice thing is that most files, whether it be a PDF or Word document, can be dropped into different folders online and sent. It's not a big deal like it was before'. Software from Amcom allows companies in the USA, such as Eddie Bauer, to provide the exact location of someone who calls from an Eddie Bauer retail location to emergency call centres.[4] According to a company technical analyst, 'We take communications and security very seriously. The Amcom system is a perfect communications safety net in case someone dials 911 and can't explain where they are'.

In most cases, application software resides on the computer's hard drive before it is brought into the computer's memory and run. Application software can also be stored on CDs, DVDs and USB flash drives. An increasing amount of application software is available on the web. Sometimes referred to as a *rich Internet application* (*RIA*), a web-delivered application combines hardware resources of the web server and the PC to deliver valuable software services through a web browser interface. Before a person, group or enterprise decides on the best approach for acquiring application software, they should analyze their goals and needs carefully.

Supporting Individual, Group and Organizational Goals

Every organization relies on the contributions of people, groups and the entire enterprise to achieve its business objectives. One useful way of classifying the many potential uses of information systems is to identify the scope of the problems and opportunities that an organization addresses. This scope is called the *sphere of influence*. For most companies, the spheres of influence are personal, workgroup and enterprise. Table 4.1 shows how various kinds of software support these three spheres.

Table 4.1 Software Supporting Individuals, Workgroups and Enterprises

Software	Personal	Workgroup	Enterprise
Systems software	Smartphone, tablet computer, personal computer and workstation operating systems	Network operating systems	Server and mainframe operating systems
Application software	Word processing, spreadsheet, database and graphics	Electronic mail, group scheduling, shared work and collaboration	General ledger, order entry, payroll and human resources

Information systems that operate within the **personal sphere of influence** serve the needs of individual users. These information systems help users improve their personal effectiveness, increasing the amount and quality of work

personal sphere of influence The sphere of influence that serves the needs of an individual user.

personal productivity software The software that enables users to improve their personal effectiveness, increasing the amount of work and quality of work they can do.

workgroup Two or more people who work together to achieve a common goal.

workgroup sphere of influence The sphere of influence that helps workgroup members attain their common goals.

enterprise sphere of influence The sphere of influence that serves the needs of the firm in its interaction with its environment.

4

they can do. Such software is often called **personal productivity software**. For example, MindManager software from Mindjet provides tools to help people represent complex ideas and projects using an intuitive graphic interface.[5]

When two or more people work together to achieve a common goal, they form a **workgroup**. A workgroup might be a large formal, permanent organizational entity, such as a section or department or a temporary group formed to complete a specific project. An information system in the **workgroup sphere of influence** helps workgroup members attain their common goals. Often, software designed for the personal sphere of influence can extend into the workgroup sphere. For example, people can use online calendar software such as Google Calendar to store personal appointments and also to schedule meetings with others.

Information systems that operate within the **enterprise sphere of influence** support the firm in its interaction with its environment, which includes customers, suppliers, shareholders, competitors, special-interest groups, the financial community and government agencies. This means the enterprise sphere of influence includes business partners, such as suppliers that provide raw materials; retail companies that store and sell a company's products; and shipping companies that transport raw materials to the plant and finished goods to retail outlets. For example, many enterprises use IBM Cognos software as a centralized web-based system where employees, partners and stakeholders can report and analyze corporate financial data.[6]

4.2 Systems Software

Controlling the operations of computer hardware is one of the most critical functions of systems software. Systems software also supports the application programs' problem-solving capabilities. Types of systems software include operating systems, utility programs and middleware.

Operating Systems

operating system (OS) A set of computer programs that controls the computer hardware and acts as an interface with applications.

An **operating system (OS)** is a set of programs that controls the computer hardware and acts as an interface with applications (see Figure 4.2). Operating systems can control one or more computers, or they can allow multiple users to interact with one computer. The various combinations of OSs, computers and users include the following:

- *Single computer with a single user.* This system is commonly used in a personal computer, tablet computer or a smartphone that supports one user at a time. Examples of OSs for this setup include Microsoft Windows, Mac OS X and Google Android.
- *Single computer with multiple simultaneous users.* This system is typical of larger server or mainframe computers that can support hundreds or thousands of people, all using the computer at the same time. Examples of OSs that support this kind of system include UNIX, z/OS and HP UX.
- *Multiple computers with multiple users.* This type of system is typical of a network of computers, such as a home network with several computers attached or a large computer network with hundreds of computers attached supporting many users, sometimes located around the world. Most PC operating systems double as network operating systems. Network server OSs include Red Hat Linux, Windows Server and Mac OS X Server.

- *Special-purpose computers.* This type of system is typical of a number of computers with specialized functions, such as those that control sophisticated military aircraft, space shuttles, digital cameras or home appliances. Examples of OSs for these purposes include Windows Embedded, Symbian and some distributions of Linux.

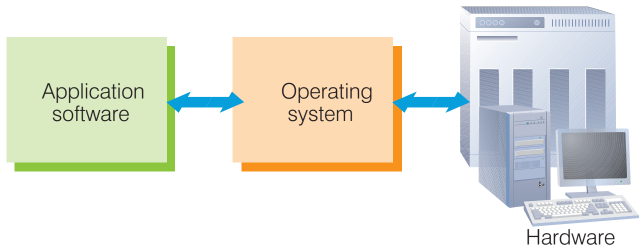


Figure 4.2 **Role of Operating Systems**
The role of the operating system is to act as an interface between application software and hardware.

The OS, which plays a central role in the functioning of the complete computer system, is usually stored on disc on general-purpose computers and in solid state memory on special-purpose computers such as mobile phones and smartphones. After you start, or 'boot up', a computer system, portions of the OS are transferred to memory as the system needs them. This process can take anywhere from a split second on a smartphone, to a few minutes on a desktop PC, to hours on a large mainframe or distributed computer systems. OS developers are continuously working to shorten the time required to boot devices from being shut down and wake devices from sleep mode.

You can also boot a computer from a CD, DVD or even a USB flash drive. A storage device that contains some or all of the OS is often called a *rescue disc* because you can use it to start the computer if you have problems with the primary hard disc.

The programs that make up the OS perform a variety of activities. They can:

- Perform common computer hardware functions.
- Provide a user interface and input/output management.
- Provide a degree of hardware independence.
- Manage system memory.
- Manage processing tasks.
- Provide networking capability.
- Control access to system resources.
- Manage files.

The **kernel**, as its name suggests, is the heart of the OS and controls its most critical processes. The kernel ties all of the OS components together and regulates other programs. For a really gentle introduction on how to write an operating system, head to the University of Cambridge Computer Laboratory at www.cl.cam.ac.uk/projects/raspberrypi/tutorials/os. The tutorial will show you how to write a simple kernel for the Rasberry Pi computer.

kernel The heart of the operating system, which controls its most critical processes.

Common Hardware Functions

All applications must perform certain hardware-related tasks, such as the following:

- Get input from the keyboard or another input device.
- Retrieve data from discs.

- Store data on discs.
- Display information on a monitor or printer.

Each of these tasks requires a detailed set of instructions. The OS converts a basic request into the instructions that the hardware requires. In effect, the OS acts as an intermediary between the application and the hardware. The OS uses special software provided by device manufacturers, called device drivers, to communicate with and control a device. Device drivers are installed when a device is initially connected to the computer system.

User Interface and Input/Output Management

user interface The element of the operating system that allows people to access and interact with the computer system.

command-based user interface A user interface that requires you to give text commands to the computer to perform basic activities.

One of the most important functions of any OS is providing a **user interface**, which allows people to access and interact with the computer system. The first user interfaces for mainframe and personal computer systems were command based. A **command-based user interface** requires you to give text commands to the computer to perform basic activities. For example, the command ERASE 00TAXRTN would cause the computer to erase a file named 00TAXRTN. RENAME and COPY are other examples of commands used to rename files and copy files from one location to another. Today's systems engineers and administrators often use a command-based user interface to control the low-level functioning of computer systems. Most modern OSs (including popular graphical user interfaces such as Windows) provide a way to interact with the system through a command line.

graphical user interface (GUI) An interface that displays pictures (icons) and menus that people use to send commands to the computer system.

A **graphical user interface (GUI)** displays pictures (called *icons*) and menus that people use to send commands to the computer system. GUIs are more intuitive to use because they anticipate the user's needs and provide easy to recognize options. Microsoft Windows is a popular GUI. As the name suggests, Windows is based on the use of a window, or a portion of the display screen dedicated to a specific application. The screen can display several windows at once.

While GUIs have traditionally been accessed using a keyboard and mouse, more recent technologies allow people to use touch screens and spoken commands. Today's mobile devices and some PCs, for example, use a touch user interface also called a *natural user interface (NUI)* or multitouch interface by some. Speech recognition is also available with some operating systems.[7] By speaking into a microphone, the operating system commands and controls the computer system. Sight interfaces use a camera on the computer to determine where a person is looking on the screen and performs the appropriate command or operation. Some companies are also experimenting with sensors attached to the human brain (brain interfaces) that can detect brain waves and control a computer as a result. Sight and brain interfaces can be very helpful to disabled individuals.

Hardware Independence

application program interface (API) Tools software developers use to build application software without needing to understand the inner workings of the OS and hardware.

Software applications are designed to run on a particular operating system by using the operating system's **application program interface (API)**, which provides software developers with tools they use to build application software without needing to understand the inner workings of the OS and hardware (see Figure 4.3). Being able to develop software without concern for the specific underlying hardware is referred to as *hardware independence*. When new hardware technologies are introduced, the operating system is required to adjust to address those changes, not the application software that runs on the operating system.

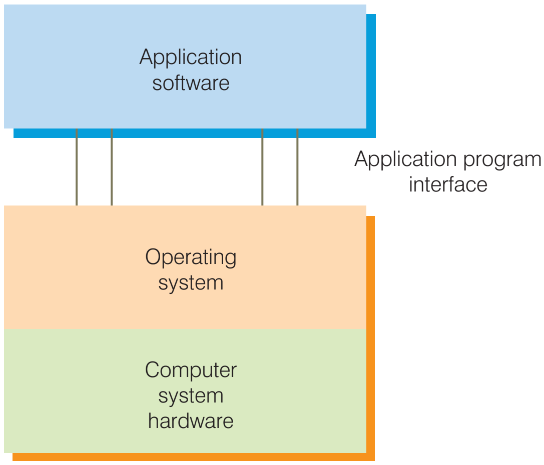


Figure 4.3 Application Program Interface (API)
The API links application software to the operating system, providing hardware independence for software developers.

Memory Management

The OS also controls how memory is accessed, maximizing the use of available memory and storage to provide optimum efficiency. The memory-management feature of many OSs allows the computer to execute program instructions effectively and to speed processing. One way to increase the performance of an old computer is to upgrade to a newer OS and increase the amount of memory.

Most OSs support *virtual memory*, which allocates space on the hard disc to supplement the immediate, functional memory capacity of RAM. Virtual memory works by swapping programs or parts of programs between memory and one or more disc devices – a concept called paging. This procedure reduces CPU idle time and increases the number of jobs that can run in a given time span.

Processing Tasks

The task-management features of today's OSs manage all processing activities. Task management allocates computer resources to make the best use of each system's assets. Task-management software lets one user run several programs or tasks at the same time (multitasking) and allows several users to use the same computer at the same time (time sharing).

An OS with multitasking capabilities allows a user to run more than one application at the same time. While you're working in the *foreground* in one program, one or more other applications can be churning away, unseen, in the *background*. Background activities include tasks such as sorting a database, printing a document, or performing other lengthy operations that otherwise would monopolize your computer and leave you staring at the screen unable to perform other work. Multitasking can save users a considerable amount of time and effort. *Time sharing* allows more than one person to use a computer system at the same time. For example, 15 customer service representatives might enter sales data into a computer system for a mail-order company at the same time. The ability of the computer to handle an increasing number of concurrent users smoothly is called *scalability*. This feature is critical for systems expected to handle a large and possibly fluctuating number of users, such as a mainframe computer or a web server.

Networking Capability

Most operating systems include networking capabilities so that computers can join together in a network to send and receive data and share computing resources. Operating systems for larger server computers are designed specifically for computer networking environments.

Access to System Resources and Security

Because computers often handle sensitive data that can be accessed over networks, the OS needs to provide a high level of security against unauthorized access to the users' data and programs. Typically, the OS establishes a logon procedure that requires users to enter an identification code, such as a user name and a matching password. Operating systems may also control what system resources a user may access. When a user successfully logs on to the system, the OS restricts access to only portions of the system for which the user has been cleared. The OS records who is using the system and for how long, and reports any attempted breaches of security.

File Management

The OS manages files to ensure that files in secondary storage are available when needed and that they are protected from access by unauthorized users. Many computers support multiple users who store files on centrally located discs or tape drives. The OS keeps track of where each file is stored and who can access them.

Current Operating Systems

Today's operating systems incorporate sophisticated features and impressive graphic effects. Table 4.2 classifies a few current OSs by sphere of influence.

Table 4.2 Operating Systems Serving Three Spheres of Influence

Personal	Workgroup	Enterprise
Microsoft Windows	Microsoft Windows Server	Microsoft Windows Server
Mac OS X, Mac OS X iPhone	Mac OS X Server	Linux
Linux	Linux	UNIX
Google Android, Chrome OS	UNIX	IBM i and z/OS
HP webOS	IBM i and z/OS	HP-UX

Microsoft PC Operating Systems

In 1980, executives from IBM approached Microsoft regarding the creation of an operating system for IBM's first personal computer. The operating system they delivered was based on a system called the Quick and Dirty Operating System (QDOS), written by Tim Paterson of Seattle Computer Products. Microsoft had bought the rights to QDOS for $50,000. QDOS, in turn, was based on Gary Kildall's Control Program for Microcomputers (CP/M). Quickly relabelled as Microsoft Disk Operating System (MS-DOS), IBM allowed Microsoft to retain the rights to MS-DOS and to market it separately from the IBM personal computer. This has allowed Microsoft to dominate the operating systems market ever since from the licensing of MS-DOS and its descendants.[8] MS-DOS, which had a command-based interface that was difficult to learn and use, eventually gave way to the more user-friendly Windows operating system, which opened the PC market to everyday users.

With the launch of Windows 10, Microsoft announced that it was moving away from its usual practice of releasing major new versions of its Windows operating system every few years. Instead, the company would be providing ongoing, incremental upgrades and improvements, rolled out automatically, perhaps as often as monthly for individual consumers. Organizations, whose information systems professionals desire minimal change in order to ensure reliable operations of their corporate applications, may elect to opt out of such frequent updates. Microsoft hopes that the automatic, rapid update cycle will force users to stay current and discontinue the use of older operating systems. One benefit of this approach is that it will allow Microsoft to gradually shift some of its resources away from updating and maintaining earlier versions of Windows. Ideally, those resources will instead be refocused on efforts to improve Windows 10. Microsoft also plans to make Windows 10 a common platform with a single app store for any machine: smartphone, laptop, desktop, xBox game station, etc. (with variations to allow for differing screen sizes and uses).[9]

Apple Computer Operating Systems

Ironically, the demise of the original line of Apple computers in many ways allowed them to come back more successfully. Just as Microsoft would like to stop supporting old versions of Windows, problems at Apple allowed them to make a clean break from their 'classic line' of computers in the mid-1990s. The current Apple operating system is called OS X. Based on the UNIX operating system, OS X is focused on an enhanced user experience. Since its first release, Apple has upgraded OS X multiple times. The first eight versions were named after big cats, and the latest are named after places in California. The latest version offers the Siri personal assistant, enhanced security features and the ability to launch the iBooks app, and books you've already downloaded to your iPad, iPhone, or iPod Touch will appear in your library. Directions, bookmarks and recent searches are automatically passed on to all your iOS devices, and you can now use natural language when using the Spotlight search feature (e.g. 'spreadsheet I worked on yesterday'). The new Split View feature automatically positions two app windows side by side in full screen so you can work with both apps at the same time. Power-saving technology in Apple laptops and other mobile devices enables you to browse longer, and upgraded graphics-rendering technology has improved overall system performance compared to previous versions.[10]

Because OS X runs on Intel processors, Mac users can set up their computers to run both Windows and OS X and select the platform they want to work with when they boot their computer. Such an arrangement is called dual booting. While Macs can dual boot into Windows, the opposite is not true. OS X cannot be run on any machine other than an Apple device. However, Windows PCs can dual boot with Linux and other OSs.

Linux

Linux is an operating system developed in 1991 by Linus Torvalds while he was a student in Finland. The word Linux is typically used to mean a complete operating system although it originally meant the software that interfaced directly with a computer's hardware, called the kernel. Sometimes the complete operating system is called GNU/Linux although Torvalds thinks this is unnecessary. Because the Linux kernel is really good at interfacing software with hardware, it is used in many hardware devices that you might not expect – car brakes, ATM machines and phones are examples.

The Linux OS is distributed under the GNU General Public License, and its source code is freely available to everyone. It is therefore an open-source operating system. Individuals and organizations can use the open-source Linux code to create their own distribution (flavour) of Linux. A distribution consists of the Linux kernel (the core of the operating system), which controls the hardware, manages files, separates processes and performs other basic functions along with other software. This other software defines the terminal interface and available commands, produces the graphical user interface and provides other useful utility programs. A Linux distributor takes all the code for these programs and combines it into a single operating system that can be installed on a computer. The distributor may also add finishing touches that determine what the desktop looks like, what colour schemes and character sets are displayed, and what browser and other optional software are included. Typically, the distribution is optimized to perform in a particular environment, such as for a desktop computer, server, or TV cable box controller. More than 100 distributions of Linux have been created[11] with Ubuntu being one of the most popular. If you want to use Linux on a PC or laptop, you may struggle to buy one. Instead you'll have to buy the machine and then install Linux yourself. Very few users want to do this, which is a major factor in keeping Linux out of the PC market. However, Torvalds is convinced it is only a matter of time before his software becomes mainstream in PCs the way it already has in other devices.

Information Systems @ Work

Privacy for Everyone, Everywhere

A 'live operating system' is one that is not installed on your computer's internal memory but is stored on a memory stick or similar device. You simply put the memory stick in the USB slot (or the SD card in its slot, or the CD in the disk drive) and turn the computer on. The operating system boots from the drive and not from whatever is stored in internal memory. A live operating system can save a lot of hassle if for instance you need to do something using the GNU/Linux operating system but don't want to install it permanently on your computer. It also has allowed specialist operating systems to be created, ones that you wouldn't want to use all the time and which, in fact, you might not want any trace of on your computer at all.

Tails is a free, live operating system that is designed to preserve its users' privacy and anonymity, and when they turn their computer off and pull out the memory stick Tails is entirely removed from the computer. Based on Linux, Tails comes with several built-in applications pre-configured with security in mind: a web browser, instant messaging client, email client and office software. All messages sent and received by Tails go through the Tor network. Tor was developed by the US military to protect anonymity by routing messages through a random number of computers located all over the world. Each connection between any two of them is protected by HTTPS technology, which is described fully in the ethical case in Chapter 6.

Tails will work on almost any computer or laptop and so can be used on a home machine, a work machine or a machine at the local library. Once the memory stick is removed and the computer restarted, the normal operating system starts as usual, with no record that anything else has happened.

Tails' most famous user is whistleblower Edward Snowden. He used it to evade notice when he downloaded thousands of files from the National Security Agency. In a movie version of the incident, Snowden hides a tiny USB stick inside a square in a Rubik's cube on which he stored all of the documents he took. In reality though, the cube was dramatic licence. When Snowden started contacting journalists about his story, he used Tails. He said at the Free Software Foundation's LibrePlanet 2016 conference that what he did at the NSA couldn't have happened without free software. 'I didn't use Microsoft machines when I was in my operational phase, because I couldn't trust them. Not because I knew that there was a particular back door or anything like that, but because I couldn't be sure.'

So why does being open-source software make back doors impossible? As the code is open source, anyone can inspect it and people do. That's how users can be sure it is actually doing what it claims to be doing and isn't full of security holes or a plot to grab sensitive data.

Questions

1 Should people be anonymous online?

2 Should we be suspicious of all Tails users?

3 Who would inspect open-source software?

4 Can we trust Microsoft software? Do an Internet search to inform your answer.

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Chrome OS and Android

Over the years, Google has extended its reach beyond its popular search engine (Google) to offer application software (Google Docs), email services (Gmail), a mobile operating system (Android), web browser (Chrome) and, more recently, a PC operating system, Chrome OS. Chrome OS is a Linux-based operating system for Chromebooks and other inexpensive and low-power notebooks and desktop PCs. It is primarily used to access web-based information and services such as email, web browsing, social networks and Google online applications. Chrome OS for personal computers is designed to start up extremely quickly – Chromebooks boot up in eight seconds – and provide secure access to applications through the Internet. The Chromebook is probably the safest computer you can use and does not require any anti-virus software. An open-source version of Chrome OS, named Chromium OS, was made available at the end of 2009. Because it is open-source software, developers can customize the source code to run on different platforms, incorporating unique features.

More popular so far than Chrome OS are the various releases of the Android operating system, which is also based on Linux. Android – and therefore Linux – has surpassed 1 billion users across all devices with 80 per cent of mobile phones worldwide operating on Android.[12]

Workgroup Operating Systems

To keep pace with user demands, the technology of the future must support a world in which network usage, data-storage requirements and data-processing speeds increase at a dramatic rate. Powerful and sophisticated OSs are needed to run the servers that meet these business needs for workgroups.

Windows Server

Microsoft designed Windows Server to perform a host of tasks that are vital for websites and corporate web applications. For example, Microsoft Windows Server can be used to coordinate and manage large data centres. Windows Server delivers benefits such as a powerful web server management system, virtualization tools that allow various operating systems to run on a single server, advanced security features and robust administrative support. Windows Server 2016 provides further enhancements for 'containerization' with individual containers having their own Windows Server kernel that is not shared with the host machine. This ensures that users can run jobs without worrying that workloads running on one container will reach outside their bounds and interfere with either the host machine or other applications running on it. Windows Home Server allows individuals to connect multiple PCs, storage devices, printers and other devices into a home network. Windows Home Server provides a convenient way for home users to store and manage photos, video, music and other digital content. It also provides back-up and data recovery functions.

UNIX

UNIX is a powerful OS originally developed by AT&T for minicomputers, the predecessors of servers, which were larger than PCs and smaller than mainframes. UNIX can be used on many computer system types and platforms, including workstations, servers and mainframe computers. UNIX also makes it easy to move programs and data between computers or to connect mainframes and workstations to share resources. There are many variants of UNIX, including HP-UX from Hewlett-Packard, AIX from IBM and Solaris from Oracle. UNIX computers are considered high cost compared to Linux and Windows Server.

The Solaris operating system is a UNIX-based operating system originally developed by Sun Microsystems. Oracle, known primarily as a database management software firm, acquired Sun in 2010. Sun products included server hardware, the Solaris operating system and the Java programming language. Oracle now offers so-called general-purpose engineered systems that include a combination of Oracle and Sun software running on powerful Sun servers, dubbed SPARC.[13]

Red Hat Linux

Red Hat Software offers Red Hat Enterprise Linux Server, an operating system that is very efficient at serving web pages and can manage a cluster of several servers. Distributions such as Red Hat have proved that Linux is a very stable and efficient OS. Red Hat Enterprise Virtualization (RHEV) software provides virtualization capabilities for servers and desktop computers to enable the hardware to run more than one operating system.

Casio is a multinational electronics manufacturing company headquartered in Japan. Its products include calculators, mobile phones, cameras, musical instruments and watches. Casio migrated to RHEV, and its virtual servers now use only 60 per cent of the resources used by physical servers. The firm has also been able to ensure that in the event of a server failure, other servers will have the capacity to pick up the load without a serious effect on the entire system.[14]

Mac OS X Server

The Mac OS X Server is the first modern server OS from Apple and is based on the UNIX OS. Designed for OS X and iOS, OS X Server makes it easy to collaborate, develop software, host websites and wikis, configure Mac and iOS devices, and remotely access a network. Smartphone users running iOS can now open, edit and save documents on OS X Server.

Enterprise Operating Systems

Mainframe computers provide the computing and storage capacity required for massive data-processing environments, and they provide systems that can support many users while delivering high performance and excellent system availability, strong security and scalability. A wide range of application software has been developed to run in the mainframe environment, making it possible to purchase software to address almost any business problem. Examples of mainframe OSs include z/OS from IBM, HP-UX from Hewlett-Packard, and Linux. The z/OS is IBM's first 64-bit enterprise OS and is capable of handling very heavy workloads, including serving thousands of concurrent users and running an organization's critical applications. (The z stands for zero downtime.)

Embedded Operating Systems

An embedded system is a computer system (a device that includes some sort of processor) that is implanted in and dedicated to the control of another device. Android and other mobile phone operating systems have already been mentioned, but other embedded systems control many devices in common use today, including TV cable boxes, smartphones, digital watches, digital cameras, MP3 players, calculators, microwave ovens, washing machines and traffic lights. A modern car contains many embedded systems, including those that control antilock brakes, air bag deployment, fuel injection, active suspension devices, transmission control and cruise control. A global positioning system (GPS) device uses an embedded system to help people find their way around town or more remote areas. As was previously mentioned, the Linux kernel is often used in such devices. Being open source it is convenient for manufacturers to customize.

Other embedded operating systems exist. Palm was an early smartphone manufacturer and developed its well-regarded Palm webOS operating system to run its Pre and Pixi smartphones. Although webOS was considered innovative, Palm's smartphones were a market failure, and in 2010, HP bought the company along with webOS, hoping to use it to develop its mobile platform. HP's efforts were also unsuccessful, and in early 2013, LG bought all the assets associated with webOS from HP. LG now uses the specialized software in its smart TVs to enable users to stream movies and television shows and YouTube videos, connect to social networks, play games, get news and download apps.[15]

Windows Embedded

Windows Embedded is a family of Microsoft operating systems included with or embedded into small computer devices. For example, Windows Embedded Compact includes several versions that provide computing power for TV set-top boxes, automated industrial machines, media players, medical devices, digital cameras, PDAs, GPS receivers, ATMs, gaming devices and business devices such as cash registers.

Syndicat Mixte Autolib is an electric car-sharing program implemented by the city of Paris and surrounding municipalities. The goals of the program are to relieve traffic congestion, reduce noise and air pollution, and provide people with flexible transit options. Various components of the Windows Embedded operating system provide connectivity between the in-car system, rental kiosks, charging stations and a central control system. Syndicat Mixte Autolib has reduced carbon dioxide emissions by 1.5 metric tonnes annually and replaced 25,000 privately owned petrol vehicles. Autolib subscribers enjoy additional benefits including GPS navigation and free parking.[16]

Utility Programs

utility programs Program that helps to perform maintenance or correct problems with a computer system.

Utility programs help to perform a variety of tasks. For example, some utility programs merge and sort sets of data, keep track of computer jobs being run, compress files of data before they are stored or transmitted over a network (thus saving space and time) and perform other important tasks. Parallels Desktop is a popular utility that allows Apple Mac computers to run Windows programs.[17] The utility, which costs under €75, creates a virtual Windows machine inside a Mac computer.

Another type of utility program allows people and organizations to take advantage of unused computer power over a network. Often called *grid computing*, this approach can be very efficient and less expensive than purchasing additional hardware or computer equipment. CERN, home of the Large Hadron Collider (LHC), the world's largest scientific instrument, is also home to one of the world's largest scientific grid computing and storage systems. The LHC Computing Grid (LCG) project provides scientists around the world with access to shared computer power and storage systems over the Internet.[18] In 2012, this project helped identify a particle that may be the Higgs boson.

Although many PC utility programs come installed on computers, you can also purchase utility programs separately. The following sections examine some common types of utilities.

Hardware Utilities

Some hardware utilities are available from companies such as Symantec, which produces Norton Utilities. Hardware utilities can check the status of all parts of the PC, including hard discs, memory, modems, speakers and printers. Disc utilities check the hard disc's boot sector, file allocation tables and directories, and analyze them to ensure that the hard disc is not damaged. Disc utilities can also optimize the placement of files on a crowded disc.

Security Utilities

Computer viruses and spyware from the Internet and other sources can be a nuisance – and sometimes can completely disable a computer. Antivirus and antispyware software can be installed to constantly monitor and protect the computer. If a virus or spyware is found, most of the time it can be removed. It is also a good idea to protect computer systems with firewall software. Firewall software filters incoming and outgoing packets, making sure that neither hackers nor their tools are attacking the system. Symantec, McAfee and Microsoft are the most popular providers of security software.

File-Compression Utilities

File-compression programs can reduce the amount of disc space required to store a file or reduce the time it takes to transfer a file over the Internet. Both Windows and Mac operating systems let you compress or decompress files and folders. A zip file has a .zip extension, and its contents can be easily unzipped to the original size. *MP3 (Motion Pictures Experts Group-Layer 3)* is a popular file-compression format used to store, transfer and play music and audio files, such as podcasts – audio programs that can be downloaded from the Internet.

Spam-Filtering Utilities

Receiving unwanted email (spam) can be a frustrating waste of time. Email software and services include spam-filtering utilities to assist users with these annoyances. Email filters identify spam by learning what the user considers spam and routing it to a junk mail folder. However, this method is insufficient for protecting enterprise-level email systems where spam containing viruses is a serious threat. Businesses often use additional spam-filtering software from companies including Cisco, Barracuda Networks and Google at the enterprise level to intercept dangerous spam as it enters the corporate email system.

Network and Internet Utilities

A broad range of network- and systems-management utility software is available to monitor hardware and network performance and trigger an alert when a server is crashing or a network problem occurs.[19] IBM's Tivoli Netcool and Hewlett-Packard's Automated Network Management Suite can be used to solve computer-network problems and help save money.[20] In one survey, about 60 per cent of responding organizations used monitoring software to determine if their Internet sites and Internet applications were running as expected.

Server and Mainframe Utilities

Some utilities enhance the performance of servers and mainframe computers. James River Insurance uses a utility program from Confio to help it monitor the performance of its computer systems and databases.[21] According to a manager for James River, 'We take a proactive approach to database management to ensure we maintain high availability and performance in our virtual and physical environments'. IBM and other companies have created systems-management software that allows a support person to monitor the growing number of desktop computers attached to a server or mainframe computer. Similar to the virtual machine software discussed earlier, *server virtualization software* allows a server to run more than one operating system at the same time. For example, you could run four different virtual servers simultaneously on one physical server.

Other Utilities

Utility programs are available for almost every conceivable task or function. Managing the vast array of operating systems for smartphones and mobile devices, for example, has been difficult for many companies. In one survey, two-thirds of responding organizations allowed managers and workers to connect to corporate databases using smartphones and mobile devices with very little or no guidance or supervision.[22] Utility programs can help. Research in Motion (RIM) has developed a utility program that helps companies manage mobile phones and mobile devices from its company and others.[23] Often called *mobile device management (MDM)*, this type of software should help companies as smartphones and other mobile devices become more popular for managers and workers in a business setting. MDM software helps a company manage security, enforce corporate strategies and control downloads and content streaming from corporate databases into smartphones and mobile devices. In addition, a number of companies, such as CNET, offer utilities that can be downloaded for most popular operating systems.[24]

Middleware

Middleware is software that allows various systems to communicate and exchange data. It is often developed to address situations where a company acquires different types of information systems through mergers, acquisitions or expansion and wants the systems to share data and interact. Middleware can also serve as an interface between the Internet and private corporate systems. For example, it can be used to transfer a request for information from a corporate customer on the corporate website to a traditional database on a mainframe computer and return the results to the customer on the Internet.

middleware Software that allows various systems to communicate and exchange data.

The use of middleware to connect disparate systems has evolved into an approach for developing software and systems called SOA. A **service-oriented architecture (SOA)** uses modular application services to allow users to interact with systems and systems to interact with each other. Systems developed with SOA are flexible and ideal for businesses that need a system to expand and evolve over time. SOA modules can be reused for a variety of purposes, thus reducing development time. Because SOA modules are designed using programming standards so that they can interact with other modules, rigid custom-designed middleware software is not needed to connect systems.

service-oriented architecture (SOA) A modular method of developing software and systems that allows users to interact with systems and systems to interact with each other.

4.3 Application Software

As discussed earlier in this chapter, the primary function of application software is to apply the power of the computer to give people, workgroups and the entire enterprise the ability to solve problems and perform specific tasks. One debt collection agency, for example, was able to save more than €180,000 annually by using application software from Latitude to monitor people not paying their bills on time.[25] Applications help you perform common tasks, such as create and format documents, perform calculations or manage information. Some applications are more specialized. Accenture, for example, offers application software specifically for the property and causality insurance industry.[26] NB Publishers in South Africa uses application software to format books so they can be read on e-readers.[27] Yusen Logistics in Australia uses application software to calculate its costs and to route packages from sender to receiver.[28] New passenger-screening software at Tulsa International Airport has streamlined the check-in process and reduced privacy concerns.[29] The software, called automated target recognition, uses a new full-body scanning technology. The US Army is testing new application software on smartphones and tablet computers in combat zones.[30] The military software will help commanders and combat troops analyze surveillance video and data from battlefields to help them locate and eliminate enemy troops, giving new meaning to the term ‘killer app’.

Overview of Application Software

Proprietary software and off-the-shelf software are important types of application software. **Proprietary software** is one-of-a-kind software designed for a specific application and owned by the company, organization or person that uses it. Proprietary software can give a company a competitive advantage by providing services or solving problems in a unique manner, better than methods used by a competitor. **Off-the-shelf software** is mass-produced by software vendors to address needs that are common across businesses, organizations or individuals. For example, Amazon uses the same off-the-shelf payroll software as many businesses, but the company uses custom-designed

proprietary software One-of-a-kind software designed for a specific application and owned by the company, organization or person that uses it.

off-the-shelf software Software mass-produced by software vendors to address needs that are common across businesses, organizations or individuals.

proprietary software on its website that allows visitors to more easily find items to purchase. The relative advantages and disadvantages of proprietary software and off-the-shelf software are summarized in Table 4.3.

Table 4.3 Comparison of Proprietary and Off-the-Shelf Software

Proprietary Software		Off-the-Shelf Software	
Advantages	**Disadvantages**	**Advantages**	**Disadvantages**
You can get exactly what you need in terms of features, reports, etc.	It can take a long time and significant resources to develop required features	The initial cost is lower because the software firm can spread the development costs over many customers	An organization might have to pay for features that are not required and never used
Being involved in the development offers control over the results	In-house systems development staff may be hard pressed to provide the required level of ongoing support and maintenance because of pressure to move on to other new projects	The software is likely to meet the basic business needs – you can analyze existing features and the performance of the package before purchasing	The software might lack important features, thus requiring future modification or customization. This lack can be very expensive because users must adapt future releases of the software as well
You can modify features that you might need to counteract an initiative by competitors or to meet new supplier or customer demands	The features and performance of software that has yet to be developed present more potential risk	The package is likely to be of high quality because many customer firms have tested the software and helped identify its bugs	The software might not match current work processes and data standards

Many companies use off-the-shelf software to support business processes. Key questions for selecting off-the-shelf software include the following. First, will the software run on the OS and hardware you have selected? Second, does the software meet the essential business requirements that have been defined? Third, is the software manufacturer financially solvent and reliable? Finally, does the total cost of purchasing, installing and maintaining the software compare favourably to the expected business benefits?

Some off-the-shelf programs can be modified, in effect blending the off-the-shelf and customized approaches. For example, El Camino Hospital in Mountain View, California, customized Microsoft's e-health management system, Amalga, to track patients with the H1N1 flu and those that may have been exposed to it.[31] Similar tracking innovations were explored worldwide in relation to the COVID-19 pandemic.

application service provider (ASP) A company that provides the software, support and computer hardware on which to run the software from the user's facilities over a network.

software as a service (SaaS) A service that allows businesses to subscribe to web-delivered application software.

Another approach to obtaining a customized software package is to use an application service provider. An **application service provider (ASP)** is a company that can provide the software, support and computer hardware on which to run the software from the user's facilities over a network. Some vendors refer to the service as *on-demand software*.

Today, many companies are running software on the web. This approach is called **Software as a Service (SaaS)**, which allows businesses to subscribe to web-delivered application software. In most cases, the company pays a monthly service charge or a per-use fee.[32] Guardian Life Insurance, for example, implemented an actuarial application by using Amazon's Ec2 SaaS approach.[33] According to the CIO of the company, 'We don't do anything because it's Cloud. But if the financials look right, if the risk profile looks right, if the richness and robustness look right, we go with that solution'. Like ASP, SaaS providers maintain software on their own servers and provide access to it over the Internet. SaaS usually uses a web browser-based user interface. Many business activities are supported by SaaS. Vendors include Oracle, SAP, Net Suite, Salesforce and Google. Tidewell, a hospice that serves about 8,000 Florida families, acquired software from Salesforce.com to save money and streamline its operations.[34] SaaS can reduce expenses by sharing its running applications across many businesses. Some people, however, are concerned about the security of data and programs on the Internet using the SaaS approach.[35]

SaaS and new web development technologies have led to a new paradigm in computing called cloud computing.[36] *Cloud computing* refers to the use of computing resources, including software and data storage, on the Internet (the cloud) rather than on local computers. Google, for example, is launching new personal computers built by Samsung and Acer called Chromebooks that include only an Internet browser. All of the software applications are accessed through an Internet connection.[37] Businesses can get a Chromebook and Chrome OS for under €22 per user.[38] In addition, Google's email and productivity suite can be purchased for about €37 per month per individual. Rather than installing, storing and running software on your own computer, with cloud computing you use the web browser to access software stored and delivered from a web server. Typically the data generated by the software is also stored on the web server. For example, Tableau software allows users to import databases or spreadsheet data to create powerful visualizations that provide useful information.[39] Cloud computing also provides the benefit of being able to easily collaborate with others by sharing documents on the Internet.

4

ASP, SaaS and cloud computing, however, involve some risks. For example, sensitive information could be compromised in a number of ways, including unauthorized access by employees or computer hackers; the host might not be able to keep its computers and network up and running as consistently as necessary; or a disaster could disable the host's data centre, temporarily putting an organization out of business. In addition, these approaches are not accepted and used by everyone.[40] According to one survey, about 15 per cent of enterprises are either using the SaaS approach or plan to use the approach in the next year. It can also be difficult to integrate the SaaS approach with existing software. According to the CIO of Hostess Brands, 'Figuring out integration requirements and how providers handle those and getting everything in sync have been among our tougher challenges'.[41]

Personal Application Software

Hundreds of computer applications can help people at school, home and work. New computer software under development and existing GPS technology, for example, will allow people to see 3D views of where they are, along with directions and 3D maps to where they would like to go. Absolute Software, which uses GPS technology, helps people and organizations retrieve stolen computers. The company has recovered almost 10,000 devices worth over €7 million.[42] According to a special investigator for the Detroit Public Schools (DPS), 'At DPS, we've already seen the effect of these recoveries. We would have never recovered any of the 300 plus laptops stolen from our district without the aid of Absolute Software'.

The features of some popular types of personal application software are summarized in Table 4.4. In addition to these general-purpose programs, thousands of other personal computer applications perform specialized tasks that help you do your taxes, get in shape, lose weight, get medical advice, write wills and other legal documents, repair your computer, fix your car, write music, and edit your pictures and videos. This type of software, often called *user software* or *personal productivity software*, includes the general-purpose tools and programs that support individual needs.

Word-Processing

Word-processing applications are installed on most PCs today. These applications come with a vast array of features, including those for checking spelling, creating tables, inserting formulas, creating graphics and much more. Much of the work required to create this book uses the popular word-processing software, Microsoft Word.

A team of people can use a word-processing program to collaborate on a project. This book was written in part using Google Docs, a cloud-based word-processing package which makes it easy for two or more people to contribute to one file.

4

Table 4.4 Examples of Personal Application Software

Type of Software	Explanation	Example
Word-processing	Create, edit and print text documents	Microsoft Word Google Docs Apple Pages LibreOffice Writer
Spreadsheet	Provide a wide range of built-in functions for statistical, financial, logical, database, graphics, and date and time calculations	Microsoft Excel IBM Lotus 1-2-3 Google Spreadsheet Apple Numbers LibreOffice Calc
Database	Store, manipulate and retrieve data	Microsoft Access IBM Lotus Approach Borland dBASE Google Base LibreOffice Base
Graphics	Develop graphs, illustrations and drawings	Adobe Illustrator Canva Microsoft PowerPoint LibreOffice Impress
Project management	Plan, schedule, allocate and control people and resources (money, time and technology) needed to complete a project according to schedule	Microsoft Project Symantec On Target Scitor Project Scheduler Symantec Time Line
Financial management	Provide income and expense tracking and reporting to monitor and plan budgets (some programs have investment portfolio management features)	Intuit Quicken
Desktop publishing (DTP)	Use with personal computers and high-resolution printers to create high-quality printed output, including text and graphics; various styles of pages can be laid out; art and text files from other programs can also be integrated into published pages	QuarkXPress Microsoft Publisher Adobe InDesign Corel Ventura Publisher Apple Pages

Spreadsheet Analysis

Spreadsheets are powerful tools for manipulating and analyzing numbers and alphanumeric data. Individuals and organizations use spreadsheets. Features of spreadsheets include formulas, statistical analysis, built-in business functions, graphics, limited database capabilities and much more. The business functions include calculation of depreciation, present value, internal rate of return and the monthly payment on a loan, to name but a few.

Optimization is another powerful feature of many spreadsheet programs. *Optimization* allows the spreadsheet to maximize or minimize a quantity subject to certain constraints. For example, a small furniture manufacturer that produces chairs and tables might want to maximize its profits. The constraints could be a limited supply of timber, a limited number of workers who can assemble the chairs and tables, or a limited amount of various hardware fasteners that might be required. Using an optimization feature, such as Solver in Microsoft Excel, the spreadsheet can determine what number of chairs and tables to produce with labour and material constraints to maximize profits.

Database Applications

Database applications are ideal for storing, organizing and retrieving data. These applications are particularly useful when you need to manipulate a large amount of data and produce reports and documents. Database manipulations include merging, editing and sorting data. The uses of a database application are varied. You can keep track of a CD collection, the items in your apartment, tax records and expenses. A student club can use a database to store names, addresses, phone numbers and dues paid. In business, a database application can help process sales orders, control inventory, order new supplies, send letters to customers and pay employees. Database management systems can be used to track orders, products and customers; analyze weather data to make forecasts for the next several days; and summarize medical research results. A database can also be a front end to another application. For example, you can use a database application to enter and store income tax information and then export the stored results to other applications, such as a spreadsheet or tax-preparation application.

Presentation Graphics Program

It is often said that a picture is worth a thousand words. With today's graphics programs, it is easy to develop attractive graphs, illustrations and drawings that assist in communicating important information. Presentation graphics programs can be used to develop advertising brochures, announcements and full-colour presentations, and to organize and edit photographic images. If you need to make a presentation at school or work, you can use a special type of graphics program called a presentation application to develop slides and then display them while you are speaking. Because of their popularity, many colleges and departments require students to become proficient at using presentation graphics programs.

Many graphics programs, including Microsoft PowerPoint, consist of a series of slides. Each slide can be displayed on a computer screen, printed as a handout or (more commonly) projected onto a large viewing screen for audiences. Powerful built-in features allow you to develop attractive slides and complete presentations. You can select a template for a type of presentation, such as recommending a strategy for managers, communicating news to a sales force, giving a training presentation or facilitating a brainstorming session. The presentation graphics program lets you create a presentation step-by-step, including applying colour and attractive formatting. You can also design a custom presentation using the many types of charts, drawings and formatting available. Most presentation graphics programs come with many pieces of *clip art*, such as drawings and photos of people meeting, medical equipment, telecommunications equipment, entertainment and much more.

Personal Information Managers

Personal information management (PIM) software helps people, groups and organizations store useful information, such as a list of tasks to complete or a set of names and addresses. PIM software usually provides an appointment calendar, an address book or contacts list, and a place to take notes. In addition, information in a PIM can be linked. For example, you can link an appointment with a sales manager in the calendar to information on the sales manager in the address book. When you click the appointment in the calendar, a window opens displaying information on the sales manager from the address book. Microsoft Outlook is an example of very popular PIM software. Increasingly, PIM software is moving online where it can be accessed from any Internet-connected device.

Some PIMs allow you to schedule and coordinate group meetings. If a computer or handheld device is connected to a network, you can upload the PIM data and coordinate it with the calendar and schedule of others using the same PIM software on the network. You can also use some PIMs to coordinate emails inviting others to meetings. As users receive their invitations, they click a link or button to be automatically added to the guest list.

Software Suites and Integrated Software Packages

software suite A collection of single programs packaged together in a bundle.

A **software suite** is a collection of single programs packaged together in a bundle. Software suites can include a word-processor, spreadsheet program, database management system, graphics program, communications tools, organizers and more. Some suites support the development of web pages, note taking and speech recognition so that applications in the suite can accept voice commands and record dictation. Software suites offer many advantages. The software programs have been designed to work similarly so that after you learn the basics for one application, the other applications are easy to learn and use. Buying software in a bundled suite is cost effective; the programs usually sell for a fraction of what they would cost individually.

Microsoft Office, Corel WordPerfect Office, Lotus SmartSuite and LibreOffice are examples of popular general-purpose software suites for personal computer users. Microsoft Office has the largest market share. Most of these software suites include a spreadsheet program, word processor, database program and graphics presentation software. All can exchange documents, data and diagrams (see Table 4.5). In other words, you can create a spreadsheet and then cut and paste that spreadsheet into a document created using the word-processing application.

Table 4.5 Major Components of Leading Software Suites

Personal Productivity Function	Microsoft Office	Lotus Symphony	Corel WordPerfect Office	LibreOffice	Apple iWork	Google
Word-Processing	Word	Documents	WordPerfect	Writer	Pages	Docs
Spreadsheet	Excel	Spreadsheets	Quattro Pro	Calc	Numbers	Spreadsheet
Presentation Graphics	PowerPoint	Presentations	Presentations	Impress and Draw	Keynote	Presentation
Database	Access			Base		

In addition to suites, some companies produce *integrated application packages* that contain several programs. For example, Microsoft Works is one program that contains a basic word-processor, spreadsheet, database, address book, calendar and other applications. Although not as powerful as stand-alone software included in software suites, integrated software packages offer a range of capabilities for less money. QuickOffice can be used on tablet computers and smartphones to read and edit Microsoft Office documents.[43] Onlive can also be used to open and edit Microsoft Office documents on an Apple iPad.[44] Some integrated packages cost about €75.

Some companies offer web-based productivity software suites that require no installation – only a web browser. Zoho, Google and Thinkfree offer free online word-processor, spreadsheet, presentation and other software that requires no installation on the PC. Adobe has developed Acrobat.com, a suite of programs that can be used to create and combine Adobe PDF (Portable Document Format) files, convert PDF files to Microsoft Word or Excel files, create web forms and more.[45] After observing this trend, Microsoft responded with an online version of some of its popular Office applications. Office 365 (to be known as Microsoft 365 from 21 April 2020 onwards) offers basic software suite features over the Internet using cloud computing.[46] The cloud-based applications can cost €7 per user per month depending on the features used.[47] Microsoft offers plans for professionals and small businesses, enterprises and education. Some believe that Office 365 has advantages over many other online suites.[48] According to the director of online services at Microsoft, 'With Office 365, businesses of all sizes can get the same robust capabilities that have given larger businesses an edge for years'.[49] The city of Winston-Salem, North Carolina, for example, used Office 365 to save money and place software applications on the Internet. According to the CIO of the city, 'I have to improve technology with a constrained budget. Because we were able to package Microsoft cloud and local products in one enterprise agreement, we ended up with more bang for no additional cost'. The online versions of Word, Excel, PowerPoint and OneNote are tightly integrated with Microsoft's desktop Office suite for easy sharing of documents among computers and collaborators.

Other Personal Application Software

In addition to the software already discussed, people can use many other interesting and powerful application software tools. In some cases, the features and capabilities of these applications can more than justify the cost of an entire computer system. TurboTax, for example, is a popular tax-preparation program in the US. You can find software for creating web pages and sites, composing music, and editing photos and videos. Many people use educational and reference software and entertainment, games and leisure software. Game-playing software is popular and can be very profitable for companies that develop games and various game accessories, including virtual avatars such as colourful animals, fish and people.[50] Game-playing software has even been used as therapy for young children and adults recovering from cancer and other diseases.[51] According to a hospital executive, 'It's a very motivating tool for the patients. It's visual, the feedback is instant, and it's fun'. Some believe that online game players may have solved an important AIDS research question.[52] The gamers were playing a protein-folding game called Foldit and were able to predict the structure of an enzyme that is involved in how HIV multiples, a structure that the scientific community had been trying to unlock for a decade. Engineers, architects and designers often use computer-aided design (CAD) software to design and develop buildings, electrical systems, plumbing systems and more. Autosketch, CorelCAD and AutoCad are examples of CAD software. Other programs perform a wide array of statistical tests. Colleges and universities often have a number of courses in statistics that use this type of application software. Two popular applications in the social sciences are SPSS and SAS.

Mobile Application Software

The number of applications (apps) for smartphones and other mobile devices has exploded in recent years. Besides the valuable mobile applications that come with these devices, tens of thousands of applications have been developed by third parties. For example, iPhone users can download and install thousands of applications using Apple's App Store.[53] Many iPhone apps are free, while others range in price from 99 cents to hundreds of euros. Thousands of mobile apps are available in the Android Market for users of Android handsets. Microsoft and other software companies are also investing in mobile applications for devices that run on its software.[54] SceneTap, an application for iPhones and Android devices, can determine the number of people at participating bars, pubs or similar establishments, and the ratio of males to females.[55] This approach uses video cameras and facial recognition software to identify males and females. SocialCamera, an application for Android phones, allows people to take a picture of someone and then search their Facebook friends for a match.[56] New facial-recognition software developed at Carnegie Mellon University was able to correctly identify about a third of the people tested from a simple photograph from a mobile phone or camera.[57] Facial-recognition software, however, could be a potential invasion of privacy.[58] The smartphones market was valued at over €700 billion in 2019.[59] Table 4.6 lists a few mobile application categories.

Table 4.6 Categories of Mobile Applications for Smartphones

Category	Description
Books and reference	Access e-books, subscribe to journals or look up information in dictionaries on Wikipedia
Business and finance	Track expenses, trade stocks and access corporate information systems
Entertainment	Access all forms of entertainment, including movies, television programs, music videos and local night life
Games	Play a variety of games, from 2D games such as Pacman and Tetris, to 3D games such as Need for Speed, Rock Band and The Sims
Health and fitness	Track workout and fitness progress, calculate calories and even monitor your speed and progress from your wirelessly connected Nike shoes
Lifestyle	Find good restaurants, select wine for a meal and more
Music	Find, listen to and create music
News and weather	Access major news and weather providers including Reuters, AP, the *New York Times* and the Weather Channel
Photography	Organize, edit, view and share photos taken on your camera phone
Productivity and utilities	Create grocery lists, practise PowerPoint presentations, work on spreadsheets, synchronize with PC files and more
Social networking	Connect with others via major social networks including Facebook, Twitter and Instagram
Sports	Keep up with your favourite team or track your own golf scores
Travel and navigation	Use the GPS in your smartphone to get turn-by-turn directions, find interesting places to visit, access travel itineraries and more

Workgroup Application Software

workgroup application software Software that supports teamwork, whether team members are in the same location or dispersed around the world.

Workgroup application software is designed to support teamwork, whether team members are in the same location or dispersed around the world. This proved particularly useful during many countries "lockdown" response to the COVID-19 pandemic, when teams normally meeting in physical teams suddenly had to work remotely. 'Slack' is an example of a valuable cloud based work-flow and communication tool used by many businesses. This support can be accomplished with software known as *groupware* that helps groups of people work together effectively. Microsoft Exchange Server, for example, has groupware and email features.[60] Also called *collaborative software*, this approach allows a team of managers to work on the same production problem, letting them share their ideas and work via connected computer systems.

Examples of workgroup software include group-scheduling software, electronic mail and other software that enables people to share ideas. Lotus Notes and Domino are examples of workgroup software from IBM. Web-based software is ideal for group use. Because documents are stored on an Internet server, anyone with an Internet connection can access them easily. Google provides options in its online applications that allow users to share documents, spreadsheets, presentations, calendars and notes with other specified users or everyone on the web. This sharing makes it convenient for several people to contribute to a document without concern for software compatibility or storage. Google also provides a tool for creating web-based forms and surveys. When invited parties fill out the form, the data is stored in a Google spreadsheet.

Enterprise Application Software

Software that benefits an entire organization – enterprise application software – can also be developed specifically for the business or purchased off the shelf. The Copper Mountain Ski Resort in the USA used Visual One software from Agilysys to manage apartment blocks and other real estate holdings.[61] According to the information technology director, 'We need a dynamic software system that allows us to manage our rather complex condominium lodging model'. Accountancy firms have now acquired sophisticated tax software for their corporate clients.[62] According to a manager at the Citrin Cooper CPA firm in the USA, 'The number of available software programs has expanded in recent years. At the same time, more specialized software is available that focuses on individual industries'. Verafin has developed specialized software that helps banks find people and organizations that attempt to launder money.[63] The software works by looking for suspicious transactions or patterns in large databases of financial transactions.[64]

Enterprise software also helps managers and workers stay connected. Traditional email might not be the best approach.[65] According to the vice president of a large publishing company, 'If you have a really important message you need to get to people; email is where it goes to die. People need a sense of ambient awareness'. This type of awareness can come from enterprise software and group support systems, first introduced in Chapter 1. The following are some applications that can be addressed with enterprise software:

Accounts payable	Invoicing
Accounts receivable	Manufacturing control
Airline industry operations	Order entry
Automatic teller systems	Payroll
Cash-flow analysis	Receiving
Cheque processing	Restaurant management
Credit and charge card administration	Retail operations
Distribution control	Sales ordering
Fixed asset accounting	Savings and time deposits
General ledger	Shipping
Human resource management	Stock and bond management
Inventory control	Tax planning and preparation

According to a survey, cost is the greatest concern for selecting enterprise software.[66] Other factors include the difficulty of installing and managing enterprise software and the ability to integrate enterprise software with other software applications. Increasingly, enterprise application software is being found on smartphones and mobile devices. In one survey, over 80 per cent of respondents believe that having enterprise application software that can be used on smartphones and mobile devices was an important factor in selecting enterprise software.[67]

Application Software for Information, Decision Support and Competitive Advantage

Specialized application software for information, decision support and competitive advantage is available in every industry. For example, many schools and colleges use Blackboard or other learning management software to organize class materials and grades. Genetic researchers, as another example, are using software to visualize and analyze the human genome. Music executives use decision support software to help pick the next hit song. Companies seeking a competitive advantage, first discussed in Chapter 2, are increasingly building or developing their own enterprise software.[68] According to the CIO of the New York Stock Exchange Euronext, 'Building is not easy. If it were, everyone would do it and we'd get no edge'. But how are all these systems actually developed and built? The answer is through the use of programming languages, which is discussed next.

4.4 Programming Languages

Both system and application software are written in coding schemes called *programming languages*. The primary function of a programming language is to provide instructions to the computer system so that it can perform a processing activity. Information systems professionals work with **programming languages**, which are sets of keywords, symbols and rules for constructing statements that people can use to communicate instructions to a computer. Programming involves translating what a user wants to accomplish into a code that the computer can understand and execute. *Program code* is the set of instructions that signal the CPU to perform circuit-switching operations. In the simplest coding schemes, a line of code typically contains a single instruction such as, 'Retrieve the data in memory address X'. As discussed in Chapter 3, the instruction is then decoded during the instruction phase of the machine cycle. Like writing a report or a paper in English, writing a computer program in a programming language requires the programmer to follow a set of rules. Each programming language uses symbols, keywords and commands that have special meanings and usage. Each language also has its own set of rules, called the **syntax** of the language. The language syntax dictates how the symbols, keywords and commands should be combined into statements capable of conveying meaningful instructions to the CPU. Rules such as 'statements must terminate with a semicolon', and 'variable names must begin with a letter', are examples of a language's syntax. A variable is a quantity that can take on different values. Program variable names such as SALES, PAYRATE and TOTAL follow the syntax because they start with a letter, whereas variables such as %INTEREST, $TOTAL and #POUNDS do not.

programming languages Sets of keywords, commands, symbols and rules for constructing statements by which humans can communicate instructions to a computer.

syntax A set of rules associated with a programming language.

Ethical and Societal Issues

Adblockers: Salvation for Web Users Or a High-Tech Protection Racket?

One of the most annoying daily online experiences for many web users is dealing with pop-up adverts. Enter Adblockers, software that automatically removes them as the web pages load. Adblock Plus, AdFender and Popup Blocker Pro are popular examples, but their use is controversial.

Web users seem to get a lot for free. Google alone offers free web searches, free email, free online storage, free access to maps of all varieties and free office software. But it's not really free. In exchange for all of this, you are giving Google data about yourself – your interests, who your family and friends are, your habits, your location and more. Google uses this to offer targeted adverts. Other content providers, such as news agencies, do the same, albeit in a less targeted way – when you go onto their websites you see adverts, some of which might be relevant to you, some of which might not be.

As soon as web users start to block adverts, advertisers will stop paying websites to include their ads, and everything that once was free will no longer be. So adblockers might give you a cleaner and faster web experience, but they also undermine the economy of the web. A report from Page Fair and Adobe suggests that for businesses that depend on web advertising, adblockers could cost an estimated $18 billion in lost revenue each year.

Content providers are fighting back. Some block access to their website if they detect that adblocking is turned on. CityA.M., a free London-based business newspaper, has tried this and reports 'no perceivable drop in traffic' since it launched the strategy in October 2015. The BBC reports that other providers, like men's magazine *GQ*, have tried charging adblocker users for access, while another strategy followed by US business magazine *Forbes* is asking users to turn their blockers off in exchange for an 'ad-light' experience.

In the UK, the then culture secretary John Whittingdale went further, suggesting that adblocking is a modern day protection racket. What he was implying is that adblockers are offering to allow adverts through their blocks in exchange for payment in the same way that unfortunate companies had to pay the mafia to allow their supply trucks safe passage. 'Ten years ago, the music and film industries faced a threat to their very existence from online copyright infringement by illegal file-sharing or pirate sites', he said. In the current climate, adblocking potentially poses a 'similar threat'.

Most web users are familiar with online adverts and will happily accept them if they are unobtrusive and don't block the content they are consuming. So an advert in one corner that doesn't flash or cover up text would be tolerated. Perhaps this is the best way forward. It will surprise no one that Google is already on top of this. Adverts displayed on their search results appear at the top of the screen and are coloured differently to distinguish them from real results, but otherwise are simple text and seem to bother no one.

Questions

1. Write a bullet list of guidance for creating acceptable adverts.
2. Why might advertisers not like your list? How could you change it?
3. Should web users start to pay for more of the content and services they consume?
4. Is Whittingdale right that adblocking is a protection racket?

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4

The Evolution of Programming Languages

The desire for faster, more efficient, more powerful information processing has pushed the development of new programming languages. The evolution of programming languages is typically discussed in terms of generations of languages (see Table 4.7).

Table 4.7 Evolution of Programming Languages

Generation	Language	Approximate Development Date	Sample Statement or Action
First	Machine language	1940s	00010101
Second	Assembly language	1950s	MVC
Third	High-level language	1960s	READ SALES
Fourth	Query and database languages	1970s	PRINT EMPLOYEE NUMBER IF GROSS PAY > 1000
Fifth generation and beyond	Natural and intelligent languages	1980s	IF gross pay is greater than 40, THEN pay the employee overtime pay

Visual, Object-Oriented and Artificial Intelligence Languages

Today, programmers often use visual and object-oriented languages. In the future, they may be using artificial intelligence languages to a greater extent. In general, these languages are easier for nonprogrammers to use, compared with older generation languages.

Visual programming uses a graphical or 'visual' interface combined with text-based commands. Prior to visual programming, programmers were required to describe the windows, buttons, text boxes and menus that they were creating for an application by using only text-based programming language commands. With visual programming, the software engineer drags and drops graphical objects such as buttons and menus onto the application form. Then, using a programming language, the programmer defines the capabilities of those objects in a separate code window. Visual Basic was one of the first visual programming interfaces. Today, software engineers use Visual Basic.NET, Visual C++, Visual C# (# is pronounced 'sharp' as in music) and other visual programming tools.

Many people refer to visual programming interfaces such as Visual C# as 'visual programming languages'. This custom is fine for casual references, but a lesser-known category of programming language is more truly visual. With a true visual programming language, programmers create software by manipulating programming elements only graphically, without the use of any text-based programming language commands. Examples include Alice, Mindscript and Microsoft Visual Programming Language (VPL). Visual programming languages are ideal for teaching novices the basics about programming without requiring them to memorize programming language syntax.

Some programming languages separate data elements from the procedures or actions that will be performed on them, but another type of programming language ties them together into units called *objects*. An object consists of data and the actions that can be performed on the data. For example, an object could be data about an employee and all the operations (such as payroll calculations) that might be performed on the data. Programming languages that are based on objects are called *object-oriented programming languages*. C ++ and Java are popular general-purpose object-oriented programming languages.[69] Languages used for web development, such as Javascript and PHP, are also object oriented. In fact, most popular languages in use today take the object-oriented approach – and for good reason.

Using object-oriented programming languages is like constructing a building using prefabricated modules or parts. The object containing the data, instructions and procedures is a programming building block. The same objects (modules or parts) can be used repeatedly. One of the primary advantages of an object is that it contains reusable code. In other words, the instruction code within that object can be reused in different programs for a variety of applications, just as the same basic prefabricated door can be used in two different houses. An object can relate to data on a product, an input routine or an order-processing routine. An object can even direct a computer to execute other programs or to retrieve and manipulate data. So, a sorting routine developed for a payroll application could be used in both a billing program and an inventory control program. By reusing program code, programmers can write programs for specific application problems more quickly. By combining existing program objects with new ones, programmers can easily and efficiently develop new object-oriented programs to accomplish organizational goals.

Programming languages used to create artificial intelligence or expert systems applications are often called *fifth-generation languages* (*5GLs*). Fifth-generation languages are sometimes called *natural languages* because they use even more English-like syntax than 4GLs. They allow programmers to communicate with the computer by using normal sentences. For example, computers programmed in fifth-generation languages can understand queries such as ‘How many athletic shoes did our company sell last month?’

With third-generation and higher-level programming languages, each statement in the language translates into several instructions in machine language. A special software program called a **compiler** converts the programmer’s source code into the machine-language instructions, which consist of binary digits, as shown in Figure 4.4. A compiler creates a two-stage process for program execution. First, the compiler translates the program into a machine language; second, the CPU executes that program. Another approach is to use an *interpreter*, which is a language translator that carries out the operations called for by the source code. An interpreter does not produce a complete machine-language program. After the statement executes, the machine-language statement is discarded, the process continues for the next statement and so on.

compiler A special software program that converts the programmer’s source code into the machine-language instructions, which consist of binary digits.

The majority of software used today is created using an integrated development environment. An *integrated development environment*, or *IDE*, combines all the tools required for software engineering into one package. For example, the popular IDE Microsoft Visual Studio includes an editor that supports several visual programming interfaces and languages, a compiler and interpreter, programming automation tools, a debugger (a tool for finding errors in the code) and other tools that provide convenience to the developer.[70]

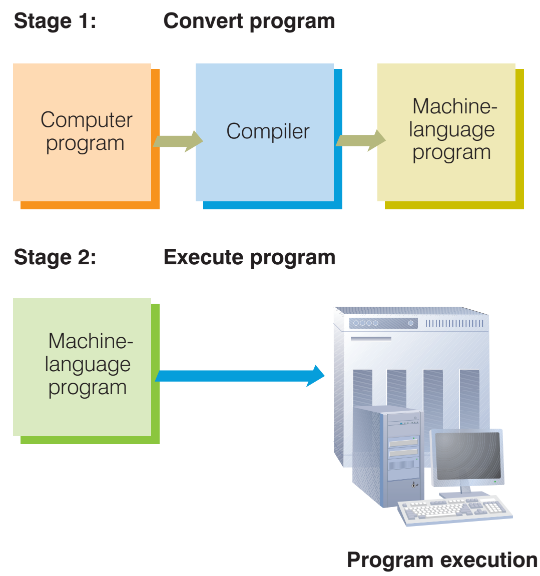

Figure 4.4 **How a Compiler Works** *A compiler translates a complete program into a complete set of binary instructions (Stage 1). After this is done, the CPU can execute the converted program in its entirety (Stage 2).*

Software Development Kits (SDKs) often serve the purpose of an IDE for a particular platform. For example, software developers for Google's Android smartphone platform use Java (an object-oriented programming language) along with the Eclipse SDK. They use special code libraries provided by Google for Android functionality, and they test out their applications in an Android Emulator.[71]

IDEs and SDKs have made software development easier than ever. Many novice coders and some who might have never considered developing software are publishing applications for popular platforms such as Facebook and the iPhone.

4.5 Software Issues and Trends

Because software is such an important part of today's computer systems, issues such as software bugs, licensing, upgrades, global software support and taxation have received increased attention. The governor of Colorado and the Colorado General Assembly, for example, repealed a tax on certain types of software.[72] The tax repeal should help Colorado's software industry. Software can also be harmful to companies and countries. Many tech companies now offer rewards to users who find software bugs. Facebook for example will pay at least 500 US dollars as a 'bug bounty' with this figure increasing depending on the severity of the error.[73]

Software Bugs

A software bug is a defect in a computer program that keeps it from performing as it is designed to perform.[74] Some software bugs are obvious and cause the program to terminate unexpectedly. Other bugs are subtler and allow errors to creep into your work. Computer and software vendors say that as long as people design and program hardware and software, bugs are inevitable.[75] The following list summarizes tips for reducing the impact of software bugs:

- Register all software so that you receive bug alerts, fixes and patches.
- Check the manual or read-me files for solutions to known problems.

- Access the support area of the manufacturer's website for patches.
- Install the latest software updates.
- Before reporting a bug, make sure that you can recreate the circumstances under which it occurs.
- After you can recreate the bug, call the manufacturer's tech support line.
- Consider waiting before buying the latest release of software, to give the vendor a chance to discover and remove bugs. Many schools and businesses don't purchase software until the first major revision with patches is released.

Copyrights and Licences

Most companies aggressively guard and protect the source code of their software from competitors, lawsuits and other predators.[76] As a result, most software products are protected by law using copyright or licensing provisions. Those provisions can vary, however. In some cases, you are given unlimited use of software on one or two computers. This stipulation is typical with many applications developed for personal computers. In other cases, you pay for your usage. If you use the software more, you pay more. This approach is becoming popular with software placed on networks or larger computers. Most of these protections prevent you from copying software and giving it to others. Some software now requires that you *register* or *activate* it before it can be fully used. This requirement is another way software companies prevent illegal distribution of their products.

When people purchase software, they don't actually own the software, but rather they are licensed to use the software on a computer. This is called a single-user licence. A **single-user licence** permits you to install the software on one or more computers, used by one person. A single-user licence does not allow you to copy and share the software with others. Table 4.8 describes different types of software licences. Licences that accommodate multiple users are usually provided at a discounted price.

single-user licence A software licence that permits you to install the software on one or more computers, used by one person.

Table 4.8 Software Licences

Licence	Description
Single-user licence	Permits you to install the software on one computer, or sometimes two computers, used by one person
Multiuser licence	Specifies the number of users allowed to use the software and can be installed on each user's computer. For example, a 20-user licence can be installed on 20 computers for 20 users
Concurrent-user licence	Designed for network-distributed software, this licence allows any number of users to use the software but only a specific number of users to use it at the same time
Site licence	Permits the software to be used anywhere on a particular site, such as a college campus, by everyone on the site

Freeware and Open-Source Software

Some software developers are not as interested in profiting from their intellectual property as others and have developed alternative copyrights and licensing agreements. *Freeware* is software that is made available to the public for free.[77] Software developers might give away their product for several reasons. Some want to build customer interest and name recognition. Others simply don't need the money and want to make a valuable donation to society. Still others, such as those associated with the Free Software Foundation (www.fsf.org), believe that all software should be free. Some freeware is placed in the public domain where anyone can use the software free of charge. (Creative works that reach the end of their term of copyright revert to the public domain.) Table 4.9 shows some examples of freeware.

Table 4.9 Examples of Freeware

Software	Description
Thunderbird	Email and newsgroup software
Pidgin	Instant messaging software
Adobe Reader	Software for viewing Adobe PDF documents
AVG Anti-Virus	Antivirus security software
WinPatrol	Antispyware software
IrfanView	Photo-editing software

Freeware differs slightly from free software. Freeware simply implies that the software is distributed for free. The term free software was coined by Richard Stallman and the Free Software Foundation and implies that the software is not only freeware, but it is also open source. **Open-source software** is distributed, typically for free, with the source code also available so that it can be studied, changed and improved by its users.[78] Open-source software evolves from the combined contribution of its users. The Code For America (CFA) organization, for example, used open-source software in Boston and other US cities to help cities and municipalities solve some of their traffic problems, such as locating fire hydrants that might be completely covered with snow in the winter.[79] CFA made its efforts free to other cities and municipalities. Table 4.10 provides examples of popular open-source software applications.

open-source software Software that is distributed, typically for free, with the source code also available so that it can be studied, changed and improved by its users.

Table 4.10 Examples of Open-Source Software

Software	Category
Linux	Operating system
LibreOffice	Application software
MySQL	Database software
Mozilla Firefox	Internet browser
Gimp	Photo editing
OpenProj	Project management
Grisbi	Personal accounting

Open-source software is not completely devoid of restrictions. Much of the popular free software in use today is protected by the GNU General Public Licence (GPL). The GPL grants you the right to do the following:

- Run the program for any purpose.
- Study how the program works and adapt it to your needs.
- Redistribute copies so you can help others.
- Improve the program and release improvements to the public.

Software under the GPL is typically protected by a 'copyleft' (a play on the word copyright), which requires that any copies of the work retain the same licence. A copyleft work cannot be owned by any one person, and no one is allowed to profit from its distribution. The Free Software Directory (directory.fsf.org) lists over 5,000 software titles in 22 categories licensed under the GPL.

Why would an organization run its business using software that's free? Can something that's given away over the Internet be stable, reliable or sufficiently supported to place at the core of a company's day-to-day operations? The answer is surprising – many believe that open-source software is often *more* reliable and secure than commercial software. How can this be? First, because a program's source code is readily available, users can fix any problems they discover. A fix is often available within hours of the problem's discovery. Second, because the source code for a program is accessible to thousands of people, the chances of a bug being discovered and fixed before it does any damage are much greater than with traditional software packages.

However, using open-source software does have some disadvantages. Although open-source systems can be obtained for next to nothing, the up-front costs are only a small piece of the total cost of ownership that accrues over the years that the system is in place. Some claim that open-source systems contain many hidden costs, particularly for user support or solving problems with the software. Licensed software comes with guarantees and support services, while open-source software does not. Still, many businesses appreciate the additional freedom that open-source software provides. The question of software support is the biggest stumbling block to the acceptance of open-source software at the corporate level. Getting support for traditional software packages is easy – you call a company's freephone support number or access its website. But how do you get help if an open-source package doesn't work as expected? Because the open-source community lives on the Internet, you look there for help. Through use of Internet discussion areas, you can communicate with others who use the same software, and you might even reach someone who helped develop it. Users of popular open-source packages can get correct answers to their technical questions within a few hours of asking for help on the appropriate Internet forum. Another approach is to contact one of the many companies emerging to support and service such software – for example, Red Hat for Linux and Sendmail, Inc., for Sendmail. These companies offer high-quality, for-pay technical assistance.

Software Upgrades

Software companies revise their programs periodically. Software upgrades vary widely in the benefits that they provide, and what some people call a benefit others might call a drawback. Deciding whether to upgrade to a new version of software can be a challenge for corporations and people with a large investment in software. Should the newest version be purchased when it is released? Some users do not always get the most current software upgrades or versions unless it includes significant improvements or capabilities. Developing an upgrading strategy is important for many businesses. American Express, for example, has standardized its software upgrade process around the world to make installing updated software faster and more efficient.[80] The standardized process also helps the company make sure that updated software is more stable with fewer errors and problems.

Global Software Support

Large global companies have little trouble persuading vendors to sell them software licences for even the most far-flung outposts of their company. But can those same vendors provide adequate support for their software customers in all locations? Supporting local operations is one of the biggest challenges IS teams face when putting together standardized companywide systems. Slower technology growth markets, such as Eastern Europe and Latin America, might not have any official vendor presence. Instead, large vendors such as Sybase, IBM and Hewlett-Packard typically contract with local providers to support their software.

One approach that has been gaining acceptance in North America is to outsource global support to one or more third-party distributors. The user company can still negotiate its licence with the software vendor directly, but it then hands the global support contract to a third-party supplier. The supplier acts as a intermediary between software vendor and user, often providing distribution, support and invoicing.

In today's computer systems, software is an increasingly critical component. Whatever approach people and organizations take to acquire software, everyone must be aware of the current trends in the industry. Informed users are wise consumers.

Summary

Systems and application software are critical in helping individuals and organizations achieve their goals. Software consists of programs that control the workings of the computer hardware. The two main categories of software are systems software and application software. Systems software is a collection of programs that interacts between hardware and application software and includes operating systems, utility programs and middleware. Application software can be proprietary or off the shelf and enables people to solve problems and perform specific tasks.

An operating system (OS) is a set of computer programs that controls the computer hardware to support users' computing needs. An OS converts an instruction from an application into a set of instructions needed by the hardware. This intermediary role allows hardware independence. An OS also manages memory, which involves controlling storage access and use by converting logical requests into physical locations and by placing data in the best storage space, including virtual memory.

An OS manages tasks to allocate computer resources through multitasking and time sharing. With multitasking, users can run more than one application at a time. Time sharing allows more than one person to use a computer system at the same time.

The ability of a computer to handle an increasing number of concurrent users smoothly is called *scalability*, a feature critical for systems expected to handle a large number of users.

An OS also provides a user interface, which allows users to access and command the computer. A command-based user interface requires text commands to send instructions. A graphical user interface (GUI), such as Windows, uses icons and menus. Other user interfaces include touch and speech.

Software applications use the OS by requesting services through a defined application program

interface (API). Programmers can use APIs to create application software without having to understand the inner workings of the OS. APIs also provide a degree of hardware independence so that the underlying hardware can change without necessarily requiring a rewrite of the software applications.

Over the years, many popular OSs have been developed, including Microsoft Windows, the Mac OS X and Linux. There are several options for OSs in the enterprise as well, depending on the type of server. UNIX is a powerful OS that can be used on many computer system types and platforms, from workstations to mainframe systems. Linux is the kernel of an OS whose source code is freely available to everyone. Some OSs, such as Mac OS X iPhone, Windows Embedded, Symbian, Android, webOS and variations of Linux, have been developed to support mobile communications and consumer appliances. When an OS is stored in solid state memory, embedded in a device, it is referred to as an embedded operating system or an embedded system for short.

Utility programs can perform many useful tasks and often come installed on computers along with the OS. This software is used to merge and sort sets of data, keep track of computer jobs being run, compress files of data, protect against harmful computer viruses, monitor hardware and network performance, and perform dozens of other important tasks. Virtualization software simulates a computer's hardware architecture in software so that computer systems can run OSs and software designed for other architectures or run several OSs simultaneously on one system. Middleware is software that allows different systems to communicate and transfer data back and forth.

Organizations use off-the-shelf application software for common business needs and proprietary application software to meet unique business needs and provide a competitive advantage. Application software applies the power of the computer to solve problems and perform specific tasks. One useful way of classifying the many potential uses of information systems is to identify the scope of problems and opportunities addressed by a particular organization or its sphere of influence. For most companies, the spheres of influence are personal, workgroup and enterprise.

User software, or personal productivity software, includes general-purpose programs that enable users to improve their personal effectiveness, increasing the quality and amount of work that can be done. Software that helps groups work together is often called workgroup application software. It includes group scheduling software, electronic mail and other software that enables people to share ideas. Enterprise software that benefits the entire organization, called enterprise resource planning software, is a set of integrated programs that help manage a company's vital business operations for an entire multisite, global organization.

Three approaches to acquiring application software are to build proprietary application software, buy existing programs off the shelf, or use a combination of customized and off-the-shelf application software. Building proprietary software (in-house or on contract) has the following advantages. The organization gets software that more closely matches its needs. Further, by being involved with the development, the organization has further control over the results. Finally, the organization has more flexibility in making changes. The disadvantages include the following. It is likely to take longer and cost more to develop. Additionally, the in-house staff will be hard pressed to provide ongoing support and maintenance. Last, there is a greater risk that the software features will not work as expected or that other performance problems will occur.

Some organizations have taken a third approach – customizing software packages. This approach usually involves a mixture of the preceding advantages and disadvantages and must be carefully managed.

An application service provider (ASP) is a company that provides the software, support and computer hardware on which to run the software from the user's facilities over a network. ASPs customize off-the-shelf software on contract and speed deployment of new applications while helping IS managers avoid implementation headaches. ASPs reduce the need for many skilled IS staff members and also lower a project's start-up expenses. Software as a Service (SaaS) allows businesses to subscribe to web-delivered business application software by paying a monthly service charge or a per-use fee.

SaaS and recent web development technologies have led to a paradigm in computing called cloud computing. Cloud computing refers to the use of computing resources, including software and data storage, on the Internet (the cloud), not on local computers. Rather than installing, storing and running software on your own computer, with cloud computing you access software stored on and delivered from a web server.

Although hundreds of computer applications can help people at school, home and work, the most popular applications are word-processing, spreadsheet analysis, database, graphics and personal information management. A software suite, such as SmartSuite, WordPerfect, StarOffice or Microsoft Office, offers a collection of these powerful programs sold as a bundle.

Many thousands of applications are designed for businesses and workgroups. Business software generally falls under the heading of information systems that support common business activities, such as accounts receivable, accounts payable, inventory control and other management activities.

Organizations should choose programming languages with functional characteristics that are appropriate for the task at hand and well suited to the skills and experience of the programming staff. All software programs are written in coding schemes called *programming languages*, which provide instructions to a computer to perform some processing activity. The several classes of programming languages include machine, assembly, high-level, query and database, object-oriented and visual programming.

Programming languages have changed since their initial development in the early 1950s. In the first generation, computers were programmed in machine language and, in the second, assembly languages were used. The third generation consists of many high-level programming languages that use English-like statements and commands. They must be converted to machine language by special software called a compiler. Fourth-generation languages include database and query languages such as SQL.

Fifth-generation programming languages combine rules-based code generation, component management, visual programming techniques, reuse management and other advances. Object-oriented programming languages use groups of related data, instructions and procedures called *objects* which serve as reusable modules in various programs. These languages can reduce program development and testing time. Java can be used to develop applications on the Internet. Visual programming environments, integrated development environments (IDEs) and software development kits (SDKs) have simplified and streamlined the coding process and made it easier for more people to develop software.

The software industry continues to undergo constant change; users need to be aware of recent trends and issues to be effective in their business and personal life. Software bugs, software licensing and copyrighting, open-source software, shareware and freeware, multiorganizational software development, software upgrades and global software support are all important software issues and trends.

A software bug is a defect in a computer program that keeps it from performing in the manner intended. Software bugs are common, even in key pieces of business software.

Freeware is software that is made available to the public for free. Open-source software is freeware that also has its source code available so that others may modify it. Open-source software development and maintenance is a collaborative process, with developers around the world using the Internet to download the software, communicate about it and submit new versions of it.

Software upgrades are an important source of increased revenue for software manufacturers and can provide useful new functionality and improved quality for software users.

Global software support is an important consideration for large global companies putting together standardized companywide systems. A common solution is outsourcing global support to one or more third-party software distributors.

Self-Assessment Test

1. Software can broadly be separated into __________ and __________ software.
2. Linux was developed in 1991 by __________.
3. The PC operating system by Google is called __________.
4. An operating system designed for a device such as a smartphone is often known as __________.
5. One-of-a-kind software developed for a specific business application is called __________.

6 Providing application software via a web browser is known as __________.

7 PowerPoint is an example of __________ software.

8 A __________ converts source code into machine-language instructions.

9 __________ is available for free and with its source code which can be modified.

10 MySQL is an example of __________.

Review Questions

1 Give four examples of application software.

2 List four tasks performed by operating software.

3 Name an embedded operating system, a PC operating system and a workgroup operating system.

4 What are the advantages of off-the-shelf software?

5 Name two visual programming languages.

6 Define syntax with examples.

7 How can you fix a software bug?

8 Describe the GPL software licence.

9 What are the advantages of software upgrades? Are there any disadvantages?

10 What is the difference between freeware and open-source software?

Discussion Questions

1 Why might open-source software be better quality than proprietary software?

2 Would being able to program a computer be a useful skill for you to have? What are you going to do about it?

Web Exercises

1 Search for information about the world's first computer programmer. Write a short report on what the person you identify achieved.

2 Search for alternatives to the spreadsheet package Excel. What are the pros and cons of each?

Case One

Software Cuts Legal Costs

Startup companies face many challenges. These include finding and paying for employees, finding and renting property and machinery, reaching customers, providing quality after sales services and many others. Some of these require costly legal services to write employment contracts, check rental agreements and patent products. Digital marketer, Josh Steimle, says, 'I used to harbour less than positive feelings about attorneys – until I needed to hire one. Now I have a huge amount of respect for the attorneys I work with. They provide services that are valuable to my business. I'm less enamoured, however, with government regulations that force me into a position of requiring so many of their services'. These regulations cover becoming incorporated, drafting employment contracts and registering trademarks, legal services that become very costly very quickly.

Anything that reduces these costs would be welcomed by business owners. Dragon Law is providing software to lower these costs. Based in Hong Kong where regulation is tight, its app guides clients through the process of creating their own legal documents. 'When I signed up to create an employment contract for a new hire, the software asked me questions, and once I answered them it presented me with a completed document, ready for electronic signature by myself and my new team member', says Mr Steimle. The documents can even be signed online through a tablet device.

'I have worked as a lawyer in a global law firm. I have seen how legal services can be inefficient and overpriced', says Ryanne Lai, Dragon Law's business and product director. The company was started by Daniel Walker and Jake Fisch when they saw that businesses were spending money solving problems such as customers not paying and business partners agreements that would never have arisen if proper contracts had been put in place. Mr Walker said, 'We asked businesses why they weren't doing this. The reason was clear: they had no time, no money, and no clue how to start. In fact this was hardly surprising. At a minimum – to help in this way, a lawyer would need to review the proposed terms, draft the contract, and spend time giving advice. So our next question was "How could we 'unbundle' this process?" Why couldn't technology provide a business with the expertise it needs to solve routine legal tasks. What if lawyers only gave advice? This would take the mystery out of legal services, and give business owners the know-how and confidence to make business decisions that would protect and save significant time and money'.

The app they came up with has different levels of service. The first simply gives startup firms a template from an online library of legal documents. Next, it offers more interactive help by providing access to a team of lawyers for email and telephone support on an ad hoc basis. Last, help is provided to firms with larger document requirements. If that isn't enough, Dragon Law offers referrals to Hong Kong law firms. For those on the first level, Dragon Law's 'DoubleCheck' allows clients to have a lawyer review documents if they're unsure about the final product or have any questions. Prices can be as cheap as €20.

Questions

1. What concerns might clients have when using this service? How could Dragon Law handle these?
2. Are there any other services that could be provided to businesses in a similar way?
3. Is Dragon Law a positive advance for the legal profession?
4. What are the essential features of a signature? How could these best be captured online in your opinion? Does someone really have to drag their finger across a tablet computer?

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Case Two

Ready. Steady. Go!

On 16 March 2016, world Go champion Lee Sedol was beaten four to one by Google's artificial intelligence program AlphaGo, a feat many AI experts felt was more than ten years away. More complex than chess, Go is a two player Chinese board game played with white and black stones where the goal is to surround more board territory than the opponent. There are 10 to the power of 170 board configurations. That's more than the number of atoms in the universe.

Developed by London-based, Google-owned, company DeepMind, AlphaGo was not taught how to play Go – in fact it taught itself how to play. AlphaGo's algorithm is a general purpose problem solver that uses a technique known as deep-learning to interpret the game's patterns. DeepMind's co-founder, Demis Hassabis, says the same approach could be used on many real world problems. These include making medical diagnoses and improving climate change models.

Richard Sutton, a computer scientist who studies learning says, 'Understanding the mind is an incredibly difficult problem, but games allow you to break it down into parts that you can study', which is why the team behind AlphaGo started with a game.

AlphaGo is inspired by the design of a human brain and 'thinks' by sending signals through a vast network of simulated neurons. Learning involves adjusting the strength of the signals so that they affect different parts of the 'brain' differently. These neurons are organized into several hierarchical layers. The first layer will notice some high level aspect such as identifying the position of the pieces on a board. The next may start to figure out the different moves that players can make. The next might distinguish between winning moves and others. Using only the screen's pixels and game outcome as input, the algorithm learns by trial and error which moves to take at any given time to bring the greatest rewards. To get better, AlphaGo plays itself over and over again.

Google decided to try deep-learning in the speech recognition system in its Android smartphone operating system. Afterwards, it achieved a 25 per cent reduction in word errors. 'That's the kind of drop you expect to take ten years to achieve', says computer scientist, Geoffrey Hinton, which gives you an idea of how difficult a problem this is. 'That's like ten breakthroughs all together.'

After the March tournament, Lee Sedol was said to look ten years older. In a sombre mood he said, 'I apologize for being unable to satisfy a lot of people's expectations. I kind of felt powerless.'

Questions

1. Why are games a good test bed for AI?
2. Why is it so difficult to imitate human intelligence? (Hint: try to define human intelligence first.)
3. What business applications could deep-learning be used for?
4. Should Lee Sedol keep playing Go?

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Case Three

Software Error Dooms Spacecraft

The ASTRO-H spacecraft was the sixth in a series of X-ray astronomy satellites (this means that they study objects by detecting and measuring the high-energy electromagnetic radiation that the objects emit), designed and launched by the Japan Aerospace Exploration Agency (JAXA). ASTRO-H (which was renamed Hitomi just before launch) was expected to make major contributions to our knowledge of the structure and evolution of the Universe and the distribution of dark matter in galaxy clusters. Despite being constructed by a major international collaboration led by JAXA with over 70 contributing institutions in Japan, the USA, Canada and Europe, all did not go according to plan.

The satellite launched successfully on 17 February 2016, but JAXA lost contact with it one month later as they were running through initial checks and calibrations. As they tried desperately to re-establish control, the US Joint Space Operations Center, which tracks space debris, reported seeing five objects in the vicinity of the spacecraft which they characterized as pieces of a 'break-up'. The satellite was in pieces. A month later, JAXA declared the €250 million spacecraft lost. At least ten pieces had broken off its main body.

The problems started when Hitomi passed through the belts of radiation that envelop the Earth. These interfere with the 'star tracker' system, one of the ways Hitomi keeps itself oriented in space. At 3 am Japanese time on 26 March, the spacecraft began a preprogrammed manoeuvre to swivel from looking at the Crab Nebula to the galaxy Markarian 205. With star tracker out of action because of the radiation, it relied on a secondary system, a set of gyroscopes, to calculate which way it was facing. However, a software error caused the gyroscopes to report that the spacecraft was rotating at a rate of about 20 degrees per hour, when in fact it was not. Hitomi began to compensate, turning tiny motors known as reaction wheels to counteract the supposed rotation. A system designed to prevent the reaction wheels from running out of control was not operational (because it needed to know which way it was pointing in order for it to work) and therefore failed to slow the reaction wheels. The troubles didn't end there. The spacecraft automatically switched into safe mode and fired its thrusters to try to stop the rotation, but the command to fire thrusters had been uploaded without proper testing and the engines only caused the spacecraft to accelerate further.

The incident caused three JAXA executive employees to voluntarily take a 10 per cent pay cut to their salary for four months.

The mission did get to make one crucial observation before the accident. As *Nature* magazine explained, 'About eight days after launch, Hitomi turned its X-ray gaze on the Perseus cluster, about 250 million light years from Earth. By measuring the speed of gas flowing from the cluster, Hitomi can reveal how the mass of galaxy clusters changes over time as stars are born and die – a test of the crucial cosmological parameter known as dark energy'. Richard Mushotzky, an astronomer at the University of Maryland in College Park, said, 'We had three days. We'd hoped for ten years.'

Questions

1. How could an untested command be sent to a €250m spacecraft?
2. How could the command have been tested?
3. How would you ensure this could never happen again?
4. What can businesses learn from this failure?

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05

Organizing and Storing Data

Principles	Learning Objectives
Data management and modelling 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 the relational database model and outline its basic features.
A well-designed and well-managed database is central to almost all information systems and is an extremely valuable tool in supporting decision making.	■ Identify the common functions performed by all database management systems and identify popular user database management systems.
The number and type of database applications will continue to evolve and yield real business benefits.	■ Identify and briefly discuss current database applications.

Why Learn About Organizing Data?

Having had an overview of IS in organizations and examined different types of hardware and software, we now turn to look at using that hardware and software to store and process data. Databases are the heart of almost all IS. A huge amount of data is entered into computer systems every day. In this chapter, you will learn about database management systems and how they can help you. 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 work in business law, 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 to analyze the impact of payrises, employee benefits and retirement contributions on long-term costs to your company. Using database management systems 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.

5.1 Data Management and Data Modelling

At the centre of almost every information system is a database, used to store data so that it can be processed to provide useful information. A database is used by almost every firm to record a history of that firm's transactions. This historical data can be hugely useful in uncovering patterns and relationships the firm had never even considered before, a practice known as 'data mining', something that is explained later in this chapter. The most common type of database is a relational database, so-named because the basic structure for storing data is a table, and the word relation is another name for a table. A **relational database** is defined as a series of related tables, stored together with a minimum of duplication to achieve a consistent and controlled pool of data.

relational database A series of related tables, stored together with a minimum of duplication to achieve consistent and controlled pool of data.

So a relational database is made up of a number of tables. In loose terms, each table stores the data about someone or something of interest to the firm. This someone or something is known as an **entity**. (We will see later that sometimes the data about one entity is stored in two or more tables, and sometimes the data about two or more entities are stored in one table.) For example, a small business selling office furniture might have a customer table to store all the data about their customers, a supplier table to store information about suppliers and an order table that records all the orders that are placed by its customers. In this example, there are three entities – customer, order and supplier.

entity A person, place or thing about whom or about which an organization wants to store data.

The rows in a table collect together all the data about one specific entity. For example, in the customer table, each row stores all the data about one particular customer – Jane Smith, for instance, or Desmond Paton. These rows are known as **records**. The columns in a table are the specific items of data that get stored; for example, first name, surname or telephone number. These columns are known as **fields** or attributes.

records A row in a table; all the data pertaining to one instance of an entity.

fields A characteristic or attribute of an entity that is stored in the database.

So a database is made up of tables, which are made up of records, which are made up of fields. This is illustrated in Figure 5.1 using the customer table example. Notice that in the Figure each customer has been given a unique customer number. This is because, as can be seen, there are two customers called Jane Wilson. Both work for the same company and therefore have the same address and phone number.

The database needs some way of differentiating between them, and that is the job of the customer number, which is the **primary key**. Every table should have a primary key field used to identify individual records, and also to create relationships between tables, something we will examine next.

primary key A field in a table that is unique – each record in that table has a different value in the primary key field. The primary key is used to uniquely identify each record and to create relationships between tables.

Customer_Number	First_Name	Surname	Address1	Address2
10	Jane	Wilson	London Road	Oxford
11	John	Smith	Quai d'Orsay	Paris
12	Jane	Wilson	London Road	Oxford
13	Desmond	Paton	Marshall Street	Johannesburg
14	Susan	Haynes	Baker Street	London

Figure 5.1 The Customer Table for an Office Furniture Seller

The advantages and disadvantages of using a relational database to store data are listed in Table 5.1.

Table 5.1 Advantages and Disadvantages of the Database Approach

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 resource
Reduced data redundancy	Data is organized by the database management system (DBMS) and stored in only one location. This results in 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 kept in separate files. This is prevented with the database approach because no separate files contain copies of the same piece of data
Easier modification and updating	The DBMS coordinates updates and data modifications. 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 stored in only one location in most cases
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

(continued)

Table 5.1 *Continued*

Advantages	Explanation
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 needs to address only the DBMS, not the actual data files, reducing application development time
Better overall 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
Disadvantages	**Explanation**
More complexity	DBMS 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	DBMS can be more expensive to purchase and operate. 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

Relationships Between Tables

Consider the customer table (Figure 5.1) and the order table (Figure 5.2) in the office furniture seller's database. It should be obvious that there is a relationship between these two – the firm needs to know which orders have been placed by which customer, otherwise they wouldn't know where to ship the goods or who to charge for them. How this relationship is created in a database is shown in Figure 5.2, which shows the order table. The fourth record in the table is an order for a computer desk. The first field in the table, Order_Number, is the order table's primary key. Then there are details of what the order is, description, price and colour. The last field on the right-hand side is the Customer_Number. This creates the relationship between an order and a customer – customer 13 has ordered the computer desk. To find out who customer 13 is, look back at Figure 5.1, find 13 in the Customer_Number field, and we see it is Desmond Paton. We also find the delivery address – the desk is being shipped to South Africa. The customer number in the order table is known as a **foreign key**. An important concept when setting up relationships is 'referential integrity'. What this means is that you cannot have an instance of a foreign key before it exists as an instance of a primary key. Using the office furniture database as an example, if the database has enforced referential integrity (which it should), it means you can't have an order for Customer_Number 15 unless there actually is a customer with Customer_Number 15 in the customer table.

foreign key When a primary key is posted into another table to create a relationship between the two, it is known as a foreign key.

This is an extremely convenient and useful way of organizing data (refer back to Table 5.1). It means, in this case, that the delivery address doesn't have to be stored twice – once with the order and again with the customer details. Storing the same information twice is very bad practice and leads to all sorts of problems. If a customer moves and one address is updated but the other is not, then the firm has useless data – it is not known which address is the correct one. A large part of organizing data involves deciding which fields are going to be primary keys and identifying where the foreign keys should be. A process for making that decision is described next.

Order_Number	Description	Price	Colour	Customer_ Number
100	Swivel chair	€89	Black	10
101	Coat rack	€15	Silver	10
102	White board	€23	White	11
103	Computer desk	€150	Brown	13
104	Filing cabinet	€50	Grey	10

Figure 5.2 The Order Table for an Office Furniture Seller

Designing Relational Databases

This section describes an approach to designing a relational database. A database design is also known as a data model or a database schema. It is a list of all the tables in the database, along with all the fields, with any primary and foreign keys identified. The approach has four stages:

1 Identify all entities.
2 Identify all relationships between entities.
3 Identify all attributes.
4 Resolve all relationships.

If you are trying this approach out for yourself, you are unlikely to get the perfect data model first time. The approach is iterative; that is, you do all four stages once, and examine the resulting schema. If it doesn't work perfectly, go back to stage one and adjust your list of entities, then go through the rest of the stages again. Do this over and over again until, eventually, a good data model emerges.

Identify Entities

The first step is to identify all the entities you want to store data about. This is usually done by interviewing the firm's managers and staff. If there are too many of them to interview, sometimes database designers will use a questionnaire to get opinions from as many people as possible. If you are designing a database for a student project, you will probably think that this first step is the easy bit, but in fact getting the right list of entities is vital if your data model is to be useful, and it is often not a trivial task, specifically because you have to interview different people and each might give you a different list! (This problem is examined more closely in a later chapter on system development.)

Identify Relationships

You next need to identify any relationships that exist between entities. The sort of relationships that you have to identify are relationships that the firm wants to store information about. For example, there might be a relationship between customers and suppliers – some of them might play golf together. However, this is unlikely to be the sort of thing the firm will want to store. The relationship between customers and orders is definitely something that the firm will want to store, so that they can see which customers have placed which orders. Like identifying entities, identifying relationships between them is not trivial and may take several attempts to get right.

Once you identify a relationship, there are three things you need to document about it: its degree, cardinality and optionality.

degree The number of entities involved in a relationship.

The **degree** of a relationship is simply how many entities are involved, and this figure is often two. When the degree is two, it is known as a 'binary relationship'.

cardinality In a relationship, cardinality is the number of one entity that can be related to another entity.

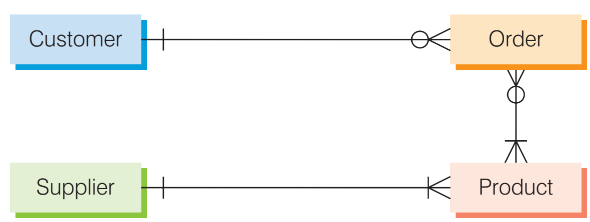
The **cardinality** of a relationship is whether each entity in the relationship is related to one or more than one of the other entities. For example, going back to the customer–order relationship, each order is placed by just one customer, but each customer can place many orders. Hence the cardinality in this case is one to many (1 : *M*). Cardinality for a binary relationship can be one to one (1 : 1), one to many (1 : *M*) or many to many (*M* : *M*).

optionality If a binary relationship is optional for an entity, that entity doesn't have to be related to the other.

Last, the **optionality** documents whether the relationship must exist for each entity or whether it is optional. For instance, an order must be placed by a customer – there is no option. An order can't exist unless a customer has placed it! However, a customer can be in the database even though they have no current orders, so the relationship is optional for the customer.

All of the above are documented in an entity–relationship diagram, shown in Figure 5.3.

Figure 5.3 **Entity–Relationship Diagram (E–RD) with Notation Explained**



The crow's foot notation means 'many', so a supplier supplies many products, but each product is supplied by only one supplier.

The 0 and | represent optionality – a 0 means the relationship is optional so a customer doesn't have to have an order. A | means not-optional (or 'obligatory') so an order has to have one (and only one) customer.

It is important to note that the database designer doesn't get to make up the degree, cardinality and optionality herself. These are dictated to her by what are known as the **enterprise rules**, which the designer must uncover by, usually, interviewing staff. An example of the enterprise rules describing the customer–order relationship is as follows:

enterprise rules The rules governing relationships between entities.

- Each order must be placed by one and only one customer.
- Each customer can place many orders, but some won't have placed any orders.

Enterprise rules are specific to the firm. For example, consider the relationship between employee and car, which a firm wants to store so it can manage its parking spaces. One employee can own as many cars as he can afford, so does that mean this relationship is one to many? Not necessarily. If the firm has decided that it is only going to store information on one car for each of its employees, then the relationship is one to one regardless of how many cars each actually owns. The relationship will probably be optional on one side because not every employee will own a car, but every car in the database will be owned by an employee.

Identify Attributes

The third stage is to identify all the attributes that are going to be stored for each entity. An attribute should be the smallest sensible piece of data that is to be stored. For example, customer name is probably a bad attribute – customer first name and surname would be better (some databases also include title and initial as separate attributes). Why is this? It is so that first name and surname can be accessed separately. For example, if you wanted to start a letter to a customer, 'Dear John', you would be unable to do this if you had stored the name as 'John Smith'. In this case, the letter would have to read 'Dear John Smith'. As before, attributes can be identified by interviewing staff.

Resolve Relationships

The customer–order relationship was implemented by taking the primary key of customer and posting it as a foreign key in the order table. This is essentially what resolving a relationship means – deciding how to implement it. Sometimes a relationship between two entities will result in three tables being implemented, sometimes one, most often two. There is a series of rules to decide what tables to implement and which primary keys to use as a foreign key.

First, let us examine the customer–order relationship more closely to see why we implemented it the way we did. If we had taken the order table primary key (order number) and posted it as a foreign key in the customer table, we would have had two problems, both illustrated in Figure 5.4. First, we have a repeating group – that means we would be trying to squeeze more than one piece of information into one cell in the database, in this case the fact that customer 10 has three orders. We also have a null (blank space) because customers 12 and 14 haven't placed any orders. Posting the customer number into the order table (look back at Figure 5.2) solves both those problems. Basically, the null isn't too big a problem, but a relational database cannot cope with a repeating group. Trying to implement the relationship by posting the order number into the customer table simply won't work.

Customer_Number	First_Name	Surname	Address1	Address2	Order_Number
10	Jane	Wilson	London Road	Oxford	100,101,104
11	John	Smith	Quai d'Orsay	Paris	102
12	Jane	Wilson	London Road	Oxford	
13	Desmond	Paton	Marshall Street	Johannesburg	103
14	Susan	Haynes	Baker Street	London	

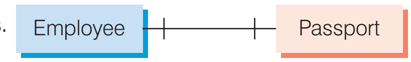
Figure 5.4 Posting Order Number into Customer Table for an Office Furniture Seller

A full discussion of resolving relationships is beyond the scope of this book. However, there only are six types of binary relationship. Figure 5.5 gives one example of each and explains how to implement each one. Note that the figure illustrates the most 'elegant' way to resolve each relationship, not necessarily the most efficient in terms of access time. A company with a lot of data would implement its database for speed rather than elegance. (What this means in practice is that its database might have some nulls in the foreign keys or store some information twice.)

What you should end up with after you resolve each relationship is a list of tables along with all primary and foreign keys identified, such as that shown in Figure 5.6. This could then be implemented using a DBMS.

Figure 5.5 **The Six Types of Binary Relationship**

1. One-to-one relationship, obligatory on both sides.

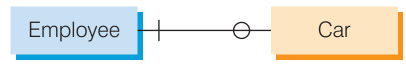


   Employee – Passport

   Each employee must have one and only one passport; each passport must have one and only one employee.

   To resolve this relationship, combine both entities into one table.

2. One-to-one relationship, optional on one side.

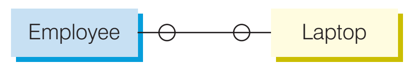


   Employee – Company car

   Each employee might have one and only one company car; each company car is owned by one and only one employee.

   To resolve this relationship, take the primary key from employee and post it as a foreign key in company car.

3. One-to-one relationship, optional on both sides.

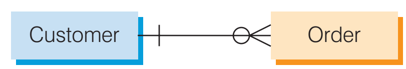


   Employee – Laptop

   Each employee might have one laptop; each laptop might belong to one employee (but some are for general use and therefore won't belong to anyone).

   To resolve this relationship, implement three tables – an employee table, a laptop table and a new table that we will call 'owns'. The owns table only has two fields – employee number and laptop number. The primary key of owns is a 'composite key', i.e. it is the employee number and laptop number combined, and each combination of the two is unique.

4. One-to-many relationship, many side obligatory to one side.

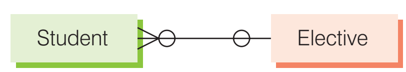


   Customer – Order

   A customer can place many orders but might have placed no orders; each order must be placed by one and only one employee.

   Resolve this relationship by taking the primary key from customer and posting it as a foreign key in order.

5. One-to-many relationship, many side optional to one side.



   Student – Elective module

   A student might take one elective module; each module is taken by many students (i.e. the students don't have to take an elective module).

   Most companies would implement this in the same way as for Relationship 4 above. However, the way to avoid nulls in the foreign key is to implement three tables – one for student, one for elective module and one that we'll call 'studies' (as a student studies a module). The studies table has just two fields – student number and module number. The primary key of the studies table is student number (or you could implement a composite key).

6. Many-to-many relationship.

   Student – Tutor

   Each tutor teaches many students; each student is taught by many tutors.

   To resolve this relationship, implement three tables – one for student, one for tutor, and a third we'll call 'teaches'. The teaches table has two fields – student number and tutor number, and its primary key is a composite key, i.e. a combination of student number and tutor number.

Figure 5.6 **A Database Design (Also Known as a Data Model or a Database Schema)** *Primary keys are identified with a # symbol, foreign keys are underlined.*

Customer{Customer_Number#, FirstName, Surname, Telephone}

Order{Order_Number#, Description, Price, Colour, <u>Customer_Number</u>}

Supplier{Supplier_Number#, Company_Name, Contact_FirstName, Contact_Surname, Telephone}

5.2 Database Management Systems

How do we actually create, implement, use and update a database? The answer is found in the DBMS. A DBMS is a group of programs used as an interface between a database and application programs or between a database and the user. The capabilities and types of database systems vary, however, but generally they provide the following.

Creating and Modifying the Database

Schemas or designs 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. Structured Query Language (SQL) is a DDL. Figure 5.7 shows four SQL statements to create a database called Lettings, a table called Landlords and insert a record about John Smith.

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

5

```
CREATE DATABASE Lettings;

USE Lettings;

CREATE TABLE landlords(
Firstname CHAR(10),
Surname CHAR(10),
Telephone CHAR(10));

INSERT INTO landlords(
'John', 'Smith', '123456');
```

Figure 5.7 SQL as a DDL *SQL code is being used to create a database called 'Lettings' with a table called 'Landlords' which has three fields: 'Firstname', 'Surname' and 'Telephone'. The code then enters one landlord called John Smith into the table.*

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 describes all the fields in the database, their range of accepted values, the type of data (such as alphanumeric or numeric), the amount of storage space needed for each and a note of who can access each and who updates each. Figure 5.8 shows a typical data dictionary entry.

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

Attribute	Data Type	Primary Key?	Required?
Customer_Number	Text	Y	Y
First_Name	Text	N	Y
Surname	Text	N	Y
Date_of_Birth	Date	N	N

Figure 5.8 A Typical Data Dictionary Entry for the Customer Table for an Office Furniture Seller

A data dictionary helps achieve the advantages of the database approach in these ways:

- *Reduced data redundancy.* By providing standard definitions of all data, it is less likely that the same data item will be stored in different places under different names.

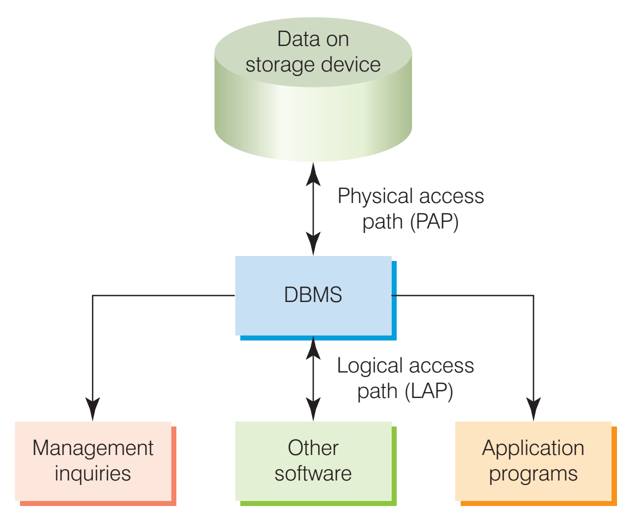
For example, a data dictionary reduces the likelihood that the same part number would be stored as two different items, such as PT_NO and PARTNO.

- *Increased data reliability.* A data dictionary and the database approach reduce the chance that data will be destroyed or lost. In addition, it is more difficult for unauthorized people to gain access to sensitive data and information.
- *Assists program development.* With a data dictionary, programmers know what data is stored and what data type each field is. This information is valuable when writing programs that make use of the data.
- *Easier modification of data and information.* The data dictionary and the database approach make modifications to data easier because users do not need to know where the data is stored. The person making the change indicates the new value of the variable or item, such as part number, that is to be changed. The database system locates the data and makes the necessary change.

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 that data through the DBMS. Suppose that to calculate the total price of a new car, a car dealer pricing program needs price data on the engine option – six cylinders instead of the standard four cylinders. The application program thus 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 disc 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 disc drive to retrieve the price data for six-cylinder engines. This relationship is shown in Figure 5.9.

Figure 5.9 Logical and Physical Access Paths



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 EUROS. This is the logical access path (LAP). Then, the DBMS might go to the options price section of a disc to get the information for the user. This is the physical access path (PAP).

Two or more people or programs attempting to access the same record in the same database 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 more inventory was just received. Without proper database control, one of the inventory updates might not be correctly made, 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.

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

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. Some databases use Query-by-Example (QBE), which is a visual approach to developing database queries or requests.

Alternatively, SQL can be used to query the database. For example, SELECT * FROM EMPLOYEE WHERE JOB_CLASSIFICATION = 'C2'.

This will output all employees who have a job classification of 'C2'. The '*' tells the DBMS to include all columns from the EMPLOYEE table in the results. In general, the commands that are used to manipulate the database are part of the **data manipulation language (DML)**, of which SQL is an example. (So SQL is both a DDL and DML.) SQL commands can be used in a computer program to query a database, which is convenient for programmers.

data manipulation language (DML) The commands that are used to manipulate the data in a database.

SQL, which is pronounced like the word 'sequel', was developed in the 1970s at the IBM Research Laboratory in San Jose, California. 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), find the largest value (MAX), find the smallest value (MIN) and others. Table 5.2 contains examples of SQL commands.

Table 5.2 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.ClientNum=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. Programmers and database users also find SQL valuable because SQL statements can be embedded into many programming languages (discussed in Chapter 4), such as C#, Visual Basic and COBOL. Because SQL uses standardized and simplified procedures for retrieving, storing and manipulating data in a database system, the popular database query language can be easy to understand and use.

After a database has been set up and loaded with data, it can produce any desired reports, documents and other outputs. 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 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.

A DBMS can produce a wide variety of documents, reports and other outputs 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, accounting 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 towards completion and delivery.

Databases can also provide support to help executives and other people make better decisions. CloudERP, based in South Africa, develops software apps to help streamline processes and make data available to help with decision making.[1] The apps all make use of existing, open source business software, which helps lower costs. In addition, and as was discussed in the previous chapter, open source software is generally better quality than proprietary software.

A database is central to every business selling over the Internet. Amazon, for example, has a huge amount of data on customers' past purchases, which its competitors must envy, that it uses to make personal recommendations and generate more sales. Each time a returning customer comes back to the website, a report is produced of their recommendations, which becomes part of the web page itself, something described later in this chapter.

Database Administration

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

Database systems require a skilled **database administrator (DBA)**. A DBA is expected to have a clear understanding of the fundamental business of the organization, be proficient in the use of selected DBMSs 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.

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 DBMS 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.

Some organizations have also created a position called the **data administrator**, a non-technical but important role that ensures data is managed as an important organizational resource. The data administrator is 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.

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

Selecting a Database Management System

The DBA often selects the DBMS 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 DBMS 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 (the number of concurrent users).
- *Performance.* How fast the database is able to update records.
- *Integration.* The ability to be integrated with other applications and databases.
- *Vendor.* The reputation and financial stability of the database vendor.

The amount of electronic data in the world is estimated to double every two years.[2] Companies such as Tesco and Sainsbury's add billions of rows to their databases every day, as they capture every scrap of data that they can on their customers. Scientific databases are larger still. By 2017, CERN, the European Organization for Nuclear Research, had more than 200 petabytes of data in its archive.[3]

Using Databases with Other Software

DBMSs are often used with other software packages or the Internet. A DBMS can act as a front-end application or a back-end application. A front-end application is one that directly interacts with people or users. Marketing researchers often use a database as a front end to a statistical analysis program. The researchers enter the results of marketing 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 website, the website can interact with a database (the back end) that supplies the desired information. For example, you can connect to a university website to find out whether the university's library has a book you want to read. The website then interacts with a database that contains a catalogue of library books and articles to determine whether the book you want is available.

5.3 Database Applications

Database applications manipulate the content of a database to produce useful information. Common manipulations are searching, filtering, synthesizing and assimilating the data contained in a database using a number of database applications. These applications allow users to link the company databases to the Internet, set up data warehouses, use databases for strategic business intelligence, place data at different locations, use online processing and open connectivity standards for increased productivity, and search for and use unstructured data, such as graphics, audio and video.[4, 5]

Linking Databases to the Internet

Linking databases to the Internet is an incredibly useful application for organizations and individuals. Every e-commerce website uses database technology to dynamically create its web pages, saving vast amounts of effort. Every time you visit Amazon, for instance, or the South African fashion retailer Edgars, or one of thousands of other Internet businesses, the pages you see are created at that time from a database of product and customer information. This simplifies the maintenance of the website – to add new stock, all that needs to be done is enter a new record in the product table.

Many governments have published their public records databases online to give their citizens easy access to them. The National Archives, for example, is the official archive and publisher for the UK government and in this role, manages the website www.legislation.gov.uk.[6] This site publishes all UK laws and should be required reading for anyone accused of a crime – if for no other reason than to check that what the prosecutors say they did is actually a crime! Likewise many museums are publishing photographs of their collections online. The British Museum does this and says it is to offer everyone unparalleled access.[7]

Developing a seamless integration of traditional databases with the Internet is often called a 'semantic web'. A semantic web allows people to access and manipulate a number of traditional databases at the same time through the Internet. Many software vendors – including IBM, Oracle, Microsoft, Macromedia, Inline Internet Systems and Netscape Communications – are incorporating the capability of the Internet into their products. Such databases allow companies to create an Internet-accessible catalogue, which is nothing more than a database of items, descriptions and prices.

In addition to the Internet, organizations are gaining access to databases through networks to get good prices and reliable service. Connecting databases to corporate websites and networks can lead to potential problems, however. One database expert believes that up to 40 per cent of websites that connect to corporate databases are susceptible to hackers taking complete control of the database. By typing certain characters in a form on some websites, a hacker can issue SQL commands to control the corporate database.

Big Data Applications

Much of the data that organizations store comes from their Transaction Processing Systems, which are described fully in Chapter 7. However, firms are frequently storing less well-structured data too, such as photos, videos, data from customers' blogs, data from social networks and from their own website, including the order in which people view their web pages. All of this is often called Big Data – large amounts of unstructured data that are difficult or impossible to capture and analyze using traditional DBMSs.

Big Data can provide valuable insights to help organizations achieve their goals. It can reveal which potential customers are most likely to purchase which products. It can identify where and when a customer tends to shop. It can even determine how much a customer would be willing to pay for a product.

Special Big Data hardware and software tools have been developed to collect, store and analyze these data. Apache Hadoop is an open-source database that can be used to manage large unstructured datasets in conjunction with relational databases.[8] Yahoo! for example, uses Hadoop to collect and analyze exabytes (millions of terabytes) of data.[9] Oracle has developed Big Data Appliance, which is a combination of hardware and software specifically designed to capture, store and analyze large amounts of unstructured data. IBM has developed InfoSphere BigInsights, which is based on Hadoop, to help organizations analyze continuously created data.

Data Warehouses

The 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 transaction processing systems (explained fully in Chapter 7). A **data warehouse** is a database or a collection of databases 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. A data warehouse stores historical data that has been extracted from transaction processing systems, as well as data from external sources (see Figure 5.10). This operational and external data is 'cleaned' to remove inconsistencies and integrated to create a new information database that is more suitable for business analysis.

data warehouse A database or collection of databases that collects business information from many sources in the enterprise, covering all aspects of the company's processes, products and customers.

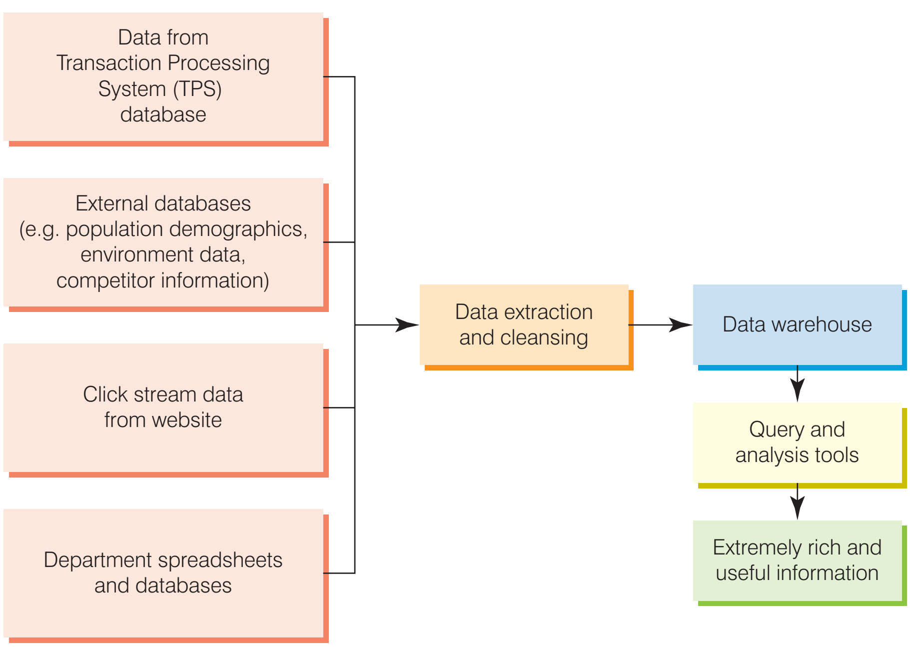


Figure 5.10 Elements of a Data Warehouse

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 various sources, one data warehouse is built that business analysts can use. To keep it accurate, the data warehouse receives regular updates. Old data that is no longer needed is purged. 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 to make the warehouse, automate data collection and verification, delete unwanted data and maintain the data. Data warehouses can also receive data from unique sources. 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. A data warehouse can be extremely difficult to establish, with the typical cost exceeding €2 million.

Ethical and Societal Issues

Three Words and a Few Symbols Cost a Business €40m

In October 2015, almost 157,000 customers of the telecoms giant TalkTalk had their personal details stolen from the company's computers. This was around 4 per cent of the company's entire customer base and included 15,656 people whose bank account numbers and sort codes were taken. The company was quick to respond, with the CEO Baroness Diana Mary Harding appearing on a number of television news programmes almost immediately giving out information. In a move that should be admired, her information seemed to be 'hot off the press' and was released as soon as TalkTalk had uncovered it. This speed and openness was welcomed, but it did mean that at times, Baroness Harding was badly briefed. In one interview she said the company had been the subject of a 'sequential attack'. What she meant was an SQL Injection attack (SQL is usually pronounced Sequel). It's a little technical, but here's what this means in detail.

When you enter data into a textbox on a website (for instance when you type in your name and address on an e-commerce site), what you are doing on almost all such websites is interacting directly with the company's database. This can be very dangerous and web designers have to be careful to implement this correctly. Let's say you type in the address: 10 London Road. Behind the scenes a computer converts this to an SQL command which looks like this:

INSERT INTO CUSTOMER (Address_Line_1) VALUES
("10 London Road");

Note that the computer adds"); at the end of the statement. If the web designers haven't been careful enough, a user can play with this. Let's say we type in exactly the following:

10 London Road"); Hello!

The close quotes, bracket and semi colon that we typed in ourselves will cause trouble. The computer might interpret this as its own close quotes and then send this to the database:

INSERT INTO CUSTOMER (Address_Line_1) VALUES
("10 London Road"); Hello!");

The first part is perfectly valid and will be run by the database, but our "); after London Road will end the statement before it should come to an end. Then the Hello!"); will generate an error message. Now, if instead we type the following into the textbox, there will be a big problem:

ABC"); SELECT * FROM CUSTOMER;

The computer will generate the following SQL:

INSERT INTO CUSTOMER (Address_Line_1) VALUES
("ABC"); SELECT * FROM CUSTOMER; ");

Look at this carefully to make sure you can see what is going on. The first part is the INSERT statement generated by the computer trying to insert the first line of our address. We have artificially ended this by putting "); after ABC. (By the way, the ABC is irrelevant – it's just there to try to make this clearer. A space would have done instead.) Then we have injected SELECT * FROM CUSTOMER; This is perfectly valid SQL and the database will obey it and return all the data from the customer table. The ''); on its own at the very end will generate an error message but by that stage, who cares? We've already stolen all the customer data.

That's pretty much it! That's all it took to steal customer data from TalkTalk. To prevent this attack the web designers should have verified the input from the textbox properly – there are a variety of ways of doing this. There are bug bounties available if you find vulnerabilities in a company's website and let them know. Usually they are only offered by large firms. Facebook and Google for instance have a bug bounty scheme. Run a web search for 'penetration test' if you want to know more. You should remember however that if you play around with SQL Injection 'just to see what happens', there is a risk that you could be fined or even arrested.

Questions

1. How should companies inform customers of a data theft? Should the information given out be hot off the press?
2. Create a strategy that a company could use to secure its data from SQL Injection attacks.
3. Should business information systems students learn the technical details of attacks like these or should this information be kept more secret?
4. Should companies give bug bounties? Is this at all risky? How and where should they be advertised?

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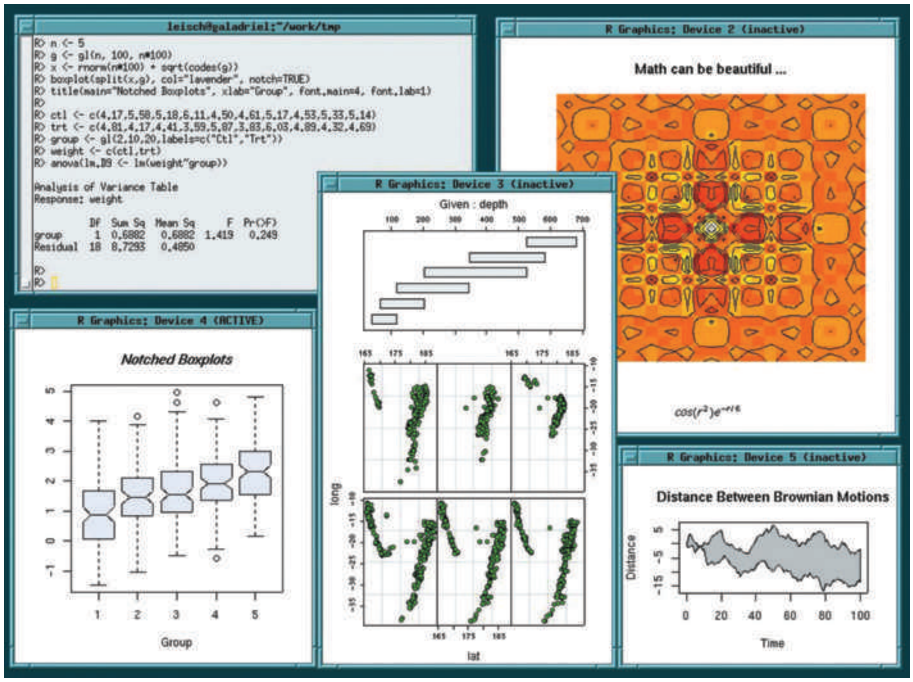
Data Mining

Data mining is the process of analyzing data to try to discover patterns and relationships within the data. Typically, a data warehouse is mined. Like gold mining, data mining sifts through mountains of data to find a few nuggets of valuable information. There are a number of data mining tools and techniques. Association rules algorithms are used to find associations between items in the data. A question that an association rule algorithm might be used to answer is, if someone buys eggs, how likely is it that they will also buy cheese? This information could be used in a supermarket to lay out the goods in the best configuration. Rattle (Figure 5.11) is an extremely powerful data mining application which can be used within the programming language R. Both are entirely free and can be downloaded from www.r-project.org/.

data mining The process of analyzing data to try to discover patterns and relationships within the data.

Data mining is used extensively in marketing to improve customer retention; identify cross-selling opportunities; manage marketing campaigns; market, channel and pricing analysis; and customer segmentation analysis (especially one-to-one marketing). Data-mining tools help users find answers to questions they haven't thought to ask.

Figure 5.11 **Data Mining with Rattle** *Rattle is a software package that runs in the R programming language. Both are available for free. To get started visit www.r-project.org.*



E-commerce presents another major opportunity for effective use of data mining. Attracting customers to websites is tough; keeping them can be tougher. For example, when retail websites launch deep-discount sales, they cannot easily determine how many first-time customers are likely to come back and buy again. Neither do they have a way of understanding which customers acquired during the sale are price sensitive and more likely to jump on future sales. As a result, companies are gathering data on user traffic through their websites and storing that data in databases. This data is then analyzed using data-mining techniques to personalize and customize the website, and develop sales promotions targeted at specific customers.

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 5.3 summarizes a few of the most frequent applications for data mining. See Case Two at the end of the chapter for an explanation of one data-mining algorithm.

Business Intelligence

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.

Closely linked to the concept of data mining is the use of databases for business-intelligence purposes. **Business intelligence (BI)** involves gathering enough of the right information in a timely manner and usable form, and analyzing it so that it can be used to have a positive effect on business strategy, tactics or operations. Zoho Analytics is BI software that users, without help, can set up to create visually appealing data visualizations and insightful dashboards.[10] BI turns data into useful information that is then distributed throughout an enterprise.

Table 5.3 Common Data-Mining Applications

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 what they prefer
Trend analysis	Analyze how key variables (e.g. sales, spending, promotions) vary over time

Information Systems @ Work

The IBM Quantum Experience

IBM Research has recently made quantum computing available to members of the public by allowing access to a first-of-a-kind quantum computing platform delivered via the IBM Cloud onto any desktop or mobile device. Called the IBM Quantum Experience, the platform will allow users to run algorithms and experiments on IBM's quantum processor to explore tutorials and simulations around what might be possible with quantum computing. It has been realized for several decades that there are great advantages to storing, transmitting and processing information encoded in systems that exhibit quantum properties, as this would dramatically improve computational power for particular tasks.

'Quantum computers are very different from today's computers, not only in what they look like and are made of, but more importantly in what they can do', said Arvind Krishna, senior vice president and director, IBM Research. 'Quantum computing is becoming a reality and it will extend computation far beyond what is imaginable with today's computers. This moment represents the birth of quantum cloud computing. By giving hands-on access to IBM's experimental quantum systems, the IBM Quantum Experience will make it easier for researchers and the scientific community to accelerate innovations in the quantum field, and help discover new applications for this technology.'

The physics of small particles like photons and electrons are strange. These particles can exist in more than one state at the same time and can form partnerships with each other in a way that even if the two of them are separated by several miles, each of them somehow knows what state the other is in. This is known as entanglement. If these particles could be reliably manipulated, they could quickly perform computing tasks that would take normal computers many thousands of years,

(continued)

because they would be able to perform multiple calculations simultaneously.

To understand why this is, imagine a simple calculation: XXX + XXX = XXXX, where each of the Xs is either a 1 or a 0 (there is an extra X in the result as this would be a bigger number than the others). Taking just the first XXX, this number could be 000 or 001 or 110; there are only a few permutations of 1s and 0s possible (in fact there are 8 – see if you can list them).

If a quantum computer could create Xs that were simultaneously 1 and 0, then every possible permutation of 1s and 0s – every way of possibly adding together XXX and XXX – could be calculated in one addition. In a traditional computer this would take 64 additions, so the quantum computer will be much faster! (Why 64 additions? This figure comes from: 0+0, 0+1, 0+2, 0+3 ... then 1+0, 1+1, 1+2, 1+3 ... all the way up to 7+7.)

The problem is that quantum states are very fragile. The most critical aspect of quantum computers is that they must be 'closed boxes': a quantum computer's internal operations, while under the programmer's control, must be isolated from the rest of the universe, otherwise its particles will lose their entanglement. Small amounts of information leakage cause a destructive process known as decoherence. However, if decoherence can be solved, there are huge gains to be had. IBM envisions medium-sized quantum processors of 50–100 qubits to be operational within the next decade. A quantum computer built of just 50 qubits would work faster than any of the current top 500 fastest supercomputers, which reflects the tremendous potential this technology has. The IBM Quantum Experience computer has 5 qubits.

IBM is not the only one working towards this goal. Documents leaked by the whistle-blower Edward Snowden reveal that the US National Security Agency (NSA) has been conducting 'basic research' to determine whether it is possible to build a quantum computer that would be useful for cracking encrypted communications. This is because quantum computers should excel at factoring large numbers which could be used to break commonly used encryption methods, which derive their security from the fact that ordinary computers can't find factors quickly. So, in principle, the NSA could use a quantum computer to read secret data. Another possible application is super-fast searches to sift through vast amounts of data. However, the Snowden documents state that they are nowhere near reaching this goal.

Currently, the tutorials at the IBM Quantum Experience cover the basic principles of qubits, lessons illustrating entanglement and how entangled particles can create the logic gates necessary to build a computer, and a first look at programming quantum algorithms.

Questions

1. Why would IBM release this platform to the general public? Is there a business case for it?
2. Why would the NSA be interested in quantum computing?
3. Who else should be interested? Who do you think the users of the IBM Quantum Experience are?
4. Have a look at the IBM Quantum Experience website. If you are feeling brave, register for an account and try the first tutorial.

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

Competitive intelligence is one aspect of BI 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.

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.

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 is spread across several smaller databases connected through telecommunications devices – works on much the same principle. A user in the London 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 5.12).

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

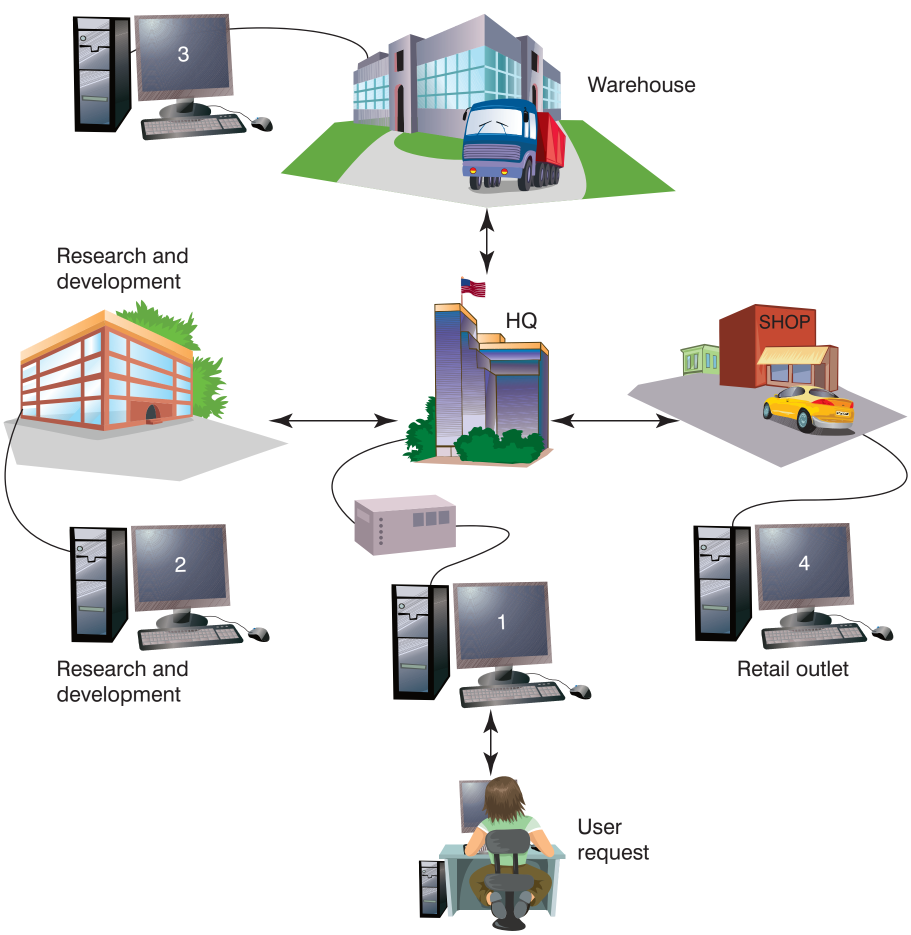

Figure 5.12 The Use of a Distributed Database
This figure shows how data from a clothing manufacturer is stored across multiple sites.

For the clothing manufacturer, computers might be located at the headquarters, in the research and development centre, 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.

Wide Column Store

Distributed databases often don't use the relational model. When data is stored in tables using the relational model, in order to find a specific piece of information the computer must look up separate facts in separate tables – the first table is searched for the primary key of interest to find the relevant foreign key of interest; the computer then switches to a second table and searches for that foreign key (which of course is the primary key of the second table) and so on. When there is a lot of data stored in many tables, and the tables are stored across multiple computers, this can be slower than alternatives such as a wide column store. Wide column store databases such as Apache Cassandra and Google Bigtable do not use SQL – in fact they are referred to as NoSQL databases. One way of thinking about wide column store databases is a set of 'raggedy' tables that don't have the same number of columns in each row. This means that data that would be stored in many relational tables can be stored in one table in a wide column store, potentially reducing the number of processes that must be performed to access any one fact in the data.

Distributed databases give 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 Medical Literature Analysis and Retrieval System Online, or MEDLINE, is an online bibliographic database which stores details of papers and news reports published in medical journals. Over 5,000 journals are included in 40 languages. The details for each paper are its title, the authors and their affiliations, the abstract and a link to the paper on the publisher's website. MEDLINE allows users all over the world to search for health related information.[11]

Despite its advantages, distributed processing creates additional challenges in integrating different databases (information integration), maintaining data security, accuracy, timeliness and conformance to standards.[12, 13] Distributed databases allow more users direct access at different sites, thus controlling who accesses and changes data is sometimes difficult.[14] Also, because distributed databases rely on telecommunications lines to transport data, access to data can be slower.

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

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. 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 railway, for example, can use a replicated database to increase punctuality, safety and reliability. The primary database can hold data on fares, routes and other essential information. The data can be continually replicated and downloaded from the master database to hundreds of remote servers across the country. The remote locations can send back the latest figures on ticket sales and reservations to the main database.

Online Analytical Processing (OLAP)

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

For nearly two decades, databases and their 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 colourful 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 Cognos, Comshare, Hyperion Solutions, Oracle, MineShare, WhiteLight and Microsoft. (Note that in this context, the word 'online' does not refer to the Internet – it simply means that a query is made and answered immediately, as opposed to a user submitting a query and the processing taking place at some other time, for instance at night when the servers are used less.)

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 behaviour, which might otherwise go undetected. Table 5.4 compares the OLAP and data-mining approaches to data analysis.

Table 5.4 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

Visual, Audio and Other Database Systems

Organizations are increasingly 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 medical staff 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. The PetroView database and analysis tool allows petroleum engineers to analyze geographic information to help them determine where to drill for oil and gas. Visual-fingerprint database are often used to solve cold cases.[15] Visual databases can be stored in some object-relational databases or special-purpose database systems. Many relational databases can also store graphic content.

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 are developing virtual database systems to allow different databases to work together as a unified database system. DiscoveryLink, one of IBM's projects, can integrate biomedical data from different sources. The Center for Disease Control and Prevention (CDC) in the USA also has the problem of integrating more than 100 databases on various diseases.

In addition to visual, audio and virtual databases, there are a number of other special-purpose database systems. 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. MapExtreme is spatial technology software from MapInfo that extends a user's database so that it can store, manage and manipulate location-based data. Police departments, for example, can use this type of software to bring together crime data and map it visually so that patterns are easier to analyze. Police officers can select and work with spatial data at a specified location, within a rectangle, a given radius or a polygon such as their area of jurisdiction. For example, a police officer can request a list of all alcohol shops within a two-mile radius of the police station. 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.

Summary

Data management and modelling are key aspects of organizing data and information. Data is one of the most valuable resources that a firm possesses. The most common way to organize data is in a relational database. A relational database is made up of tables, each table is made up of records and each record is made up of fields. Loosely, each table stores information about an entity. An entity is someone or something that the firm wants to store information about. The fields are the characteristics or attributes about the entity that are stored. A record collects together all the fields of a particular instance of an entity. A primary key uniquely identifies each record.

Designing a database involves identifying entities and the relationships between them, as well as the attributes of each entity. There are rules to follow to convert related entities into a data model, a list of all tables to be implemented in the database, with primary and foreign keys identified. Basic data manipulations include selecting, projecting and joining.

A well-designed and well-managed database is central to almost all information systems and 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. 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 specialized data manipulation language is 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.

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 DBMS.

The number and types of database applications will continue to evolve and yield real business benefits. Organizations are building data warehouses, which are relational DBMSs specifically designed to support management decision making. Data mining, which is the automated discovery of patterns and relationships in a data warehouse, is emerging as a practical approach to generating hypotheses about the patterns and anomalies in the data that can be used to predict future behaviour.

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.

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.

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 object-oriented programming, first discussed in Chapter 4. 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 increasingly finding a need to store large amounts of visual and audio signals in an organized fashion. There are also a number of special-purpose database systems.

Self-Assessment Test

1. A _________ uniquely identifies a record.
2. A relational database is made up of _________.
3. An _________ is a person, place or thing about whom or about which a company stores data.
4. If a company stores a fact only once, it is said to have reduced _________.
5. SQL is a data _________ language and a data _________ language.
6. The _________ statement is used to extract data from a database.
7. The person who manages a database is the _________.
8. A collection of databases collecting information on all aspects of a business is known as a data _________.
9. _________ is a popular and free data mining tool.
10. A database that holds a duplicate set of frequently used data is _________.

Review Questions

1. What can you do with SQL?
2. Explain the CREATE SQL statement.
3. Explain the SELECT SQL statement.
4. What does DBMS stand for? What does it do?
5. What is data mining?
6. What is business intelligence?
7. How can data mining be used to improve an e-commerce website?
8. What is Hadoop?
9. How does Rattle work?
10. List some SQL functions.

Discussion Questions

1. Should a company store every scrap of data it can get its hands on?
2. Should there be any industries or sectors where data mining is considered unethical?

Web Exercises

1. Write an SQL statement to create the order table for the furniture seller. If you are comfortable and competent at installing software from the web, download the DBMS LibreOffice Base and implement the table.
2. If you are comfortable and competent at installing software from the web, install R and the Rattle package. Search for a YouTube tutorial and work through it.

Case One

Click Here to Reset Your Password

Nature magazine recently published a list of the most common passwords. The top five were:

1. 123456
2. password
3. qwerty
4. 12345
5. 123456789

It's understandable that people are stressed with trying to manage their passwords – almost every time you make a purchase online – or even read an article in an online newspaper – a company tries to get you to 'register for all these great benefits' that you probably don't want or care about. When money isn't on the line (that is, when they're not handing over their credit card details), many people seem to care less and use 12345 as their password.

What's more interesting is where *Nature* is getting its data, because password information is not as easy to find as you might think, unless the company storing them doesn't know what they are doing. *Nature* can't have just phoned up Google to ask them for their most common passwords, and we know that not just because Google probably wouldn't tell them – we know it because Google doesn't know your password!

Have you ever forgotten your login details, requested them from a company and then been annoyed when you get emailed a link to click on to reset them? *Why don't they just send me my password?* If they did send just your password, it would mean that any systems administrator at your email company could see it. And by extension, any systems administrator at the company you're dealing with could see it as well. Rather than having a field in a database called 'password' which someone could peer into, it's much safer not to store passwords at all. So how does that work?

One way a small company can achieve this is by forming a partnership with a big technology company. You may have seen this when you get the option to 'login with your Facebook account' or 'login with your Google account' when you are buying something from a craft shop or second-hand book store. What's happening is that the company you're dealing with is passing on the responsibility of identifying you to someone who is better at it than they are.

Another approach is to store an encrypted version of your password. So your password – let's say in plain text it's 'bubblegum' – gets transformed into a meaningless encrypted string. It looks like gibberish, maybe it's 'jh8yg2buj', and is what gets stored in the database. This may sound like a good idea but it means that everyone who uses the same password generates the same gibberish and anyone who managed to get access to the database could easily identify which were the common passwords. If they figured out one, they would have access to many accounts. There have even been cases of big technology firms storing encrypted passwords alongside the plain text password hints. So an unauthorized person could look in the database and see the gibberish 'kj3oy' stored alongside the user's hint 'the name of my cat'. A few tries and they'll guess the password is 'moggy'!

A better approach, called salting, involves the company adding a random string of text to your password, then encrypting both of these together and storing the (now much longer) encrypted gibberish. The same random string is added to your password every time you type it in – it's unique to you. This is then run through the encryption algorithm and the gibberish that is generated is compared with the gibberish that is stored in the database. This means that if anyone sees the file of gibberish, they can't work out any patterns. It also means that when you ask for your password, the company can't give it to you because they don't know it (they only store the gibberish). To add to the security, instead of storing a password hint, if you forget your password some companies will send a code in a text to your mobile phone, which you must type in.

Incidentally, many hackers won't bother trying to see the password database in the first place. It's much easier to contact you and say something like: 'Hi, I'm from IT. We're having a problem with our password file, it's got all mangled up. You won't be able to login until we fix it. We have your password stored as bubblegum. Is that right?' Many people are likely to quickly say 'No my password is moggy'.

Questions

1. If your credit card is not involved and you don't really care about the service you are registering for, does it matter if you use 12345 as your password?
2. The hacker at the end is using something called social engineering. How would you protect yourself from this sort of attack? How would you protect your employees?
3. Why do you think Facebook and Google offer a login service?
4. Why do you think people use such easy to guess passwords? How could you prevent this?

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Case Two

Machine Learning: How Many Books Have You Read?

Developed at the University of Waikato, New Zealand, Weka is a collection of machine learning algorithms for data-mining tasks. Named after a flightless bird found only in New Zealand, Weka is open source software. Weka is a popular way to learn data mining.

One application for Weka is text mining, which involves processing chunks of text to extract useful summary information from it. For example, Weka has been used to automatically process movie reviews to determine whether most reviewers like it or love it, something known as 'sentiment analysis'. When Google announced Google Books, researcher Erez Lieberman Aiden saw an opportunity to text mine on a grand scale.

In 1996, Google cofounders Sergey Brin and Larry Page had the idea for Google Books, a world in which vast collections of books are digitized, indexed by a computer program to analyze their content and explore the connections between them. In fact, the program they envisioned for this task was their BackRub algorithm, which developed into the Google search program, the core search technology that makes Google Google! Before being in a position to make it happen, Brin and Page envisioned people everywhere being able to search through all of the world's books to find the ones they're looking for.

Fast forward 15 years and the eventual size of the data Lieberman Aiden's team examined was an amazing 4 per cent of all books ever published. That's 361 billion words in English, 45 billion in French, 37 billion in German and 13 billion in Chinese. This cannot be read by a human. The only way to digest it is by using software such as Weka. To digitize the books, Google used optical character recognition, a set of algorithms that transform a picture of a word into the corresponding digital text. This process isn't perfect. The most common error was reading an s as an f, because of how s was written in the Middle Ages. (It's called a 'medial s' and leads to all sorts of jokes featuring the word succour, which was used more frequently back then than it is today!)

The team analyzed the resulting dataset to investigate cultural trends and explore how grammar has evolved. Actually, this is quite a simple example of text mining. All that the team was doing was creating frequency counts of words (counting the number of times each word was used). The main challenge they had was in dealing with the amount of data. The frequencies allowed the team to report on a number of phenomena. For instance, in the 1950s, 'speed up' overtook 'sped' as the most frequently used verb meaning to get faster. One hundred years previously in America, 'burned' overtook 'burnt'; it wasn't until the 1980s that this happened in the UK. Any given year is discussed a lot in print over the following three years, after which mentions of it drop vastly. Fame is more short lived than it used to be: in the past, famous people were mentioned in books for longer than famous people are today. The name they gave to analyzing these data with text mining is culturomics.

Weka can be downloaded from the University of Waikato website, and there are many books and online tutorials to help you if you would like to explore it, and the Culturomics dataset can be explored at its website.

Questions

1. What uses of culturomics, if any, can you think of for a business?
2. What uses of sentiment analysis can you think of?
3. Why should a business be interested in text mining?
4. Should every company that collects data have a knowledge of software such as Weka?

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Case Three

Protect Your Data: Life is Valuable

You should think twice before you hand over sensitive data to a company that is likely to be a target for hackers.

The web is awash with dating sites and each of them is trying to carve out a particular niche. There are sites for those looking for a long-term partner, a one-night stand, a person who works in uniform, a person of the same religion, or a discreet relationship. Ashley Madison falls into the latter category. It specializes in helping married people have an affair. As you would imagine, the list of the site's members is extremely sensitive and so it was with some amount of shock and shame that those members woke to news of a data breach in July 2015.

The site had been hacked. The perpetrators gave themselves the name Impact Team and seemed to have been led by an ex-employee. Journalist Brian Krebs was one of the first to hear about the leak. An anonymous informant had sent him a link to a database of real names, addresses and credit card numbers of Ashley Madison members. More than 30 million people in more than 40 countries were affected, including South Africa. Technology news site www.MyBroadBand.co.za was keen to take a look.

'Unfortunately', reporter Jan Vermeulen said, 'the country code field in the Ashley Madison member database did not have a single value for all South African users – making it difficult to get an accurate total [of South African users]. However, it was possible to query the number of .za email addresses used to register accounts, as well as the South African cities and towns members said they were "looking for action" in'. They found about 50,000 users.

Elsewhere, politicians, priests, military members, civil servants and celebrities were waking up to the news that their secret was out. In fact hundreds of public figures were found among the listed membership. An Alabama newspaper printed all the names of people from that region who were in the Ashley Madison's database. 'There's a very real chance that people are going to overreact', Brian Krebs wrote. 'I wouldn't be surprised if we saw people taking their lives because of this.'

Sadly, in fact, there were a small number of suicides, including a priest from Louisiana. There were blackmail threats too. These came first electronically via email and then physically as letters. The letters demanded payment, in the thousands of dollars, to avoid having their membership of the site made public. The security journalist Graham Cluley reported one such letter which demanded over $4,000 be paid in Bitcoin (see Chapter 10 for more information about Bitcoin) with a threat to expose the existence of the account 'to people close to' the victim if he or she refused. The advice on receiving any such letter is to ignore it – the blackmailer can always demand more money and has no motivation to destroy what information they have.

5

Questions

1. How could users of sites like this protect themselves from data breaches?
2. What should Ashley Madison's response have been?
3. What would your advice be to anyone who received a similar letter?
4. Do partners not have a right to see if their loved one is on a site like this?

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5

06

Computer Networks

Principles	Learning Objectives
Effective communications are essential to organizational success.	■ Define the terms 'communications' and 'telecommunications' and describe the components of a telecommunications system.
Communications technology lets more people send and receive all forms of information over great distances.	■ Identify several communications hardware devices and discuss their function. ■ Describe many of the benefits associated with a telecommunications network. ■ Define the term 'communications protocols' and identify several common ones.
The Internet is like many other technologies – it provides a wide range of services, some of which are effective and practical for use today, others are still evolving, and still others will fade away from lack of use.	■ Briefly describe how the Internet works, including alternatives for connecting to it and the role of Internet service providers. ■ Describe the World Wide Web and the way it works. ■ Explain the use of web browsers, search engines and other web tools. ■ Outline a process for creating web content.
Because the Internet and the World Wide Web are becoming more universally used and accepted for business use, management, service and speed, privacy and security issues must continually be addressed and resolved.	■ Define the terms 'intranet' and 'extranet' and discuss how organizations are using them.

Why Learn About Computer Networks?

We have examined hardware and software, and paid special attention to how data is organized for storage. The power of information technology greatly increases when devices are linked or networked, which is the subject of this chapter. Today's decision makers need to access data wherever it resides. They must be able to establish fast, reliable connections to exchange messages, upload and download data and software, route business transactions to processors, connect to databases and network services, and send output to printers. Regardless of your chosen career field, you will need the communications capabilities provided by computer networks. The world's largest network is the Internet. To say that the Internet has had a big impact on organizations of all types and sizes would be a huge understatement. Since the early 1990s, when the Internet was first used for commercial purposes, it has affected all aspects of business. Businesses use the Internet to sell and advertise their products and services, reaching out to new and existing customers. People working in every field and at every level use the Internet in their jobs. Whatever your career, you will probably use the Internet daily.

6.1 Telecommunications

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

Telecommunications refers to the electronic transmission of signals for communications, by such means as telephone, radio and television. Telecommunications impacts businesses greatly because it lessens the barriers of time and distance. Telecommunications is not only changing the way businesses operate but also the nature of commerce itself. As networks are connected with one another and transmit information more freely, a competitive marketplace demands excellent quality and service from all organizations.

Figure 6.1 shows a general model of telecommunications. The model starts with a sending unit (1), such as a person, a computer system, a terminal or another device, that originates the message. The sending unit transmits a signal (2) to a telecommunications device (3). The telecommunications device – a hardware component that facilitates electronic communication – performs many tasks, which can include converting the signal into a different form or from one type to another. The telecommunications device then sends the signal through a medium (4). A telecommunications medium is any material substance that carries an electronic signal to support communications between a sending and receiving device. Another telecommunications device (5) connected to the receiving computer (6) receives the signal. The process can be reversed, and the receiving unit (6) can send another message to the original sending unit (1). An important characteristic of telecommunications is the speed at which information is transmitted, which is measured in bits per second (bps). Common speeds are in the range of thousands of bits per second (Kbps) to millions of bits per second (Mbps) and even billions of bits per second (Gbps).

Advances in telecommunications technology allow us to communicate rapidly with clients and co-workers almost anywhere in the world. Communication between two people can occur synchronously or asynchronously. With synchronous communication, the receiver gets the message almost instantaneously when it is sent. Phone communication is an example of synchronous communication. With asynchronous communication, there is a measurable delay between the sending and receiving of the message, sometimes hours or even days. Sending a letter through the post office or by email are examples of asynchronous communications. Both types of communications are important in business. However, to use telecommunications effectively, you must carefully analyze telecommunications media and devices.

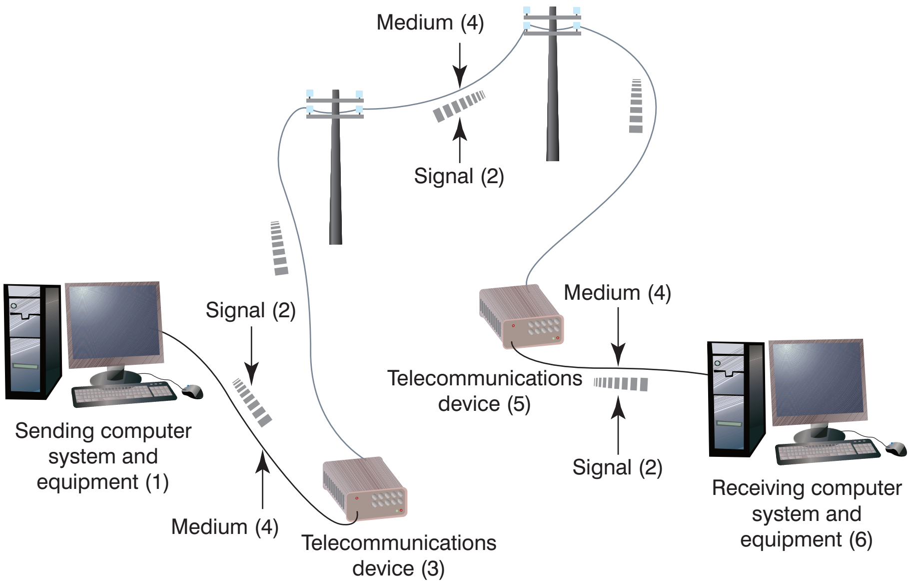

Figure 6.1 Elements of a Telecommunications System *Telecommunications devices relay signals between computer systems and transmission media.*

Channel Bandwidth

Telecommunications **channel bandwidth** refers to the rate at which data is exchanged, usually measured in bits per second (bps) – the broader the bandwidth, the more information can be exchanged at one time. **Broadband communications** can exchange data very quickly, as opposed to **narrowband communications** which supports a much lower rate of data exchange. Telecommunications professionals consider the capacity of the channel when they recommend transmission media for a business. In general, today's organizations need more bandwidth for increased transmission speed to carry out their daily functions. To increase bandwidth, first consider the different types of telecommunications media you can use.

channel bandwidth The rate at which data is exchanged over a communications channel, usually measured in bits per second (bps).

broadband communications A telecommunications system in which a very high rate of data exchange is possible.

narrowband communications A telecommunications system that supports a much lower rate of data exchange than broadband.

Guided Transmission Media Types

Transmission media can be divided into two broad categories: guided transmission media, in which communications signals are guided along a solid medium; and wireless, in which the communications signal is broadcast over airwaves as a form of electromagnetic radiation.

There are many different guided transmission media types. Table 6.1 summarizes the guided media types by physical media type. Several guided transmission media types are discussed in the sections following the table.

Twisted-Pair Wire

Twisted-pair wire contains two or more twisted pairs of wire, usually copper (see Figure 6.2a). Proper twisting of the wire keeps the signal from 'bleeding' into the next pair and creating electrical interference. Because the twisted-pair wires are insulated, they can be placed close together and packaged in one group. Hundreds of wire pairs can be grouped into one large wire cable.

Twisted-pair wires are classified by category, depending on the frequency of data transmission. The lower categories are used primarily in homes. Higher categories are sometimes used in smaller networks. Ten gigabit ethernet (labelled IEEE 802.3an) is an emerging standard for transmitting data at the speed of 10 billion bits per second for limited distances over shielded twisted-pair wires. It will be used for the high-speed links that connect groups of computers or to move data stored in large databases on large computers to stand-alone storage devices.[1]

6

Table 6.1 Guided Transmission Media Types

Guided Media Types			
Media Type	**Description**	**Advantages**	**Disadvantages**
Twisted-pair wire	Twisted pairs of copper wire, shielded or unshielded	Used for telephone service; widely available	Transmission speed and distance limitations
Coaxial cable	Inner conductor wire surrounded by insulation	Cleaner and faster data transmission than twisted-pair wire	More expensive than twisted-pair wire
Fibre-optic cable	Many extremely thin strands of glass bound together in a sheathing; uses light beams to transmit signals	Diameter of cable is much smaller than coaxial; less distortion of signal; capable of high transmission rates	Expensive to purchase and install
Broadband over power lines	Data is transmitted over standard high-voltage power lines	Can provide Internet service to rural areas where cable and phone service may be non-existent	Can be expensive and may interfere with ham/amateur radios, and police and fire communications

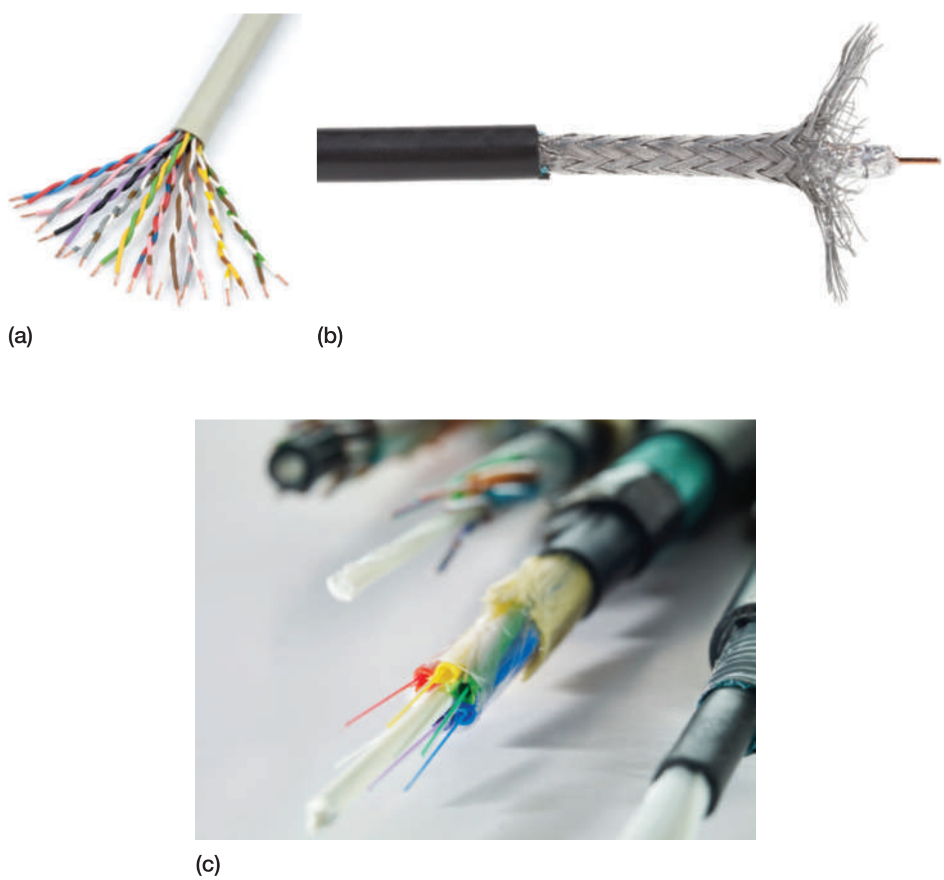

Figure 6.2 **Types of Guided Transmission Media** *(a) Twisted-pair wire (b) Coaxial cable (c) Fibre-optic cable*

Coaxial Cable

Figure 6.2b shows a typical coaxial cable. Coaxial cable falls in the middle of the guided transmission media in terms of cost and performance. The cable itself is more expensive than twisted-pair wire but less so than fibre-optic cable. However, the cost of installation and other necessary communications equipment makes it difficult to compare the total costs of each media. Coaxial cable offers cleaner and crisper data transmission (less noise) than twisted-pair wire. It also offers a higher data transmission rate. Companies such as Virgin Media are aggressively courting customers for telephone service, enticing them away from the phone companies such as BT by bundling Internet and phone services along with TV.

Fibre-Optic Cable

Fibre-optic cable, consisting of many extremely thin strands of glass or plastic bound together in a sheathing (a jacket), transmits signals with light beams (see Figure 6.2c). These high-intensity light beams are generated by lasers and are conducted along the transparent fibres. These fibres have a thin coating, called cladding, which effectively works like a mirror, preventing the light from leaking out of the fibre. The much smaller diameter of fibre-optic cable makes it ideal when there is not room for bulky copper wires – for example, in crowded conduits, which can be pipes or spaces carrying both electrical and communications wires. In such tight spaces, the smaller fibre-optic telecommunications cable is very effective. Because fibre-optic cables are immune to electrical interference, they can transmit signals over longer distances with fewer expensive repeaters to amplify or rebroadcast the data. Fibre-optic cable and associated telecommunications devices are more expensive to purchase and install than their twisted-pair wire counterparts, although the cost is decreasing.

Laying thousands of miles of fibre-optic cable across its vast expanses is credited for helping propel India into the high-tech world. With the capability that this infrastructure provided, Indian workers were able to collaborate closely with their Western counterparts even though they were thousands of miles away.[2] As a result, India has emerged as a key business partner to many firms that have outsourced part of their business operations or that use Indian firms for information systems projects.

Broadband Over Power Lines

Many utilities, cities and organizations are experimenting with providing network connections over standard high-voltage power lines. Manassas, Virginia, became the first city in the USA to offer this service to all its citizens. To access the Internet, broadband over power lines (BPL) users connect their computer to a special hardware device that plugs into any electrical wall socket. A potential issue with BPL is that transmitting data over unshielded power lines can interfere with both ham radio broadcasts, and police and fire radios. However, BPL can provide Internet service in rural areas where broadband access is unavailable, because electricity is prevalent in homes even more than telephone lines.[3]

Wireless Transmission Media Types

Many technologies are used to transmit communications wirelessly. The major technologies include microwave, satellite, radio and infrared. Their key distinguishing feature is the frequency at which signals are transmitted.

Microwave Transmission

Microwave is a high-frequency (300 MHz–300 GHz) signal sent through the air (see Figure 6.3). Terrestrial (Earth-bound) microwaves are transmitted by line-of-sight devices, so that the line of sight between the transmitter and receiver must be unobstructed. Typically, microwave stations are placed in a series – one station receives a signal, amplifies it and retransmits it to the next microwave transmission tower. Such stations can be located roughly 30 miles apart before the curvature of the Earth makes it impossible for the towers to 'see one another'. Microwave signals can carry thousands of channels at the same time.

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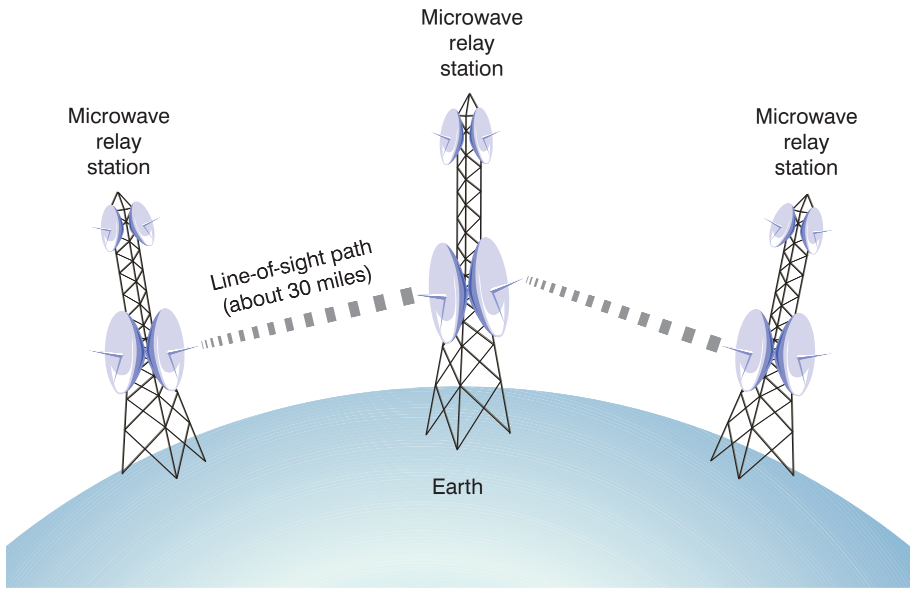

Figure 6.3 **Microwave Communications** *Because they are line-of-sight transmission devices, microwave dishes are frequently placed in relatively high locations, such as atop mountains, towers or tall buildings.*

A communications satellite also operates in the microwave frequency range (see Figure 6.4). The satellite receives the signal from the Earth station, amplifies the relatively weak signal and then rebroadcasts it at a different frequency. The advantage of satellite communications is that it can receive and broadcast over large geographic regions. Such problems as the curvature of the Earth, and mountains and other structures that block the line-of-sight microwave transmission, make satellites an attractive alternative. Geostationary, low Earth orbit and small mobile satellite stations are the most common forms of satellite communications.

A geostationary satellite orbits the Earth directly over the equator approximately 35,400 km (22,000 miles) above the Earth so that it appears stationary. Three such satellites, spaced at equal intervals (120 angular degrees apart), can cover the entire world. A geostationary satellite can be accessed using a dish antenna aimed at the spot in the sky where the satellite hovers.

A low Earth orbit (LEO) satellite system employs many satellites, each in a circular orbit at an altitude of a few hundred kilometres. The satellites are spaced so that from any point on the Earth at any time, at least one satellite is on a line of sight.

A very small aperture terminal (VSAT) is a two-way satellite ground station with a dish antenna smaller than three metres in diameter. Many retail chains employ this technology to support point-of-sale transactions, including credit cards. News organizations employ VSAT dishes that run on battery power to transmit news stories from remote locations. VSAT technology is being used to rebuild the telecommunications infrastructure in Afghanistan and Iraq.

5G Wireless Communication

Wireless communications have evolved through four generations of technology and services. The first-generation (1G) of wireless communications standards originated in the 1980s and was based on analogue communications. The second-generation (2G) networks were fully digital, superseding 1G networks in the early 1990s. With 2G networks, phone conversations were encrypted, mobile phone usage was expanded, and short message services (SMS) or texting was introduced. 3G wireless communications supports wireless voice and broadband speed data communications in a mobile environment at speeds of 2 to 4 Mbps. Additional capabilities include mobile video, mobile e-commerce, location-based services, mobile gaming, and the downloading and playing of music. 4G broadband mobile wireless delivered more advanced versions of enhanced multimedia, smooth streaming video, universal access and portability across all types of devices. 4G can deliver 3 to 20 times the speed of 3G networks for mobile devices such as smartphones, tablets and laptops.

The latest generation (which is what the 'G' stands for), 5G, is bringing higher data transmission rates, lower power consumption, higher connection reliability with fewer dropped calls, increased geographic coverage and lower infrastructure costs. In the UK, the 5G network is currently being rolled out in stages and most users will need to upgrade their devices to make full use of it. The development is controversial though, with parts of the development contract possibly going to Chinese company (the decision is under review) Huawei against the advice of the USA, that thinks the Chinese government will use this as an opportunity to gather data on UK military bases and power stations.[4] Vodacom Group is planning to launch 5G services in South Africa in 2020[5] using hardware being built by African operator Liquid Telecom.

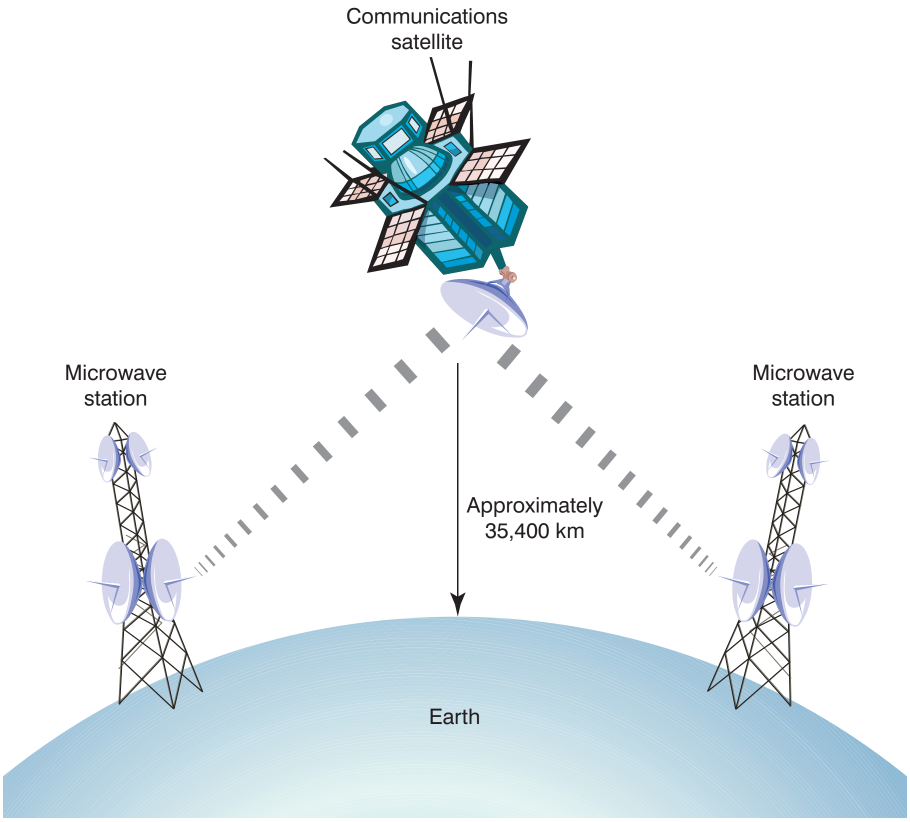

Figure 6.4 Satellite Transmission *Communications satellites are relay stations that receive signals from one Earth station and rebroadcast them to another.*

Wi-Fi

Wi-fi is a wireless telecommunications technology brand owned by the Wi-Fi Alliance which consists of about 300 technology companies including AT&T, Dell, Microsoft, Nokia and Qualcomm. The Alliance exists to improve the interoperability of wireless local area network products based on the IEEE 802.11 series of telecommunications standards.

wi-fi A medium-range wireless telecommunications technology brand owned by the Wi-Fi Alliance.

Wi-fi is a medium-range wireless option typically operating up to about 30 metres around a single building. With a wi-fi network, the user's computer, smartphone or tablet has a wireless adapter that translates data into a radio signal and transmits it using an antenna.

A wireless access point, which consists of a transmitter with an antenna, receives the signal and decodes it. The access point then sends the information to the Internet over a wired connection. When receiving data, the wireless access point takes the information from the Internet, translates it into a radio signal and sends it to the device's wireless adapter (see Figure 6.5). Mobile devices typically come with built-in wireless transmitters and software that enable them to detect the existence of a wi-fi network and alert the user. The area covered by one or more interconnected wireless access points is called a 'hot spot'. Wi-fi has proven so popular that hot spots have been established in many airports, coffee shops, libraries, university campuses and hotels.

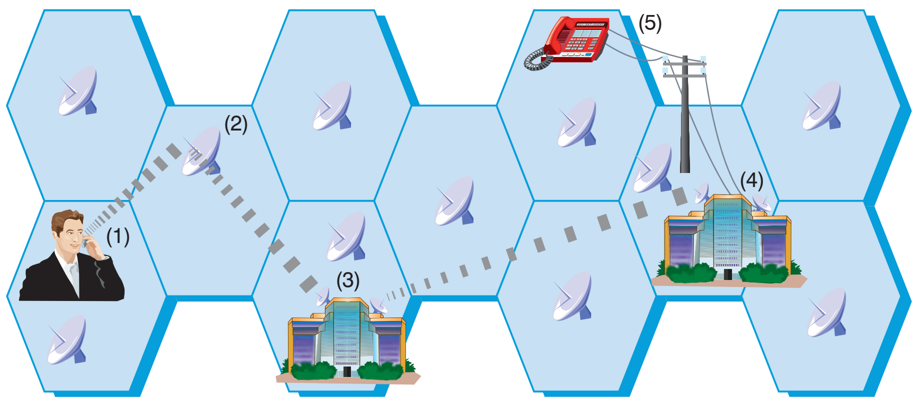

Figure 6.5 A Typical Mobile Transmission Scenario *Using a mobile phone, the caller dials the number (1). The signal is sent from the phone's antenna to the low-powered mobile antenna located in that area (2). The signal is sent to the regional mobile phone switching office, also called the mobile telephone subscriber office (MTSO) (3). The signal is switched to the local telephone company switching station located nearest the call destination (4). Now integrated into the regular phone system, the call is switched to the number originally dialled (5), all without the need for operator assistance.*

Near Field Communication

near field communication (NFC) A very short-range wireless connectivity technology designed for consumer electronics, smartphones and credit cards.

Near field communication (NFC) is a very short-range wireless connectivity technology designed for consumer electronics, smartphones and credit cards. Once two NFC-enabled devices are in close proximity (touching or a few centimetres apart), they exchange the necessary communications parameters and passwords to enable Bluetooth, wi-fi or other wireless communications between the devices. Because only two devices participate, NFC establishes a peer-to-peer network. Barclays Bank was one of the first banks in the UK to offer a contactless payment system built into its credit cards. Customers can pay for goods easily and safely by waving their card across a reader in the store. The system uses NFC technology.

Bluetooth A wireless communications specification that describes how smart-phones, computers, printers and other electronic devices can be interconnected over distances of a few metres at a rate or about 2 Mbps.

Bluetooth

Bluetooth is a wireless communications specification that describes how smartphones, computers, printers and other electronic devices can be interconnected over distances of a few metres at a rate of about 2 Mbps. One important application of bluetooth is in hands-free use of mobile phones when driving, using a bluetooth headset to connect to a phone.

Ultra Wideband

Ultra wideband (UWB) communications involves the transmission of extremely short electromagnetic pulses lasting just 50 to 1,000 picoseconds. (One picosecond is one trillionth or one-millionth of one-millionth of a second.) The pulses are capable of supporting data transmission rates of 480 to 1320 Mbps over relatively short ranges of 10 to 50 metres. UWB offers several advantages over other communications means: a high throughput rate, the ability to transmit virtually undetected and impervious to interception or jamming, and a lack of interference with current communications services.

ultra wideband (UWB) A form of short-range communication that employs extremely short electromagnetic pulses lasting 50 to 1,000 picoseconds that are transmitted across a broad range of radio frequencies or several gigahertz.

Potential UWB applications include wirelessly connecting printers and other devices to desktop computers or enabling home multimedia networks. Manufacturers of medical instruments are using UWB for video endoscopes, laryngoscopes and ultrasound transducers.[6]

Infrared Transmission

Another mode of transmission, called infrared transmission, sends signals through the air via light waves at a frequency of 300 GHz and above. Infrared transmission requires line-of-sight transmission and short distances – under a few hundred metres. Infrared transmission can be used to connect a display screen, a printer and a mouse to a computer, meaning there are no wires to clutter up the desk. Some special-purpose phones can also use infrared transmission. You can use infrared to establish a wireless network, with the advantage that devices can be moved, removed and installed without expensive wiring and network connections.

The Apple remote is a remote control made for use with Apple products with infrared capabilities. It has just six buttons: Menu, Play/Pause, Volume Up, Volume Down, Previous/Rewind and Next/Fast-forward. The Mac Mini features an infrared port designed to work with the Apple remote and supports Front Row, a multimedia application that allows users to access shared iTunes and iPhoto libraries and video throughout their home.[7]

Telecommunications Hardware

Telecommunications hardware devices include modems, multiplexers and front-end processors.

Modems

At different stages in the communication process, telecommunications often uses transmission media of different types and capacities. If you use an analogue telephone line to transfer data, it can only accommodate an **analogue signal** (a variable signal continuous in both time and amplitude so that any small fluctuations in the signal are meaningful). Because a computer generates a **digital signal** representing bits, you need a special device to convert the digital signal to an analogue signal and vice versa (see Figure 6.6). Translating data from digital to analogue is called ‘modulation’, and translating data from analogue to digital is called ‘demodulation’. Thus, these devices are modulation/demodulation devices or **modems**.

Modems can dial telephone numbers, originate message sending and answer incoming calls and messages. Cellular modems in laptop computers allow people on the go to communicate with other computer systems and devices.

analogue signal A variable signal continuous in both time and amplitude so that any small fluctuations in the signal are meaningful.

digital signal A signal that represents bits.

modems A telecommunications hardware device that converts (modulates and demodulates) communications signals so they can be transmitted over the communication media.

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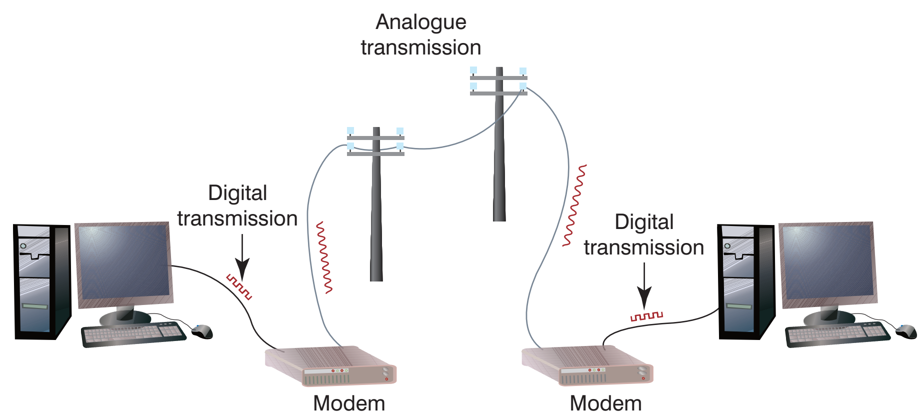
Figure 6.6 How a Modem Works *Digital signals are modulated into analogue signals, which can be carried over existing phone lines. The analogue signals are then demodulated back into digital signals by the receiving modem.*

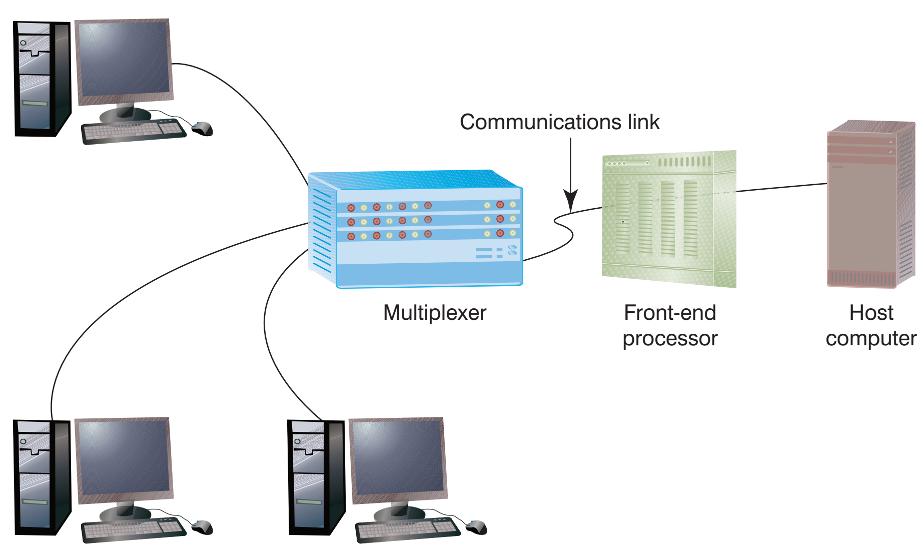


multiplexer A device that encodes data from two or more data sources onto a single communications channel, thus reducing the number of communications channels needed and therefore lowering telecommunications costs.

Multiplexers

A **multiplexer** is a device that encodes data from two or more data sources onto a single communications channel, thus reducing the number of communications channels needed and therefore lowering telecommunications costs (see Figure 6.7).

Figure 6.7 Use of a Multiplexer to Consolidate Data Communications Onto a Single Communications Link



front-end processors A special-purpose computer that manages communications to and from a computer system serving hundreds or even thousands of users.

Front-End Processors

Front-end processors are special-purpose computers that manage communications to and from a computer system serving hundreds or even thousands of users. They poll user devices to see if they have messages to send and facilitate efficient, error-free communications. By performing this work, the front-end processor relieves the primary computer system of much of the overhead processing associated with telecommunications.

Private Branch Exchange

A **private branch exchange (PBX)** is a telephone switching exchange that serves a single organization. It enables users to share a certain number of outside lines (trunk lines) to make telephone calls to people outside the organization. This sharing reduces the number of trunk lines required, which in turn reduces the organization's telephone costs. A PBX also enables the routing of calls between individuals within the organizations. The PBX can also provide many other functions including voicemail, voice paging, three-way calling, call transfer and call waiting. A VoIP-PBX can accept Voice over IP (VoIP) calls as well as traditional phone calls. With VoIP calls, the callers' voices are converted into packets of data for routing over the Internet.

private branch exchange (PBX) A telephone switching exchange that serves a single organization.

Switches, Bridges, Routers and Gateways

In addition to communications protocols, certain hardware devices switch messages from one network to another at high speeds. A **switch** uses the physical device address in each incoming message on the network to determine to which output port it should forward the message to reach another device on the same network. A **bridge** connects one local area network (LAN) to another LAN that uses the same telecommunications protocol. A **router** forwards data packets across two or more distinct networks towards their destinations through a process known as 'routing'. A **gateway** is a network device that serves as an entrance to another network.

switch A telecommunications device that uses the physical device address in each incoming message on the network to determine to which output port it should forward the message to reach another device on the same network.

bridge A telecommunications device that connects one LAN to another LAN that uses the same telecommunications protocol.

router A telecommunications device that forwards data packets across two or more distinct networks towards their destinations, through a process known as routing.

gateway A telecommunications device that serves as an entrance to another network.

6.2 Networks and Distributed Processing

A **computer network** consists of communications media, devices and software needed to connect two or more computer systems or devices. The computers and devices on the networks are called 'network nodes'. After they are connected, the nodes can share data, information and processing jobs. Increasingly, businesses are linking computers in networks to streamline work processes and allow employees to collaborate on projects. If a company uses networks effectively, it can grow into an agile, powerful and creative organization. Organizations can use networks to share hardware, programs and databases. Networks can transmit and receive information to improve organizational effectiveness and efficiency. They enable geographically separated workgroups to share information, which fosters teamwork, innovative ideas and new business strategies.

computer network The communications media, devices and software needed to connect two or more computer systems and/or devices.

Network Types

Depending on the physical distance between nodes on a network and the communications and services it provides, networks can be classified as personal area, local area, metropolitan area or wide area.

Personal Area Networks

A **personal area network (PAN)** is a wireless network that connects information technology devices within a range of ten metres or so. One device serves as the controller during wireless PAN initialization, and this controller device mediates communication within the PAN. The controller broadcasts a beacon that synchronizes all devices and allocates time slots for the devices. With a PAN, you

personal area network (PAN) A network that supports the interconnection of information technology within a range of ten metres or so.

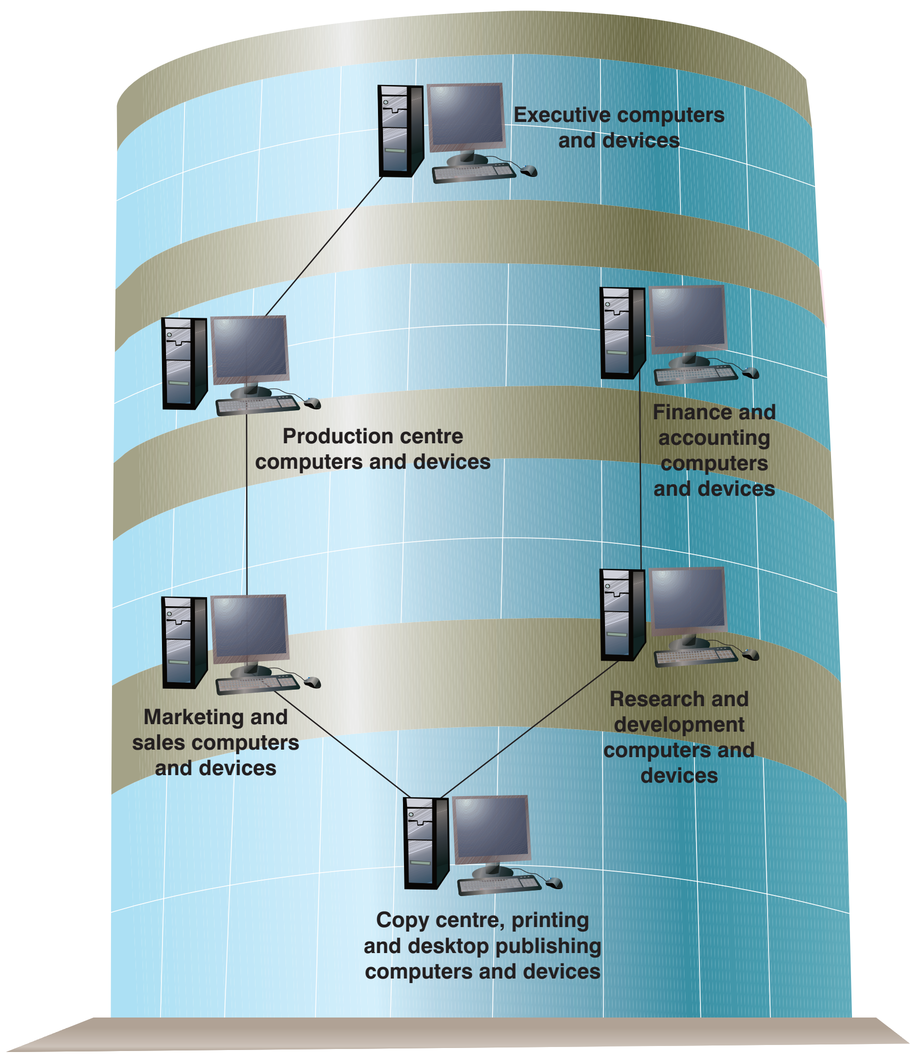
can connect a laptop, digital camera and portable printer without physical cables. You could download digital image data from the camera to the laptop and then print it on a high-quality printer – all wirelessly. The Bluetooth communication protocol is the industry standard for PAN communications.

A personal area network could be used to create a home office connecting a wireless mouse, keyboard and printer to a laptop, and the laptop to a smart TV to which videos could be cast.

Local Area Networks

A network that connects computer systems and devices within a small area, such as an office, home or several floors in a building, is a LAN. Typically, LANs are wired into office buildings and factories (see Figure 6.8). Although LANs often use unshielded twisted-pair wire, other media – including fibre-optic cable – is also popular. Increasingly, LANs are using some form of wireless communications.

Figure 6.8 **A Typical LAN** *All network users within an office building can connect to each other's devices for rapid communication. For instance, a user in research and development could send a document from her computer to be printed at a printer located in the desktop publishing centre.*



An example of a sophisticated LAN is the one that DigitalGlobe uses. DigitalGlobe is the company responsible for the detailed satellite images accessed by millions of Google Earth users. The firm uses a high-speed LAN (10 GB/sec) to connect workers to its huge file storage system (200 TB) so that new images can be quickly captured and added to its rapidly growing repository of Earth photos.[8]

A basic type of LAN is a simple peer-to-peer network that a small business might use to share files and hardware devices such as printers. In a peer-to-peer network, you set up each computer as an independent computer, but let other computers access specific files on its hard drive or share its printer. These types of networks have no server. Instead, each computer is connected to the next machine. Examples of peer-to-peer networks include Windows for Workgroups, Windows NT and AppleShare. Performance of the computers on a peer-to-peer network is usually slower because one computer is actually sharing the resources of another computer. However, these networks provide a good foundation from which small businesses can grow. The software cost is minimal, and businesses can use the network cards if they decide to enlarge the system. In addition, peer-to-peer networks are becoming cheaper, faster and easier to use for home-based businesses.

With more people working at home, a trend which began to rise following the COVID-19 pandemic, connecting home computing devices and equipment into a unified network is on the rise. Small businesses are also connecting their systems and equipment. A home or small business network can connect computers, printers, scanners and other devices. A person working on one computer, for example, can use data and programs stored on another computer's hard disc. In addition, several computers on the network can share a single printer. To make home and small business networking a reality, many companies are offering standards, devices and procedures.

Ethical and Societal Issues

The Great British Data Grab

Almost all computer communications are sent as beams of light along fibre-optic cables. (See the Information Systems @ Work case in this chapter for more information.) Light is easily reflected. If you stand in your kitchen at night with the light on and look out of the window, all that you will see is your own reflection. However, someone standing outside will be able to see you perfectly. What is happening is that the glass in the window is reflecting some of the light back to you while letting some of it travel straight through. A more refined version of this effect can be used to split a beam of light; in other words, you end up with two copies of the beam. When you do this with the fibre-optic cables that carry electronic communications, you get two perfect copies of those communications.

A previously top secret UK GCHQ government project is doing this with almost all Internet traffic that passes through British landing stations (the buildings where Internet cables leave the UK land network and continue overseas). All signals are copied. One copy continues to its intended destination, the other is saved for a few days so that it can be processed and searched. This is being done with the full knowledge and cooperation – although perhaps not willing cooperation – of the companies that manage the cables, and there have been some reports of these companies being paid for their participation. Reports also suggest that these companies are forbidden from revealing the existence of warrants compelling them to allow GCHQ access to the cables.

Codenamed Tempora, we only know about its existence through the work of whistleblower Edward Snowden. Operating indiscriminately, Tempora collects data on everyone, not just those suspected of committing a crime. Lawyers for GCHQ said it would be impossible to list the total number of

(*continued*)

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people whose data was taken because 'this would be an infinite list which we couldn't manage'. *The Guardian* newspaper reported an anonymous source with knowledge of the intelligence community saying that GCHQ was collecting a 'vast haystack of data'.

'Essentially', they said, 'we have a process that allows us to select a small number of needles in a haystack. We are not looking at every piece of straw. There are certain triggers that allow you to discard or not examine a lot of data so you are just looking at needles. If you had the impression we are reading millions of emails, we are not. There is no intention in this whole programme to use it for looking at UK domestic traffic – British people talking to each other. The vast majority of the data is discarded without being looked at … we simply don't have the resources'.

So what could GCHQ do with this data? If a terrorist emailed another terrorist to say, 'I'm going to bomb the palace tomorrow', a computer could identify this as a threatening phrase and report it to a human who would then assess what to do next. If, instead, the terrorist had used an encrypted instant messaging service, all GCHQ would have got is a meaningless string of text (see Case One in this chapter for more details on this). Even more basically, if the terrorist had emailed, 'I'm going to deliver the parcel to grandma tomorrow', then again the GCHQ computer would get nothing. Some people think this alone makes Tempora useless, although on the other hand, after the palace had been attacked, the data could be used to build a case against any suspects.

What about using data-mining algorithms to predict who the terrorists are by their online behaviour before they get up to any mischief? As we have discussed already in this book, data mining can be very good at making predictions, but in order to do this, you need data. Lots of data. If you want to predict who might buy a tin of baked beans, you need data on people who bought beans and people who did not. And there is ample data available on both. When it comes to terrorists, we may have plenty of data on people who do not commit acts of terror, but almost none on those who do, making this prediction very unlikely to succeed.

Questions

1. Should this project be kept secret? What has really changed since we all found out about it? If nothing, then what difference does it make if we know about it?
2. How would terrorists respond to this information? What could GCHQ do next?
3. Why can't data-mining algorithms be used to predict who the terrorists are?
4. Should GCHQ be allowed to collect this data?

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Metropolitan Area Networks

metropolitan area network (MAN) A telecommunications network that connects users and their devices in a geographical area that spans a campus or city.

A **metropolitan area network (MAN)** is a telecommunications network that connects users and their computers in a geographical area that spans a campus or city. Most MANs have a range of roughly 100 kilometres. For example, a MAN might redefine the many networks within a city into a single larger network or connect several LANs into a single campus LAN. EasyStreet (an Internet service provider) and OnFibre (a metro network solutions provider) designed a MAN for the city of Portland, Oregon, to provide local businesses with fast (more than 1 Gps), low-cost Internet connections.[9]

Wide Area Networks

A **wide area network (WAN)** is a telecommunications network that connects large geographic regions. A WAN might be privately owned or rented and includes public (shared users) networks. When you make a long-distance phone call or access the Internet, you are using a WAN. WANs usually consist of computer equipment owned by the user, together with data communications equipment and telecommunications links provided by various carriers and service providers (see Figure 6.9).

wide area network (WAN) A telecommunications network that ties together large geographic regions.

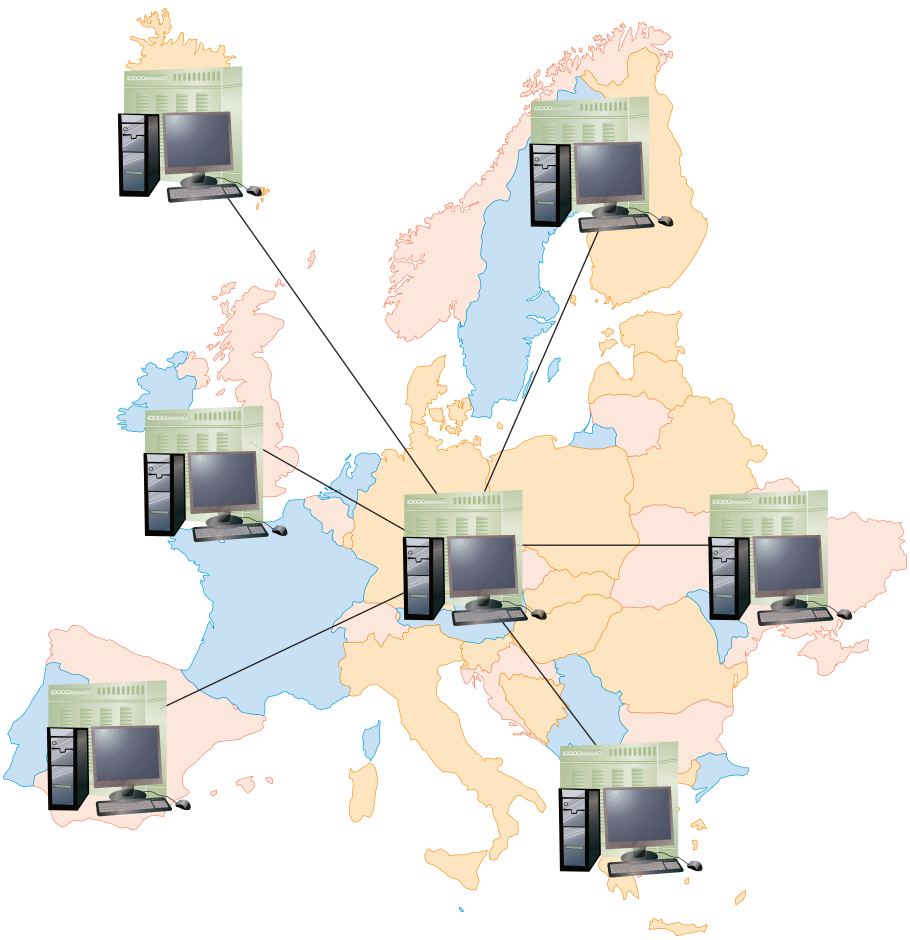


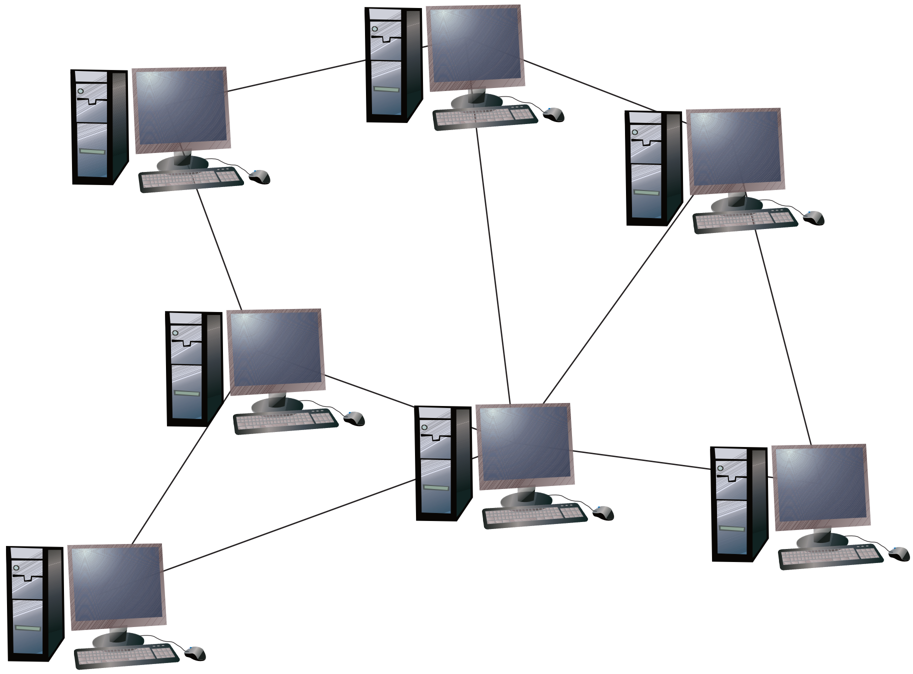
Figure 6.9 A Wide Area Network *WANs are the basic long-distance networks used around the world. The actual connections between sites, or nodes, might be any combination of satellites, microwave or cabling. When you make a long-distance telephone call or access the Internet, you are using a WAN.*

Mesh Networking

Mesh networking is a way to route communications among network nodes (computers or other devices) by allowing for continuous connections and reconfiguration around blocked paths by 'hopping' from node to node until a connection can be established. In the full mesh topology, each node (workstation or other device) is connected directly to each of the other nodes. In the partial mesh topology, some nodes might be connected to all the others, and other nodes are connected only to nodes with which they frequently exchange communications (see Figure 6.10). Mesh networks are very robust: if one node fails, all the other nodes can still communicate with each other, directly or through one or more intermediate nodes. Mesh networks are being set up to blanket large areas to provide Internet access, secure connections to corporate networks and VoIP calls. Many cities throughout Europe are setting up mesh networks to give residents, sometimes free, Internet access.

mesh networking A way to route communications between network nodes (computers or other devices) by allowing for continuous connections and reconfiguration around blocked paths by 'hopping' from node to node until a connection can be established.

Figure 6.10 Partial Mesh Network



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Distributed Processing

centralized processing Processing alternative in which all processing occurs at a single location or facility.

decentralized processing Processing alternative in which processing devices are placed at various remote locations.

When an organization needs to use two or more computer systems, it can use one of three basic processing alternatives: centralized, decentralized or distributed. With **centralized processing**, all processing occurs in a single location or facility. This approach offers the highest degree of control because a single centrally managed computer performs all data processing.

With **decentralized processing**, processing devices are placed at various remote locations. Each computer system is isolated and does not communicate with another system. Decentralized systems are suitable for companies that have independent operating divisions.

With distributed processing, computers are placed at remote locations but connected to each other via telecommunications devices. One benefit of distributed processing is that managers can allocate data to the locations that can process it most efficiently.

The 11 September 2001 terrorist attacks on the World Trade Center in New York and the relatively high level of natural disasters such as hurricane Katrina in the Gulf of Mexico in the southern USA in 2005 sparked many companies to distribute their workers, operations and systems much more widely, a reversal of the recent trend towards centralization. The goal is to minimize the consequences of a catastrophic event at one location while ensuring uninterrupted systems availability.

Client/Server Systems

Users can share data through file server computing, which allows authorized users to download entire files from certain computers designated as file servers. After downloading data to a local computer, a user can analyze, manipulate, format and display data from the file (see Figure 6.11).

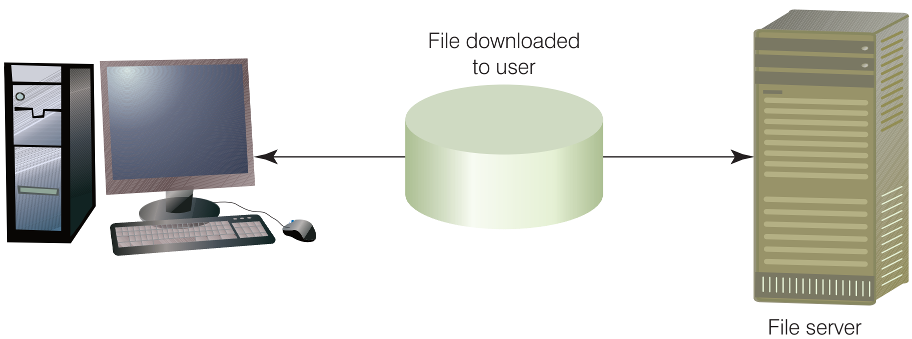


Figure 6.11 File Server Connection *The file server sends the user the entire file that contains the data requested. The user can then analyze, manipulate, format and display the downloaded data with a program that runs on the user's personal computer, and copy data back to the server.*

In **client/server** architecture, multiple computer platforms are dedicated to special functions such as database management, printing, communications and program execution. These platforms are called servers. Each server is accessible by all computers on the network. Servers can be computers of all sizes; they store both application programs and data files and are equipped with operating system software to manage the activities of the network. The server distributes programs and data to the other computers (clients) on the network as they request them. An application server holds the programs and data files for a particular application, such as an inventory database. The client or the server can do the processing. An email server sends and receives emails. A web server sends out web pages.

client/server An architecture in which multiple computer platforms are dedicated to special functions such as database management, printing, communications and program execution.

A client is any computer (often a user's personal computer) that sends messages requesting services from the servers on the network. A client can converse with many servers concurrently (see Figure 6.12).

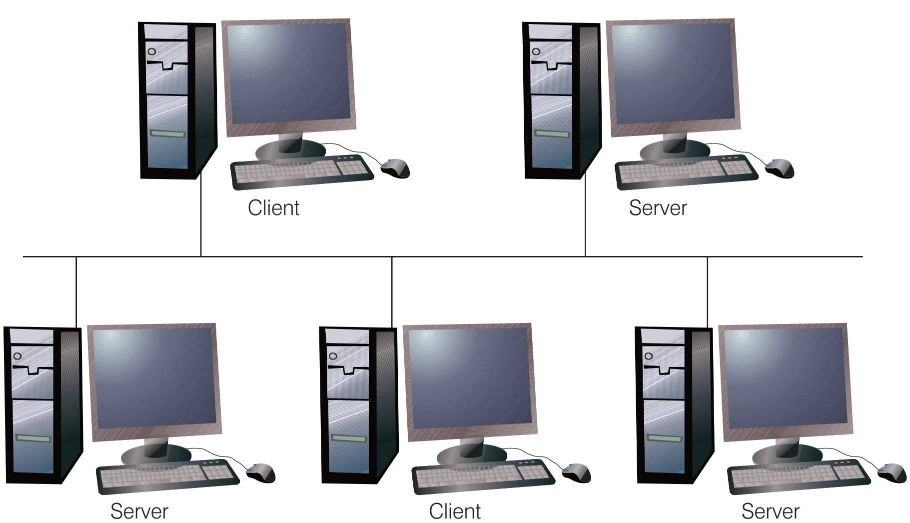


Figure 6.12 Client/Server Connection *Multiple computer platforms, called servers, are dedicated to special functions. Each server is accessible by all computers on the network. The client requests services from the servers, provides a user interface and presents results to the user.*

Communications Software

In Chapter 4 you learned that all computers have operating systems that control many functions. When an application program requires data from a disc drive, it goes through the operating system. Now consider a computer attached to a network that connects large disc drives, printers, and other equipment and devices. How does an application program request data from a disc drive on the network? The answer is through the network operating system.

network operating system (NOS) Systems software that controls the computer systems and devices on a network and allows them to communicate with each other.

A **network operating system (NOS)** is systems software that controls the computer systems and devices on a network and allows them to communicate with each other. The NOS performs the same types of functions for the network as operating system software does for a computer, such as memory and task management and coordination of hardware. When network equipment (such as printers, plotters and disc drives) is required, the NOS makes sure that these resources are used correctly. In most cases, companies that produce and sell networks provide the NOS. For example, NetWare is the NOS from Novell, a popular network environment for personal computer systems and equipment.

network-management software Software that enables a manager on a networked desktop to monitor the use of individual computers and shared hardware (such as printers), scan for viruses and ensure compliance with software licences.

Software tools and utilities are available for managing networks. With **network-management software**, a manager on a networked personal computer can monitor the use of individual computers and shared hardware (such as printers), scan for viruses and ensure compliance with software licences. Network-management software also simplifies the process of updating files and programs on computers on the network – a manager can make changes through a communications server instead of on individual computers. In addition, network-management software protects software from being copied, modified or downloaded illegally, and performs error control to locate telecommunications errors and potential network problems. Some of the many benefits of network-management software include fewer hours spent on routine tasks (such as installing new software), faster response to problems and greater overall network control.

Network management is one of the most important tasks of IS managers. In fact, poor management of the network can cause a whole company to suffer. Because companies use networks to communicate with customers and business partners, network downtime or slow performance can even mean a loss of business. Network management includes a wide range of technologies and processes that monitor the infrastructure and help IS staff identify and address problems before they affect customers, business partners or employees.

Fault detection and performance management are the two types of network-management products. Both employ the Simple Network Management Protocol (SNMP) to obtain key information from individual network components. SNMP allows anything on the network, including switches, routers, firewalls and even operating systems and server products and utilities, to communicate with management software about its current operations and state of health. SNMP can also control these devices and products, telling them to redirect traffic, change traffic priorities or even to shut down.

Fault management software alerts IS staff in real time when a device is failing. Equipment vendors place traps (code in a software program for handling unexpected or unallowable conditions) on their hardware to identify problems. In addition, the IS staff can place agents – automated pieces of software – on networks to monitor functions. When a device exceeds a given performance threshold, the agent sends an alarm to the company's IS fault management program. For example, if a CPU registers that it is more than 80 per cent busy, the agent might trigger an alarm.

Performance management software sends messages to the various devices (i.e. polls them) to sample their performance and to determine whether they are operating within acceptable levels. The devices reply to the management system with performance data that the system stores in a database. This real-time data is correlated to historical trends and displayed graphically so that the IS staff can identify any unusual variations.

Today, most IS organizations use a combination of fault management and performance management to ensure that their network remains up and running and that every network component and application is performing acceptably. With the two technologies, the IS staff can identify and resolve fault and performance issues before they affect customers and service. The latest network-management technology even incorporates automatic fixes – the network-management system identifies a problem, notifies the IS manager and automatically corrects the problem before anyone outside the IS department notices it.

Sierra Pacific is a wood products provider in the USA that, prior to installing network-management software, learned about network problems in the worst way – from users calling the network operations centre to complain. The company has operations in about 50 distributed server locations, including deep in the woods where users are connected through routers to a high-speed network. Sierra Pacific installed Systems Intrusion Analysis and Reporting Environment open-source software on all servers to collect network and performance data around the clock and forward it to a central network server. Now, Sierra Pacific has the data it needs to identify bottlenecks and failed components before users are affected.[10]

Software-Defined Networking

A typical network comprises hundreds or thousands of network devices that perform such tasks as routing and switching of data through the network, providing network access and control, and enabling access to a variety of applications and services. In today's current network environment, each network device must be configured individually, usually via manual keyboard input. For a network of any size, this becomes a labour-intensive and error-prone effort, making it difficult to change the network so it can meet the changing needs of the organization. Software-defined networking (SDN) is an emerging approach to networking that allows network administrators to manage a network via a controller that does not require physical access to all the network devices. This approach automates tasks such as configuration and policy management and enables the network to dynamically respond to application requirements. As a result, new applications can be made available sooner, the risk of human error (a major contributor to network downtime) is reduced, and overall network support and operations costs are also reduced. Google is implementing Andromeda, the underlying software-defined networking architecture that will enable Google's cloud computing services to scale better, more cheaply and more quickly. With SDN, even though many customers are sharing the same network, they can be configured and managed independently with their own address management, firewalls and access control lists. Google competitors in cloud services, such as Microsoft and Amazon, also employ software-defined networks.[11]

Securing Data Transmission

The interception of confidential information by unauthorized individuals can compromise private information about employees or customers, reveal marketing or new product development plans, or cause organizational embarrassment. Organizations with widespread operations need a way to maintain the security of communications with employees and business partners, wherever their facilities are located.

Guided media networks have an inherently secure feature: only devices physically attached to the network can access the data. Wireless networks, on the other hand, are surprisingly often configured by default to allow access to any device that attempts to 'listen to' broadcast communications. Action must be taken to override the defaults.

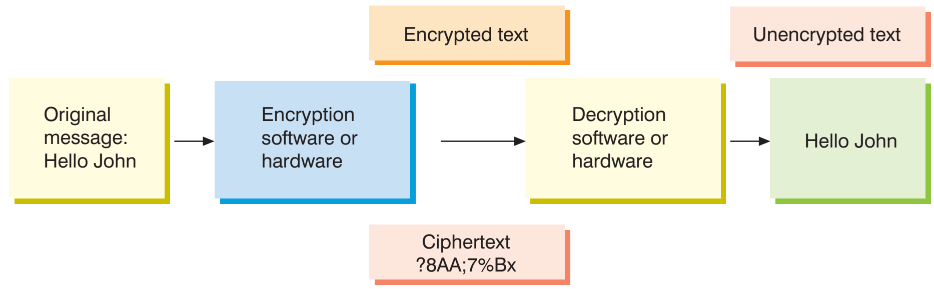
Encryption of data is one approach taken to protect the security of communications over both wired and wireless networks. **Encryption** is the process of converting an original message into a form that can be understood only by the intended receiver. An **encryption key** is a variable value that is applied (using an algorithm) to a set of unencrypted text to produce encrypted text or to decrypt encrypted text (see Figure 6.13). The key is chosen from one of a large number of possible encryption keys. The longer the key, the greater the number of possible encryption keys. An encryption protocol based on a 56-bit key, for example, has 256 different possible keys, while one based on a 128-bit key has 2,128 different possible keys. Of course, it is essential that the key be kept secret from possible interceptors. A hacker who obtains the key by whatever means can recover the original message from the encrypted data.

encryption The process of converting an original message into a form that can be understood only by the intended receiver.

encryption key A variable value that is applied (using an algorithm) to a set of unencrypted text to produce encrypted text or to decrypt encrypted text.

6

Figure 6.13
Encryption Process



Encryption methods rely on the limitations of computing power for their security. If breaking a code requires too much computing power, even the most determined hacker cannot be successful.

With headquarters in Dallas, Texas, 7-Eleven operates franchises or licenses over 8,800 stores in North America and another 33,900 in 16 countries. The company uses encryption to secure its email. Todd Cohen, leader of 7-Eleven's Information Security, Risk and Compliance practice, states that 'The protection of sensitive partner information is essential to our leadership as a trusted retailer. Email is a critical communication tool in everyday business with our partners, and [encryption services] enable us to use email securely and confidently'.[12]

Securing Wireless Networks

WEP and WPA are the two main approaches to securing wireless networks such as wi-fi and WiMAX. Wired equivalent privacy (WEP) used to use encryption based on 64-bit key, which has been upgraded to a 128-bit key. WEP represents an early attempt at securing wireless communications and is not difficult for hackers to crack. Most wireless networks now use the Wi-Fi Protected Access (WPA) security protocol that offers significantly improved protection over WEP.

The following steps, while not foolproof, help safeguard a wireless network:

- *Connect to the router and change the default logon (admin) and password (password) for the router*. These defaults are widely known by hackers.
- *Create a service set identifier (SSID).* This is a 32-character unique identifier attached to the header portion of packets sent over a wireless network that differentiates one network from another. All access points and devices attempting to connect to the network must use the same SSID.
- *Configure the security to WPA.* Surprisingly, many routers are shipped with encryption turned off.
- *Disable SSID broadcasting.* By default, wireless routers broadcast a message communicating the SSID so wireless devices within range (such as a laptop) can identify and connect to the wireless network. If a device doesn't know the wireless network's SSID, it cannot connect. Disabling the broadcasting of the SSID will discourage all but the most determined and knowledgeable hackers.
- Configure each wireless computer on the network to access the network by setting the security to WPA and entering the same password entered to the router.

War driving involves hackers driving around with a laptop and antenna trying to detect insecure wireless access points. Once connected to such a network, the hacker can gather enough traffic to analyze and crack the encryption.

Virtual Private Network (VPN)

The use of a virtual private network is another means used to secure the transmission of communications. A **virtual private network (VPN)** is a private network that uses a public network (usually the Internet) to connect multiple remote locations. A VPN provides network connectivity over a potentially long physical distance and thus can be considered a form of wide area network. VPNs support secure, encrypted connections between a company's employees and remote users through a third-party service provider. Telecommuters, salespeople and frequent travellers find the use of a VPN to be a safe, reliable, low-cost way to connect to their corporate intranets. It also proved invaluable for facilitating smooth remote working for whole business teams during the COVID-19 pandemic. Often, users are provided with a security token that displays a constantly changing password to log onto the VPN. This solution avoids the problem of users forgetting their password while providing added security through use of a password constantly changing every 30 to 60 seconds.

virtual private network (VPN) A private network that uses a public network (usually the Internet) to connect multiple remote locations.

Werner Enterprises is a transportation and logistics company with a fleet of 7,250 trucks, nearly 25,000 tractors, and more than 13,000 employees and independent contractors.[13] Most of its business is in North America, but it is expanding globally with customers in Africa, China, Europe and Latin America. Werner employs a VPN solution to link its Shanghai operations centre to its headquarters and data centre in Omaha, Nebraska, so that employees can access load management systems to support global operations.[14]

6.3 The Internet

The Internet is the world's largest computer network. Actually, the Internet is a collection of interconnected networks, all freely exchanging information. Nobody knows exactly how big the Internet is because it is a collection of separately run, smaller computer networks. There is no single place where all the connections are registered. Figure 6.14 shows the staggering growth of the Internet, as measured by the number of Internet host sites or domain names. Domain names are discussed later in the chapter.

The Internet is truly international in scope, with users on every continent – including Antarctica. China has spent many billions on its telecommunications infrastructure in the last few years. China, however, restricts the use of the Internet.[15]In 2005, for example, China implemented new Internet rules. According to the Xinhua News Agency of China, '[Only] healthy and civilized news and information that is beneficial to the improvement of the quality of the nation, beneficial to its economic development and conductive to social progress will be allowed. The sites are prohibited from spreading news and information that goes against state security and public interest'. The penalties for sharing unauthorized information are severe, with more than one Internet user being imprisoned for things they have published online.

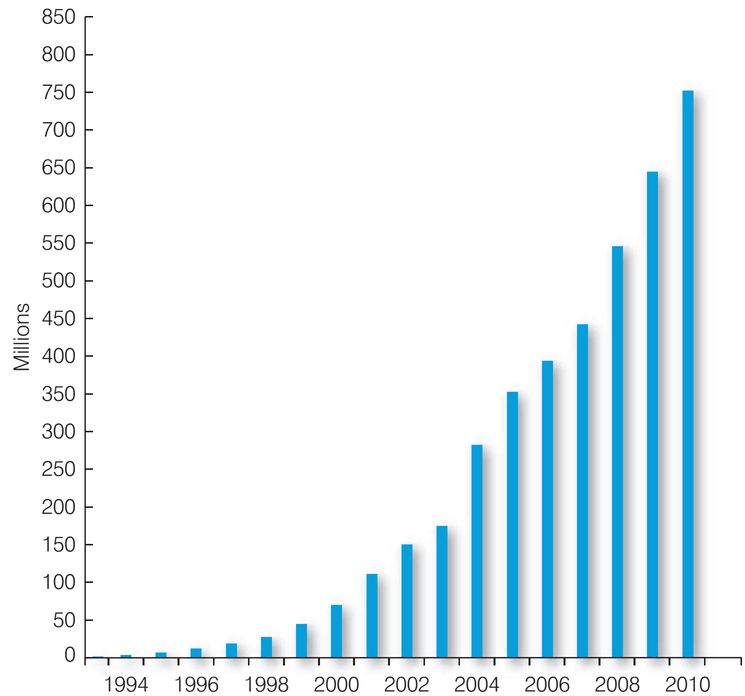
The ancestor of the Internet was the **ARPANET**, a project started by the US Department of Defense (DoD) in 1969. The ARPANET was both an experiment in reliable networking and a means to link DoD and military research contractors, including many universities doing military-funded research. (ARPA stands for the Advanced Research Projects Agency, the branch of the DoD in charge of awarding grant money. The agency is now known as DARPA – the added D is for Defense.) The ARPANET was highly successful, and every university in the country wanted to use it. This wildfire growth made it difficult to manage the ARPANET, particularly its large and rapidly growing number of university sites. So, the ARPANET was broken into two networks: MILNET, which included all military sites, and a new, smaller ARPANET, which included all the non-military sites. The two networks remained connected, however, through use of the **Internet Protocol (IP)**, which enables traffic to be routed from one network to another as needed. Katie Hafner's book, *Where Wizards Stay Up Late: The Origins of the Internet*, gives a detailed description of the history of the Internet.[16]

ARPANET A project started by the US Department of Defense (DoD) in 1969 as both an experiment in reliable networking and a means to link DoD and military research contractors, including many universities doing military-funded research.

Internet Protocol (IP) A communication standard that enables traffic to be routed from one network to another as needed.

6

Figure 6.14 Internet Growth: Number of Internet Domain Names



Today, people, universities and companies are attempting to make the Internet faster and easier to use. Robert Kahn, who managed the early development of the ARPANET, wants to take the Internet to the next level. He is president of the non-profit organization, National Research Initiatives, which provides guidance and funding for the development of a national information infrastructure. The organization is looking into using 'digital objects', which allow all types of computer systems to use and share programs and data. To speed Internet access, a group of corporations and universities called the University Corporation for Advanced Internet Development (UCAID) is working on a faster, new Internet. Called Internet2 (I2), Next Generation Internet (NGI) or Abilene (depending on the universities or corporations involved), the new Internet offers the potential of faster Internet speeds, up to 2 Gbps or more.[17] Some I2 connections can transmit data at 100 Mbps, which is about 200 times faster than dial-up connections. This speed would allow you to transfer the contents of a DVD in less than a minute.

How the Internet Works

The Internet transmits data from one computer (called a host) to another (see Figure 6.15). If the receiving computer is on a network to which the first computer is directly connected, it can send the message directly. If the receiving and sending computers are not directly connected to the same network, the sending computer relays the message to another computer, which forwards it on. The message might be sent through a router to reach the forwarding computer. The forwarding host, which needs to be attached to at least one other network, delivers the message directly if it can or passes it to another forwarding host. A message can pass through a dozen or more forwarders on its way from one part of the Internet to another.

The various networks that are linked to form the Internet work in much the same way – they pass data around in chunks called packets, each of which carries the addresses of its sender and its receiver. The set of conventions used to pass packets from one host to another is known as the Internet Protocol (IP). Many other protocols are used in connection with IP. The best known is the **Transmission Control Protocol (TCP)**, which operates at the transport layer. Many people use TCP/

Transmission Control Protocol (TCP) The widely used transport-layer protocol that most Internet applications use with IP.

IP as an abbreviation for the combination of TCP and IP used by most Internet applications. After a network following these standards links to a **backbone** – one of the Internet's high-speed, long-distance communications links – it becomes part of the worldwide Internet community.

backbone One of the Internet's high-speed, long-distance communications links.

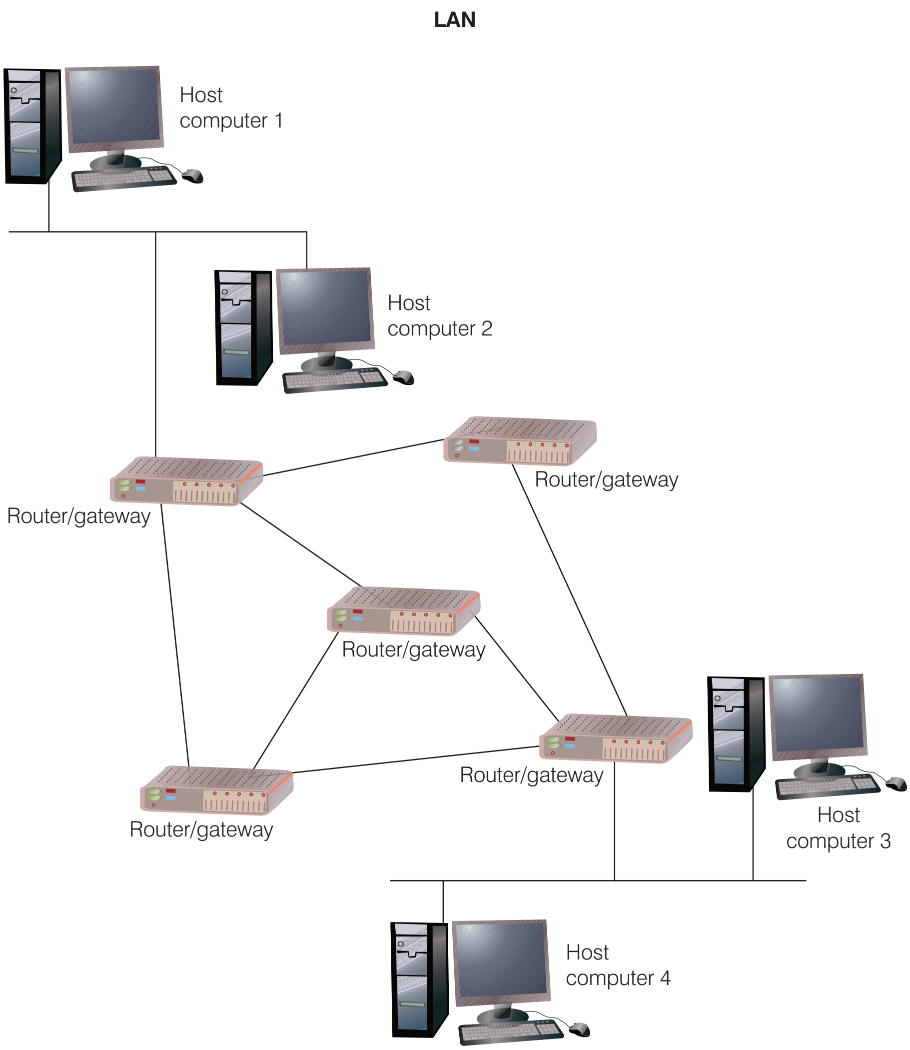


Figure 6.15 Routing Messages Over the Internet

Each computer on the Internet has an assigned address called its **uniform resource locator (URL)**, to identify it to other hosts. The URL gives those who provide information over the Internet a standard way to designate where Internet elements such as servers, documents and newsgroups can be found. Consider the URL for Cengage Learning, http://www.cengage.co.uk.

uniform resource locator (URL) An assigned address on the Internet for each computer.

The 'http' specifies the access method and tells your software to access a file using the Hypertext Transport Protocol. This is the primary method for interacting with the Internet. In many cases, you don't need to include http:// in a URL because it is the default protocol. Thus, http://www.cengage.co.uk can be abbreviated to www.cengage.co.uk.

The 'www' part of the address signifies that the files associated with this website reside on the World Wide Web server of 'cengage.co.uk'. The 'cengage.co.uk' itself is the domain name that identifies the Internet host site. Domain names must adhere to strict rules. They always have at least two parts, with each part separated by a dot (full stop). For some Internet addresses, the far right part of the domain name is the country code (such as uk for the United Kingdom, au for Australia, ca for Canada, dk for Denmark, fr for France and jp for Japan). Many Internet addresses have a code denoting affiliation categories. Table 6.2 contains a few popular categories. The far left part of the domain name identifies the host network or host provider, which might be the name of a university or business.

Table 6.2 Some Top-Level Domain Affiliations

Affiliation ID	Affiliation
com	Commercial organizations
edu	Educational sites (mostly based in the USA)
gov	Government sites (mostly based in the USA)
net	Networking organizations
org	Organizations
scot	Related to Scotland and Scottish culture

Originally, Herndon, Virginia-based Network Solutions, Inc. (NSI), was the sole company in the world with the direct power to register addresses using .com, .net or .org domain names. However, its government contract ended in October 1998, as part of the US government's move to turn management of the web's address system over to the private sector. Today, other companies, called registrars, can register domain names, and additional companies are seeking accreditation to register domain names from the Internet Corporation for Assigned Names and Numbers (ICANN). Some registrars are concentrating on large corporations, where the profit margins might be higher, compared with small businesses or individuals.

Internet service provider (ISP) Any company that provides people or organizations with access to the Internet.

An **Internet service provider (ISP)** is any company that provides people and organizations with access to the Internet. Thousands of organizations serve as Internet service providers, ranging from universities to major communications giants such as BT and AT&T. To use this type of connection, you must have an account with the service provider and software that allows a direct link via TCP/IP. In most cases, ISPs charge a monthly fee of around €20 for unlimited Internet connection through a standard modem. Some ISPs are experimenting with low-fee or no-fee Internet access, though strings are attached to the no-fee offers in most cases, typically that the user must subscribe to telephone services as well.

6.4 Internet Applications

Many people believe the terms 'Internet' and 'World Wide Web' are synonymous. However the web, which is examined next, is just one application of the Internet. Others also discussed in this section are email, telnet and FTP. More applications are given in Chapter 10.

The World Wide Web

World Wide Web (WWW or W3) A collection of tens of thousands of independently owned computers that work together as one in an Internet service.

The **World Wide Web** was developed by Tim Berners-Lee at CERN, the European Organization for Nuclear Research in Geneva. He originally conceived of it as an internal document-management system. From this modest beginning, the World

Wide Web (web, WWW or W3) has grown to a collection of tens of thousands of independently owned computers that work together as one in an Internet service. These computers, called web servers, are scattered all over the world and contain every imaginable type of data. Thanks to the high-speed Internet circuits connecting them and some clever cross-indexing software, users can jump from one web computer to another effortlessly, creating the illusion of using one big computer. Because of its ability to handle multimedia objects, including linking multimedia objects distributed on web servers around the world, the web has become the most popular means of information access on the Internet today.

The web is a menu-based system that uses the client/server model. It organizes Internet resources throughout the world into a series of menu pages or screens that appear on your computer. Each web server maintains pointers or links to data on the Internet and can retrieve that data. However, you need the right hardware and telecommunications connections, or the web can be painfully slow.

Data can exist on the web as ASCII characters, word-processing files, audio files, graphic and video images, or any other sort of data that can be stored in a computer file. A website is like a magazine, with a cover page called a **home page** which includes links to the rest of its material. The words on a website are typically written in hypertext. **Hypertext** allows the linking of certain words to other web pages, so users can click on them to access related material. This feature gives the web its name, as all information is linked together like a spider's web.

home page A cover page for a website that has graphics, titles and text.

hypertext Text used to connect web pages, allowing users to access information in whatever order they wish.

Hypertext Markup Language (HTML) is the standard page description language for web pages. One way to think about HTML is as a set of highlighter pens that you use to mark up plain text to make it a web page – one colour for the headings, another for bold and so on. The **HTML tags** let the browser know how to format the text: as a heading, as a list or as main text, for example. HTML also tells whether pictures, videos and other elements should be inserted, and where they should go. Users mark up a page by placing HTML tags before and after a word or words. For example, to turn a sentence into a heading, you place the <h1> tag at the start of the sentence. At the end of the sentence, you place the closing tag </h1>. When you view this page in your browser, the sentence will be displayed as a heading. So, an HTML file is made up of two things: text and tags. The text is your message, and the tags are codes that mark the way words will be displayed. All HTML tags are enclosed in a set of angle brackets (< and >), such as <h2>. The closing tag has a forward slash in it, such as for closing bold. Consider the following text and tags:

Hypertext Markup Language (HTML) The standard page description language for web pages.

HTML tags Codes that let the web browser know how to format text – as a heading, as a list, or as body text – and whether images, sound or other elements should be inserted.

<h1 align="center">Principles of Business Information Systems</h1>

This HTML code centres Principles of Information Systems as a major, or level 1, heading. The 'h1' in the HTML code indicates a first-level heading. On some web browsers, the heading might be 14-point type size with a Times Roman font. On other browsers, it might be a larger 18-point size in a different font. There is a standard, but not all browsers stick to it. Figure 6.16 shows a simple document and its corresponding HTML tags. Notice the <html> tag at the top indicating the beginning of the HTML code. The <title> indicates the beginning of the title: 'Cengage Learning – Shaping the Future of Global Learning'. The </title> tag indicates the end of the title.

Some newer web standards are gaining in popularity, including Extensible Markup Language (XML), Extensible Hypertext Markup Language (XHTML), Cascading Style Sheets (CSS), Dynamic HTML (DHTML) and Wireless Markup Language (WML). WML can display web pages on small screens, such as smartphones and PDAs. XHTML is a combination of XML and HTML that has been approved by the World Wide Web Consortium (W3C).

Extensible Markup Language (XML) is a markup language for web documents containing structured information, including words and pictures. XML does not have a predefined tag set. With HTML, for example, the <h1> tag always means

Extensible Markup Language (XML) The markup language for web documents containing structured information, including words, pictures and other elements.

a first-level heading. The content and formatting are contained in the same HTML document. With XML, web documents contain the content of a web page. The formatting of the content is contained in a separate style sheet. A few typical instructions in XML follow:

<chapter>Hardware
<topic>Input Devices
<topic>Processing and Storage Devices
<topic>Output Devices

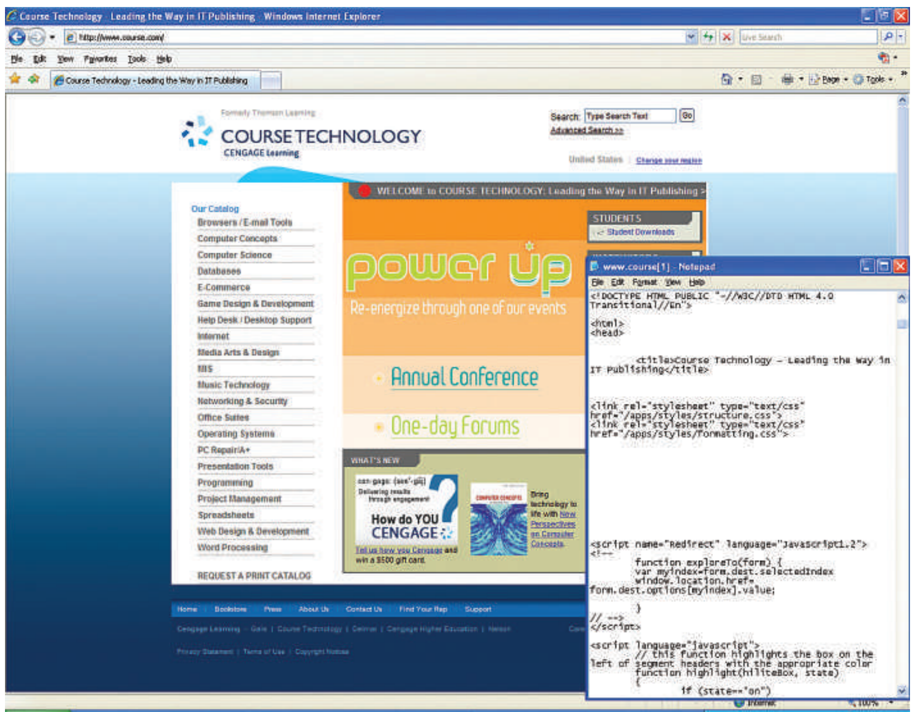


Figure 6.16 **Sample Hypertext Markup Language** *Shown on the left of the screen is a document, and at the right are the corresponding HTML tags.*

How the preceding content is formatted and displayed on a web page is contained in the corresponding style sheet, such as the following cascading style sheet (CSS). Note that the chapter title 'Hardware' is displayed on the web page in a large font (18 points). 'Hardware' will appear in bold blue text. 'Input Devices' and the other titles will appear in a smaller font (12 points) in italic red text:

chapter: (font-size: 18pt; color: blue; font-weight: bold; display: block; font-family: Arial; margin-top: 10pt; margin-left: 5pt)
topic: (font-size: 12pt; color: red; font-style: italic; display: block; font-family: Arial; margin-left: 12pt)

XML includes the capabilities to define and share document information over the web. A company can use XML to exchange ordering and invoicing information with its customers. CSS improves web page presentation, and DHTML provides dynamic presentation of web content. These standards move more of the processing for animation and dynamic content to the web browser and provide quicker access and displays.

web browser Software that creates a unique, hypermedia-based menu on a computer screen, providing a graphical interface to the web.

hypermedia An extension of hypertext where the data, including text, images, video and other media, on web pages is connected allowing users to access information in whatever order they wish.

Web Browsers

A **web browser** translates HTML so you can read it. It provides a graphical interface to the web. The menu consists of graphics, titles and text with hypertext links. **Hypermedia** links you to Internet resources, including text documents, graphics, sound files and newsgroup servers. As you choose an item or resource, or move from one document to another, you might be accessing various computers on the Internet without knowing it, while the web handles all the connections. The beauty of web browsers and the web is that they make surfing the Internet fun. Clicking with a mouse on a highlighted word or graphic whisks you effortlessly to computers halfway around the world. Most browsers offer basic features such as support for backgrounds and tables, displaying a web page's HTML source code and a way to create hot lists of your favourite sites. Web browsers enable net surfers to view more complex graphics and 3D models, as well as audio and video material, and to run small programs embedded in web pages called **applets**. A web browser plug-in is an external program that is executed by a web browser when it is needed. For example, if you are working with a web page and encounter an Adobe pdf file, the web browser will typically run the external Adobe pdf reader program or plug-in to allow you to open the file. Microsoft Internet Explorer and Google Chrome are examples of web browsers for PCs. Safari is a popular web browser from Apple for their Macintosh computer, and Mozilla Firefox is a web browser available in numerous languages that can be used on PCs, computers with the Linux operating system and Apple Mac computers.

applets A small program embedded in web pages.

Information Systems @ Work

Tech Firms Plan the Highest Capacity Atlantic Data Link

According to the European Subsea Cables Association, 97 per cent of the world's communications are transported around the world via fibre-optic submarine cables. Subsea cables are bundles of fibre-optic cables, thin strands of glass just a little thicker than a human hair. Data is transmitted along the cables as a beam of light and can therefore reach the other side of the planet – to all intents and purposes – immediately. (See the Ethical and Societal Issues case in this chapter for more information about the light that travels along these cables.)

Each strand is capable of carrying vast amounts of information, upwards of 400 Gb per second. The first subsea communications cable was laid in 1850 between the UK and France to carry a telegraph signal. Modern cables, all 361 of them, connect the entire planet, and they lie deep, preferably buried under the sea floor, although sometimes they just rest on the bottom. With all the insulation and water proofing needed they are just too big to get your hands around and because of their size can be a danger to fishing boats if they get caught on them. Fishing equipment and ships' anchors can damage the cables, which is why, particularly on the continental shelf, it's best to bury them. The most common method of doing this is a cable plough. The plough sinks to the bottom and is pulled along by a ship at the surface. The front of the plough digs a shallow trench in the sea floor, the cable slides in and the back of the plough covers it up.

Microsoft and Facebook teamed up to build a link between the USA and Europe in order to quickly and cheaply move data between their data centres. Microsoft wanted to use the cable to boost its cloud service while Facebook committed to expanding global Internet access.

The cable stretches from Virginia in the USA to Bilbao, Spain and is being managed by Spanish telecommunications firm Telefonica. They sell any unused capacity on the cable to other customers. Called MAREA, the cable carries more data than any other, a staggering 160 terabits per second, and is over 6,000 km long. Construction began in August 2016 and was completed a year later. Microsoft's director of global network acquisition, Frank Rey, said, 'This marks an important new step in building the next generation infrastructure of the internet'.

In the past, the two companies had joined in with a group of telecom companies that operate subsea cables, but this didn't give them the speed and control that they needed. 'The consortium model is much slower than what we would like', says Najam Ahmad, Facebook's vice president of network engineering.

Bilbao is already a landing point for one cable, the *TGN-Western Europe link*, and it has good connections into Spain. Most trans-Atlantic cables join the USA to the UK, but Microsoft and Facebook may have had security fears about landing their cable in the UK (again see the Ethical and Societal Issues case in this chapter). Landing sites have to have little marine traffic (boats), generally calm conditions and allow the cables to be buried as described above, to avoid damage.

Questions

1 Why do technology companies want direct control over communication cables?

2 Was this good news for the people of Virginia and Bilbao?

3 How will this improve Microsoft's cloud service?

4 Why are good connections so important in choosing a landing site?

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Search Engines and Web Research

search engines A web search tool.

Looking for information on the web is like browsing in a library – without the alphabetic listing of books in the card catalogue, it is difficult to find information. Web search tools – called **search engines** – take the place of the card catalogue. Most search engines, such as Google, are free. They make money by, among other things, charging advertisers to put ad banners in their search engine results. Companies often pay a search engine for a sponsored link, which is usually displayed at the top of the list of links for an Internet search. Google handles nearly 90 per cent of Internet searches.[18]

Search engines that use keyword indexes produce an index of all the text on the sites they examine. Typically, the engine reads at least the first few hundred words on a page, including the title and any keywords or descriptions that the author has built into the page structure. The engine throws out common words such as 'and', 'the', 'by' and 'for'. The engine assumes remaining words are valid page content; it then alphabetizes these words (with their associated sites) and places them in an index where they can be searched and retrieved. Some companies include a meta tag in the HTML header for search engine robots from sites such as Google to find and use. Meta tags are not shown on the web page when it is displayed; they only help search engines discover and display a website. To place the search results in the most relevant order, Google counts the number of links that are made to each from other websites and puts the one with the most at the top.

Today's search engines do more than look for words, phrases or sentences on the web. For example, you can use Google to search for images and video.[19] You can even search for geographic locations to get a view from the skies using satellites.[20] Google, for example, offers Google Maps and Google Earth to provide aerial views. After downloading and installing Google Earth, you can type an address and Google will show you the neighbourhood or even a house in some cases. Microsoft Virtual Earth and Local Search also give aerial views and close-ups of some locations, including retail stores in some cases.[21] You can also use news organizations' websites, such as the BBC's (www.bbc.co.uk/news), to access current information on a variety of topics. Some websites maintain versions in different languages, especially for research purposes. In addition, many ordinary web users are publishing lists of their favourite web pages along with explanations of what they are, to classify web content and to make it easier for them (and others) to retrieve information. Such lists are known as 'folksonomies', although this word has been voted one of the most annoying Internet terms.

Web Programming Languages

There are a number of important web programming languages. **Java**, for example, is an object-oriented programming language from Sun Microsystems based on the C++ programming language, which allows small programs – the applets mentioned earlier – to be embedded within an HTML document. When the user clicks the appropriate part of an HTML page to retrieve an applet from a web server, the applet is downloaded onto the client workstation, where it begins executing. Unlike other programs, Java software can run on any type of computer. Programmers use Java to make web pages come alive, adding splashy graphics, animation and real-time updates.

Java An object-oriented programming language from Sun Microsystems based on C++ that allows small programs (applets) to be embedded within an HTML document.

The user accesses the web page from a web server. If the user clicks the app rectangle to execute the Java applications, the client's computer checks for a copy on its local hard drive. If it does not find the applet, the client requests the web server to download the applet.

The web server that delivers the Java applet to the web client cannot determine what kind of hardware or software environment the client is running, and the developer who creates the Java applet does not have to worry about whether it will work correctly on Windows, UNIX or Mac OS. Java is thus often described as a 'cross-platform' programming language.

In addition to Java, companies use a variety of other programming languages and tools to develop websites. Ruby on Rails is a popular software framework for developing web applications that is optimized for programming productivity. It has been used by companies like Airbnb, Fab.com and Hulu to develop their web-based products. VBScript and ActiveX (used with Internet Explorer) are Internet languages used to develop web pages and perform important functions, such as accepting user input. Hypertext Preprocessor, or PHP, is an open-source programming language. PHP code or instructions can be embedded directly into HTML code. Unlike some other Internet languages, PHP can run on a web server, with the results being transferred to a client computer. PHP can be used on a variety of operating systems. It can also be used with a variety of database management systems, such as DB2, Oracle, Informix, MySQL and many others. These characteristics – running on different operating systems and database management systems, and being an open-source language – make PHP popular with many web developers.

Developing Web Content

The art of web design involves working within the technical limitations of the web and using a set of tools to make appealing designs. A study at Glamorgan University Business School in Wales, for example, concluded that women prefer web pages with more colour in the background and informal pictures and images.[22] Men prefer darker colours and like 3D, moving images. You can create a web page using one of the following approaches: (a) write your copy with a word processor and then use an HTML converter to convert the page into HTML format; (b) use an HTML editor to write text (it will add HTML tags at the same time); (c) edit an existing HTML template (with all the tags ready to use) to meet your needs; or (d) use an ordinary text editor such as Notepad and type the start and end tags for each item.

After you develop web content, your next step is to place or publish the content on a web server so others can access it. Popular publishing options include using ISPs, free sites and web hosting. BT's starter package comes with 5 GB of web space and users can pay to increase this.[23] Free sites offer limited space for a website. In return, free sites often require the user to view advertising or agree to other terms and conditions. Web hosting services provide space on their websites for people and businesses that don't have the financial resources, time or skills to host their own website. A web host charges a monthly fee, depending on services offered. Some web hosting sites include domain name registration, web authoring software, and activity reporting and monitoring of the website. Often, FTP (described later in this chapter) is used to copy files from the developer's computer to the web server.

Some web developers are creating programs and procedures to combine two or more websites into one website, called a 'mash-up'.[24] A mash-up is named for the process of mixing two or more (often hip-hop) songs into one song. A website containing crime information, for example, can be mashed up with a mapping website to produce a website with crime information placed on top of a map of a metropolitan area. People are becoming very creative in how they mash up several websites into new ones. Mashing up websites is becoming popular, but not everyone is happy with the practice. Some companies are trying to block the mash-up of the content on their website without permission.

After a website has been constructed, a content management system (CMS) can keep the website running smoothly. CMS consists of both software and support. Companies that provide CMS can charge from €11,000 to more than €400,000 annually, depending on the complexity of the website being maintained and the services being performed. Adobe Experience Manager is an example of a CMS.

Many products make it easy to develop web content and interconnect web services. Microsoft, for example, has introduced a development and web services platform called .NET. The .NET platform allows developers to use different programming languages to create and run programs, including those for the web. The .NET platform also includes a rich library of programming code to help build XML web applications.

Web Services

web services Standards and tools that streamline and simplify communication among websites for business and personal purposes.

Web services consist of standards and tools that streamline and simplify communication among websites, promising to revolutionize the way we develop and use the web for business and personal purposes. Internet companies, including Amazon, eBay and Google, are now using web services. Amazon, for example, has developed Amazon Web Services (AWS) to make the contents of its huge online catalogue available by other websites or software applications.

The key to web services is XML. Just as HTML was developed as a standard for formatting web content into web pages, XML is used within a web page to describe and transfer data between web service applications. XML is easy to read and has wide industry support. Besides XML, three other components are used in web service applications:

1. SOAP (Simple Object Access Protocol) is a specification that defines the XML format for messages. SOAP allows businesses, their suppliers and their customers to communicate with each other. It provides a set of rules that makes it easier to move information and data over the Internet.
2. WSDL (Web Services Description Language) provides a way for a web service application to describe its interfaces in enough detail to allow a user to build a client application to talk to it. In other words, it allows one software component to connect to and work with another software component on the Internet.
3. UDDI (Universal Discovery Description and Integration) is used to register web service applications with an Internet directory so that potential users can easily find them and carry out transactions over the web.

Developing Web Content and Applications

Popular tools for creating web pages and managing websites include Adobe Dreamweaver, Microsoft Expression Web and the open source alternative Nvu. Such software allows users to create web pages using an interface similar to a word-processor. The software converts what the user types into HTML code and creates hyperlinks to connect the pages.

Web application frameworks have arisen to simplify web development by providing the foundational code – or framework – for a professional interactive website which users can customize as they need. Websites are usually developed on a user's computer and then uploaded to a web server. Although a business may manage its own web server, the job is often outsourced to a web-hosting company.

Email

Email or electronic mail is a method of sending communications over computer networks. It is no longer limited to simple text messages. Depending on your hardware and software, and the hardware and software of your recipient, you can embed sound and images in your message and attach files that contain text documents, spreadsheets, graphics or executable programs. Email travels through the systems and networks that make up the Internet. Gateways can receive email messages from the Internet and deliver them to users on other networks. Thus, you can send email messages to anyone in the world if you know that person's email address and you have access to the Internet or another system that can send email. For large organizations whose operations span a country or the world, email allows people to work around the time zone changes. Some users of email claim that they eliminate two hours of verbal communications for every hour of email use.

Some companies use bulk email to send legitimate and important information to sales representatives, customers and suppliers around the world. With its popularity and ease of use, however, some people feel they are drowning in too much email. Many emails are copies sent to a large list of corporate users. Users are taking a number of steps to cope with and reduce their mountain of email. For instance, some users only look at their in-boxes once each day. Many companies have software that scans incoming messages for possible junk or bulk email, called spam, and deletes it or places it in a separate file. Some have banned the use of copying others in on emails unless it is critical.

Telnet and FTP

Telnet is a terminal emulation protocol that enables you to log on to other computers on the Internet to gain access to their publicly available files. Telnet is particularly useful for perusing library holdings and large databases. It is also called 'remote logon'.

File Transfer Protocol (FTP) is a protocol that describes a file transfer process between a host and a remote computer. Using FTP, users can copy files from one computer to another. Companies, for example, use it to transfer vast amounts of business transactional data to the computers of their customers and suppliers. You can also use FTP to gain access to a wealth of free software on the Internet. FTP can be used to upload or download content to a website.

Telnet A terminal emulation protocol that enables users to log on to other computers on the Internet to gain access to public files.

File Transfer Protocol (FTP) A protocol that describes a file transfer process between a host and a remote computer and allows users to copy files from one computer to another.

Cloud Computing

Cloud computing refers to a computing environment in which software and storage are provided as an Internet service and accessed by users through their web browser. Google and Yahoo!, for example, store the email of many users, along with calendars, contacts and to-do lists on their servers meaning those users don't have to store these data on their own desktops and can access them from any device. Apple developed its iCloud service to allow people to store their documents, music, photos, apps and other content on its servers.[25] In addition to its social networking features, Facebook offers users the ability to store personal photos in the cloud as does Flickr and many other photo sites. Pandora delivers music, and Hulu and YouTube

cloud computing A computing environment where software and storage are provided as an Internet service and are accessed via a web browser.

deliver movies via the cloud. LibreOffice, Google Apps, Microsoft Office 365, Zoho and others provide web-delivered productivity and information management software. Cloud computing offers many advantages to businesses. With cloud computing, organizations can avoid large, up-front investments in hardware as well as the ongoing investment in the resources that would be required to manage that hardware. Instead, they can provision just the right type and size of information system resources from their cloud computing provider, pay for it on an ongoing basis, and let the service provider handle the system support and maintenance. In most cases, the cloud computing service provider provides access to state-of-the-art technology at a fraction of the cost of owning it and without the lengthy delays that can occur when an organization tries to acquire its own resources. This can increase the speed and reduce the costs of new product and service launches. For example, Spotify offers its users instant access to over 16 million licensed songs. The company faces an ongoing struggle to keep pace with the rapid release of new music, adding over 20,000 tracks to its catalogue each day. In 2016, Spoify moved from using Amazon's cloud service to using Google's. In all, the move involved transfering 1.5 billion files.[26]

Cloud computing can be deployed in several different ways. The methods discussed thus far in this chapter are considered public cloud services. Public cloud computing refers to deployments in which service providers offer their cloud-based services to the general public, whether that is an individual using Google Calendar or a corporation using the Salesforce.com application. In a private cloud deployment, cloud technology is used within the confines of a private network.

Public Cloud Computing

In a public cloud computing environment, a service provider organization owns and manages the infrastructure (including computing, networking and storage devices) with cloud user organizations (called tenants) accessing slices of shared hardware resources via the Internet. The service provider can deliver increasing amounts of computing, network and storage capacity on demand and without requiring any capital investment on the part of the cloud users. Thus, public cloud computing is a great solution for organizations whose computing needs vary greatly depending on changes in demand. Amazon, Cisco Systems, IBM, Microsoft, Rackspace, Verizon Communications Inc. and VMware are among the largest cloud computing service providers. These firms typically offer a monthly or annual subscription service model; they may also provide training, support and data integration services.[27] Public cloud computing can be a faster, cheaper and more agile approach to building and managing your own IT infrastructure. However, since cloud users are using someone else's data centre, potential issues with service levels, loss of control, disaster recovery and data security should not be overlooked. Data security in particular is a key concern because when using a public cloud computing service, you are relying on someone else to safeguard your data. In addition, your organization's data may reside on the same storage device as another organization's (perhaps even a competitor's) data. All of the potential issues of concern must be investigated fully before entering into a public cloud computing arrangement. Organizations subject to tight regulation and complex regulatory requirements (e.g. financial, healthcare and public utility organizations) must ensure that their own processes and applications as well as those of the cloud provider are compliant. If the cloud provider resides in a different country from the user, the user must ensure that the data protection laws in their country can be followed when storing data in another country. A major startup issue is the effort of getting your organization's data moved to the cloud in the first place. That introduces an issue of vendor lock-in, meaning once an organization's servers and data are hosted with one cloud provider, it is not likely to be willing to go through the time-consuming migration process a second time to move to a different provider in the future. So choose your cloud provider wisely, as it is a business relationship that you and your business will likely need to live with for the foreseeable future. Cloud computing can be divided into three main types of services: Infrastructure as a service (IaaS) is an information systems strategy in which an organization outsources the equipment used to support its data processing operations, including servers, storage devices and networking components. The service provider owns the equipment and is responsible for housing, running and maintaining it. The outsourcing organization may pay on a per-use or monthly basis.

Software as a service (SaaS) is a software delivery approach that provides users with access to software remotely as a web-based service. SaaS pricing is based on a monthly fee per user and typically results in lower costs than a licensed application. Another advantage of SaaS is that because the software is hosted remotely, users do not need to purchase and install additional hardware to provide increased capacity. Furthermore, the service provider handles necessary software maintenance and upgrades.

Platform as a service (PaaS) provides users with a computing platform, typically including operating system, programming language execution environment, database services and a web server. The user can create an application or service using tools and/or libraries from the provider. The user also controls software deployment and configuration settings. The PaaS provider provides the networks, servers, storage and other services required to host the consumer's application. PaaS enables application developers to develop, test and run their software solutions on a cloud platform without the cost and complexity of buying and managing the underlying hardware and software.

Organizations contemplating moving to the cloud are advised to proceed carefully, as almost one in three organizations encounter major challenges during the transition. Frequent problems include complex pricing arrangements and hidden costs that reduce expected cost savings, performance issues that cause wide variations in performance over time, poor user support and greater than expected downtime.[28] Condé Nast, publisher of *Vogue, The New Yorker* and *Wired* magazines, among many others, decommissioned its 67,000-square-foot data centre and migrated its data and processing capacity to Amazon Web Services (AWS). Over a period of just three months in 2014, the firm migrated 500 servers; 1 petabyte of storage; 100 database servers; 100 switches, routers and firewalls, and all of its mission-critical applications to AWS. According to Condé Nast, operating costs have been cut by 40 per cent and performance has improved by 30 per cent to 40 per cent since the transition, which created a dynamic environment that can adjust as the company needs it to. The old data centre facilities were eventually put on the market and sold.[29]

Private Cloud Computing

A private cloud environment is a single tenant cloud. Organizations that implement a private cloud often do so because they are concerned that their data will not be secure in a public cloud. Private clouds can be divided into two distinct types. Some organizations build their own on-premises private cloud, and others elect to have a service provider build and manage their private cloud (sometimes called a virtual private cloud). A general rule of thumb is that companies that spend €1 million or more per month on outsourced computing are better off implementing an on-premises private cloud.[30] Many complications must be overcome and deep technical skills and sophisticated software are needed to build and manage a successful private cloud. An organization might establish several private clouds, with one for finance, another one for product development and a third for sales, for example. Each private cloud has a defined set of available resources and users, with predefined quotas that limit how much capacity users of that cloud can consume. Revlon is a global cosmetics, hair colour, fragrance and skin-care company with recent annual sales exceeding €1.7 billion.[31] The firm implemented an on-premises private cloud that includes 531 applications and makes up 97 per cent of the company's computing power. The private cloud has helped reduce application deployment time by 70 per cent and, as a result of virtualization and consolidation, reduced data centre power consumption by 72 per cent.[32]

Autonomic Computing

An enabling technology for cloud computing is autonomic computing or the ability of IT systems to manage themselves and adapt to changes in the computing environment, business policies and operating objectives. The goal of autonomic computing is to create complex systems that run themselves, while keeping the system's complexity invisible to the end user. Autonomic computing addresses four key functions: self-configuring, self-healing, self-optimizing and self-protecting.[33] As cloud computing environments become increasingly complex, the number of skilled people required to manage these environments also increases. Autonomic computing is used to reduce the overall cost of operating and managing complex cloud computing environments. While this is an emerging area, software products such as Tivoli from IBM are partially filling the need.

6.5 Intranets and Extranets

An intranet is an internal company network built using Internet and World Wide Web standards and products. Employees of an organization use it to gain access to company information. After getting their feet wet with public websites that promote company products and services, corporations are seizing the web as a swift way to streamline – even transform – their organizations. A big advantage of using an intranet is that many people are already familiar with Internet technology, so they need little training to make effective use of their corporate intranet.

An intranet is an inexpensive yet powerful alternative to other forms of internal communication, including conventional computer setups. One of an intranet's most obvious virtues is its ability to reduce the need for paper. Because web browsers run on any type of computer, the same electronic information can be viewed by any employee. That means that all sorts of documents (such as internal phone books, procedure manuals, training manuals and requisition forms) can be inexpensively converted to electronic form on the web and be constantly updated. An intranet provides employees with an easy and intuitive approach to accessing information that was previously difficult to obtain. For example, it is an ideal solution to providing information to a mobile sales force that needs access to rapidly changing information.

A rapidly growing number of companies offer limited access to their intranet to selected customers and suppliers. Such networks are referred to as extranets, and connect people who are external to the company. An extranet is a network that links selected resources of the intranet of a company with its customers, suppliers or other business partners. Again, an extranet is built around web technologies. Eikos Risk Applications in South Africa, for example, uses an extranet to provide tailored content to its clients. The firm is an insurance broker, and their extranet gives clients access to policy information, information about claims and facility management reports. Clients log in to the extranet on a secure web page.

Security and performance concerns are different for an extranet than for a website or network-based intranet. User authentication and privacy are critical on an extranet so that information is protected. Obviously, performance must be good to provide a quick response to customers and suppliers. Table 6.3 summarizes the differences between users of the Internet, intranets and extranets.

Table 6.3 Summary of Internet, Intranet and Extranet Users

Type	Users	Need User ID and Password?
Internet	Anyone	No
Intranet	Employees and managers	Yes
Extranet	Employees, managers and business partners	Yes

6.6 The Internet of Things

The Internet of Things (IoT) is a network of physical objects or 'things' embedded with sensors, processors, software and network connectivity to enable them to exchange data with the manufacturer of the device, device operators and other connected devices. Sensors are being installed in a variety of machines and products, ranging from home appliances to cars to clothing to grocery products. A sensor is a device that is capable of sensing something about its surroundings, such as pressure, temperature, humidity, pH level, motion, vibration, or level of light. The sensor detects an event or changes in quantity and produces a corresponding output, usually an electrical or optical signal. To be truly part of the IoT, these networked devices need IP addresses and a connection to the public Internet. The data is then transmitted over the Internet to an operational historical database containing data from many sensors. The database may be on a data storage device in a local control room, in an enterprise data centre in another state, or hundreds of miles away in the cloud. The Operational data can be accessed via the Internet and analyzed by users with personal computers or portable devices including smartphones. Updates, alerts or even automatic adjustments may be sent to the devices on the IoT based on this analysis. According to Don DeLoach, CEO and president of Infobright Inc., manufacturing has been automated at various levels for many years, but IoT brings automation to a deep, broad level, one where interconnectivity between various elements in manufacturing exists in a way it did not before.[34] Applying analytics to these streams of data enables workers to detect patterns and potential problems as they are occurring and to make appropriate adjustments in the operation of the devices being measured. For example, sensors embedded in General Electric (GE) aircraft engines collect some 5,000 individual data points per second. This data is analyzed while the aircraft is in flight to adjust the way the aircraft performs, thereby reducing fuel consumption. The data is also used to plan predictive maintenance on the engines based on engine component wear and tear. In 2013, this technology helped GE earn $1 billion in incremental income by delivering performance improvements, less downtime and more flying miles.[35]

Other examples of the types of organizations using sensors and the IoT to monitor and control key operational activities include:

- *Asset monitoring.* Food and drug manufacturers can monitor shipping containers for changes in temperatures that could affect product quality and safety using cheap battery-powered sensors and 4G LTE connectivity.
- *Construction.* SK Solutions is using IoT technology to prevent cranes from colliding on crowded construction sites in Dubai. The Internet-connected system collects data from sensors mounted to the cranes and other equipment to detect if construction cranes are swinging too close to each other and, if so, halts them from moving further.[36]

6

- *Agriculture.* Farmers are using IoT technology to collect data about water moisture and nitrogen levels to improve yields while conserving water, a precious commodity in many places.
- *Manufacturing.* IoT-enabled sensors on plant-floor equipment, such as a conveyor line, can alert plant floor personnel to problems in real time.The data can also be analyzed to uncover patterns to allow technicians to predict potential failures or redeploy resources in a more optimal fashion.
- *Predictive maintenance.* Sensors are used extensively in the utilities industry to capture operational data to achieve 24/7 uptime. Sensor data is carefully analyzed to predict when critical pieces of equipment or power lines are about to fail so that quick, anticipatory corrective action can take place before any failure.
- *Retailing.* Retailers use in-store sensors to detect in-store behaviour and optimize the shopping experience in order to increase revenue and market share. Streaming data from sensors is analyzed, along with other information (like inventory, social media chatter and online-shop user profiles) to send customized and personal offers while the shopper is in the process of making a purchase decision.
- *Traffic monitoring.* The Aegean motorway is the oldest and most important motorway in Greece, connecting the country's largest cities, Athens and Thessaloniki. More than 5,000 devices are deployed along a 200-km stretch of the highway to keep drivers safe and the roadway running efficiently. All these devices must work in a smooth and coordinated fashion to monitor traffic, detect traffic incidents using traffic cameras, warn travellers of road conditions via electronic billboards and operate toll booths. The devices are connected to a central control system using Cisco's Internet of Everything system to connect data, people, processes and things.[37]

Unfortunately, there can be many issues with simply receiving and recognizing usable sensor data. Sometimes a faulty sensor or bad network connection results in missing data or sensor data lacking time stamps indicating when the reading occurred. As a result, sensor data can be incomplete or contain inconsistent values indicating a potential sensor failure or a drop in a network. Developers of IoT systems must be prepared for and be able to detect faulty sensor data. Security is a very major issue with IoT applications. In today's manufacturing environment, the factory network is a closed environment designed to communicate with plant sensors and devices but not typically with the outside world. So, a key decision organizations must make when considering implementation of an IoT is: Are the benefits of doing so sufficient to overcome the risk of making detailed company information accessible through the Internet and exposing internal systems to hacking, viruses and destructive malware? Hackers who gain access to an organization's IoT can steal data, transfer money out of accounts and shut down websites, and they can also wreak physical havoc by tampering with critical infrastructure like air traffic control systems, healthcare devices, power grids, and supervisory control and data acquisition (SCADA) systems. One of the first things developers of IoT applications should focus on is building in security from the start. This needs to include ways of updating the system in a secure manner.

Summary

Effective communications are essential to organizational success. Telecommunications refers to the electronic transmission of signals for communications, including telephone, radio and television. Telecommunications is creating profound changes in business because it removes the barriers of time and distance.

The elements of a telecommunications system include a sending unit, such as a person, a computer system, a terminal or another device, that originates the message. The sending unit transmits a signal to a telecommunications device, which performs a number of functions such as converting the signal into a different form or from one type to another. A telecommunications device is a hardware component that facilitates electronic communication. The telecommunications device then sends the signal through a medium, which is anything that carries an electronic signal and serves as an interface between a sending device and a receiving device. The signal is received by another telecommunications device that is connected to the receiving computer. The process can then be reversed, and another message can pass from the receiving unit to the original sending unit. With synchronous communications, the receiver gets the message instantaneously, when it is sent. Voice and phone communications are examples. With asynchronous communications there is a delay between sending and receiving the message. A communications channel is the transmission medium that carries a message from the source to its receivers.

Communications technology lets more people send and receive all forms of information over greater distances. The telecommunications media that physically connect data communications devices can be divided into two broad categories: guided transmission media, in which communications signals are guided along a solid medium, and wireless media, in which the communications signal is sent over airwaves. Guided transmission media include twisted-pair wire cable, coaxial cable, fibre-optic cable and broadband over power lines. Wireless media types include microwave, cellular and infrared.

A modem is a telecommunications hardware device that converts (modulates and demodulates) communications signals so they can be transmitted over the communication media.

A multiplexer is a device that encodes data from two or more data sources onto a single communications channel, thus reducing the number of communications channels needed and, therefore, lowering telecommunications costs.

A front-end processor is a special-purpose computer that manages communications to and from a computer system serving hundreds or even thousands of users.

Telecommunications carriers offer a wide array of phone and dialling services, including digital subscriber line (DSL) and wireless telecommunications.

The effective use of networks can turn a company into an agile, powerful and creative organization, giving it a long-term competitive advantage. Networks let users share hardware, programs and databases across the organization. They can transmit and receive information to improve organizational effectiveness and efficiency. They enable geographically separated workgroups to share documents and opinions, which fosters teamwork, innovative ideas and new business strategies.

The physical distance between nodes on the network and the communications and services provided by the network determines whether it is called a personal area network (PAN), local area network (LAN), metropolitan area network (MAN) or wide area network (WAN). A PAN connects information technology devices within a range of about 10 metres. The major components in a LAN are a network interface card, a file server and a bridge or gateway. A MAN connects users and their computers in a geographical area larger than a LAN but smaller than a WAN. WANs link large geographic regions, including communications between countries, linking systems from around the world. The electronic flow of data across international and global boundaries is often called transborder data flow.

A mesh network is a way to route communications between network nodes (computers or other devices) by allowing for continuous connections and reconfiguration around blocked paths by ‘hopping’ from node to node until a connection can be established.

A client/server system is a network that connects a user's computer (a client) to one or more host computers (servers). A client is often a PC that requests services from the server, shares processing tasks with the server and displays the results. Many companies have reduced their use of mainframe computers in favour of client/server systems using midrange or personal computers to achieve cost savings, provide more control over the desktop, increase flexibility and become more responsive to business changes. The start-up costs of these systems can be high, and the systems are more complex than a centralized mainframe computer.

When people on one network want to communicate with people or devices in a different organization on another network, they need a common communications protocol and various network devices to do so. A communications protocol is a set of rules that govern the exchange of information over a communications channel. There are myriad communications protocols, including international, national and industry standards.

In addition to communications protocols, telecommunications uses various devices. A switch uses the physical device address in each incoming message on the network to determine which output port to forward the message to in order to reach another device on the same network. A bridge is a device that connects one LAN to another LAN that uses the same telecommunications protocol. A router forwards data packets across two or more distinct networks towards their destinations, through a process known as routing. A gateway is a network device that serves as an entrance to another network.

When an organization needs to use two or more computer systems, it can follow one of three basic data-processing strategies: centralized, decentralized or distributed. With centralized processing, all processing occurs in a single location or facility. This approach offers the highest degree of control. With decentralized processing, processing devices are placed at various remote locations. The individual computer systems are isolated and do not communicate with each other. With distributed processing, computers are placed at remote locations but are connected to each other via telecommunications devices. This approach helps minimize the consequences of a catastrophic event at one location, while ensuring uninterrupted systems availability.

Communications software performs important functions, such as error checking and message formatting. A network operating system controls the computer systems and devices on a network, allowing them to communicate with one another. Network-management software enables a manager to monitor the use of individual computers and shared hardware, scan for viruses and ensure compliance with software licences.

The Internet is like many other technologies – it provides a wide range of services, some of which are effective and practical for use today, others are still evolving and still others will fade away from lack of use. The Internet started with ARPANET, a project sponsored by the US Department of Defense (DoD). Today, the Internet is the world's largest computer network. Actually, it is a collection of interconnected networks, all freely exchanging information. The Internet transmits data from one computer (called a host) to another. The set of conventions used to pass packets from one host to another is known as the Internet Protocol (IP). Many other protocols are used with IP. The best known is the Transmission Control Protocol (TCP). TCP is so widely used that many people refer to the Internet protocol as TCP/IP, the combination of TCP and IP used by most Internet applications. Each computer on the Internet has an assigned address to identify it from other hosts, called its uniform resource locator (URL). There are several ways to connect to the Internet: via a LAN whose server is an Internet host or via an online service that provides Internet access.

An Internet service provider is any company that provides access to the Internet. To use this type of connection, you must have an account with the service provider and software that allows a direct link via TCP/IP. Among the value-added services ISPs provide are electronic commerce, intranets and extranets, website hosting, web transaction processing, network security and administration, and integration services.

Because the Internet and the World Wide Web are becoming more universally used and accepted for business use, management, service and speed, privacy and security issues must continually be addressed and resolved. A rapidly growing number of companies are doing business on the web and enabling shoppers to search for and buy products online. For many people, it is easier to shop on the web than search through catalogues or trek to the high street.

The steps to creating a web page include organizing storage space on a web server; writing your copy with a word-processor, using an HTML editor, editing an existing HTML document, or using an ordinary text editor to create your page; opening the page using a browser, viewing the result on a web browser, and correcting any tags; adding links to your home page to take viewers to another home page; adding pictures and sound; uploading the HTML file to your website; reviewing the web page to make sure that all links are working correctly; and advertising your web page. After a website has been constructed, a content management system (CMS) can be used to keep the website running smoothly. Web services are also used to develop web content. Web services consist of a collection of standards and tools that streamline and simplify communication between websites, which could revolutionize the way people develop and use the web for business and personal purposes.

An intranet is an internal corporate network built using Internet and World Wide Web standards and products. It is used by the employees of an organization to gain access to corporate information. Computers using web server software store and manage documents built on the web's HTML format. With a web browser on your PC, you can call up any web document – no matter what kind of computer it is on. Because web browsers run on any type of computer, the same electronic information can be viewed by any employee. That means all sorts of documents can be converted to electronic form on the web and constantly be updated.

An extranet is a network that links selected resources of the intranet of a company with its customers, suppliers or other business partners. It is also built around web technologies. Security and performance concerns are different for an extranet than for a website or network-based intranet. User authentication and privacy are critical on an extranet. Obviously, performance must be good to provide quick response to customers and suppliers.

Management issues and service and speed affect all networks. No centralized governing body controls the Internet. Also, because the amount of Internet traffic is so large, service bottlenecks often occur. Privacy, fraud and security issues must continually be addressed and resolved.

Self-Assessment Test

1. __________ is the rate at which data is exchanged.
2. Fibre-optic cable transmits data as a __________.
3. Using electricity cables for data transmission is __________.
4. A very short range wireless data transmission is __________.
5. A __________ uses a physical device address in each incoming message on a network to determine to which output port it should forward the message to reach another device on the same network.
6. __________ and __________ are communications software.
7. The __________ tag turns text on a web page bold.
8. __________ allow websites to communicate with each other.
9. FTP is __________.
10. Google Docs and Zoho are examples of __________.

Review Questions

1. What is the difference between synchronous and asynchronous communication?
2. Describe a metropolitan area network. How does it compare to a LAN?
3. Describe microwave transmission.
4. What can you do with a PAN?
5. What is mesh networking?
6. What are some of the uses of NFC?
7. What is FTP used for?
8. What is an intranet?
9. What is HTML?
10. What is a web service?

Discussion Questions

1 What are the advantages of using cloud computing?

2 What will you use 5G for?

Web Exercises

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1 Find a map of the Internet cables that connect the world. 'Drive' past by using Google StreetView or similar. Is the station marked in any way?

2 Search for an HTML tutorial and work your way through it.

Case One

Instant Messaging is Easier to Secure Than Email

If you look at the top left corner of your web browser you'll notice that web pages start with 'http://'. Sometimes an 's' is added to give 'https' and a padlock might also appear. The 's' stands for secure and when you see it, all traffic that leaves your computer to go to the web server that is storing the web page you are currently looking at, and all the traffic that comes back, is encrypted using something called 'forward secrecy'. The result is that messages between your computer and the web server appear to everyone else as mixed up, random gibberish. The messages only make sense when your computer and the server decrypt them.

This is easy to achieve when the two computers (yours and the server) are interacting with each other directly or 'synchronously'. So if you are instant messaging someone, using WhatsApp for example, your chat can be secured. However, this doesn't work with email. Email is asynchronous. An email to your friend gets sent to your email provider and then their email provider and then later your friend accesses their provider's server to read it. Your computer is at no time in direct contact with your friend's computer. But why does this make a difference?

It's all to do with the code or key that is used to lock up the message. Let's say you encrypt your email message somehow. How could your friend get hold of the key to unlock it? You could email it to them, but it would have to go to them as plain text not gibberish, otherwise your friend couldn't use it, which defeats the whole purpose. In that case you may as well not bother to encrypt the message in the first place.

However, when two computers interact directly they can create what's known as a shared secret. This provides 'forward secrecy' because the secret code is created and used once and then discarded, meaning that past messages are always secure. (It's called forward secrecy because it protects past messages against future compromises.)

In brief, this works as follows. Each computer chooses a private number and one of them chooses and shares a public number with the other computer. Each computer performs a calculation on its private number and the public number. For now, let's say the calculation is multiplication. The result is shared with each computer. The shared result is then multiplied by the receiving computer's private number. Each computer should now have the same number, a number that has never been shared publicly.

Let's try it. Computer 1 creates private number 5 and public number 10. Multiplying each of these gets 50 which is shared with Computer 2. Meanwhile Computer 2 creates private number 6 meaning it shares 6*10 which is 60 with Computer 1. Computer 1 multiplies 60 by its private number 5 giving 300. Computer 2 multiplies 50 by 6 also giving 300.

It will be obvious that any observer in the middle could work backwards from the publicly shared numbers to come up with the supposedly secret code 300. That is why https in reality doesn't use multiplication, it uses something called 'clock arithmetic'. Clock arithmetic just means divide by some number and take the remainder.

The result is a super secret code that is used once and then forgotten. The size of the numbers used means that each code is extremely unlikely to ever be used twice. Ever! It would be like two people choosing the same grain of sand on a million planet Earths. This has grave implications for those governments who would like to be able to read everyone's private messages. Especially given how easy the above is to 1) explain and 2) implement on a computer.

(Note that some software developers are working on end-to-end encryption for email, to make it as secure as encrypted instant messaging. The Dark Mail Technical Alliance for instance states as their mission, 'To bring the world our unique end-to-end encrypted protocol and architecture that is the "next-generation" of private and secure email'.)

Questions

1. Does this mean that email is less secure than instant messaging?
2. Should a government be able to read all instant messages? Why or why not?
3. Investigate clock arithmetic in enough detail so that you can explain it to a friend.
4. Could governments ever be able to control encryption technology?

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Case Two

Anatomy of a Hack

A Remote Administration Tool (RAT) is software that allows users to access their computer from a distance. The classic example is accessing your work computer, which is usually underneath the desk in your office, from home. A RAT lets users do anything that they would be able to do if they were at their computer including creating, reading, copying and deleting files.

Cybercriminals use RATs to steal both data and processing time on a company's computers. Many businesses have been victims of this sort of attack, and many more are but do not yet realize it. PlugX is a good example of a RAT attack. Discovered in 2012, this software is used in targeted attacks, so called spear-phishing. A spear-phishing attack is where cybercriminals identify particular targets, actual individuals, often on social media, who work for a particular firm, and then contact them with an email that appears to come from a friend.

For example, an employee who works for a company that the cybercriminals want to target announces this fact on his Facebook page. The criminals can see this and also who his friends are. They may also be able to see his company email address, or they may be able to guess this – it's often just 'first_name.surname@company.com'. They send him an email, with content tailored to arouse his interest. The message will appear to be from one of his friends – the friend's name is taken from Facebook – and will contain an attachment, typically a Word file, with a name that should appeal to them. For instance, if the basis of their Facebook friendship appears to be rock climbing, then the attachment will appear to be about climbing.

The attached file contains what is known as a software dropper, a program that installs the

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RAT. Essentially, the dropper fools the operating system into letting it install its program, which is downloaded from the Internet. Once installed, PlugX allows the cybercriminals to copy files, log keystrokes and capture video and screen shots. It hides its activity well so that the user may suspect nothing.

Kevin O'Reilly from security firm Context IS told the BBC that 'once it's got a foothold it makes sure it will run automatically with Windows and it will then phone home and be told to do whatever its controllers want it to do. Ultimately, this is controlled by a person. It does not do much by itself'. In other words, the software gives an external human control over a business's computer. They can use it to have a look at the company's data and steal it if they desire, or they may use the processor to work on something they want, effectively stealing the use of a company resource.

PlugX has been used to attack government-related institutions and key industries all over the world, including in Japan, Russia and Tibet, and is thought to have been used to steal government and political secrets. 'In the old days', said former FBI agent Eric O'Neill, 'spies had to sneak into buildings to steal documents. Nowadays they don't. Espionage and spies have evolved.'

Questions

1. Outline a company policy that would minimize the threat of PlugX.
2. Why would cybercriminals want to steal data?
3. Who would want to steal government and political secrets?
4. Should an employee be blamed if they allow a malicious RAT to be installed?

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Case Three

Digital Cartography Gets It Wrong

Each object that connects to the Internet – whether it's a computer, a fridge, a car or even a dog (the Internet of Dogs is, believe it or not, an active area of research) – is assigned an IP or Internet Protocol address. Basically it's a unique identifier. Every Internet connected device needs one. When you visit a website, that site's server has almost always taken a note of your IP, which becomes a record of all the online addresses that have visited it. But the IP address doesn't relate to your specific computer, because it changes when you connect at home, at work, a hotel or in a cafe. IP addresses aren't tied to specific location addresses either – they often are, but they don't have to be, and the phone company can change your IP address. Basically, the server that notes down your IP address has a rough idea of where you are in the world, but no more than that.

Massachusetts-based digital mapping company MaxMind decided it wanted to provide 'IP intelligence' for companies who wanted to pin down the location of the people who were using different websites. The company battles online fraud, and one of their services is known as IP geolocation, in essence finding what building address goes along with an IP address. Content providers could use this information to send letters to people who are downloading and sharing content illegally. The police could use it to identify the location of a computer that was involved in a crime.

However, as was said above, IP geolocation isn't an exact science, and often it is difficult to pin an IP address to a physical address. As technology writer Kashmir Hill explains, 'MaxMind decided to set default locations at the city, state and country level for when it knows only roughly where the IP address lives. If it knows only that an IP address is somewhere in the U.S., and can't figure out anything more about where it is, it will point to the centre of the country'. If you happen to live in the centre of the country (in the USA it's in Northern Kansas, near the Nebraska border), this could be a big problem.

James and Theresa Arnold moved into their rented 623-acre farm in Butler County, Kansas, in March 2011. The house gave them the privacy they craved but less than a week after they had moved in, law officials turned up looking for a stolen vehicle. More followed. They were accused and implicated in countless thefts, abduction plots and computer fraud. Police showed up looking for missing persons and runaway children, and to check on attempted suicides. They had no idea why.

This went on for five years until they read an article by Ms Hill about MaxMind. MaxMind was identifying their property as the default spot for IPs when it knew nothing other than it's 'in the US' – their house is in the north of the state, near the Nebraska border. Having finally found out what was happening, the couple took to the courts.

Court documents report that 'In 2013, the Butler County Sheriff Department ran a background check on the plaintiffs because of all the activity taking place at the residence', and they were receiving, 'weekly reports about fraud, scams, stolen Facebook accounts, missing person reports' linked to the home.

MaxMind company founder said, 'to my knowledge, we have never claimed that our database could be used to locate a household'. In any case, MaxMind has now changed the default centre points to be in the middle of a body of water.

Questions

1. Why do you think MaxMind's clients (the police for instance) were not aware of the inexact nature of this service?
2. What could MaxMind do to keep the service being useful but stop problems like this?
3. What other uses could IP geolocation be put to?
4. Should IP geolocation be an exact science? (Should telecoms firms be forced to pin down exactly where devices are?)

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World Views Case

IT Purchase Decisions: What Should You Buy?

Laptop or desktop? Windows, OS X or GNU Linux? Tablet or smartphone? As an IT manager, how do you actually go about choosing technology for your colleagues? What do they really need? What will they need in six months' time? And, once you've chosen, how do you select between all the different suppliers? Some technology will come with a one-year warranty, others will have two. Some will feature a 24-hour helpline, while some will be cheaper than others.

Tadashi Tokieda's first job was as a painter. Judging by his web page, he probably means the artistic kind rather than a decorator, but this is rather unclear. In any case, later in life he switched careers and began to study mathematics, learning from notes written in Russian (he grew up in Japan). A few years later he ended up as professor of mathematical physics at the University of Cambridge. Professor Tokieda thinks that everyone – whether studying information systems or not – should know about the following. We think he's probably right.

Let's say we've got to choose between four laptop computers. An independent online technology review magazine has given each of them a rating out of ten, on six characteristics: price, computational speed, screen resolution, screen size, future proofing and weight. The results are shown in the table below.

Feature	Laptop A	Laptop B	Laptop C	Laptop D
Price	6	7	8	9
Speed	6	7	8	9
Resolution	6	7	8	5
Screen size	6	7	4	5
Future proof	6	3	4	5
Weight	6	3	4	5

We could take the average score of each and use that to judge which is best, but if we did there might be a laptop that has one really strong feature but which is otherwise mediocre that could win. Instead we'll compare them two at a time to try to see if that helps. Let's start with Laptop A versus Laptop B. Imagine choosing one feature from each laptop at random (and we don't necessarily have to compare the same feature for each laptop) – which computer is more likely to come out on top? It's clear that Laptop B will beat Laptop A four times out of six, which is more than half the time so we'll say Laptop B has it.

Comparing Laptop B with Laptop C, Professor Tokieda has a neat argument we can use to avoid any complicated sums. Laptop C beats Laptop B half the time, because 8 – which will come up half the time – will beat both 7 and 3. However, even if screen size, future proof or weight is chosen, Laptop C can still beat Laptop B some of the time, so overall Laptop C will win more than half the time. Therefore, it beats Laptop B.

Do the same for Laptop C and D. Here, Laptop C loses half the time (any time that screen size, future proof or weight are chosen) and of the other possibilities (price, speed and resolution) Laptop D wins at least some of the time. So, Laptop D beats Laptop C more than half the time. Therefore, out of all of the laptops, D is the overall winner.

Except, no it isn't.

Now compare Laptop A with Laptop D: Laptop A will beat it four times out of the six, more than half. So we have:

Laptop B beats Laptop A
Laptop C beats Laptop B
Laptop D beats Laptop C
Laptop A beats Laptop D

And this is the lesson: when comparing technologies in this way, we cannot conclude that just because Technology 1 beats Technology 2, and Technology 2 beats Technology 3, that Technology 1 will beat Technology 3. The fancy name for this is that the choices are non-transitive.

Essentially, here we have been comparing probabilities: the probability that a randomly chosen feature of one laptop will be rated higher than a randomly chosen feature of another laptop, but the same thing can happen with a simple purchase rule.

Imagine that a user is about to choose between three smartphones that vary on price and screen size as shown in the table below.

Feature	Smartphone A	Smartphone B	Smartphone C
Price	€100	€150	€200
Screen size	Small	Medium	Large

The company finance officer suggests the following decision rule: choose the cheaper phone if the difference in price is greater than 50, and if the difference in price is 50 or less, choose the phone with the larger screen size. When choosing between A and B, B is chosen as the price difference is 50 and B has the larger screen. When choosing between B and C the situation is the same and C is chosen. However, when choosing between A and C, the price difference is greater than 50 so A is chosen. Our preferences are therefore: C over B, B over A, A over C.

Questions

1 So how would you explain this to the finance officer?

2 How would you choose between Laptop A, B, C and D?

3 Could you design a purchasing strategy to avoid this sort of problem in the future?

4 Should the choice be up to the IT manager or the user?

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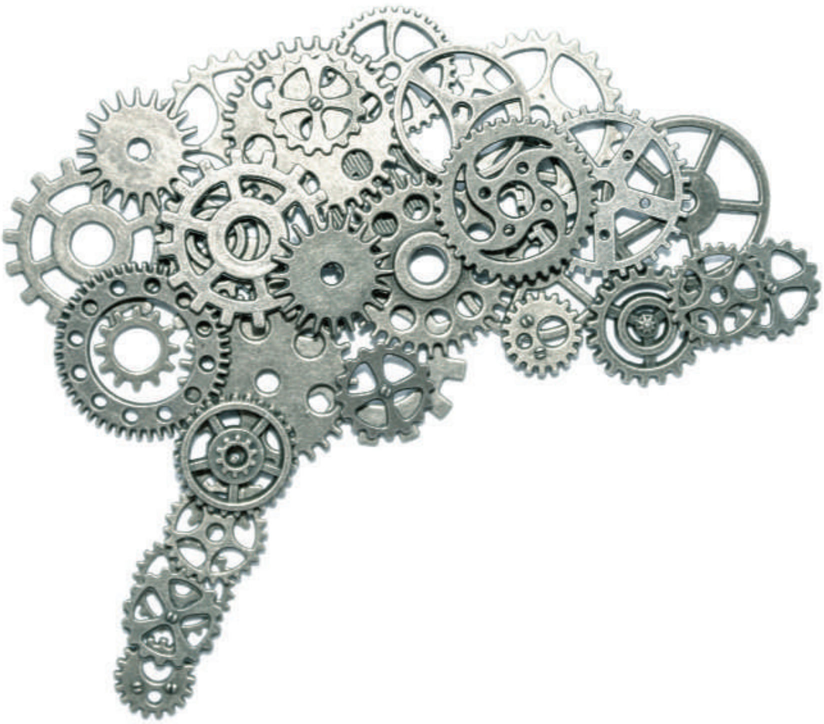
PART 3

Business Information Systems



07

Operational Systems

Principles

An organization must have information systems that support the routine, day-to-day activities that occur in the normal course of business and help a company add value to its products and services.

Learning Objectives

- Identify the basic activities and business objectives common to all transaction processing systems.
- Identify key control and management issues associated with transaction processing systems.

Traditional transaction processing systems support the various business functions of organizations that have not yet implemented enterprise resource planning systems.

- Describe the inputs, processing and outputs for the transaction processing systems associated with the order processing, purchasing and accounting business functions.

Electronic and mobile commerce allow transactions to be made by the customer, with less need for sales staff, and open up new opportunities for conducting business.

- Define e- and m-commerce and describe various forms of e-commerce.

A company that implements an enterprise resource planning system is creating a highly integrated set of systems, which can lead to many business benefits.

- Identify the challenges multinational corporations must face in planning, building and operating their transaction processing systems.
- Discuss the advantages and disadvantages associated with the implementation of an enterprise resource planning system.

Why Learn About Operational Systems?

You might recall from Chapter 2 that operational systems support the day-to-day running of a firm. Operational systems, such as transaction processing systems (TPS), allow firms to buy and sell. Without systems to perform these functions, the firm could not operate. Organizations today are moving from a collection of non-integrated transaction processing systems to highly integrated enterprise resource planning (ERP) systems to perform routine business processes and maintain records about them. These systems support a wide range of business activities associated with supply chain management and customer relationship management (as mentioned in Chapter 1). Although they were initially thought to be cost effective only for very large companies, even small and medium-sized companies are now implementing these systems to reduce costs and improve service.

Employees who work directly with customers – whether in sales, customer service or marketing – require high-quality transaction processing systems and their associated information to provide good customer service. Companies selling online need electronic- and mobile-commerce software to allow customers to perform transactions. No matter what your role, it is very likely that you will provide input to or use the output from your organization's systems. Your effective use of these systems will be essential to raise the productivity of your firm, improve customer service and enable better decision making. Thus, it is important that you understand how these systems work and what their capabilities and limitations are.

7.1 Introduction

Part 3 of this book describes the main types of business information system. This chapter looks at those systems that manage the day-to-day running of the firm. Without them an organization couldn't operate. They include systems that sell products and services to customers (transaction processing systems), systems that buy materials from suppliers (supply chain management systems), systems that help manage the after-sales service (customer relationship management systems) and systems that maintain tax records (accounting systems). Then Chapter 8 looks at systems used by the organization to manage its longer-term operations and make decisions about product offerings and marketing campaigns. Chapter 9 looks at more specialized systems including robotics and artificial intelligence. Chapter 10 then looks at the ways information technology has become part of our work and home environment.

Often, especially with the systems described in this chapter and the next, the output from one of the systems is the input to another of the systems. An alternative approach to having separate systems to do all of the jobs that are discussed is to have one enterprise-wide system that does all of them. This is the ERP approach, which is described at the start of this chapter. ERP doesn't really fit into either the day-to-day running category or the long-term planning category since it does both, and the decision to include it in this chapter rather than the next is fairly arbitrary. Also there is no agreed minimum set of tasks that a system has to perform in order for it to be classed as an ERP. However the expectation is that an ERP does some of the tasks described in this chapter, plus some of the tasks described in the next chapter. One way of looking at the material in Chapters 7 and 8 is that if an organization has an ERP, then the systems described are sub-systems of their ERP. If an organization does not have an ERP, then the systems described are stand-alone information systems in their own right.

7.2 Enterprise Resource Planning

ERP systems evolved from systems (called materials requirements planning or MRP systems) that allowed companies to plan out how much raw material they would need at a certain time in the future, plan their production, control their inventory and manage their purchasing process. Many organizations recognized that their existing systems lacked the integration needed to coordinate these activities and also to share valuable information across all the business functions of the firm. As a result, costs were higher and customer service suffered. This led firms to start to create new systems, which came to be known as ERP systems. Large organizations, especially members of the Fortune 1000, were the first to take on the challenge of implementing ERP. An ERP is a system that manages an entire company's vital business information. Many firms consider themselves to have an ERP if the system manages most, rather than all, of their information.

Advantages of ERP Systems

Increased global competition, executives' desire for control over the total cost and product flow through their enterprises, and ever-more-numerous customer interactions drive the demand for enterprise-wide access to real-time information. ERP offers integrated software from a single vendor to help meet those needs. The primary benefits of implementing ERP include improved access to data for operational decision making, elimination of inefficient or outdated systems, improvement of work processes and technology standardization. ERP vendors have also developed specialized systems for specific applications and market segments.

Improved Access to Data for Operational Decision Making

ERP systems operate via an integrated database, using one set of data to support all business functions. The systems can support decisions on optimal sourcing or cost accounting, for instance, for the entire enterprise or for business units, rather than gathering data from multiple business functions and then trying to coordinate that information manually or reconciling it with another application. The result is an organization that looks seamless, not only to the outside world but also to the decision makers who are deploying resources within that organization. The data is integrated to facilitate operational decision making and allows companies to provide greater customer service and support, strengthen customer and supplier relationships and generate new business opportunities.

A number of software developers offer specialist ERP systems tailored to particular industries. LS Retail, for example, has an ERP designed for pet stores. They claim their solution is 'purrfect' (yes, it says that on their website), and that it is simple to implement and learn. One customer, Care-A-Lot Pet Supply, was able to use their software to manage transactions made by them buying from suppliers and tracking stock into their warehouses, and transactions made by customers in their stores. LS Retail software printed a barcode on each customer receipt that could be scanned to return all the data on that transaction. This prevented items from being returned and refunded at full price when they were sold at discount, and items being returned after a specific time period.[1]

Elimination of Costly, Inflexible Legacy Systems

Adoption of an ERP system enables an organization to eliminate dozens or even hundreds of separate systems and replace them with a single, integrated set of applications for the entire enterprise. In many cases, these systems are decades old, the original developers are long gone and the systems are poorly documented. As a result, the systems are extremely difficult to fix when they break, and adapting them to meet new business needs takes too long. They become an anchor around the organization that keeps it from moving ahead and remaining competitive. An ERP system helps match the capabilities of an organization's information systems to its business needs – even as these needs evolve.

Improvement of Work Processes

Competition requires companies to structure their business processes to be as effective and customer oriented as possible. ERP vendors do considerable research to define the best business processes. They gather the requirements of leading companies within an industry and combine them with findings from research institutions and consultants. The individual application modules included in the ERP system are then designed to support these best practices, which should be one of the most efficient and effective ways to complete a business process. Thus, implementation of an ERP system ensures good work processes based on best practices. For example, for managing customer payments, the ERP system's finance module can be configured to reflect the most efficient practices of leading companies in an industry. This increased efficiency ensures that everyday business operations follow the optimal chain of activities, with all users being supplied with the information and tools they need to complete each step.

With 22,000 employees serving 4.7 million customers and generating revenues of €14 billion, Achmea is the largest insurance company in the Netherlands. The company had grown rapidly through acquisition and had evolved to using a mix of manual data collection and reporting processes. The company converted to an ERP system to standardize on a set of industry best practices, streamlined work processes and sophisticated data analysis tools across all divisions and operating companies. As a result, the company could reduce staffing levels in some areas of the business by as much as 30 per cent, thus improving productivity and cutting costs. In addition, the time required to complete month-end financial reporting was reduced by 30 per cent, with an increase in the accuracy and reliability of the data.[2]

Upgrade of Technology Infrastructure

When implementing an ERP system, an organization has an opportunity to upgrade the information technology (hardware, operating systems, databases, etc.) that it uses. While centralizing and formalizing these decisions, the organization can eliminate the multiple hardware platforms, operating systems and databases it is currently using – most likely from a variety of vendors – and standardize on fewer technologies and vendors. This reduces ongoing maintenance and support costs as well as the training load for those who must support the infrastructure.

Some of the major trends in ERP systems are integrating artificial intelligence, the Internet of Things and process automation, which for larger companies includes the use of robots. Motis Fire Rescue in Canada is a company that makes fire fighting tools that sell across the globe. They described the machines that they use to make their tools as 'dumb' and wanted to make them smarter and extend their life. To do this, they needed to measure the temperature of the machines when they were working, how much they vibrated, and how often and for how long they were 'down' (turned off to cool and rest). So sensors were added that send data to a Raspberry Pi. The Pi is connected to the company's wi-fi and sends the data to Microsoft's Azure IoT Hub, which provides cloud storage. Later on it is accessed from there and analyzed.[3]

Disadvantages of ERP Systems

Unfortunately, implementing ERP systems can be difficult and can disrupt current business practices. Some of the major disadvantages of ERP systems are the expense and time required for implementation, the difficulty in implementing the many business process changes that accompany the ERP system, the problems with integrating the ERP system with other systems, difficulty in loading data into the new system, the risks associated with making a major commitment to a single vendor and the risk of implementation failure.

Expense and Time in Implementation

Getting the full benefits of ERP takes time and money. Although ERP offers many strategic advantages by streamlining a company's TPS, large firms typically need three to five years and spend tens of millions of euros to implement a successful ERP system.

Difficulty Implementing Change

In some cases, a company has to radically change how it operates to conform to the ERP's work processes – its best practices. These changes can be so drastic to long-time employees that they retire or quit rather than go through the change. This exodus can leave a firm short of experienced workers. Sometimes, the best practices simply are not appropriate for the firm and cause great work disruptions.

Difficulty Integrating with Other Systems

Most companies have other systems that must be integrated with the ERP system, such as financial analysis programs, e-commerce operations and other applications. Many companies have experienced difficulties making these other systems operate with their ERP system. Other companies need additional software to create these links.

Difficulty in Loading Data into New ERP System

A major amount of work is required to load existing data from various sources into the new ERP database. The new ERP system may have the capability to store hundreds or even thousands of data items (e.g. customer name, bill to address, product description, etc.). The data items that will be required depend on the scope of ERP implementation. If certain processes or transactions are not included within the scope of implementation, there will be less data to load.

Data mapping is the examination of each data item required for the new ERP system and determining where that data item will come from. While most of the data for the new system will come from the files of existing legacy systems, some data items may need to be pulled from manual systems or may even need to be created for the new system. Data clean-up is required because the legacy systems are likely to contain data that is inaccurate, incomplete or inconsistent. For example, the same customer may be listed multiple times in existing customer files with varying billing addresses, or products may appear in the existing inventory files that have not been produced for years. Data loading can be performed either by using data conversion software that reads the old data and converts it into a format for loading into the database or by end-users entering data via the input screens of the new system.

Risks in Using One Vendor

The high cost to switch to another vendor's ERP system makes it extremely unlikely that a firm will do so. After a company has adopted an ERP system, the vendor has less incentive to listen and respond to customer concerns. The high cost to switch also comes with the risk that the ERP vendor allows its product to become outdated or goes out of business.

Selecting an ERP system involves not only choosing the best software product but also the right long-term business partner. It was unsettling for many companies that had implemented PeopleSoft, J.D. Edwards or Siebel Systems enterprise software when these firms were acquired by Oracle.

Risk of Implementation Failure

Implementing an ERP system for a large organization is extremely challenging and requires tremendous amounts of resources, the best IS and business people, and plenty of management support. Unfortunately, large ERP installations occasionally fail, and problems with an ERP implementation can require expensive solutions.

The following list provides tips for avoiding many common causes for failed ERP implementations:

- Assign a full-time executive to manage the project.
- Appoint an experienced, independent resource to provide project oversight and to verify and validate system performance.
- Allow sufficient time for transition from the old way of doing things to the new system and new processes.
- Plan to spend a lot of time and money training people.
- Define metrics to assess project progress and to identify project-related risks.
- Keep the scope of the project well defined and contained to essential business processes.
- Be wary of modifying the ERP software to conform to your firm's business practices.

ERP for Small- and Medium-Sized Enterprises (SMEs)

It is not only large Fortune 1000 companies that are successful in implementing ERP. SMEs (both for-profit and not-for-profit) can achieve real business benefits from their ERP efforts.

Many SMEs elect to implement open-source ERP systems. With open-source software, anyone can see and modify the source code to customize it to meet their needs. Such systems are much less costly to acquire and are relatively easy to modify to meet business needs. A wide range of organizations can perform the system development and maintenance.

Table 7.1 lists some of the open-source ERP systems geared for SMEs.

The following sections outline systems that can be considered as sub-systems of an ERP, or as information systems in their own right.

Table 7.1 Open-Source ERP Systems

Vendor	ERP Solutions
Apache	Open For Business ERP
Compiere	Compiere Open Source ERP
Openbravo	Openbravo Open Source ERP
WebERP	WebERP

7.3 Transaction Processing Systems

Every organization has many transaction processing systems (TPS). These systems include order processing, inventory control, payroll, accounts payable, accounts receivable and the general ledger, to name just a few. The input to these systems includes basic business transactions, such as a customer placing an order, an employee purchasing supplies, a customer payment and an employee signing on and off at the start and end of a day. The processing activities include data collection, data editing, data correction, data manipulation, data storage and document production. The result of processing business transactions is that the organization's records are updated to reflect the status of the operation at the time of the last processed transaction.

A TPS also has a second important function – it collects data which is input to other essential information systems – management information systems, decision support systems and other special-purpose information systems (all discussed in the following chapters). A transaction processing system serves as the foundation for these other systems. These higher-level systems require the basic business transaction data captured by the TPS (see Figure 7.1).

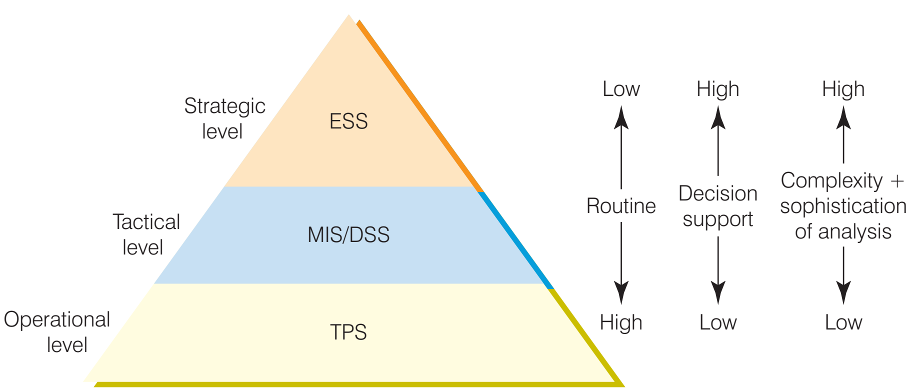


Figure 7.1 TPS, MIS/DSS and ESS in Perspective *An ERP system operates at all three levels and does some or all of the functions of each of these systems. ESS stands for Executive Support System.*

TPS support routine operations in the business. The amount of support for decision making that a TPS directly provides managers and workers is low.

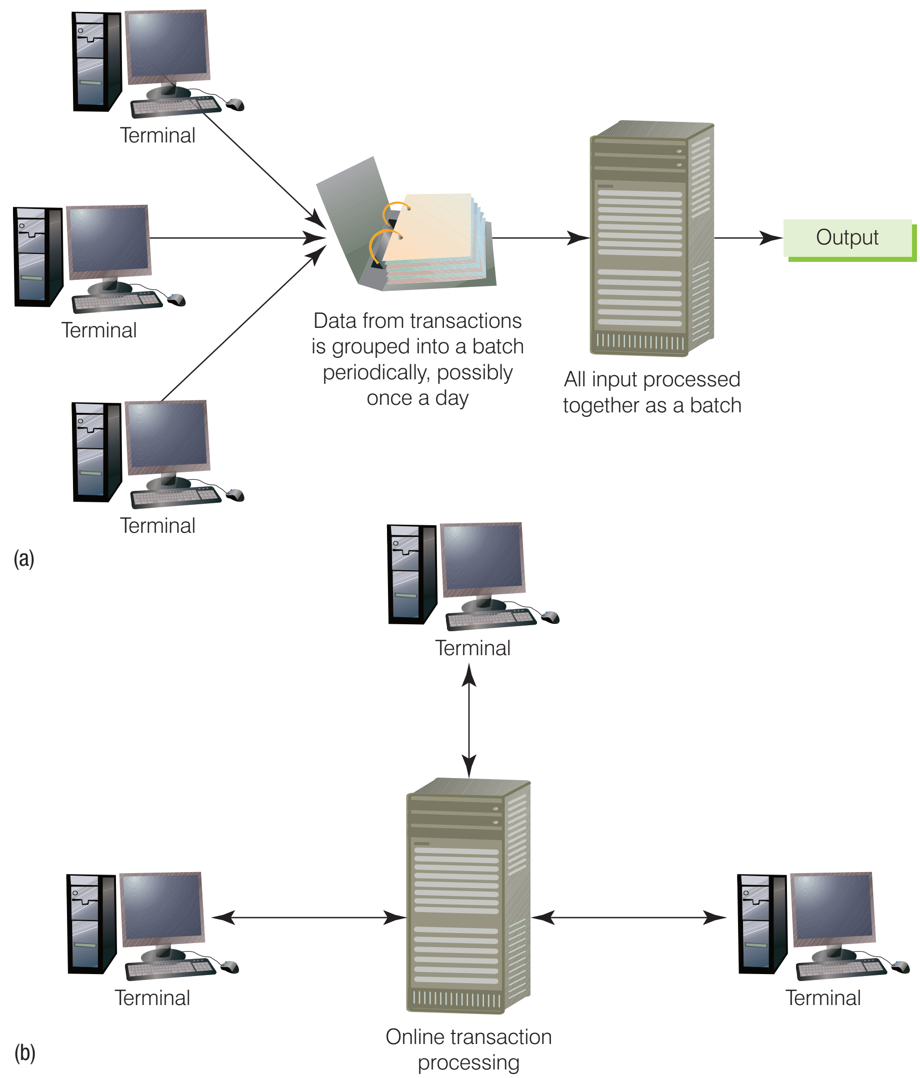
Because TPS often perform activities related to customer contacts – such as order processing and invoicing – these information systems play a critical role in providing value to the customer. For example, by capturing and tracking the movement of each package, shippers such as FedEx can provide timely and accurate data on the exact location of a package. Shippers and receivers can access an online database and, by providing the tracking number of a package, find the package's current location. If the package has been delivered, they can see who signed for it (a service that is especially useful in large companies where packages can become 'lost' in internal distribution systems and postrooms). Such a system provides the basis for added value through improved customer service.

Traditional Transaction Processing Methods and Objectives

With **batch processing systems**, business transactions are accumulated over a period of time and prepared for processing as a single unit or batch (see Figure 7.2a). Transactions are accumulated for the appropriate length of time needed to meet the needs of the users of that system. For example, it might be important to process invoices and customer payments for the accounts receivable system daily. On the other hand, the payroll system might receive process data weekly to create payments, update employee earnings records and distribute labour costs. The essential characteristic of a batch processing system is that there is some delay between an event and the eventual processing of the related transaction to update the organization's records.

batch processing systems A form of data processing where business transactions are accumulated over a period of time and prepared for processing as a single unit or batch.

Figure 7.2 Batch Versus Online Transaction Processing
(a) Batch processing inputs and processes data in groups. (b) In online processing, transactions are completed as they occur.



online transaction processing (OLTP) A form of data processing where each transaction is processed immediately, without the delay of accumulating transactions into a batch.

With **online transaction processing (OLTP)**, each transaction is processed immediately, without the delay of accumulating transactions into a batch (see Figure 7.2b). Consequently, at any time, the data in an online system reflects the current status. This type of processing is essential for businesses that require access to current data such as airlines, ticket agencies and stock investment firms. Many companies find that OLTP helps them provide faster, more efficient service, one way to add value to their activities in the eyes of the customer. Increasingly, companies are using the Internet to capture and process transaction data such as customer orders and shipping information from e-commerce applications.

Although the technology is advanced enough, TPS applications do not always run using online processing. For many applications, batch processing is more appropriate and cost effective. Payroll transactions and billing are typically done via batch processing. Specific goals of the organization define the method of transaction processing best suited to the various applications of the company.

Because of the importance of transaction processing, organizations expect their TPS to accomplish a number of specific objectives, some of which are listed next. Depending on the specific nature and goals of the organization, any of these objectives might be more important than others.

- *Process data generated by and about transactions.* The primary objective of any TPS is to capture, process and update databases of business data required to support routine business activities. Utilities, telecommunications companies and financial-services organizations especially are under pressure to process ever-larger volumes of online transactions.
- *Maintain a high degree of accuracy and integrity.* Ensuring that the data is processed accurately and completely is critical because reports generated by the TPS are used to execute key operational activities such as fulfilling customer orders and scheduling shipments to various customer locations.
- *Avoid processing fraudulent transactions.* Related to data integrity is the need to avoid processing fraudulent transactions. Advanced fraud detection software offers real-time transaction screening and reporting and analysis of user behaviour, with the ability to learn new fraudulent behaviours as criminals develop new techniques. For example, large regular payments into the accounts of a business that would not be expected to take such payments (a sweet shop for instance) would be flagged as possible money laundering.[4]
- *Produce timely user responses and reports.* The ability to conduct business transactions quickly can be essential for an organization's bottom line. For instance, if bills (invoices) are sent to customers a few days later than planned, payment is delayed, possibly forcing the firm to seek costly short-term borrowing to avoid cash flow problems. As a result, firms employ monitoring systems to measure and ensure system performance.
- *Increase labour efficiency.* Before businesses used computers, manual processes often required rooms full of administrators and office equipment to process the necessary business transactions. Today, TPS substantially reduce these and other labour requirements.
- *Help improve customer service.* Another objective of TPS is to assist an organization in providing a fast, efficient service. People clearly appreciate the convenience of transacting and making purchases on a website from the comfort of their own homes. Not only can this increase customer satisfaction, but it can also make the seller more efficient too.
- *Help build and maintain customer loyalty.* A firm's TPS are often the means for customers to communicate. Customer interaction with these systems must, therefore, keep customers satisfied and returning.
- *Achieve competitive advantage.* A goal common to almost all organizations is to gain and maintain a competitive advantage (discussed in Chapter 2). When a TPS is developed or modified, the personnel involved should carefully consider the significant and long-term benefits the new or modified system might provide. Table 7.2 summarizes some of the ways that companies can use transaction processing systems to achieve competitive advantage.

Transaction Processing Activities

TPS capture and process data of fundamental business transactions. This data is used to update databases and to produce a variety of reports people both within and outside the enterprise use. The business data goes through a **transaction processing cycle** that includes data collection, data editing, data correction, data manipulation, data storage and document production (see Figure 7.3).

transaction processing cycle The process of data collection, data editing, data correction, data manipulation, data storage and document production.

Data Collection

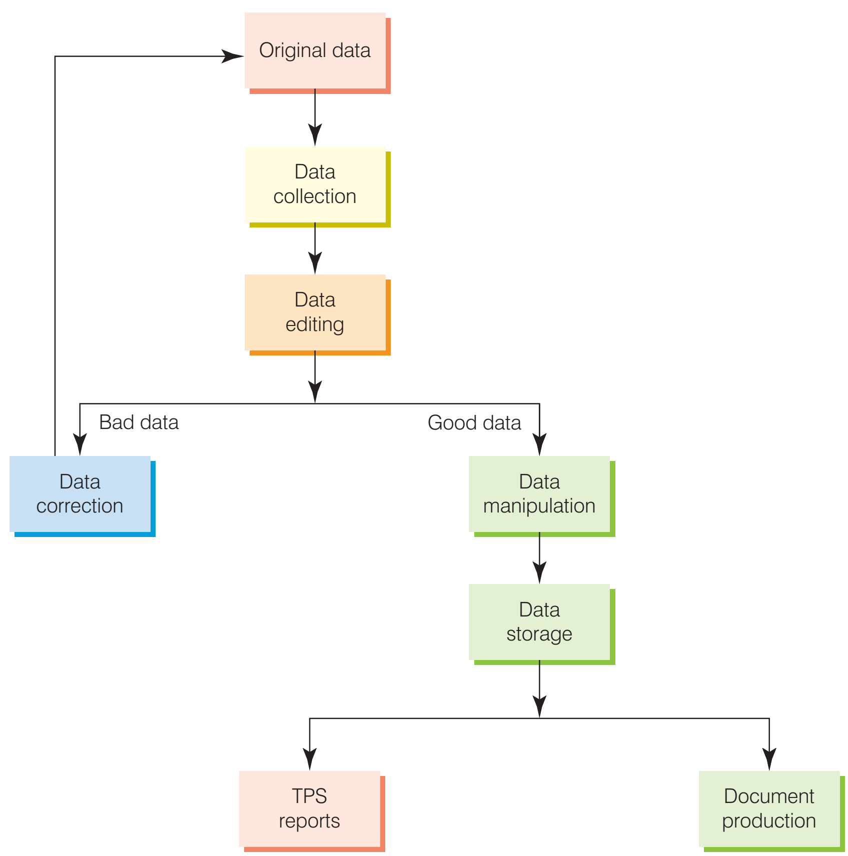
Capturing and gathering all data necessary to complete the processing of transactions is called **data collection**. In some cases, it can be done manually, such as by collecting handwritten sales orders or a customer typing in their credit card details on a web page. In other cases, data collection is automated via special input devices such as barcode scanners and RFID readers.

data collection Capturing and gathering all data necessary to complete the processing of transactions.

Table 7.2 Examples of Transaction Processing Systems for Competitive Advantage

Competitive Advantage	Example
Customer loyalty increased	Customer interaction system to monitor and track each customer interaction with the company
Superior service provided to customers	Tracking systems that customers can access to determine shipping status
Better relationship with suppliers	Internet marketplace to allow the company to purchase products from suppliers at discounted prices
Superior information gathering	Order configuration system to ensure that products ordered will meet customers' objectives
Costs dramatically reduced	Warehouse management system employing RFID technology to reduce labour hours and improve inventory accuracy
Inventory levels reduced	Collaborative planning, forecasting and replenishment to ensure the right amount of inventory is in stores

Figure 7.3 **Data-Processing Activities Common to Transaction Processing Systems**



Data collection begins with a transaction (e.g. taking a customer order) and results in data that serves as input to the TPS. Data should be captured at its source and recorded accurately in a timely fashion, with minimal manual effort, and in an electronic or digital form that can be directly entered into the computer. This approach is called 'source data automation'. An example of source data automation is a barcode reader at a supermarket which speeds the checkout process. Using barcodes is quicker and more accurate than having a shop assistant enter codes manually at the cash register. The product ID for each item is determined automatically, and its price is retrieved from the item database. This TPS uses the price data to determine the customer's bill. It also updates the shop's inventory database and its database of purchases. This data is then used by the shop's management information systems to generate reports (discussed in the next chapter).

Data Editing and Correction

An important step in processing transaction data is to perform **data editing** for validity and completeness to detect any problems. For example, quantity and cost data must be numeric and names must be alphabetic, otherwise the data is not valid. Often, the codes associated with an individual transaction are edited against a database containing valid codes. If any code entered (or scanned) is not present in the database, the transaction is rejected. For example, when you are buying something online, the system will usually check whether you have entered a correctly formatted email address, and will not allow the transaction to proceed if you have not. A **data correction** involves re-entering data that was not typed or scanned properly. It is not enough simply to reject invalid data. The system should also provide error messages that alert those responsible for editing the data. Error messages must specify the problem so proper corrections can be made. For example, a scanned barcode must match a code in a master table of valid codes. If the code is misread or does not exist in the table, the shop assistant should be given an instruction to rescan the item or type the information manually.

data editing The process of checking data for validity and completeness.

data correction The process of re-entering data that was not typed or scanned properly.

Data Manipulation

Another major activity of a TPS is **data manipulation**, the process of performing calculations and other data transformations related to business transactions. Data manipulation can include classifying data, sorting data into categories, performing calculations, summarizing results and storing data in the organization's database for further processing. In a payroll TPS, for example, data manipulation includes multiplying an employee's hours worked by the hourly pay rate. Overtime pay and tax deductions are also calculated.

data manipulation The process of performing calculations and other data transformations related to business transactions.

Data Storage

Data storage involves updating one or more databases with new transactions. As has already been emphasized several times in this chapter, this data can be further processed and manipulated by other systems so that it is available for management reporting and decision making. Thus, although transaction databases can be considered a by-product of transaction processing, they have a pronounced effect on nearly all other information systems and decision-making processes in an organization.

Document Production and Reports

Document production involves generating output records, documents and reports. These can be hard-copy paper reports or displays on computer screens (sometimes referred to as 'soft copy'). Electronic payslips for example, are produced by a payroll TPS, whereas an outstanding balance report for invoices might be a soft-copy report displayed by an accounts receivable TPS.

document production The process of generating output records and reports.

In addition to major documents such as payments and invoices, most TPS provide other useful management information and decision support, such as printed or on-screen reports that help managers and employees perform various activities. A report showing current inventory is one example; another might be a document listing items ordered from a supplier to help an administrator check the order for completeness when it arrives. A TPS can also produce reports required by law, such as tax statements.

Information Systems @ Work

Fast Food Chain Yonghe King Upgrades Their POS

Transaction processing systems allow companies to conduct business. A good example is a Point of Sale (POS) system. A POS is the system that processes sales. Examples include cash registers, self-service touch-screen displays, barcode readers and the printers that create receipts. Online, the part of an e-commerce website where you enter your credit card details is the POS.

Chinese fast food chain Yonghe King wanted to upgrade their technology to allow for rapid growth. Starting with 70 restaurants in the 1990s, their initial setup was able to cope with an expansion to 300 locations, but the parent company Jollibee Foods Corporation was keen to push this further to over 1,000. The original POS system had limited integration with their back-end systems, which meant it was difficult to analyze sales data. Analyzing sales data is vital – the knowledge contained within it is a treasure trove for any business. Sales data can help a company choose its product range and tailor it in individual outlets to cater for local demand. It helps plan sales promotions and assess whether they have been successful, and it helps to just get to know customers better.

Yonghe King wanted a solution that would connect multiple POS systems at the front of each restaurant to back-office computers in each outlet and a single corporate data centre. They brought in Shanghai company Partner Tech, a division of Partner Tech Corporation Worldwide, to implement a new POS system based on the Windows Embedded operating system. Partner Tech is a global provider of solutions for the retail, food and hospitality industries. They chose a Windows platform rather than open-source equivalent Linux in order to take advantage of its built-in features such as enhanced security. Using Microsoft would also mean that it should be easier to connect with multiple peripheral devices and applications. Yonghe King replaced their existing POS devices with the latest Partner Tech model and networked them with a back-office PC running Windows. The PCs were then connected to a server computer running in the Yonghe King headquarters, which is based in Shanghai. At the front of each restaurant the POS systems includes a touchscreen and an integrated card reader, a cash drawer and a receipt printer. In addition to handling sales, the devices also allowed for the creation of loyalty cards with a rewards scheme to encourage customers to share personal data.

Billy Yu, IT Director at Jollibee Foods said, ‘By implementing a standardized POS solution from Partner Tech based on Windows Embedded, we can halve the time it takes to open new stores and save about ¥800,000 annually’.

The POS sends orders to the kitchen printer, where paper is still valued as it can be moved about and marked as complete. Sales information is routed to the back-end PC and from there to headquarters. The restaurant managers use the PC to analyze sales data, and at headquarters they use data mining algorithms to create business intelligence. The information that is collected also improves inventory management. ‘Let’s use beef noodle soup as an example’, says Yu. ‘The POS devices tell us not only that we are selling exactly 1.6 million a day across all locations, but also how many we are selling at individual stores. As a result, we have a more accurate idea of how much inventory to deliver to each restaurant.’

Questions

1. Would you have advised Yonghe King to use Windows or an open-source platform?
2. How does the POS help Yonghe King open stores and expand?
3. How does a loyalty card capture personal data from customers?
4. How could sales data determine product ranges?

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7.4 Traditional Transaction Processing Applications

This section presents an overview of several common transaction processing systems that support the order processing, purchasing and accounting business functions (see Table 7.3).

Table 7.3 Systems that Support Order Processing, Purchasing and Accounting Functions

Order Processing	Purchasing	Accounting
Order processing	Inventory control (raw materials, packing materials, spare parts and supplies)	Budget
Sales configuration	Purchase order processing	Accounts receivable
Shipment planning	Receiving	Payroll
Shipment execution	Accounts payable	Asset management
Inventory control (finished product)		General ledger
Accounts receivable		

Order Processing Systems

The traditional TPS for order processing include order entry, sales configuration, shipment planning, shipment execution, inventory control and accounts receivable. Running these systems efficiently and reliably is critical to an enterprise. Figure 7.4 is a system-level flowchart that shows the various systems and the information that flows among them. Table 7.4 summarizes the input, processing and output (IPO) of the essential systems that include the traditional order processing systems.

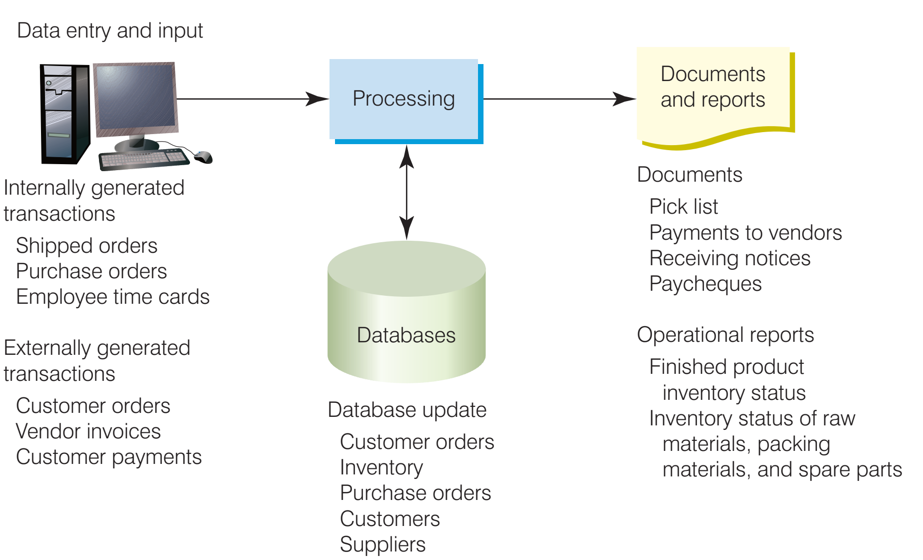

Figure 7.4 Traditional TPS Systems that Support the Order Processing Business Function

Table 7.4 IPO of the Traditional TPS Systems that Support Order Processing

System	Input	Processing	Output
Order entry	Customer order information via a variety of means: data entry by sales rep, customer input, mail, phone, e-commerce or computer to computer via EDI or XML formats	Order is checked for completeness and accuracy. On-hand inventory is checked to ensure each item can be shipped in the quantity ordered or a substitute item is suggested	An open order record
Sales configuration	Customer order information including model and options desired	Review customer order information and ensure the configuration will meet the customer's needs; suggest additional options and features when appropriate	Revised customer order
Shipment planning	Open orders, i.e. orders received but not yet shipped	Determine which open orders will be filled, when and from which location each order will be shipped to minimize delivery costs and meet customer desired delivery dates	Pick list for each order to be filled from each shipping location showing the items and quantities needed to fill the order
Shipment execution	Pick list and data entered by warehouse operations personnel as they fill the order	Data entered by warehouse operations personnel captured and used to update record of what was shipped to the customer	A shipped order record specifying exactly what was shipped to the customer – this can be different from what was ordered
Inventory control (finished product)	Record of each item picked to fill a customer order	Inventory records are updated to reflect current quantity of each item	Updated inventory database and various management reports
Accounts receivable	Shipped order records received from shipment execution that show precisely what was shipped on each order; payments from customers	Determine amount owed by each customer for each order placed	Invoice statement containing details of each order and its associated costs; customers' accounts receivable data is updated

Beaulieu Group LLC is the third-largest carpet manufacturer in the world. Its major customers include US home improvement chains The Home Depot and Lowe's Companies. Its most popular brands are Beaulieu, Coronet, Hollytex and Laura Ashley Home. In an effort to streamline its traditional order processing process, the firm equipped 250 of its commercial accounts sales staff with an order entry application that runs on a Pocket PC. With the new system, salespeople enter customer orders, access the company's pricing databases and make changes to orders over a wireless network. If a wireless connection cannot be made at the customer's site, the salesperson can enter orders on the Pocket PC and then transmit the data later when communications can be established. The new process has improved the way salespeople interact with customers and reduced the time they spend filling out paperwork. Previously, orders had to be written out at a customer's site and then sent to the company's central office, where clerical workers keyed them into an order processing system. As a result, the salespeople spent too much time on administrative work entering and correcting orders and not enough time selling.

Purchasing Systems

The traditional TPS that support the purchasing business function include inventory control, purchase order processing, receiving and accounts payable (see Figure 7.5). Table 7.5 shows the IPO associated with this collection of systems. Figure 7.6 shows a possible early form of transacting being undertaken.

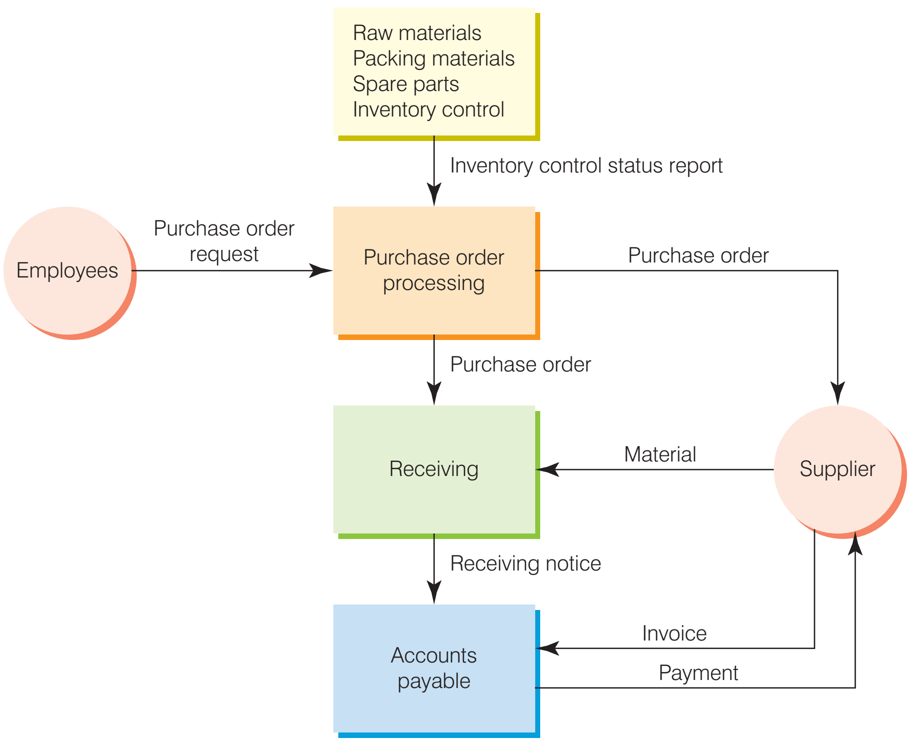

Figure 7.5 Traditional TPS Systems that Support the Purchasing Business Function

Table 7.5 IPO for the Traditional TPS Systems that Support Purchasing

System	Input	Processing	Output
Inventory control	Records reflecting any increase or decrease in the inventory of specific items of raw materials, packing materials or spare parts	Withdrawals are subtracted from inventory counts of specific items; additions are added to the inventory count	The inventory record of each item is updated to reflect its current count
Purchase order processing	Inventory records, employee-prepared purchase order requests, information on preferred suppliers	Items that need to be ordered are identified, quantities to be ordered are determined, qualified supplier with whom to place the order is identified	Purchase orders are placed with preferred suppliers for items
Receiving	Information on the quantity and quality of items received	Receipt is matched to purchase order, input data is edited for accuracy and completeness	Receiving report is created, inventory records are updated to reflect new receipts
Accounts payable	Purchase orders placed, information on receipts, supplier invoices	Supplier invoice matched to original purchase order and receiving report	Payment generated to supplier

Figure 7.6 **An Early Transaction Processing System?** *The boys are trying to transact with the gent, who looks like he's already done a deal with one of their competitors.*

Accounting Systems

accounting systems Systems that include budget, accounts receivable and payable, payroll, asset management and general ledger.

The primary **accounting systems** include the budget, accounts receivable and payable, payroll, asset management and general ledger (see Figure 7.7). Table 7.6 shows the input, processing and output associated with these systems.

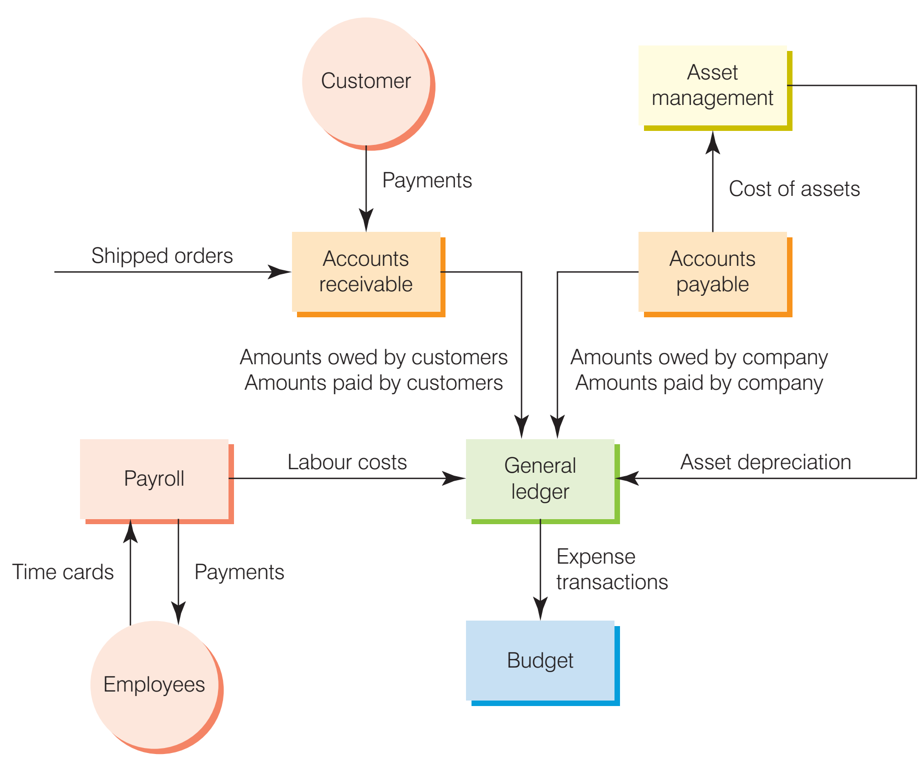

Figure 7.7 **Traditional TPS Systems that Support the Accounting and Finance Business Function**

Table 7.6 IPO for the Traditional TPS Systems that Support Accounting

System	Input	Processing	Output
Budget	Amounts budgeted for various categories of expense	Accumulates amount spent in each budget category	Budget status report showing amount under/over budget
Accounts receivable	Shipment records specifying exactly what was shipped to a customer	Determines amount to be paid by customer including delivery costs and taxes	Customer bills and monthly statements, management reports summarizing customer payments
Accounts payable	Purchase orders placed, information on receipts, supplier invoices	Supplier invoice matched to original purchase order and receiving report	Payment generated to supplier
Payroll	Number of hours worked by each employee, employee pay rate, employee tax and withholding information	Calculates employee gross pay and net pay and amount to be withheld for statutory purposes and employee benefit programmes	Payment and pay slip, payroll register (a tax year end summary report of all payroll transactions), P60 forms
Asset management	Data regarding the purchase of capital assets	Calculates depreciation and net value of all corporate assets	Listing of all assets showing purchase price and current value after depreciation
General ledger	All transactions affecting the financial standing of the firm	Posts financial transactions to appropriate accounts specified in the firm's chart of accounts	Financial reports such as the profit and loss statement, balance sheet

7.5 Electronic and Mobile Commerce

Electronic Commerce

Electronic commerce (e-commerce) is conducting a business transaction (e.g. distribution, buying, selling and servicing) electronically over computer networks, primarily the Internet but also extranets and corporate networks. An e-commerce system is a type of transaction processing system. Business activities that are strong candidates for conversion to e-commerce are paper based, time-consuming and inconvenient for customers. Thus, some of the first business processes that companies converted to an e-commerce model were those related to buying and selling. Integrated e-commerce systems directly link a firm's website, which allows customers to place orders, with its order processing system. This is the traditional **business-to-consumer (B2C) e-commerce** model.

electronic commerce (e-commerce) Conducting business transactions (e.g. distribution, buying, selling and servicing) electronically over computer networks such as the Internet, extranets and corporate networks.

business-to-consumer (B2C) e-commerce A form of e-commerce in which customers deal directly with an organization and avoid intermediaries.

Early B2C e-commerce pioneers competed with the traditional 'brick-and-mortar' retailers. For example, in 1995, Amazon.com challenged well-established US booksellers Waldenbooks, and Barnes and Noble. Although Amazon did not become profitable until 2003, the firm has grown from selling only books on a US website, to selling a wide variety of products (including clothes, CDs, DVDs, home and garden supplies, and consumer electronic devices) on international websites in Canada, China, France, Germany, Japan and the UK. Today, Amazon is one of the world's biggest companies (it is currently number 28 according to Forbes).[5]

The reasons people shop online rather than go to high street shops include convenience, because there is often a wider product range available online, and because costs are often less online. In addition, many sellers personalize their web pages for each individual customer, something high street shops cannot do. This personalization is sometimes called **B2Me e-commerce**. By using B2C e-commerce to sell directly to consumers, producers or providers of consumer products can eliminate the intermediaries between them and the consumer. In many cases, this squeezes costs and inefficiencies out of the supply chain and can lead to higher profits and lower prices for consumers.[6] The elimination of intermediate organizations between the producer and the consumer is called 'disintermediation'.

B2Me A form of e-commerce where the business treats each customer as a separate market segment. Typical B2Me features include customizing a website for each customer, perhaps based on their previous purchases and personalized (electronic) marketing literature.

Dell is an example of a manufacturer that has successfully embraced this model to achieve a strong competitive advantage. People can specify their own unique computer online, and Dell assembles the components and ships the computer directly to the consumer within five days. Dell does not inventory computers and does not sell through intermediate resellers or distributors. The savings are used to increase Dell's profits and reduce consumer prices.

Business-to-business (B2B) e-commerce is a subset of e-commerce where all the participants are organizations. B2B e-commerce is a useful tool for connecting business partners in a virtual supply chain to cut re-supply times and reduce costs. Many travel agents specialize in organizing business travel. Business Travel Direct in the UK provides flight and hotel bookings, tailoring its service for business customers. The sort of things B2B travel agents must deal with that high street agents may not are, for example, that the person who purchases the flight tickets may not be the person who will be travelling, and the decision on whether to travel may be made by a group rather than an individual.

business-to-business (B2B) e-commerce A subset of e-commerce where all the participants are organizations.

Consumer-to-consumer (C2C) e-commerce is another subset of e-commerce that involves consumers selling directly to other consumers. eBay is an example of a C2C e-commerce site; customers buy and sell items directly with each other through the site. Founded in 1995, eBay has become one of the most popular websites in the world, where 182 million users browse over 1 billion listings posted by 25 million sellers.[7,8,9] Other popular online auction websites include Craigslist, uBid, Yahoo! Auctions, Onsale, WeBidz and many others. The growth of C2C is responsible for reducing the use of the classified pages of a newspaper to advertise and sell personal items.

consumer-to-consumer (C2C) e-commerce A subset of e-commerce that involves consumers selling directly to other consumers.

E-government is the use of information and communications technology to simplify the sharing of information, speed up formerly paper-based processes and improve the relationship between citizen and government. Government-to-consumer (G2C), government-to-business (G2B) and government-to-government (G2G) are all forms of e-government, each with different applications. For example, citizens can use G2C applications to submit their tax returns online, apply for planning permission and submit e-petitions. G2B applications support the purchase of materials and services from private industry by government procurement offices, enable firms to bid on government contracts and help businesses receive current government regulations related to their operations. G2G applications are designed to improve communications between the various levels of government.

e-government The use of information and communications technology to simplify the sharing of information, speed up formerly paper-based processes and improve the relationship between citizen and government.

Mobile Commerce

Mobile commerce (m-commerce) relies on the use of wireless devices, such as personal digital assistants, mobile phones and smartphones, to transact. Handset manufacturers such as HTC, Samsung and Sony Ericsson are working with communications carriers such as Vodafone to develop wireless devices, related technology and services. In addition, content providers and mobile service providers are working together more closely than ever. Content providers recognize that customers want access to their content whenever and wherever they go, and mobile service providers seek out new forms of content to send over their networks.

In June 2017, the number of mobile phone subscribers passed 5 billion.[10] The number of devices connected to the Internet via the mobile network is much higher than this. The current version of the mobile network which is starting to be rolled out is 5G, the fifth generation. Many users will not notice any difference between accessing data through 5G and accessing through their home broadband via wi-fi. The Internet Corporation for Assigned Names and Numbers (ICANN) created a .mobi domain in late 2005 to help attract mobile users to the web.[11] mTID Top Level Domain Ltd of Dublin, Ireland, is responsible for administration of this domain and helping to ensure that the .mobi destinations work fast, efficiently and effectively with user handsets.[12] In most western European countries, communicating via wireless devices is common, and consumers are much more willing to use m-commerce. Japanese consumers are generally enthusiastic about new technology and are much more likely to use mobile technologies for making purchases.

Ethical and Societal Issues

Controlling Transactions with Biometrics

Biometrics – data about human bodies such as a person's fingerprints, the shape of their face, patterns on their eye retinas, and voice tone and pitch – are increasingly being used to control access to transaction processing systems. Many people reading this will already be using their fingerprints to unlock their phone, which allows them to transact with any number of apps. Banks and other financial institutions are investigating the use of facial recognition software to identify their customers rather than relying on customers typing in passwords. Some companies are using biometrics to control access to their ERP system. Founded in 2000, Suprema is at the forefront of this technology. A leading provider of biometrics based security, and one with major market shares in Europe, the Middle East and Africa, Suprema offers fingerprint recognition hardware and software for buildings (controlling access to doors and elevators, for example) and mobile computers, identifying the machine's user and giving them access to software. One of their main products is called BioStar 2.

Over 1 billion people use Suprema technologies. As a result, Suprema's database contains data about the bodies of many millions of people who use BioStar 2 to access a range of secure devices. This is some of the most personal data imaginable. It includes fingerprint data and images of users' faces, as well as more traditional data – home address, telephone number and email. Data on how these people access the devices being protected is also stored: when and how often people use their mobile computer, for example.

Thus it came as quite a shock in August 2019, when Israeli researchers with security company vpnMentor found that the data on over 1 million BioStar 2 users was available publicly and unencrypted. vpnMentor said on their company blog, 'The data leaked in the breach is of a highly sensitive nature. It includes detailed personal information of employees and unencrypted usernames and passwords, giving hackers access to user accounts and permissions at facilities using Biostar 2. Malicious agents could use this to hack into secure facilities and manipulate their security protocols for criminal activities. This is a huge leak that endangers both the businesses and organizations involved, as

(continued)

well as their employees. Our team was able to access over 1 million fingerprint records, as well as facial recognition information. Combined with the personal details, usernames, and passwords, the potential for criminal activity and fraud is massive'.

One particularly worrying aspect of this is that while exposed users can change passwords, they are unable to change their fingerprints. One of the researchers involved, Noam Rotem, told *The Guardian* newspaper, 'We were able to find plain-text passwords of administrator accounts'. (See the case 'Click Here to Reset Your Password' in Chapter 5 to see how these data should be stored.) 'We [were] able to change data and add new users', he added.

It took Suprema just over a week to fix the breach.

Questions

1 If you worked for a bank, how would you balance the needs of customers to readily access their account and the need to prevent fraudsters accessing their account?

2 Which do you think is more secure – access controlled by fingerprint or access controlled by password? Explain your answer.

3 Can any company really be trusted with our data?

4 Why do you think vpnMentor tests the vulnerability of a company like Suprema?

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For m-commerce to work effectively, the interface between the wireless device and its user needs to improve to the point that it is nearly as easy to purchase an item on a wireless device as it is to purchase it on a home computer. In addition, network speed must improve so that users do not become frustrated. Security is also a major concern, particularly in two areas: the security of the transmission itself and the trust that the transaction is being made with the intended party. Encryption can provide secure transmission. Digital certificates can ensure that transactions are made between the intended parties.

The handheld devices used for m-commerce have several limitations that complicate their use. Their screens are small, perhaps no more than a few square centimetres, and might be able to display only a few lines of text. Their input capabilities are limited to a few buttons, so entering data can be tedious and error prone. They have less processing power and less bandwidth than desktop computers, which are usually hardwired to a high-speed LAN. They also operate on limited-life batteries. For these reasons, it is currently impossible to directly access many websites with a handheld device. Web developers must rewrite web applications so that users with handheld devices can access them.

7.6 Production and Supply Chain Management

Production and supply chain management systems follow a systematic process for developing a production plan that draws on the information available in the system database.

The process starts with sales forecasting to develop an estimate of future customer demand. This initial forecast is at a fairly high level with estimates made by product group rather than by each individual product item. The sales forecast extends for months into the future. The sales forecast will be produced using specialized software and techniques. Many organizations are moving to a collaborative process with major customers to plan future inventory levels and production rather than relying on an internally generated sales forecast. The sales and operations plan takes demand and current inventory levels into account and determines the specific product items that need to be produced and when to meet the forecast future demand. Production capacity and any seasonal variability in demand must also be considered. The result is a high-level production plan that balances market demand with production capacity. Panasonic and other companies have outsourced the development of a sales and operation plan to i2 Technologies in India. Best Buy, a major Panasonic customer, collects information on sales of Panasonic items at its shops' checkout stations and sends the data to i2. i2 processes the data and sends manufacturing recommendations to Panasonic, which become the basis for factory schedules.[13]

Demand management refines the production plan by determining the amount of weekly or daily production needed to meet the demand for individual products. The output of the demand management process is the master production schedule, which is a production plan for all finished goods.

Detailed scheduling uses the production plan defined by the demand management process to develop a detailed production schedule specifying production scheduling details, such as which item to produce first and when production should be switched from one item to another. A key decision is how long to make the production runs for each product. Longer production runs reduce the number of machine setups required, thus reducing production costs. Shorter production runs generate less finished product inventory and reduce inventory holding costs.

Materials requirement planning determines the amount and timing for placing raw material orders with suppliers. The types and amounts of raw materials required to support the planned production schedule are determined based on the existing raw material inventory and the bill of materials or BOM, a sort of 'recipe' of ingredients needed to make each product item. The quantity of raw materials to order also depends on the lead time and lot sizing. Lead time is the time it takes from when a purchase order is placed until the raw materials arrive at the production facility. Lot size has to do with discrete quantities that the supplier will ship and the amount that is economical for the producer to receive and/or store. For example, a supplier might ship a certain raw material in batches of 80,000 units. The producer might need 95,000 units. A decision must be made to order one or two batches.

Purchasing uses the information from materials requirement planning to place purchase orders for raw materials and transmit them to qualified suppliers. Typically, the release of these purchase orders is timed so that raw materials arrive just in time to be used in production and minimize warehouse and storage costs. Often, producers will allow suppliers to tap into data via an extranet that enables them to determine what raw materials the supplier needs, thus minimizing the effort and lead time to place and fill purchase orders.

Production uses the detailed schedule to plan the details of running and staffing the production operation.

Companies must capture accurate information about what was produced and in what quantities. Many companies have personal computers on the production floor that count the number of cases of each product item produced by scanning a universal product code (UPC) code on the packing material. Other approaches for capturing production quantities include the use of RFID chips and manually entering the data via a PDA.

Separately, production-quality data can be added based on the results of quality tests run on a sample of the product for each batch of product produced. Typically, this data includes the batch identification number, which identifies this production run versus any other production run and the results of various product quality tests.

7.7 Customer Relationship Management and Sales Ordering

Customer Relationship Management

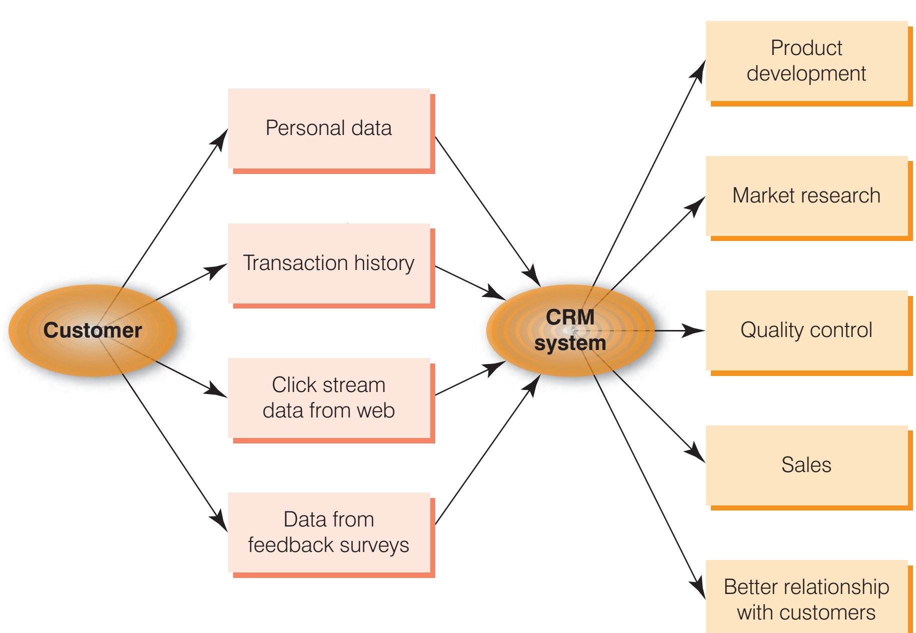
customer relationship management (CRM) system A system that helps a company manage all aspects of customer encounters, including marketing and advertising, sales, customer service after the sale and programmes to retain loyal customers.

A **customer relationship management (CRM) system** helps a company manage all aspects of customer encounters, including marketing and advertising, sales, customer service after the sale and programmes to keep and retain loyal customers (see Figure 7.8). The goal of CRM is to understand and anticipate the needs of current and potential customers to increase customer retention and loyalty while optimizing the way that products and services are sold. Businesses implementing CRM systems report business benefits such as improved customer satisfaction, increased customer retention, reduced operating costs and the ability to meet customer demand.

CRM software automates and integrates the functions of sales, marketing and service in an organization. The objective is to capture data about every contact a company has with a customer through every channel, and store it in the CRM system so the company can truly understand customer actions. CRM software helps an organization build a database about its customers that describes relationships in sufficient detail so that management, salespeople, customer service providers – and even customers – can access information to match customer needs with product plans and offerings, remind them of service requirements and know what other products they have purchased.

The focus of CRM involves much more than installing new software. Moving from a culture of simply selling products to placing the customer first is essential to a successful CRM deployment. Before any software is loaded onto a computer, a company must retrain employees. Who handles customer issues and when must be clearly defined, and computer systems need to be integrated so that all pertinent information is available immediately, whether a customer calls a sales representative or customer service representative. In addition to using stationary computers, most CRM systems can now be accessed via wireless devices.

Figure 7.8 Customer Relationship Management System



The gig economy refers to the popularity of jobs that last for a short time (a 'gig' rather than a 'job'). Popular examples include Uber drivers and Deliveroo delivery people. It can be a way for companies to shirk their employer responsibilities including offering pensions and paid leave. On the other hand, it does suit many people who can work when they choose to. Information provider Destination CRM claims that, 'According to Aspect Software's most recent Agent Experience Index, 16 percent of current customer service agents are working gig economy jobs, and many more have expressed an interest in that type of on-demand work'.[14] If this is done correctly, customers shouldn't notice. When phoning what they think is a call centre, customers are being put through to a gig worker's home phone where the worker can deal with their query. The worker should have access to the relevant customer data – orders they have placed and support they have previously had – on their laptop or desktop computer.

Sales Ordering

Sales ordering is the set of activities that must be performed to capture a customer sales order. A few of the essential steps include recording the items to be purchased, setting the sales price, recording the order quantity, determining the total cost of the order including delivery costs and confirming the customer's available credit. The determination of the sales prices can become quite complicated and include quantity discounts, promotions and incentives. After the total cost of the order is determined, it is necessary to check the customer's available credit to see if this order puts the customer over his or her credit limit.

Many SMEs are turning to ERP software to make it easier for their large customers to place orders with them. Vetco International Inc. is a small supplier of safety equipment to major oil firms such as ExxonMobile and BP. The firm uses SAP's Business One suite, which has modules that automate purchasing, sales and distribution, sales management and other business functions. It cost Vetco about €110,000 to implement the software because it is compatible with the SAP software used by many of its customers. The software enables Vetco to connect its product catalogues via easy web access to the purchasing systems of its much larger customers. The goal is to capture more business by ensuring that its offerings are just a click away from the oil companies' purchasing departments.[15]

Medical ERP systems have particularly strict requirements for managing stock – many medicines come with non-negotiable expiry dates. Medical equipment too has rigid compliance standards that must be met. IQMS Manufacturing Software develops ERP systems designed for manufacturers of medical equipment. The software allows companies to track their products, manage warranties and service schedules, and demonstrate compliance with quality standards. Similarly, the COVID-19 pandemic generated an urgent need for additional protective clothing, face masks and ventilators with strict standards. Non-medical manufacturers in other fields were quickly able to learn the standards required, and adapt their own businesses to meet this urgent demand.

7.8 Financial and Managerial Accounting

The general ledger is the main accounting record of a business. It is often divided into different categories, including assets, liabilities, revenue, expenses and equity. These categories, in turn, are subdivided into sub-ledgers to capture details such as cash, accounts payable, accounts receivable and so on. In an ERP system, input to the general ledger occurs simultaneously with the input of a business transaction to a specific module. Here are several examples of how this occurs:

- An order administrator records a sales, and the ERP system automatically creates an accounts receivable entry indicating that a customer owes money for goods received.
- A buyer enters a purchase order, and the ERP system automatically creates an accounts payable entry in the general ledger registering that the company has an obligation to pay for goods that will be received at some time in the future.

- A dock worker enters a receipt of purchased materials from a supplier, and the ERP system automatically creates a general ledger entry to increase the value of inventory on hand.
- A production worker withdraws raw materials from inventory to support production, and the ERP system generates a record to reduce the value of inventory on hand.

Thus the ERP system captures transactions entered by workers in all functional areas of the business. The ERP system then creates the associated general ledger record to track the financial impact of the transaction. This set of records is an extremely valuable resource that companies can use to support financial accounting and managerial accounting.

Financial accounting consists of capturing and recording all the transactions that affect a company's financial state and then using these documented transactions to prepare financial statements for external decision makers, such as stockholders, suppliers, banks and government agencies. These financial statements include the profit and loss statement, balance sheet and cash flow statement. They must be prepared in strict accordance with the rules and guidelines of the governing agencies.

All transactions that affect the financial state of the firm are captured and recorded in the database of the ERP system. This data is used in the financial accounting module of the ERP system to prepare the statements required by various constituencies. The data can also be used in the managerial accounting module of the ERP system, along with various assumptions and forecasts, to perform various analyses such as generating a forecasted profit and loss statement to assess the firm's future profitability.

Hosted Software Model for Enterprise Software

Business application software vendors are experimenting with the hosted software model to see if the approach meets customer needs and is likely to generate significant revenue. This pay-as-you-go approach is appealing to small businesses because they can then experiment with powerful software capabilities without making a major financial investment. Also, using the hosted software model means the small business firm does not need to employ a full-time IT person to maintain key business applications. The small business firm can expect additional savings from reduced hardware costs and costs associated with maintaining an appropriate computer environment (such as air conditioning, power and an uninterruptible power supply).

Not only is the hosted software model attractive to small and medium-sized firms but even some large companies are experimenting with it. DuPont, the large, multinational chemical company, was one of the early adopters of the hosted software model. The firm is retooling its sales force by leveraging best practices and focusing its e-business and marketing capabilities into 16 high-powered global centres. As part of the change, DuPont uses the hosted SAP Sales on Demand software across the enterprise to provide a common systems platform and a common set of business processes for DuPont's entire sales force. It has integrated the hosted system with its SAP ERP software and retired some of its legacy CRM applications. The business goal was to make sure that the firm presents itself as one DuPont to customers who buy from different DuPont businesses. Its largest customers are served as 'corporate accounts' with a point of contact who can manage all their interactions with DuPont to ensure the maximum benefit to the customer.[16]

7.9 International Issues Associated with Operational Systems

Operational systems must support businesses that transact with customers, suppliers, business partners, shareholders and government agencies in multiple countries. Different languages and cultures, disparities in IS infrastructure, varying laws and customs rules, and multiple currencies are among the challenges that must be met by an operational system of a multinational company. The following sections highlight these issues.

Different Languages and Cultures

Teams composed of people from several countries speaking different languages and familiar with different cultures might not agree on a single work process. In some cultures, people do not routinely work in teams in a networked environment. Despite these complications, many multinational companies can establish close connections with their business partners and roll out standard IS applications for all to use. However, sometimes they require extensive and costly customization. For example, even though English has become a standard business language among executives and senior managers, many people within organizations do not speak English. As a result, software might need to be designed with local language interfaces to ensure the successful implementation of a new system. Other customizations will also be needed; date fields for example: the European format is day/month/year, Japan uses year/month/day, and the US date format is month/day/year. Sometimes, users might also have to implement manual processes to override established formatting to enable systems to function correctly.

Disparities in Information System Infrastructure

The lack of a robust or common information infrastructure can also create problems. For example, much of Latin America lags behind the rest of the world in Internet usage, and online marketplaces are almost non-existent there. This gap makes it difficult for multinational companies to get online with their Latin American business partners. Even something as mundane as the fact that the power plug on a piece of equipment built in one country might not fit into the power socket of another country can affect the infrastructure.

Varying Laws and Customs Rules

Numerous laws can affect the collection and dissemination of data. For example, labour laws in some countries prohibit the recording of worker performance data. Also, some countries have passed laws limiting the transborder flow of data linked to individuals. Specifically, European Community Directive 95/96/EC of 1998 requires that any company doing business within the borders of the (currently) 27 European Union member nations protect the privacy of customers and employees. It bars the export of data to countries that do not have data-protection standards comparable to the European Union's.

Trade custom rules between nations are international laws that set practices for two or more nations' commercial transactions. They cover imports and exports, and the systems and procedures dealing with quotas, visas, entry documents, commercial invoices, foreign trade zones, payment of duty and taxes, and many other related issues. For example, the North American Free Trade Agreement (NAFTA) of 1994 created trade custom rules to address the flow of goods throughout the North American continent. Most of these custom rules and their changes over time create headaches for people who must keep systems consistent with the rules.

Multiple Currencies

The enterprise system of multinational companies must conduct transactions in multiple currencies. To do so, a set of exchange rates is defined, and the information systems apply these rates to translate from one currency to another. The systems must be current with foreign currency exchange rates, handle reporting and other transactions such as cash receipts, issue vendor payments and customer statements, record retail store payments and generate financial reports in the currency of choice.

Summary

An organization must have information systems that support the routine, day-to-day activities that occur in the normal course of business and help a company add value to its products and services. Transaction processing systems (TPS) are at the heart of most information systems in businesses today. A TPS is an organized collection of people, procedures, software, databases and devices used to capture fundamental data about events that affect the organization (transactions). All TPS perform the following basic activities: data collection, which involves the capture of source data to complete a set of transactions; data editing, which checks for data validity and completeness; data correction, which involves providing feedback of a potential problem and enabling users to change the data; data manipulation, which is the performance of calculations, sorting, categorizing, summarizing and storing data for further processing; data storage, which involves placing transaction data into one or more databases; and document production, which involves outputting records and reports.

The methods of transaction processing systems include batch and online. Batch processing involves the collection of transactions into batches, which are entered into the system at regular intervals as a group. Online transaction processing (OLTP) allows transactions to be entered as they occur.

Organizations expect TPS to accomplish a number of specific objectives including processing data generated by and about transactions, maintaining a high degree of accuracy and information integrity, compiling accurate and timely reports and documents, increasing labour efficiency, helping provide increased and enhanced service, and building and maintaining customer loyalty. In some situations, an effective TPS can help an organization gain a competitive advantage.

Traditional TPS support the various business functions of organizations that have not yet implemented enterprise resource planning systems. The traditional TPS systems that support the order processing business functions include order entry, sales configuration, shipment planning, shipment execution, inventory control and accounts receivable.

The traditional TPS that support the purchasing function include inventory control, purchase order processing, accounts payable and receiving.

The traditional TPS that support the accounting business function include the budget, accounts receivable, payroll, asset management and general ledger.

Electronic and mobile commerce allow transactions to be made by the customer, with less need for sales staff, and open up new opportunities for conducting business. E-commerce is the conducting of business activities electronically over networks. Business-to-business (B2B) e-commerce allows manufacturers to buy at a low cost worldwide, and it offers enterprises the chance to sell to a global market. Business-to-consumer (B2C) e-commerce enables organizations to sell directly to consumers, eliminating intermediaries. In many cases, this squeezes costs and inefficiencies out of the supply chain and can lead to higher profits and lower prices for consumers. Consumer-to-consumer (C2C) e-commerce involves consumers selling directly to other consumers. Online auctions are the chief method by which C2C e-commerce is currently conducted.

Mobile commerce is the use of wireless devices such as PDAs, mobile phones and smartphones to facilitate the sale of goods or services – anytime, anywhere. The market for m-commerce in North America is expected to mature much later than in western Europe and Japan. Although some industry experts predict great growth in this arena, several hurdles must be overcome, including improving the ease of use of wireless devices, addressing the security of wireless transactions and improving network speed. M-commerce provides a unique opportunity to establish one-on-one marketing relationships and support communications anytime and anywhere.

A company that implements an enterprise resource planning system is creating a highly integrated set of systems, which can lead to many business benefits. ERP software supports the efficient operation of business processes by integrating activities throughout a business, including sales, marketing, manufacturing, logistics, accounting and staffing. Implementation of an ERP system can provide many advantages, including providing access to data for operational decision making; elimination of costly, inflexible legacy systems; providing improved work processes; and creating the opportunity to upgrade technology infrastructure. Some of the disadvantages associated with an ERP system are that they are time consuming, difficult and expensive to implement.

Although the scope of ERP implementation can vary from firm to firm, most firms use ERP systems to support production and supply chain management, customer relationship management and sales ordering, and financial and managerial accounting.

The production and supply chain management process starts with sales forecasting to develop an estimate of future customer demand. This initial forecast is at a fairly high level with estimates made by product group rather than by each individual product item. The sales and operations plan takes demand and current inventory levels into account and determines the specific product items that need to be produced and when to meet the forecast future demand. Demand management refines the production plan by determining the amount of weekly or daily production needed to meet the demand for individual products. Detailed scheduling uses the production plan defined by the demand management process to develop a detailed production schedule specifying production scheduling details such as which item to produce first and when production should be switched from one item to another. Materials requirement planning determines the amount and timing for placing raw material orders with suppliers. Purchasing uses the information from materials requirement planning to place purchase orders for raw materials and transmit them to qualified suppliers. Production uses the detailed schedule to plan the details of running and staffing the production operation.

Numerous complications arise that multinational corporations must address in planning, building and operating their TPS. These challenges include dealing with different languages and cultures, disparities in IS infrastructure, varying laws and customs rules, and multiple currencies.

Self-Assessment Test

1. ERP stands for __________.
2. Systems that allow an organization to conduct business are __________.
3. OLTP is __________.
4. RFID can be used to __________ the data necessary for transaction processing.
5. The process of performing calculations and other data transformations is __________.
6. Buying a book on a smartphone is an example of __________.
7. Systems used to improve interaction between a government and its citizens form __________.
8. CRM stands for __________.
9. A wholesaler selling to a high street shop via the Internet is an example of __________.
10. When you sell an old textbook on Amazon to another student you are taking part in __________ commerce.

Review Questions

1. Compare and contrast batch processing and OLTP.
2. What basic transaction processing activities are performed by all TPS?
3. How could RFID be used to minimize data entry errors?
4. What are some of the advantages of ERP?
5. List several TPS that support order processing.
6. Why do data need correction?
7. What is B2Me?
8. Where do data for a CRM come from?
9. What is the relationship between m-commerce and e-commerce?
10. What are some of the international challenges associated with operational systems?

Discussion Questions

1 Think of a transaction you have made within the past week. What information was exchanged – what did you give and what did you get back?

2 How can an ERP give improved access to data for operational decision making?

Web Exercises

1 Log into Amazon and browse through your account and your orders. List some of the information that they store about you.

2 Search for information about two customer relationship management systems. What are the main features offered by them?

Case One

Non-Linear Presentations

7 Enterprise software is used to facilitate the day-to-day running of a business. Without it, the business could not 'transact' – they could not sell goods and services to customers. In effect, they could not do business. Support applications are not essential but they are nice to have, and can be replaced easily if there is a problem. Presentation software is an example of a support application.

At the end of 2015, BBC technology reporter Jane Wakefield wrote the following: 'Most people who've endured a terrible PowerPoint presentation will have experienced boredom, followed by frustration, then anger that it took up an hour – or possibly even more – of their lives that they will never get back'. She is right that many people will have experienced this: Click. A slide with a colourful background covered in text appears. The presenter reads the text. Click. A new slide, more text, more reading. Another click ... and so on. Perhaps it's not the fault of the software, but the presenter. If they were a better public speaker, it wouldn't be so boring. On the other hand, PowerPoint with its templates full of different ways to stack up bullet lists of text does have to take some of the blame. PowerPoint certainly encourages a linear approach to slides, moving from one to the next in one direction only. What if the speaker wants to go from Slide 1 to Slide 2, then back to Slide 1, jump to Slide 10, before going back to Slide 3? There may be good reason for doing this too. It's easy to imagine a presentation that includes a taster at the start of something from later in the presentation to show 'where we're going with this'. Of course, you can jump back and forth using PowerPoint, but the software discourages it. Or you could duplicate slides but that's not usually a good idea (if you update one, you might forget to update the other). At the far end of the presentation scale, if you have watched footage on YouTube of Steve Jobs in action at his product launches, if there even were any slides, there was certainly no text on any of them!

Wakefield identifies alternatives, many of which are freely available on the web. These include Keynote, Slides, Prezi, SlideRocket, Easel.ly, Emaze and Slidedog. Emaze makes it easy to incorporate a video as the slide background, which could be effective in grabbing an audience's attention. Prezi, discussed next, uses an innovative zoom feature. 'But', she says, 'Microsoft's software, launched in 1990, still dominates the market – with an estimated 1.2 billion users worldwide and millions of presentations made each day using the software'.

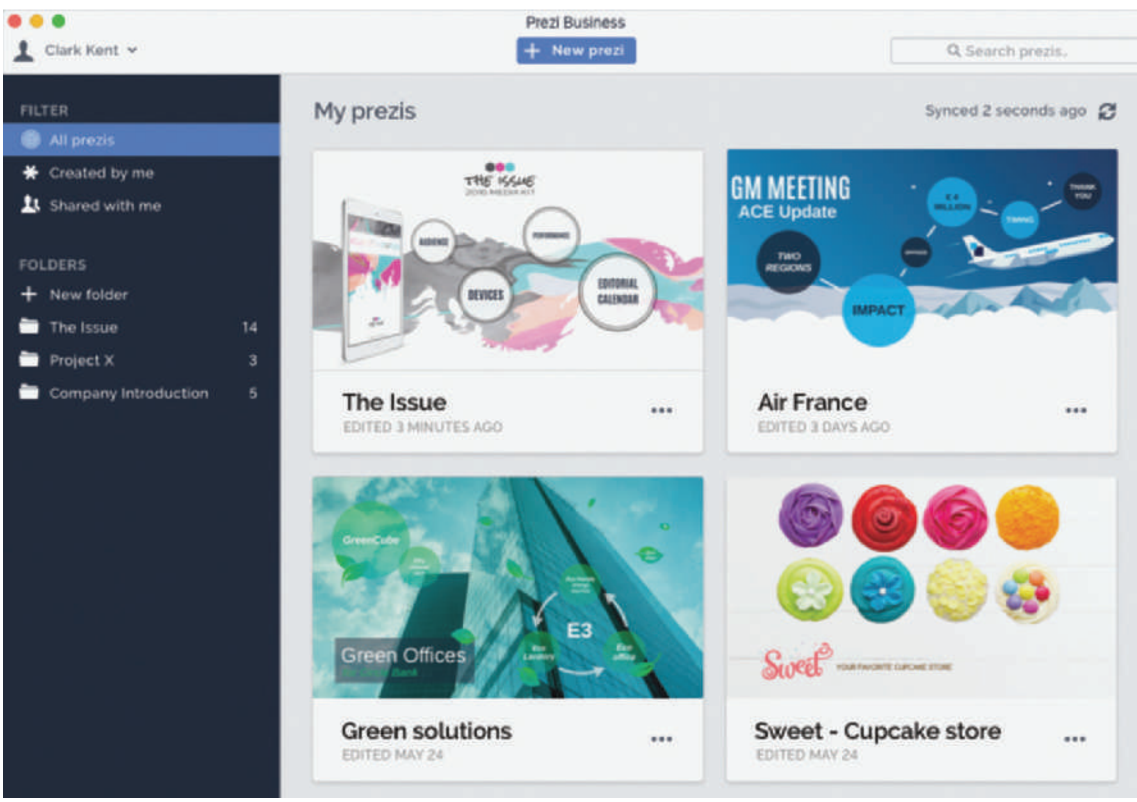
Introduced in 2008, Prezi takes a very different approach, eschewing the linear structure of slides for essentially one massive diagram that the presenter zooms in and out of (see Figure 7.9). Researchers Brian Perron and Alyson Stearns say that Prezi, 'allows for both a linear and a free-flowing presentation of a story line. The user creates a presentation on a large blank workspace called the canvas, where all the elements of a presentation are visible. A story line is then created by arranging the elements on the canvas'. It takes a little getting used to, but this approach should free presenters from thinking about slides to thinking about stories and the messages they want to get across through them. Some researchers, however, have found that too much zooming in and out can cause motion sickness in the audience.

Aaron Weyenberg helps makes slide shows for the well-known TED (Technology, Entertainment and Design) conferences. He regularly asks presenters whether they need any slides at all. 'TED's most viewed talk of all time', he says, 'hasn't a single slide, and many of TED's most successful talks have a focus on what's said, not seen.'

Questions

1. What purposes do slides serve? You should be able to list several key points.
2. Outline a guide to using Prezi that would minimize motion sickness. Does your guide effectively turn it back into PowerPoint?
3. Why do you think Steve Jobs was considered to be such a good presenter?
4. Recreate a recent presentation you gave as a talk without slides. Do you think you have made it better or worse?

Figure 7.9 Prezi



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Case Two

When Stock Becomes a Liability

South African company New Era Solutions is helping its clients to reduce stock. Working with their partners Epicor Software Corporation, New Era offers warehouse management systems to control the movement and storage of materials in a warehouse and process goods coming into the warehouse and leaving it. Warehouse management software, part of an ERP system, allows a company to manage its inventory and minimize so-called 'dead stock'.

A manufacturing company buys raw materials and turns them into finished products. Each of these (materials and products) is stock. Stock includes the materials coming in, products at all stages of being finished, and the final products ready to be shipped. Stock is a major company asset and is usually the main source of a company's revenue. However, there are times when stock can become a liability: stock can generate revenue but it is also a cost. It costs money to keep it, as the warehouse needs security guards, electricity, there may be rent to pay, or payments on a building loan.

IT Online explains how stock can be a liability. 'As a distributor, the process of making money on goods does not begin when goods enter your warehouse; it only generates income when it leaves. While stock is waiting to be sold, it costs money to store it. The longer it stays in a warehouse, the less likely it is that it will be sold'. Eventually stock that sits long enough can be considered to be 'dead'. At that point it becomes a liability. There are various ways of getting rid of dead stock. A company could sell it off cheaply, donate it to charity, try to return it to their supplier, bundle it with a new product to try to sell old and new together, or simply dump it. There are other gimmicks that could be used like 'a free gift with every purchase'.

According to New Era, the best way to deal with dead stock is to avoid it altogether. One cause of dead stock is in mishandling customer orders. Let's say a customer wants a customized product – it could be as simple as wanting it to be blue when it's usually red. Then the company buys in blue raw materials, manufacturers and ships the finished product to the customer, but they bought in too much material. Now they have blue stuff lying around in the warehouse, unable to use it to create a product, as only one customer wanted blue. The best way to avoid this is to use ERP software with warehouse management capabilities to accurately forecast exactly the materials that will be needed.

'Best in class companies perform better as they are able to make more informed decisions based on accurate data', says Stuart Scanlon, sales and marketing director at New Era. Recent research into small manufacturing enterprises in South Africa found that small businesses only want to implement ERP if they think it will integrate easily with existing systems with a quick implementation time. This isn't usually what you get with ERP, which tend to bring with them great upheaval and change. Mr Scanlon says, 'implementing a new ERP system is one of the most disruptive exercises a business can undertake and often emotions cloud what should be a logical decision'.

Questions

1. List some of the costs associated with running a warehouse.
2. How does warehouse management software help reduce dead stock?
3. How could a company decide at what point stock becomes dead stock?
4. How can companies deal with the disruption that implementing an ERP creates?

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Case Three

Netflix Analytics Creates Content That We'll Watch

Netflix has had a long interest in predicting what its viewers will like to watch. In 2006 it announced a $100,000 prize for the data mining team that could best decide whether someone will enjoy a particular movie. (In brief: Netflix had personal data about its members and the movies that they liked, then released just the personal data to the teams and compared their predictions with the real data on what people actually liked.) But the Netflix analytics division didn't stop there.

Netflix is a data-driven company. With its streaming service, it is able to capture information on how its members watch TV, including where and when they watch, what shows they watch and on what devices, when they pause, rewind and fast forward, if they stop watching and when in the show/series they stop, the ratings they give shows and how they search for content (the search terms they use coupled with their browsing behaviour). They also know when people cancel their membership.

Using all of this, Netflix can predict what you might like to watch, how long TV shows and series should be for maximum viewer engagement, when the shows should be released (what time of year, week and day), whether someone may be about to cancel their subscription, and of course what content new TV shows should have to maximize viewers. The most famous example is *House of Cards*, developed by film director David Fincher.

In 2011, Netflix decided to outbid well-known channels like HBO for the right to show the US version of British political drama *House of Cards*, spending over $4 million per episode. This was the first time they had invested so heavily in content. According to entertainment industry analyst Zach Bulygo, Netflix based the decision on three key pieces of data. They knew a lot of their members had watched the David Fincher directed movie *The Social Network* from beginning to end; they knew the British version of *House of Cards* had been popular; and they knew that those members who watched the British version had also tended to watch other films directed by David Fincher. Jonathan Friedland, Netflix's chief communications officer, said, 'Because we have a direct relationship with consumers, we know what people like to watch and that helps us understand how big the interest is going to be for a given show. It gave us some confidence that we could find an audience for a show like *House of Cards*.'

Once they had the rights to the show they started to promote it, and again for this they turned to their database. Netflix made ten different trailers, each geared towards different audiences. They then looked into their data to determine what sort of audience each member was, and showed them their own semi-personalized advert for the show. Those who were classed as fans of the main cast saw a trailer featuring them heavily. Those who liked drama saw a trailer emphasizing this aspect of the show.

The strategy appears to be working. *House of Cards* brought in 2 million new US subscribers in the first quarter of 2013, which was a 7 per cent increase over the previous quarter. It also brought in 1 million new subscribers from elsewhere in the world. These new members alone almost paid Netflix back for the cost of *House of Cards*. And a survey suggested that the show made 86 per cent of subscribers less likely to cancel their subscription.

Questions

1. Does a data-driven approach make it less likely that innovative shows will be produced in the future?
2. Does personalized advertising threaten traditional broadcast television?
3. How would you have approached the 2006 Netflix competition? You can look up the winning entry to see what they did.
4. How could similar approaches be used in other sectors such as the fitness industry?

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08

Management Information and Decision Support Systems

Principles

Good decision-making and problem-solving skills are key to developing effective information and decision support systems.

- Define the stages of decision making.
- Discuss the importance of implementation and monitoring in problem solving.

A management information system (MIS) must provide the right information to the right person in the right format at the right time.

- Explain the uses of MISs and describe their inputs and outputs.
- Discuss information systems in the functional areas of business organizations.

Decision support systems (DSSs) support decision-making effectiveness when faced with unstructured or semi-structured business problems.

- List and discuss important characteristics of DSSs that give them the potential to be effective management support tools.
- Identify and describe the basic components of a DSS.

Specialized support systems, such as group support systems (GSSs) and executive support systems (ESSs), use the overall approach of a DSS in situations such as group and executive decision making.

- State the goals of a GSS and identify the characteristics that distinguish it from a DSS.
- Identify the fundamental uses of an ESS and list the characteristics of such a system.

Learning Objectives

(The learning objectives are listed beside each principle above.)

Why Learn About Management Information Systems and Decision Support Systems?

The previous chapter looked at systems at the operational level of a firm (see also Figures 1.4 and 8.11). This chapter considers systems higher up, at the tactical and strategic levels. The true potential of information systems in organizations is in helping employees make more informed decisions, something that is supported by both management information and decision support systems. Transportation coordinators can use management information reports to find the least expensive way to ship products to market and to solve bottlenecks. A bank or credit union can use a group support system to help it determine who should receive a loan. Shop managers can use decision support systems to help them decide what and how much inventory to order to meet customer needs and increase profits. An entrepreneur who owns and operates a temporary storage company can use vacancy reports to help determine what price to charge for new storage units. Everyone wants to be a better problem solver and decision maker. This chapter shows you how information systems can help. It begins with an overview of decision making and problem solving.

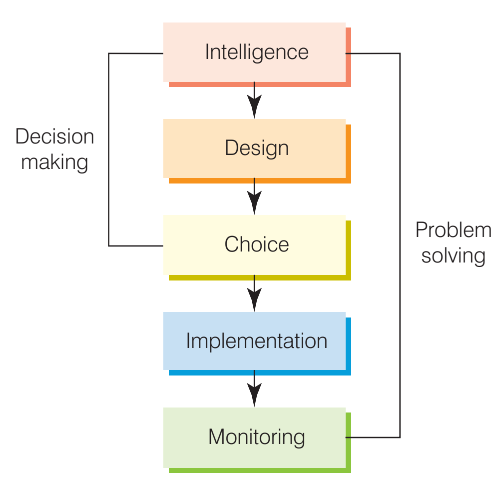
8.1 Decision Making and Problem Solving

Organizations need to make good decisions. In most cases, strategic planning and the overall goals of the organization set the course for decision making, helping employees and business units achieve their objectives and goals. Often, information systems also assist with strategic planning, helping top management make better decisions.

In business, one of the highest compliments you can receive is to be recognized by your colleagues and peers as a 'real problem solver'. Problem solving is a critical activity for any business organization. After identifying a problem, you begin the problem-solving process with decision making. A well-known model developed by Herbert Simon divides the **decision-making phase** of the problem-solving process into three stages: intelligence, design and choice. This model was later incorporated by George Huber into an expanded model of the entire problem-solving process (see Figure 8.1).

decision-making phase The first part of problem solving, including three stages: intelligence, design and choice.

Figure 8.1 How Decision Making Relates to Problem Solving



The three stages of decision making – intelligence, design and choice – are augmented by implementation and monitoring to result in problem solving.

The first stage in the problem-solving process is the **intelligence stage**. During this stage, you identify and define potential problems or opportunities. For example, you might learn about the need for an intervention or change in an unsatisfactory situation. During the intelligence stage, you also investigate resource and environmental constraints. For example, if you were a French farmer, during the intelligence stage you might explore the possibilities of shipping apples from your farm to shops in Ireland. The perishability of the fruit and the maximum price that consumers in Ireland are willing to pay for the fruit are problem constraints. Aspects of the problem environment that you must consider include import/export laws regarding the shipment of food products.

intelligence stage The first stage of decision making in which potential problems or opportunities are identified and defined.

In the **design stage**, you develop alternative solutions to the problem. In addition, you evaluate the feasibility of these alternatives. In the fruit shipping example, you would consider the alternative methods of shipment, including the transportation times and costs associated with each.

design stage The second stage of decision making in which alternative solutions to the problem are developed.

The last stage of the decision-making phase, the **choice stage**, requires selecting a course of action. Here you might select the method of shipping fruit by air from you as the solution. The choice stage would then conclude with selection of an air carrier. As you will see later, various factors influence choice; the act of choosing is not as simple as it might first appear.

choice stage The third stage of decision making which requires selecting a course of action.

Problem solving includes and goes beyond decision making. It also includes the **implementation stage**, when the solution is put into effect. For example, if your decision is to ship fruit to Ireland as air freight using a specific air freight company, implementation involves informing your farming staff of the new activity, getting the fruit to the airport and actually shipping the product.

problem solving A process that goes beyond decision making to include the implementation and monitoring stages.

implementation stage A stage of problem solving in which a solution is put into effect.

The final stage of the problem-solving process is the **monitoring stage**. In this stage, decision makers evaluate the implementation to determine whether the anticipated results were achieved and to modify the process in light of new information. Monitoring can involve feedback and adjustment. For example, you might need to change your air carrier if it regularly has shipping delays.

monitoring stage The final stage of the problem-solving process in which decision makers evaluate the implementation.

Programmed versus Non-Programmed Decisions

In the choice stage, various factors influence the decision maker's selection of a solution. One such factor is whether the decision can be programmed. **Programmed decisions** are made using a rule, procedure or quantitative method. For example, to say that inventory should be ordered when inventory levels drop to 100 units is a programmed decision because it adheres to a rule. Programmed decisions are easy to computerize using traditional information systems. The connections between system elements are fixed by rules, procedures or numerical relationships. In other words, they are structured and deal with routine, well-defined decisions.

programmed decisions A decision made using a rule, procedure or quantitative method.

Non-programmed decisions, however, deal with unusual or exceptional situations. In many cases, these decisions are difficult to quantify. Determining the appropriate training programme for a new employee, deciding whether to start a new type of product line and weighing the benefits and drawbacks of installing a new pollution control system are examples. Each of these decisions contains unique characteristics, and standard rules or procedures might not apply to them. Today, decision support systems help solve many non-programmed decisions, in which the problem is not routine, and rules and relationships are not well defined (unstructured or ill-structured problems).

non-programmed decisions A decision that deals with unusual or exceptional situations that can be difficult to quantify.

Optimization, Satisficing and Heuristic Approaches

In general, computerized decision support systems can either optimize or satisfice. An optimization model finds the best solution, usually the one that will best help the organization meet its goals. For example, an optimization model can find the appropriate number of products that an organization should produce to meet a profit goal, given certain conditions and assumptions. Optimization models use problem constraints. A limit on the number of available work hours in a manufacturing facility is an example of a problem constraint. Some spreadsheet programs, such as Microsoft Excel, have optimizing features. A business such as an appliance manufacturer can use an optimization program to reduce the time and cost of manufacturing appliances and increase profits. Optimization software also allows decision makers to explore various alternatives.

Consider a few examples of how you can use optimization to achieve huge savings. Bombardier Flexjet, a company that sells fractional ownership of jets, used an optimization program to save almost €22 million annually to better schedule its aircraft and crews.[1] Hutchinson Port Holdings, the world's largest container terminal, saved even more – over €37 million annually.[2] The company processes a staggering 10,000 trucks and 15 ships every day, and used optimization to maximize the use of its trucks. Deere & Company, a manufacturer of commercial vehicles and equipment, increased shareholder value by over €75 million annually by using optimization to minimize inventory levels and by enhancing customer satisfaction.[3]

Laps Care from TietoEnatorAM is an information system that used optimization to assign medical personnel to home healthcare patients in Sweden while minimizing costs. The system has improved care while increasing efficiency by 10 to 15 per cent and lowering costs by €20 million.[4]

satisficing model A model that will find a good – but not necessarily the best – problem solution.

A **satisficing model** is one that finds a good – but not necessarily the best – problem solution. Satisficing is usually used because modelling the problem properly to get an optimal decision would be too difficult, complex or costly. Satisficing normally does not look at all possible solutions but only at those likely to give good results. Consider a decision to select a location for a new manufacturing plant. To find the optimal (best) location, you must consider all cities in Europe. A satisficing approach is to consider only five or ten cities that might satisfy the company's requirements. Limiting the options might not result in the best decision, but it will likely result in a good decision, without spending the time and effort to investigate all cities. Satisficing is a good alternative modelling method because it is sometimes too expensive to analyze every alternative to find the best solution.

heuristics Commonly accepted guidelines or procedures that usually find a good solution.

Heuristics, often referred to as 'rules of thumb' – commonly accepted guidelines or procedures that usually find a good solution – are often used in decision making. An example of a heuristic is to order four months' supply of inventory for a particular item when the inventory level drops to 20 units or less; although this heuristic might not minimize total inventory costs, it can serve as a good rule of thumb to avoid running out of stock without maintaining excess inventory. Trend Micro, a provider of antivirus software, has developed an antispam product that is based on heuristics. The software examines emails to find those most likely to be spam. It doesn't examine all emails.

At the time of writing, the UK is wrestling with the problems of trying to leave the European Union. If it does, goods crossing from the UK to the EU will require checks and those checks will produce a lot of data. There are fears that this will cause delays with trucks and lorries backed up along motorways for many miles on both sides of the border. If this happens, any system that could reduce waiting times would become very valuable indeed. While a scheme such as Brexit will be extremely disruptive, disruption often creates opportunities for optimizing software, satisficing models and systems that exploit heuristics.

Sense and Respond

Sense and Respond (SaR) involves determining problems or opportunities (sense) and developing systems to solve the problems or take advantage of the opportunities (respond).[5]

SaR often requires nimble organizations that replace traditional lines of authority with those that are flexible and dynamic. IBM, for example, used SaR with its microelectronics division to help with inventory control. It used mathematical models and optimization routines to control inventory levels. The models sensed when a shortage of inventory for customers was likely and responded by backlogging and storing extra inventory to avoid the shortages. In this application, SaR identified potential problems and solved them before they became a reality. SaR can also identify opportunities, such as new products or marketing approaches, and then respond by building the new products or starting new marketing campaigns. One way to implement the SaR approach is through management information and decision support systems, discussed in the next section.

Big Data

The amount of data that some companies are currently collecting is becoming so huge that it is difficult to process using traditional database technology. This phenomenon is referred to as Big Data, and it is currently a hot research topic in information systems. Big Data is of interest because of the additional insight it can offer into customer behaviour, logistics, factory design and a host of other applications. Big Data involves new ways of capturing data, processing it and visualizing the patterns and trends in it. Often processing Big Data requires many computers operating in parallel.

8.2 An Overview of Management Information Systems

A management information system (MIS) is an integrated collection of people, procedures, databases, hardware and software that provides managers and decision makers with information to help achieve organizational goals. The primary purpose of an MIS is to help an organization achieve its goals by providing managers with insight into the regular operations of the organization so that they can control, organize and plan more effectively. One important role of the MIS is to provide the right information to the right person in the right format at the right time. In short, an MIS provides managers with information, typically in reports, that supports effective decision making and provides feedback on daily operations. For example, a manager might request a report of weekly sales, broken down by area. On the basis of this information, she might decide to redistribute her mobile sales staff to have greater coverage in one place and less in another.

Figure 8.2 shows the role of an MIS within the flow of an organization's information. Note that business transactions can enter the organization through traditional methods or via the Internet or an extranet connecting customers and suppliers to the firm's ERP or transaction processing systems. The use of MIS spans all levels of management. That is, they provide support to and are used by employees throughout the organization.

Inputs to a Management Information System

As shown in Figure 8.2, data that enters an MIS originates from both internal and external sources, including the company's supply chain, first discussed in Chapter 2. The most significant internal data sources for an MIS are the organization's various TPS and ERP systems. As discussed in Chapter 5, companies also use data warehouses to store valuable business information. Other internal data comes from specific functional areas throughout the firm.

External sources of data can include customers, suppliers, competitors and stockholders whose data is not already captured by the TPS, as well as other sources, such as the Internet. In addition, many companies have implemented extranets to link with selected suppliers and other business partners to exchange data and information.

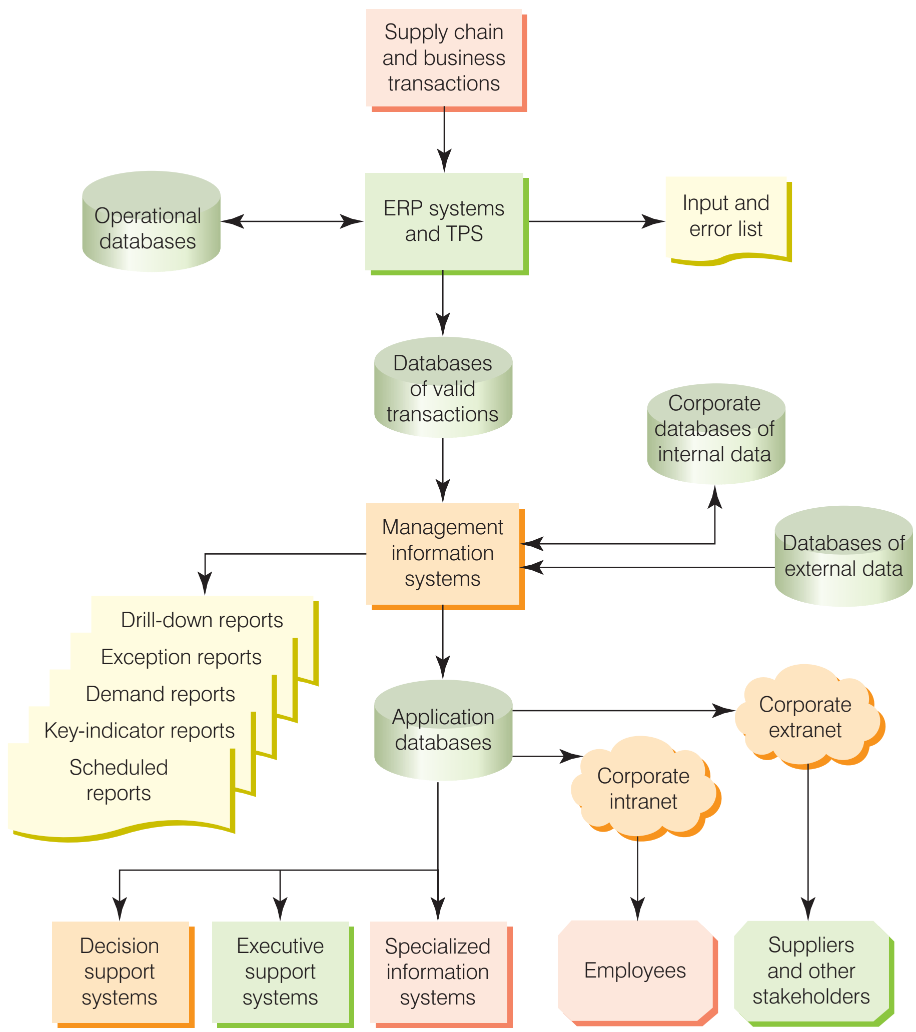


Figure 8.2 **Sources of Managerial Information**
The MIS is just one of many sources of managerial information. Decision support systems, executive support systems and expert systems also assist in decision making.

The MIS uses the data obtained from these sources and processes it into information more usable by managers, primarily in the form of predetermined reports. For example, rather than simply obtaining a chronological list of sales activity over the past week, a national sales manager might obtain his or her organization's weekly sales data in a format that allows him or her to see sales activity by region, by local sales representative, by product and even in comparison with last year's sales.

Outputs of a Management Information System

The output of most management information systems is a collection of reports that are distributed to managers. These can include tabulations, summaries, charts and graphs. Management reports can come from various company databases, data warehouses and other sources. These reports include scheduled reports, key-indicator reports, demand reports, exception reports and drill-down reports (see Figure 8.3).

Scheduled Reports

Scheduled reports are produced periodically, or on a schedule, such as daily, weekly or monthly. For example, a production manager could use a weekly summary report that lists total payroll costs to monitor and control labour and job costs. A manufacturing report generated once per day to monitor the production of a new item is another example of a scheduled report. Other scheduled reports can help managers control customer credit, performance of sales representatives, inventory levels and more.

scheduled reports A report produced periodically, or on a schedule, such as daily, weekly or monthly.

(a) Scheduled Report

Daily Sales Detail Report

Prepared: 08/10/17

Order #	Customer ID	Salesperson ID	Planned Ship Date	Quantity	Item #	Amount
P12453	C89321	CAR	08/12/14	144	P1234	€3,214
P12453	C89321	CAR	08/12/14	288	P3214	€5,660
P12454	C03214	GWA	08/13/14	12	P4902	€1,224
P12455	C52313	SAK	08/12/14	24	P4012	€2,448
P12456	C34123	JMW	08/13/14	144	P3214	€720
………	………	……….	…………	…….	…….	…….

(b) Key-Indicator Report

Daily Sales Key-Indicator Report

Prepared: 08/10/17

	This Month	Last Month	Last Year
Total Orders Month to Date	€1,808	€1,694	€1,914
Forecasted Sales for the Month	€2,406	€2,224	€2,608

(c) Demand Report

Daily Sales by Salesperson Summary Report

Prepared: 08/10/17

Salesperson ID	Amount
CAR	€42,345
GWA	€38,950
SAK	€22,100
JWN	€12,350
……….	……….
……….	……….

(d) Exception Report

Daily Sales Exception Report – Orders Over €10,000

Prepared: 08/10/17

Order #	Customer ID	Salesperson ID	Planned Ship Date	Quantity	Item #	Amount
P12345	C89321	GWA	08/12/14	576	P1234	€12,856
P22153	C00453	CAR	08/12/14	288	P2314	€28,800
P23023	C32832	JMN	08/11/14	144	P2323	€14,400
………	………	……….	…………	…….	…….	……….
………	………	……….	…………	…….	…….	……….

Figure 8.3 **Reports Generated by an MIS**
The types of reports are (a) scheduled, (b) key–indicator, (c) demand, (d) exception and (e–h) drill-down.

Figure 8.3 *Continued*

(e) First-Level Drill-Down Report

Earnings by Quarter (Millions)				
		Actual	Forecast	Variance
2nd Qtr	2014	€12.6	€11.8	6.8%
1st Qtr	2014	€10.8	€10.7	0.9%
4th Qtr	2014	€14.3	€14.5	–1.4%
3rd Qtr	2014	€12.8	€13.3	–3.8%

(f) Second-Level Drill-Down Report

Sales and Expenses (Millions)			
Qtr: 2nd Qtr 2014	Actual	Forecast	Variance
Gross Sales	€110.9	€108.3	2.4%
Expenses	€98.3	€96.5	1.9%
Profit	€12.6	€11.8	6.8%

(g) Third-Level Drill-Down Report

Sales by Division (Millions)			
Qtr: 2nd Qtr 2014	Actual	Forecast	Variance
Beauty Care	€34.5	€33.9	1.8%
Health Care	€30.0	€28.0	7.1%
Soap	€22.8	€23.0	−0.9%
Snacks	€12.1	€12.5	−3.2%
Electronics	€11.5	€10.9	5.5%
Total	€110.9	€108.3	2.4%

8

(h) Fourth-Level Drill-Down Report

Sales by Product Category (Millions)			
Qtr: 2nd Qtr 2014 Division: Health Care	Actual	Forecast	Variance
Toothpaste	€12.4	€10.5	18.1%
Mouthwash	€8.6	€8.8	−2.3%
Over-the-Counter Drugs	€5.8	€5.3	9.4%
Skin Care Products	€3.2	€3.4	−5.9%
Total	€30.0	€28.0	7.1%

Key-Indicator Reports

key-indicator report A summary of the previous day's critical activities; typically available at the beginning of each workday.

A **key-indicator report** summarizes the previous day's critical activities and is typically available at the beginning of each workday. These reports can summarize inventory levels, production activity, sales volume and the like. Key-indicator reports are used by managers and executives to take quick, corrective action on significant aspects of the business.

Demand Reports

Demand reports are developed to give certain information upon request. In other words, these reports are produced on demand. Like other reports discussed in this section, they often come from an organization's database system. For example, an executive might want to know the production status of a particular item – a demand report can be generated to provide the requested information by querying the company's database. Suppliers and customers can also use demand reports. FedEx, for example, provides demand reports on its website to allow its customers to track packages from their source to their final destination. Other examples of demand reports include reports requested by executives to show the hours worked by a particular employee, total sales to date for a product and so on.

demand reports A report developed to give certain information at someone's request.

Exception Reports

Exception reports are reports that are automatically produced when a situation is unusual or requires management action. For example, a manager might set a parameter that generates a report of all items which have been purchased and then returned by more than five customers. Such items may need to be looked at to identify any production problem, for instance. As with key-indicator reports, exception reports are most often used to monitor aspects important to an organization's success. In general, when an exception report is produced, a manager or executive takes action. Parameters or trigger points for an exception report should be set carefully. Trigger points that are set too low might result in too many exception reports; trigger points that are too high could mean that problems requiring action are overlooked. For example, if a manager wants a report that contains all projects over budget by €1,000 or more, the system might retrieve almost every company project. The €1,000 trigger point is probably too low. A trigger point of €10 ,000 might be more appropriate.

exception reports A report automatically produced when a situation is unusual or requires management action.

Drill-Down Reports

Drill-down reports provide increasingly detailed data about a situation. Through the use of drill-down reports, analysts can see data at a high level first (such as sales for the entire company), then at a more detailed level (such as the sales for one department of the company) and then a very detailed level (such as sales for one sales representative). Managers can drill down into more levels of detail to individual transactions if they want.

drill-down reports A report providing increasingly detailed data about a situation.

Developing Effective Reports

Management information system reports can help managers develop better plans, make better decisions and obtain greater control over the operations of the firm, but, in practice, the types of reports can overlap. For example, a manager can demand an exception report or set trigger points for items contained in a key-indicator report. In addition, some software packages can be used to produce, gather and distribute reports from different computer systems. Certain guidelines should be followed in designing and developing reports to yield the best results. Table 8.1 explains some of these guidelines.

Characteristics of a Management Information System

In general, MIS perform the following functions:

- *Provide reports with fixed and standard formats.* For example, scheduled reports for inventory control can contain the same types of information placed in the same locations on the reports. Different managers can use the same report for different purposes.
- *Produce hard-copy and soft-copy reports.* Some MIS reports are printed on paper, which are hard-copy reports. Most output soft copy, using visual displays on computer

screens. Soft-copy output is typically formatted in a report format. In other words, a manager might display an MIS report directly on the computer screen, but the report would still appear in the standard hard-copy format.

- *Use internal data stored in the computer system.* MIS reports use primarily internal sources of data that are contained in computerized databases. Some MISs also use external sources of data about competitors, the marketplace and so on. The web is a frequently used source for external data.
- *Allow users to develop their own custom reports.* Although analysts and programmers might be involved in developing and implementing complex MIS reports that require data from many sources, users are increasingly developing their own simple programs to query databases and produce basic reports. This capability, however, can result in several users developing the same or similar reports, which can increase the total time expended and require more storage, compared with having an analyst develop one report for all users.
- *Require users to submit formal requests for reports to systems personnel.* When IS personnel develop and implement MIS reports, they typically require others to submit a formal request to the IS department. If a manager, for example, wants a production report to be used by several people in his or her department, a formal request for the report is often required. User-developed reports require much less formality.

Table 8.1 Guidelines for Developing MIS Reports

Guidelines	Reason
Tailor each report to user needs	The unique needs of the manager or executive should be considered, requiring user involvement and input
Spend time and effort producing only reports that are useful	After being instituted, many reports continue to be generated even if no one uses them anymore
Pay attention to report content and layout	Prominently display the information that is most desired. Do not clutter the report with unnecessary data. Use commonly accepted words and phrases. Managers can work more efficiently if they can easily find desired information
Use management-by-exception reporting	Some reports should be produced only when a problem needs to be solved or an action should be taken
Set parameters carefully	Low parameters might result in too many reports; high parameters mean valuable information could be overlooked
Produce all reports in a timely fashion	Outdated reports are of little or no value
Periodically review reports	Review reports at least once per year to make sure they are still needed. Review report content and layout. Determine whether additional reports are needed

8.3 Functional MIS

Most organizations are structured along functional lines or areas. This functional structure is usually apparent from an organization chart. Some traditional functional areas are finance, manufacturing, marketing and human resources, among others. The MIS can also be divided along those functional lines to produce reports tailored to individual functions (see Figure 8.4).

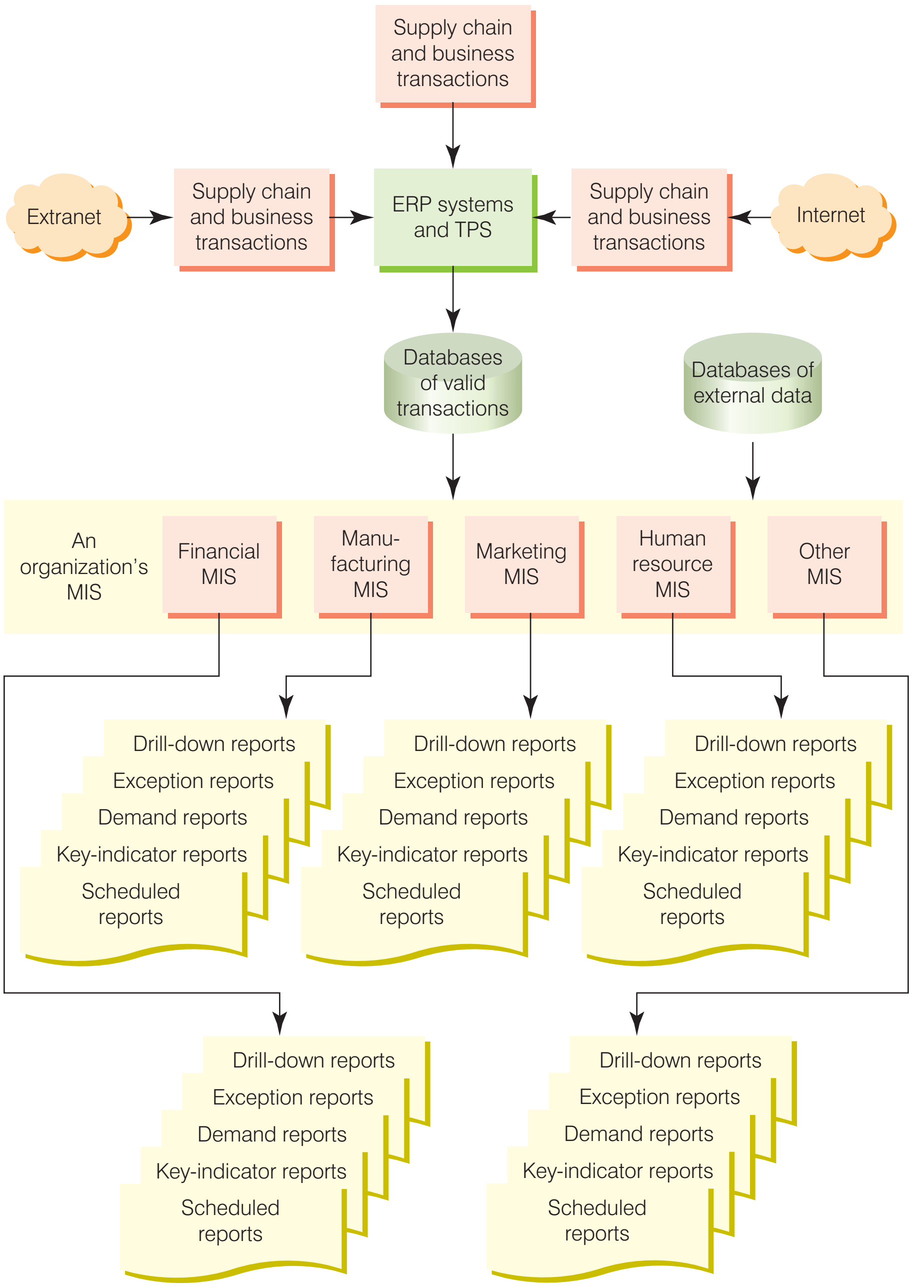


Figure 8.4 **An Organization's MIS**
The MIS is an integrated collection of functional information systems, each supporting particular functional areas.

Financial Management Information Systems

A **financial MIS** provides financial information not only for executives but also for a broader set of people who need to make better decisions on a daily basis. Financial MIS are used to streamline reports of transactions. Most financial MIS perform the following functions:

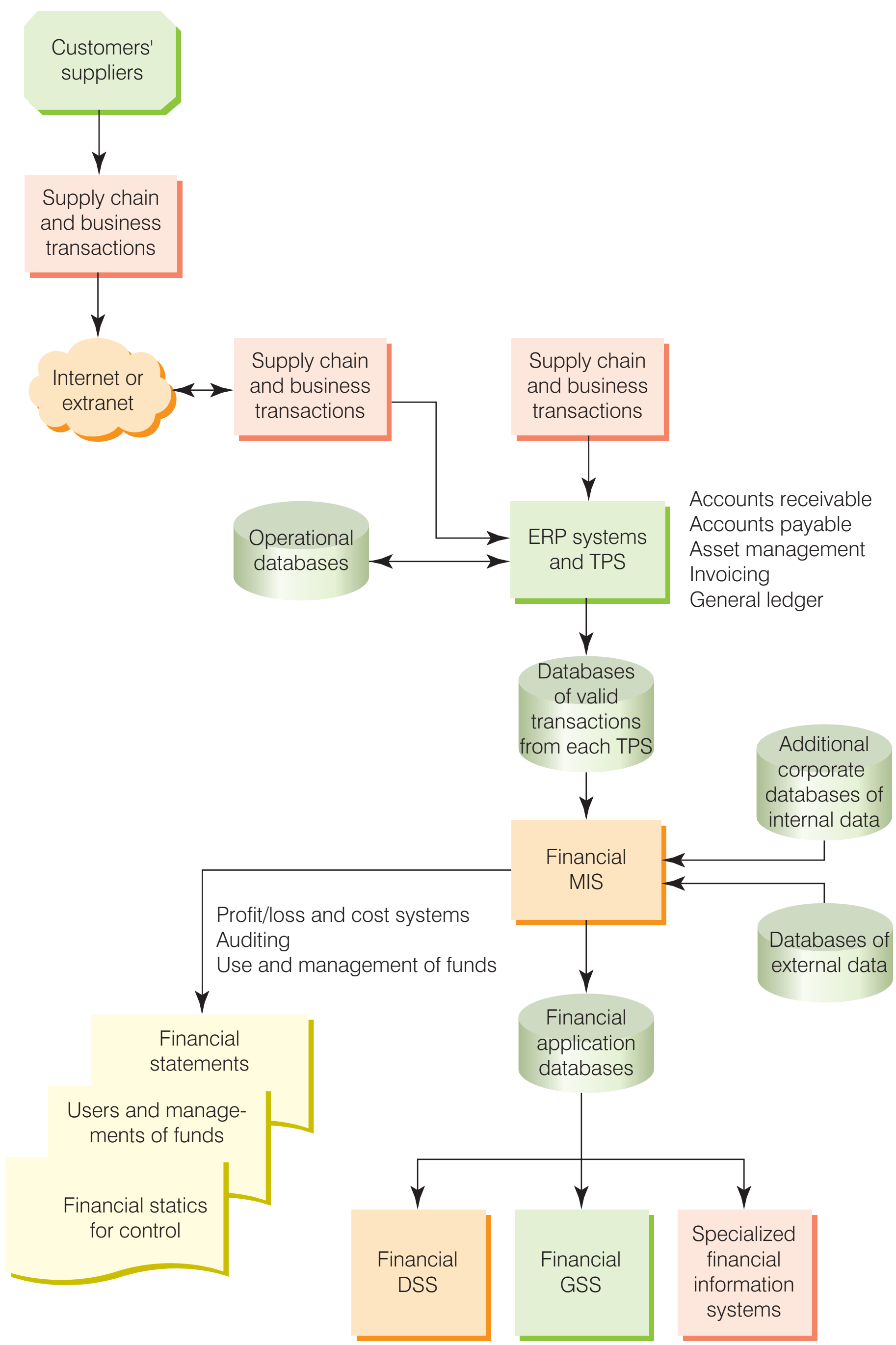
financial MIS A management information system that provides financial information not only for executives but also for a broader set of people who need to make better decisions on a daily basis.

- Integrate financial and operational information from multiple sources, including the Internet, into a single system.
- Provide easy access to data for both financial and non-financial users, often through the use of a corporate intranet to access corporate web pages of financial data and information.

- Make financial data immediately available to shorten analysis turnaround time.
- Enable analysis of financial data along multiple dimensions – time, geography, product, plant, customer.
- Analyze historical and current financial activity.
- Monitor and control the use of funds over time.

Figure 8.5 shows typical inputs, function-specific subsystems and outputs of a financial MIS, including profit and loss, auditing, and uses and management of funds.

Figure 8.5 Overview of a Financial MIS



Financial MIS are used to compute revenues, costs, profits and for **auditing**. Auditing involves analyzing the financial condition of an organization and determining whether financial statements and reports produced by the financial MIS are accurate. Financial MIS are also used to manage funds. Internal uses of funds include purchasing additional inventory, updating plant and equipment, hiring new employees, acquiring other companies, buying new computer systems, increasing marketing and advertising, purchasing raw materials or land, investing in new products, and increasing research and development. External uses of funds are typically investment related. Companies often invest excess funds in such external revenue generators as bank accounts, stocks, bonds, bills, notes, futures, options and foreign currency using financial MIS.

auditing Analyzing the financial condition of an organization and determining whether financial statements and reports produced by the financial MIS are accurate.

Manufacturing Management Information Systems

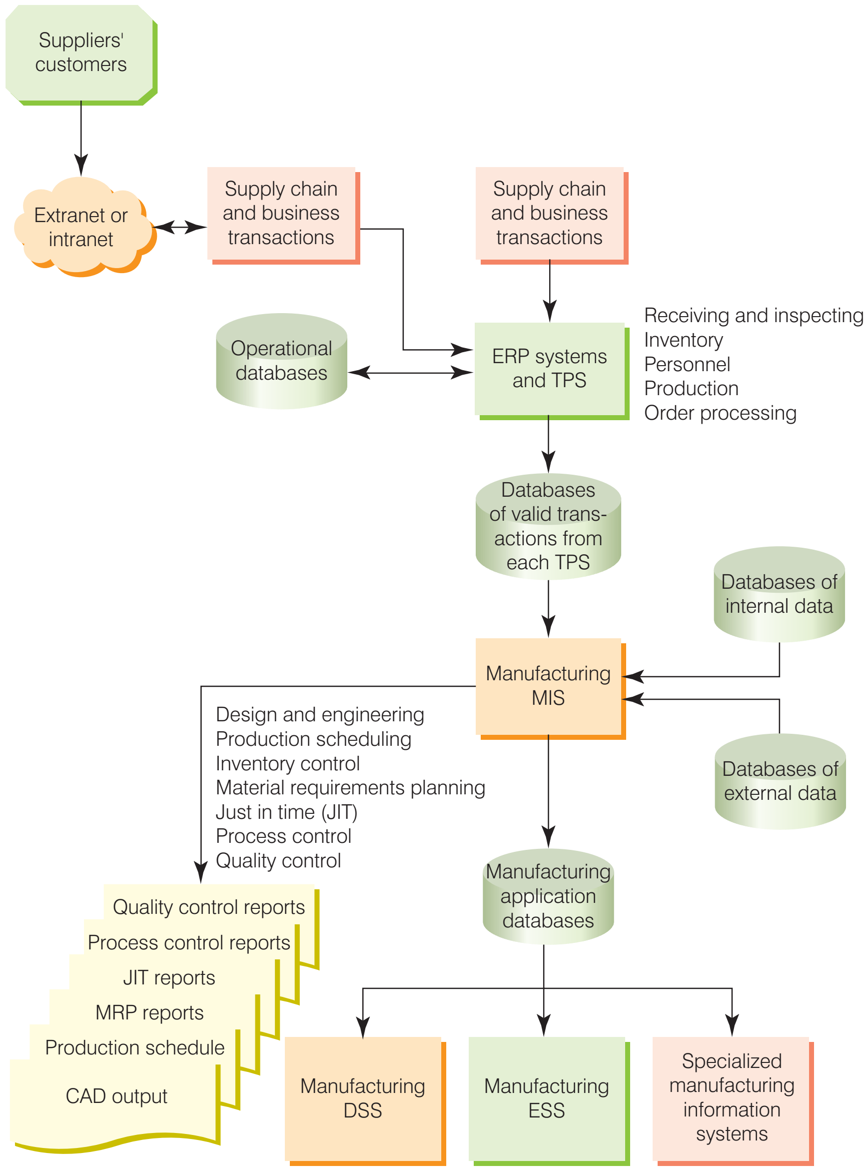
More than any other functional area, advances in information systems have revolutionized manufacturing. As a result, many manufacturing operations have been dramatically improved over the last decade. Also, with the emphasis on greater quality and productivity, having an effective manufacturing process is becoming even more critical. The use of computerized systems is emphasized at all levels of manufacturing – from the shop floor to the executive suite. People and small businesses, for example, can benefit from manufacturing MISs that once were only available to large corporations. Personal fabrication systems, for example, can make circuit boards, precision parts, radio tags and more.[6] Personal fabrication systems include precise machine tools, such as milling machines and cutting tools, and sophisticated software. The total system can cost €15,000. For example, in a remote area of Norway, Maakon Karlson uses a personal fabrication system that makes radio tags to track sheep and other animals. The use of the Internet has also streamlined all aspects of manufacturing. Figure 8.6 gives an overview of some of the manufacturing MIS inputs, subsystems and outputs.

Shoptech Software offers a manufacturing MIS, E2 Shop System, as a mobile app or desktop application. 'Shop' here refers to workshop, where machines and other tools are used to produce and repair goods – think of a factory or your local garage. E2 Shop takes care of all data related to manufacturing – buying raw materials, estimating jobs for clients, accepting orders from customers, managing inventory, scheduling jobs and organizing delivery. Extra modules are available to manage the time employees work on jobs. The system is designed for medium- to large-sized firms that produce any sort of physical goods.[7]

The manufacturing MIS subsystems and outputs monitor and control the flow of materials, products and services through the organization. As raw materials are converted to finished goods, the manufacturing MIS monitors the process at almost every stage. New technology could make this process easier. Using specialized computer chips and tiny radio transmitters, companies can monitor materials and products through the entire manufacturing process. Car manufacturers, who convert raw steel, plastic and other materials into a finished vehicle, also monitor their manufacturing processes. Car manufacturers add thousands of euros of value to the raw materials they use in assembling a car. If the manufacturing MIS also lets them provide additional services such as customized paint colours on any of their models, it has added further value for customers. In doing so, the MIS helps provide the company with the edge that can differentiate it from its competitors. The success of an organization can depend on the manufacturing function. Some common information subsystems and outputs used in manufacturing are discussed next.

- *Design and engineering.* Manufacturing companies often use computer-aided design (CAD) with new or existing products (Figure 8.6). For example, Boeing uses a CAD system to develop a complete digital blueprint of an aircraft before it ever begins its manufacturing process. As mock-ups are built and tested, the digital blueprint is constantly revised to reflect the most current design. Using such technology helps Boeing reduce its manufacturing costs and the time to design a new aircraft.

Figure 8.6 Overview of a Manufacturing MIS



- *Master production scheduling and inventory control.* Scheduling production and controlling inventory are critical for any manufacturing company. The overall objective of master production scheduling is to provide detailed plans for both short-term and long-range scheduling of manufacturing facilities. Many techniques are used to minimize inventory costs. Most determine how much and when to order inventory. One method of determining how much inventory to order is called the **economic order quantity (EOQ)**. This quantity is calculated to minimize the total inventory costs. The when-to-order question is based on inventory usage over time. Typically, the question is answered in terms of a **reorder point (ROP)**, which is a critical inventory quantity level. When the inventory level for a particular item falls to the reorder point, or critical level, the system generates a report so that an order is immediately placed for the EOQ of the product. Another inventory technique used when the demand for one item depends on the demand for another is called **material requirements planning (MRP)**.

economic order quantity (EOQ) The quantity that should be reordered to minimize total inventory costs.

reorder point (ROP) A critical inventory quantity level.

material requirements planning (MRP) A set of inventory-control techniques that help coordinate thousands of inventory items when the demand for one item is dependent on the demand for another.

The basic goal of MRP is to determine when finished products, such as cars or aeroplanes, are needed and then to work backwards to determine deadlines and resources needed, such as engines and tyres, to complete the final product on schedule. **Just-in-time (JIT)** inventory and manufacturing is an approach that maintains inventory at the lowest levels without sacrificing the availability of finished products. With this approach, inventory and materials are delivered just before they are used in a product. A JIT inventory system would arrange for a car windscreen to be delivered to the assembly line just before it is secured to the car, rather than storing it in the manufacturing facility while the car's other components are being assembled. JIT, however, can result in some organizations running out of inventory when demand exceeds expectations.[8]

just-in-time (JIT) inventory A philosophy of inventory management in which inventory and materials are delivered just before they are used in manufacturing a product.

- *Process control.* Managers can use a number of technologies to control and streamline the manufacturing process. For example, computers can directly control manufacturing equipment, using systems called **computer-aided manufacturing (CAM)**. CAM systems can control drilling machines, assembly lines and more (Figure 8.7). **Computer-integrated manufacturing (CIM)** uses computers to link the components of the production process into an effective system. CIM's goal is to tie together all aspects of production, including order processing, product design, manufacturing, inspection and quality control, and shipping. A **flexible manufacturing system (FMS)** is an approach that allows manufacturing facilities to rapidly and efficiently change from making one product to another. In the middle of a production run, for example, the production process can be changed to make a different product or to switch manufacturing materials. By using an FMS, the time and cost to change manufacturing jobs can be substantially reduced, and companies can react quickly to market needs and competition.

computer-aided manufacturing (CAM) A system that directly controls manufacturing equipment.

computer-integrated manufacturing (CIM) Using computers to link the components of the production process into an effective system.

flexible manufacturing system (FMS) An approach that allows manufacturing facilities to rapidly and efficiently change from making one product to making another.

- *Quality control and testing.* With increased pressure from consumers and a general concern for productivity and high quality, today's manufacturing organizations are placing more emphasis on **quality control**, a process that ensures the finished product meets the customer's needs. Information systems are used to monitor quality and take corrective steps to eliminate possible quality problems.

quality control A process that ensures that the finished product meets the customer's needs.

Figure 8.7 A Vanguard-Class Nuclear Powered Submarine *This submarine carries UK Trident nuclear missiles and is soon to be retired from service. Computer aided design will be used in all aspects of the design of its replacement, to be called the Dreadnought class.*

Marketing Management Information Systems

marketing MIS An information system that supports managerial activities in product development, distribution, pricing decisions and promotional effectiveness.

A **marketing MIS** supports managerial activities in product development, distribution, pricing decisions, promotional effectiveness and sales forecasting. Marketing functions are increasingly being performed on the Internet. Many companies are developing Internet marketplaces to advertise and sell products. The amount spent on online advertising is worth billions of euros annually. Software can measure how many customers see the advertising. Some companies use software products to analyze customer loyalty. Some marketing departments are actively using blogs to publish company-related information and interact with customers.[9]

Customer relationship management (CRM) programs, available from some ERP vendors, help a company manage all aspects of customer encounters. CRM software can help a company collect customer data, contact customers, educate customers on new products and sell products to customers through a website. An airline, for example, can use a CRM system to notify customers about flight changes. New Zealand's Jade Stadium, for example, uses CRM software from GlobalTech Solutions to give a single entry point to its marketing efforts and customer databases, instead of using about 20 spreadsheets.[10] The CRM software will help Jade Stadium develop effective marketing campaigns, record and track client contacts, and maintain an accurate database of clients. Yet, not all CRM systems and marketing sites on the Internet are successful. Customization and ongoing maintenance of a CRM system can be expensive. Figure 8.8 shows the inputs, subsystems and outputs of a typical marketing MIS.

Subsystems for the marketing MIS include marketing research, product development, promotion and advertising, and product pricing. These subsystems and their outputs help marketing managers and executives increase sales, reduce marketing expenses and develop plans for future products and services to meet the changing needs of customers.

- *Marketing research.* The purpose of marketing research is to conduct a formal study of the market and customer preferences. Computer systems are used to help conduct and analyze the results of surveys, questionnaires, pilot studies and interviews. Messages on social media sites such as Facebook and Twitter are regularly used for market research, as companies search for their brand names to see what people are saying about them.
- *Product development.* Product development involves the conversion of raw materials into finished goods and services and focuses primarily on the physical attributes of the product. Many factors, including plant capacity, labour skills, engineering factors and materials are important in product development decisions. In many cases, a computer program analyzes these various factors and selects the appropriate mix of labour, materials, plant and equipment, and engineering designs. Make-or-buy decisions can also be made with the assistance of computer programs.
- *Promotion and advertising.* One of the most important functions of any marketing effort is promotion and advertising. Product success is a direct function of the types of advertising and sales promotion done. Increasingly, organizations are using the Internet to advertise and sell products and services. With the use of GPS, marketing firms can promote products such as local shops and restaurants to mobile devices like phones and tablets that are close by. You could receive a discount coupon for a shop as you walk past it!
- *Product pricing.* Product pricing is another important and complex marketing function. Retail price, wholesale price and price discounts must be set. Most companies try to

develop pricing policies that will maximize total sales revenues. Computers are often used to analyze the relationship between prices and total revenues. Some companies are using Internet behavioural pricing, where the price customers pay online depends on what they might be willing to pay based on information on past transactions and Internet searches that reveal individual shopping behaviours.

- *Sales analysis.* Computerized sales analysis is important to identify products, sales personnel and customers that contribute to profits and those that do not. Several reports can be generated to help marketing managers make good sales decisions (see Figure 8.9). The sales-by-product report lists all major products and their sales for a period of time, such as a month. This report shows which products are doing well and which need improvement or should be discarded altogether. The sales-by-salesperson report lists total sales for each salesperson for each week or month. This report can also be subdivided by product to show which products are being sold by each salesperson. The sales-by-customer report is a tool that can be used to identify high- and low-volume customers.

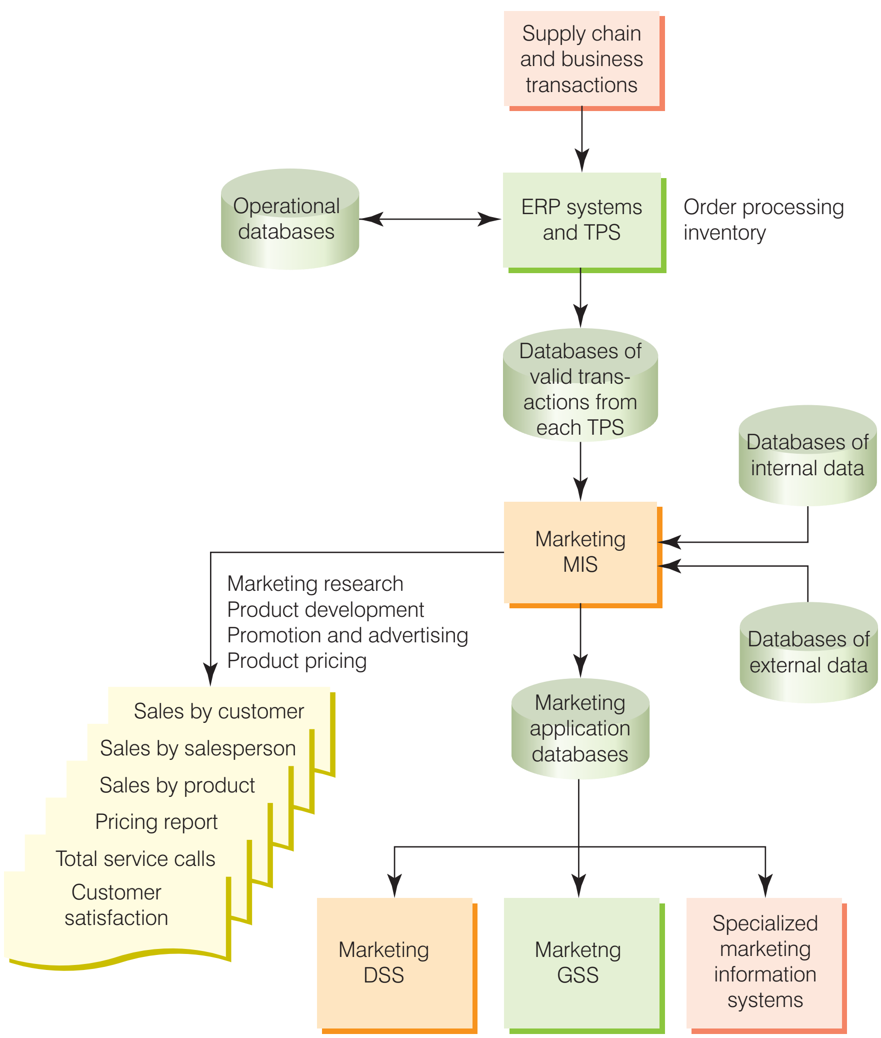


Figure 8.8 Overview of a Marketing MIS

Figure 8.9 Reports Generated to Help Marketing Managers Make Good Decisions
(a) This sales-by-product report lists all major products and their sales for the period from August to December. (b) This sales-by-salesperson report lists total sales for each salesperson for the same time period. (c) This sales-by-customer report lists sales for each customer for the period. Like all MIS reports, totals are provided automatically by the system to show managers at a glance the information they need to make good decisions.

(a) Sales by product

Product	August	September	October	November	December	Total
Product 1	34	32	32	21	33	152
Product 2	156	162	177	163	122	780
Product 3	202	145	122	98	66	633
Product 4	345	365	352	341	288	1,691

(b) Sales by salesperson

Salesperson	August	September	October	November	December	Total
Jones	24	42	42	11	43	162
Kline	166	155	156	122	133	732
Lane	166	155	104	99	106	630
Miller	245	225	305	291	301	1,367

(c) Sales by customer

Customer	August	September	October	November	December	Total
Ang	234	334	432	411	301	1,712
Braswell	56	62	77	61	21	277
Celec	1,202	1,445	1,322	998	667	5,634
Jung	45	65	55	34	88	287

Human Resource Management Information Systems

human resource MIS (HRMIS) An information system that is concerned with activities related to employees and potential employees of an organization, also called a personnel MIS.

A **human resource MIS (HRMIS)**, also called a personnel MIS, is concerned with activities related to previous, current and potential employees of the organization. Because the personnel function relates to all other functional areas in the business, the HRMIS plays a valuable role in ensuring organizational success. Some of the activities performed by this important MIS include workforce analysis and planning, hiring, training, job and task assignment, and many other personnel-related issues. An effective HRMIS allows a company to keep personnel costs at a minimum, while serving the required business processes needed to achieve corporate goals. Although human resource information systems focus on cost reduction, many of today's HR systems concentrate on hiring and managing existing employees to get the total potential of the human talent in the organization. According to the High Performance Workforce Study conducted by Accenture, the most important HR initiatives include improving worker productivity, improving adaptability to new opportunities and facilitating organizational change. Figure 8.10 shows some of the inputs, subsystems and outputs of the HRMIS.

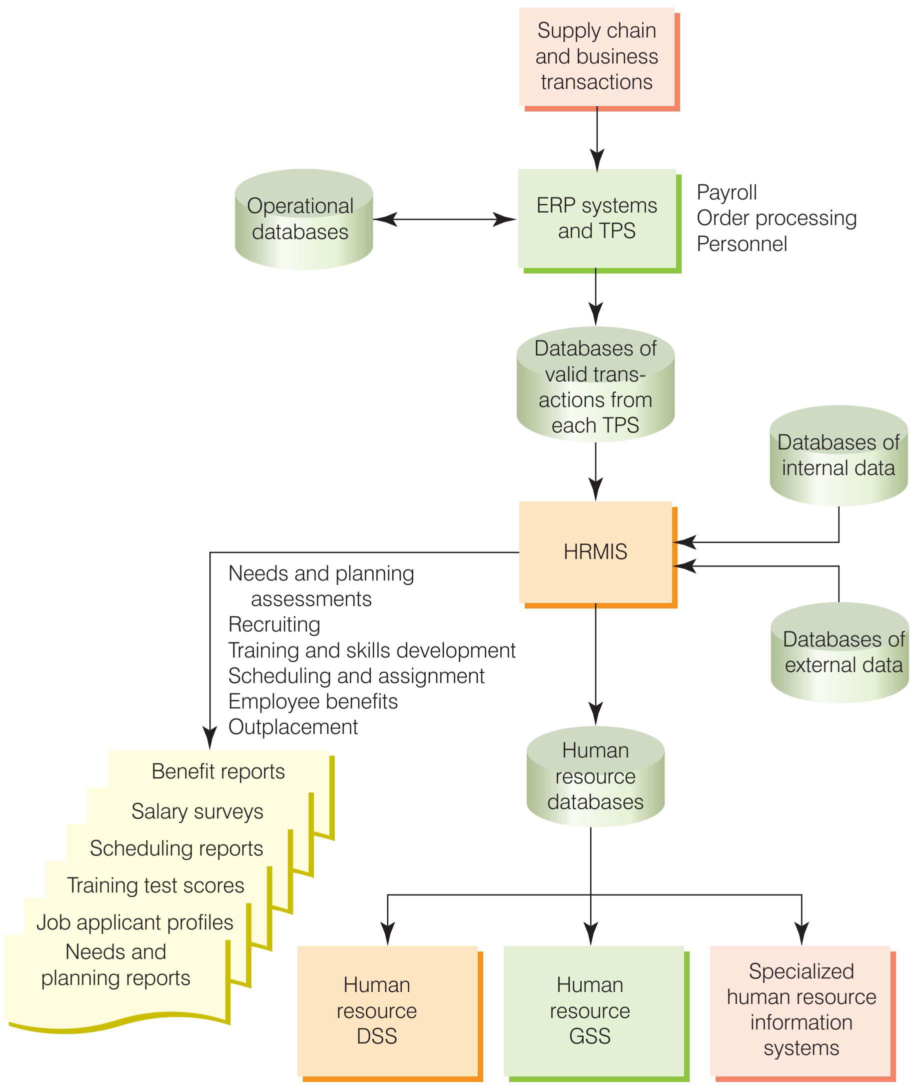


Figure 8.10 Overview of an HRMIS

Human resource subsystems and outputs range from the determination of human resource needs and hiring through retirement and outplacement. Most medium and large organizations have computer systems to assist with human resource planning, hiring, training and skills inventorying, and wage and salary administration. Outputs of the human resource MIS include reports, such as human resource planning reports, job application review profiles, skills inventory reports and salary surveys.

- *Human resource planning.* One of the first aspects of any HRMIS is determining personnel and human needs. The overall purpose of this MIS subsystem is to put the right number and kinds of employees in the right jobs when they are needed. Effective human resource planning can require computer programs, such as SPSS and SAS, to forecast the future number of employees needed and anticipating the future supply of people for these jobs. IBM is using an HR pilot program, called Professional Marketplace, to plan for workforce needs, including the supplies and tools the workforce needs to work efficiently.[11] Professional Marketplace helps IBM to catalogue employees into a glossary of skills and abilities. Like many other companies, HR and workforce costs are IBM's biggest expense.

- *Personnel selection and recruiting.* If the human resource plan reveals that additional personnel are required, the next logical step is recruiting and selecting personnel. Companies seeking new employees often use computers to schedule recruiting efforts and trips, and to test potential employees' skills. Many companies now use the Internet to screen for job applicants. Applicants use a template to load their CVs onto the Internet site. HR managers can then access these CVs and identify applicants they are interested in interviewing.
- *Training and skills inventory.* Some jobs, such as programming, equipment repair and tax preparation, require very specific training for new employees. Other jobs may require general training about the organizational culture, orientation, dress standards and expectations of the organization. When training is complete, employees often take computer-scored tests to evaluate their mastery of skills and new material.
- *Scheduling and job placement.* Employee schedules are developed for each employee, showing his or her job assignments over the next week or month. Job placements are often determined based on skills inventory reports, which show which employee might be best suited to a particular job. Sophisticated scheduling programs are often used in the airline industry, the military and many other areas to get the right people assigned to the right jobs at the right time.
- *Wage and salary administration.* Another HRMIS subsystem involves determining salaries and benefits, including medical insurance and pension payments. Wage data, such as industry averages for positions, can be taken from the corporate database and manipulated by the HRMIS to provide wage information reports to higher levels of management.

Geographic Information Systems

8 **geographic information system (GIS)** A computer system capable of assembling, storing, manipulating and displaying geographic information; that is, data identified according to its location.

Although not yet common in organizations, a **geographic information system (GIS)** is a computer system capable of assembling, storing, manipulating and displaying geographically referenced information; that is, data identified according to its location. A GIS enables users to pair maps or map outlines with tabular data to describe aspects of a particular geographic region. For example, sales managers might want to plot total sales for each region in the countries they serve. Using a GIS, they can specify that each region be shaded to indicate the relative amount of sales – no shading or light shading represents no or little sales, and deeper shading represents more sales. Staples Inc., the large office supply store chain, used a geographic information system to select about 100 new store locations, after considering about 5,000 possible sites.[12] Finding the best location is critical. It can cost up to €750,000 for a failed store because of a poor location. Staples uses a GIS tool from Tactician Corporation, along with software from SAS. Although many software products have seen declining revenues, the use of GIS software is increasing.

One of the most popular geographic information systems is Google Maps with its accompanying Street View option. People often use Google Maps to plan journeys and Street View to look for parking options. As business tools, both are extremely powerful. People search for services – cafes, garages, hotels, a Post Office and such like – that are close to them, which is a powerful example of ubiquitous computing (see Chapter 10) and the perfect marriage of a small interactive screen, a mobile data connection to access the maps, and a Global Positioning System receiver so that the device knows its exact location. Companies can also embed maps onto their own website to show customers where they are located.

8.4 Decision Support Systems

Management information systems provide useful summary reports to help solve structured and semi-structured business problems. Decision support systems (DSSs) offer the potential to assist in solving both semi-structured and unstructured problems. A DSS is an organized collection of people, procedures, software, databases and devices used to help make decisions that solve problems. The focus of a DSS is on decision-making effectiveness when faced with unstructured or semi-structured business problems. As with a TPS and an MIS, a DSS should be designed, developed and used to help an organization achieve its goals and objectives. Decision support systems offer the potential to generate higher profits, lower costs, and better products and services.

Decision support systems, although skewed somewhat towards the top levels of management, are used at all levels. To some extent, today's managers at all levels are faced with less structured, non-routine problems, but the quantity and magnitude of these decisions increase as a manager rises higher in an organization. Many organizations contain a tangled web of complex rules, procedures and decisions. DSSs are used to bring more structure to these problems to aid the decision-making process. In addition, because of the inherent flexibility of decision support systems, managers at all levels are able to use DSSs to assist in some relatively routine, programmable decisions in lieu of more formalized management information systems.

Characteristics of a Decision Support System

DSSs have many characteristics that allow them to be effective management support tools, some of which are listed here. Of course, not all DSSs work the same.

- *Provide rapid access to information.* DSSs provide fast and continuous access to information.
- *Handle large amounts of data from different sources.* For instance, advanced database management systems and data warehouses have allowed decision makers to search for information with a DSS, even when some data resides in different databases on different computer systems or networks. Other sources of data can be accessed via the Internet or over a corporate intranet. Using the Internet, an oil giant can use a decision support system to save hundreds of millions of euros annually by coordinating a large amount of drilling and exploration data from around the globe.
- *Provide report and presentation flexibility.* Managers can get the information they want, presented in a format that suits their needs. Furthermore, output can be displayed on computer screens or printed, depending on the needs and desires of the problem solvers.
- *Offer both textual and graphical orientation.* DSSs can produce text, tables, line drawings, pie charts, trend lines and more. By using their preferred orientation, managers can use a DSS to get a better understanding of a situation and to convey this understanding to others.
- *Support drill-down analysis.* A manager can get more levels of detail when needed by drilling down through data. For example, a manager can get more detailed information for a project – viewing the overall project cost, then drilling down and seeing the cost for each phase, activity and task.
- *Perform complex, sophisticated analysis and comparisons using advanced software packages.* Marketing research surveys, for example, can be analyzed in a variety of ways using programs that are part of a DSS. Many of the analytical programs associated with a DSS are actually stand-alone programs, and the DSS brings them together.
- *Support optimization, satisficing and heuristic approaches.* By supporting all types of decision-making approaches, a DSS gives the decision maker a great deal of

what-if analysis The process of making hypothetical changes to problem data and observing the impact on the results.

flexibility in computer support for decision making. For example, **what-if analysis**, the process of making hypothetical changes to problem data and observing the impact on the results, can be used to control inventory. Given the demand for products, such as cars, the computer can determine the necessary parts and components, including engines, transmissions, windows and so on. With what-if analysis, a manager can make changes to problem data, say the number of cars needed for next month, and immediately see the impact on the parts requirements.

- *Perform goal-seeking analysis.* **Goal-seeking analysis** is the process of determining the problem data required for a given result. For example, a financial manager might be considering an investment with a certain monthly net income, and the manager might have a goal to earn a return of 9 per cent on the investment. Goal seeking allows the manager to determine what monthly net income (problem data) is needed to yield a return of 9 per cent (problem result). Some spreadsheets can be used to perform goal-seeking analysis.

goal-seeking analysis The process of determining the problem data required for a given result.

- *Perform simulation.* **Simulation** is the ability of the DSS to duplicate the features of a real system. In most cases, probability or uncertainty is involved. For example, the number of repairs and the time to repair key components of a manufacturing line can be calculated to determine the impact on the number of products that can be produced each day. Engineers can use this data to determine which components need to be reengineered to increase the mean time between failures and which components need to have an ample supply of spare parts to reduce the mean time to repair. Drug companies are using simulated trials to reduce the need for human participants and reduce the time and costs of bringing a new drug to market. Drug companies are hoping that this use of simulation will help them identify successful drugs earlier in development. Corporate executives and military commanders often use computer simulations to allow them to try different strategies in different situations. Corporate executives, for example, can try different marketing decisions under various market conditions. Military commanders often use computer war games to fine-tune their military strategies in different warfare conditions. The Turkish army, for example, uses simulation to help coordinate its fuel-supply system.[13]

simulation The ability of the DSS to duplicate the features of a real system.

Capabilities of a Decision Support System

Developers of DSSs strive to make them more flexible than management information systems and to give them the potential to assist decision makers in a variety of situations. DSSs can assist with all or most problem-solving phases, decision frequencies and different degrees of problem structure. DSS approaches can also help at all levels of the decision-making process. A single DSS might provide only a few of these capabilities, depending on its uses and scope.

- *Support for problem-solving phases.* The objective of most DSSs is to assist decision makers with the phases of problem solving. As previously discussed, these phases include intelligence, design, choice, implementation and monitoring. A specific DSS might support only one or a few phases. By supporting all types of decision-making approaches, a DSS gives the decision maker a great deal of flexibility in getting computer support for decision-making activities.
- *Support for different decision frequencies.* Decisions can range on a continuum from one-of-a-kind to repetitive decisions. One-of-a-kind decisions are typically handled

by an ad hoc DSS. An **ad hoc DSS** is concerned with situations or decisions that come up only a few times during the life of the organization; in small businesses, they might happen only once. For example, a company might need to change the layout of its open plan offices. Repetitive decisions are addressed by an institutional DSS. An **institutional DSS** handles situations or decisions that occur more than once, usually several times per year or more. An institutional DSS is used repeatedly and refined over the years. For example, a DSS used to assist helpdesk staff solve employees' computer problems and queries.

ad hoc DSS A DSS concerned with situations or decisions that come up only a few times during the life of the organization.

institutional DSS A DSS that handles situations or decisions that occur more than once, usually several times per year or more. An institutional DSS is used repeatedly and refined over the years.

- *Support for different problem structures.* As discussed previously, decisions can range from highly structured and programmed to unstructured and non-programmed. **Highly structured problems** are straightforward, requiring known facts and relationships. **Semi-structured or unstructured problems**, on the other hand, are more complex. The relationships between the pieces of data are not always clear, the data might be in a variety of formats, and it is often difficult to manipulate or obtain. In addition, the decision maker might not know the information requirements of the decision in advance.
- *Support for various decision-making levels.* Decision support systems can provide help for managers at different levels within the organization. Operational managers can get assistance with daily and routine decision making. Tactical decision makers can use analysis tools to ensure proper planning and control. At the strategic level, DSSs can help managers by providing analysis for long-term decisions requiring both internal and external information (see Figure 8.11).

highly structured problems Problems that are straightforward and require known facts and relationships.

semi-structured or unstructured problems More complex problems in which the relationships between the pieces of data are not always clear, the data might be in a variety of formats, and the data is often difficult to manipulate or obtain.

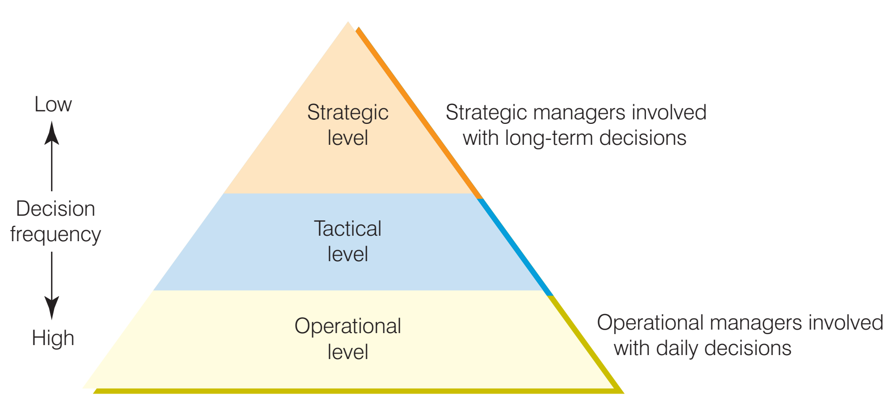


Figure 8.11 Decision-Making Level *Strategic managers are involved with long-term decisions, which are often made infrequently. Operational managers are involved with decisions that are made more frequently.*

8

A Comparison of a DSS and an MIS

A DSS differs from an MIS in numerous ways, including the type of problems solved, the support given to users, the decision emphasis and approach, and the type, speed, output and development of the system used. Table 8.2 lists brief descriptions of these differences. You should note that entity resource planning systems include both MISs and DSSs (and, as discussed in the previous chapter, TPS).

Table 8.2 Comparison of a DSS and an MIS

Factor	DSS	MIS
Problem Type	A DSS can handle unstructured problems that cannot be easily programmed	An MIS is normally used only with structured problems
Users	A DSS supports individuals, small groups and the entire organization. In the short run, users typically have more control over a DSS	An MIS supports primarily the organization. In the short run, users have less control over an MIS
Support	A DSS supports all aspects and phases of decision making; it does not replace the decision maker – people still make the decisions	This is not true of all MIS systems – some make automatic decisions and replace the decision maker
Emphasis Approach	A DSS emphasizes actual decisions and decision-making styles. A DSS is a direct support system that provides interactive reports on computer screens	An MIS usually emphasizes information only. An MIS is typically an indirect support system that uses regularly produced reports
Speed	Because a DSS is flexible and can be implemented by users, it usually takes less time to develop and is better able to respond to user requests	An MIS's response time is usually longer
Output	DSS reports are usually screen oriented, with the ability to generate reports on a printer	An MIS typically is oriented towards printed reports and documents
Development	DSS users are usually more directly involved in its development. User involvement usually means better systems that provide superior support. For all systems, user involvement is the most important factor for the development of a successful system	An MIS is frequently several years old and often was developed for people who are no longer performing the work supported by the MIS

Information Systems @ Work

Non-Linear What-If Analysis in LibreOffice

LibreOffice is a free suite of office applications that includes a word processor (called Writer), a spreadsheet package (Calc) and drawing software (Draw). It is a legitimate alternative to Microsoft Office and does not change as much. As a commercial software house, Microsoft has to release a new version every year or so in order to keep their revenue streams flowing, and they have to change the interface so that customers can see that they are getting something new. LibreOffice is under no such pressure and as such the interface is much more stable. You can download it from www.libreoffice.org.

Calc allows you to create spreadsheet models that can be used as decision support systems to perform 'what-if' analyses. A very simple example is to decide whether to open a burger bar in a new town. The data this would need might include the population of the town, the average number of times they eat out, the number of competing outlets, the percentage of vegetarians, percentage of halal and kosher meat eaters, the cost of meat and the running costs of the bar. This could all be assembled into an equation to work out how many customers we could expect each week and the expected turnover. By changing the values in the cells we could also see what would happen if for example:

- recession hits and people don't go out for food as much;
- a meat scare causes people to turn vegetarian;
- a competing burger bar opens next door.

This model would involve a relatively simple linear equation, but Calc allows us to create non-linear situations to answer more complex what-if questions.

A good example of a non-linear relationship, where the output is not directly proportional to the input, is predator-prey interaction. For instance, foxes prey on rabbits. As the number of foxes increases, more rabbits get eaten and the population of rabbits falls. As it falls, the foxes will find less food and so the number of foxes will fall. As the number of foxes falls, the pressure on the rabbits is reduced and the population can recover, so the number of rabbits rises. When the rabbits recover, they can sustain more foxes and the number of foxes grows again. All of this happens over and over in an endless cycle.

We can model this in Calc with two simple equations called the Lotka-Volterra equations. You'll need two columns labelled Rabbits and Foxes. In the next row insert numbers for the initial population, say 100 rabbits and 20 foxes. This is the state of affairs in Time Period 1. Then we need three constants: the growth rate of rabbits, the rate of predation (which is the percentage of rabbits that get eaten by foxes), and the death rate of foxes. A good set of values for these to see what is going on is 0.02, 0.0005 and 0.05.

In the next row under rabbits and foxes we need two formulae that relate to the first row. (The logic of this is that the number of creatures alive in Time Period 2 depends on the number or creatures that existed in Time Period 1.)

The formula under rabbits is:

rabbits + (0.02 * rabbits – (0.0005 * rabbits * foxes))

and the formula under foxes is:

foxes + (0.005 * rabbits * foxes – (0.05 * foxes))

You will have to change these to refer to the relevant cells (rabbits is the cell that contains the value 100, the initial population of rabbits; foxes is the cell with 20), and it would be best to enter the three constants into three cells over at one side and use absolute referencing to refer to them in the formulae. Also watch your parentheses! Then you have to copy these formula down maybe 1,000 rows.

The real fun starts when you draw a line graph of the output: number of creatures on the y-axis, time on the x-axis and one line for rabbits and one for foxes. You should see a nice oscillation between the two populations. Then at last you can start your what-if analysis. What if alternatives to foxes eating rabbits die out and the rate of predation goes up? How high does it have to go before all the rabbits die out? What happens to the rabbit population if a new virus appears killing foxes at a higher rate? Put the death rate up to 0.3 to see. What we have done simplifies reality enormously but in fact the Lotka-Volterra equations have been used to study real populations in the wild!

Questions

1. Implement the predator-prey example and try the questions at the end.
2. Which is more useful for what-if analysis – the numbers or the graph? Explain your decision.
3. What are some of the problems with the burger bar decision? Did we make any bad assumptions?
4. Why would someone pay for Microsoft Office when LibreOffice is available?

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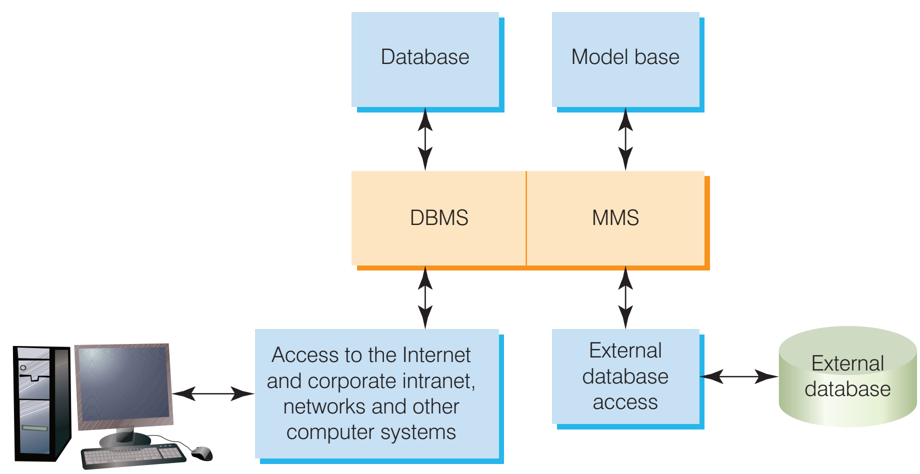
Components of a Decision Support System

dialogue manager A user interface that allows decision makers to easily access and manipulate the DSS and to use common business terms and phrases.

At the core of a DSS are a database and a model base. In addition, a typical DSS contains a user interface, also called **dialogue manager**, that allows decision makers to easily access and manipulate the DSS and to use common business terms and phrases. Finally, access to the Internet, networks and other computer-based systems permits the DSS to tie into other powerful systems, including the TPS or function-specific subsystems. Internet software agents, for example, can be used in creating powerful decision support systems. Figure 8.12 shows a conceptual model of a DSS, although specific DSSs might not have all these components.

Figure 8.12
Conceptual Model of a DSS *DSS components include a model base; database; external database access; and access to the Internet and corporate intranet, networks and other computer systems.*



The Database

The database management system allows managers and decision makers to perform qualitative analysis on the company's vast stores of data in databases and data warehouses (discussed in Chapter 5). DSSs tap into vast stores of information contained in the corporate database, retrieving information on inventory, sales, personnel, production, finance, accounting and other areas.[14] Data mining and business intelligence, introduced in Chapter 5, are often used in DSSs. Airline companies, for example, use a DSS to help identify customers for round-trip flights between major cities. The DSS can be used to search a data warehouse to contact thousands of customers who might be interested in an inexpensive flight. A casino can use a DSS to search large databases to get detailed information on patrons. It can tell how much each patron spends per day on gambling, and more. Opportunity International uses a DSS to help it make loans and provide services to tsunami victims and others in need around the world.[15] According to the information services manager of Opportunity International, 'We need to pull all the data … to one central database that we can analyze, and we need a way to get that information back out to people in the field'. A DSS can also be used in emergency medical situations to make split-second, life-or-death treatment decisions.[16]

A database management system can also connect to external databases to give managers and decision makers even more information and decision support. External databases can include the Internet, libraries, government databases and more. The combination of internal and external database access can give key decision makers a better understanding of the company and its environment.

The Model Base

In addition to the data, a DSS needs a model of how elements of the data are related, in order to help make decisions. The **model base** allows managers and decision makers to perform quantitative analysis on both internal and external data.[17] The model base gives decision makers access to a variety of models so that they can explore different scenarios and see their effects. Ultimately, it assists them in the decision-making process. Procter & Gamble, maker of Pringles potato crisps, Pampers nappies and hundreds of other consumer products, uses DSSs to streamline how raw materials and products flow from its suppliers to its customers, saving millions of euros.[18] Scientists and mathematicians also use DSSs.[19] DSSs can be excellent at predicting customer behaviours.[20, 21] Most banks, for example, use models to help forecast which customers will be late with payments or might default on their loans.

model base Part of a DSS that provides decision makers with access to a variety of models and assists them in decision making.

The models and algorithms used in a DSS are often reviewed and revised over time.[22] As a result of Hurricane Katrina in the USA, for example, US insurance companies revised their models about storm damage and insurance requirements.[23]

Model management software (MMS) is often used to coordinate the use of models in a DSS, including financial, statistical analysis, graphical and project-management models. Depending on the needs of the decision maker, one or more of these models can be used (see Table 8.3).

model management software Software that coordinates the use of models in a DSS.

Table 8.3 Model Management Software

Model Type	Description	Software
Financial	Provides cash flow, internal rate of return and other investment analysis	Spreadsheet, such as Microsoft Excel
Statistical	Provides summary statistics, trend projections, hypothesis testing and more	Statistical program, such as SPSS or SAS
Graphical	Assists decision makers in designing, developing and using graphic displays of data and information	Graphics programs, such as Microsoft PowerPoint
Project Management	Handles and coordinates large projects; also used to identify critical activities and tasks that could delay or jeopardize an entire project if they are not completed in a timely and cost-effective fashion	Project management software, such as Microsoft Project

The User Interface or Dialogue Manager

The user interface or dialogue manager allows users to interact with the DSS to obtain information. It assists with all aspects of communications between the user and the hardware and software that constitute the DSS. In a practical sense, to most DSS users, the user interface is the DSS. Upper-level decision makers are often less interested in where the information came from or how it was gathered than that the information is both understandable and accessible.

8.5 Group Support Systems

The DSS approach has resulted in better decision making for all levels of individual users. However, many DSS approaches and techniques are not suitable for a group decision-making environment. Although not all workers and managers are involved in committee meetings and group decision-making sessions, some tactical and strategic-level managers can spend more than half their decision-making time in a group setting. Such managers need assistance with group decision making. A **group support system (GSS)**, also called a group decision support system, consists of most of the elements in a DSS, plus software to provide effective support in group decision-making settings (see Figure 8.13).[24]

group support system (GSS) Software application that consists of most elements in a DSS, plus software to provide effective support in group decision making; also called a group decision support system.

Ethical and Societal Issues

Online Divorce Form Error 'Could Have Led to Unfair Settlements'

From April 2014 to December 2015, a form on the UK Ministry of Justice's website contained an error that caused a miscalculation. The form, known rather unimaginatively as Form E, helps divorcing couples provide the courts with full details of their financial arrangements. The error meant that the calculation to produce totals – by adding assets and subtracting liabilities, which are entered earlier on the form – failed to take account of the liabilities. The effect was that a person using it would appear to have more money than they actually had. In divorce proceedings, which try to split a couple's assets fairly, this was a major oversight.

The mistake meant that the settlements of couples separating within a 20-month period were incorrect. Each year 120,000 couples in England and Wales (who use the system) go through a divorce, although the Ministry was quick to point out that not all couples use the online form but choose to supply the information on paper. Nicola Matheson-Durrant, of the Family Law Clinic, was the first to spot the problem. She told *The Guardian* newspaper that, 'having discovered the fault and advised the MoJ, it became apparent that not a single solicitor, barrister or judge in the whole of the UK had noticed this error. It is such a critical fault'.

A Courts and Tribunals Services spokesman said: 'Officials are taking steps to identify rapidly cases where this regrettable error may have had an impact, and we will be writing to anyone affected as soon as possible'. Solicitors Howell Jones said, 'this is obviously a concern but in reality the chance of the error going unnoticed by the person signing the form, the spouse on the other side reviewing it and the Court when considering the matter is quite low'.

Questions

1. In technical terms this was a very simple mistake. How do you think such a simple mistake could appear on such an important website?
2. What do you think the Courts and Tribunals Services should have done after the mistake was discovered?
3. How can Howell Jones say the chance of it going unnoticed is low? It did go unnoticed for over a year after all.
4. Do you think some did but just did not report it? Why would someone do this?

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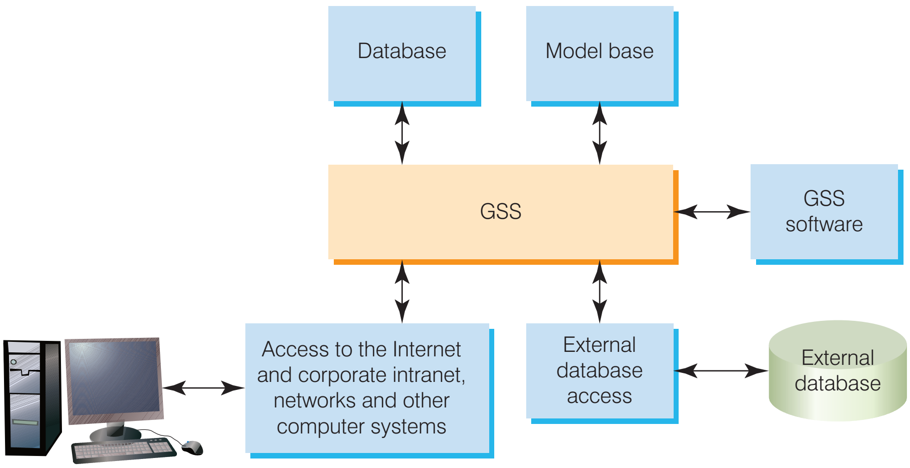

Figure 8.13
Configuration of a GSS
A GSS contains most of the elements found in a DSS, plus software to facilitate group member communications.

Any technology that allows groups of people to interact could be labelled as a GSS. Many forms of private social media would qualify – a WhatsApp group for example. Google Sheets could be used to create a basic GSS. A Google Sheet spreadsheet has all the essential elements of a DSS plus the ability for multiple users to communicate by text with each other while using it.

Group support systems are used in most industries. Architects are increasingly using GSSs to help them collaborate with other architects and builders to develop the best plans and to compete for contracts. Manufacturing companies use GSSs to link raw material suppliers to their own company systems.

Characteristics of a GSS that Enhance Decision Making

It is often said that two heads are better than one. When it comes to decision making, GSSs unique characteristics have the potential to result in better decisions. Developers of these systems try to build on the advantages of individual support systems while adding new approaches, unique to group decision making. For example, some GSSs can allow the exchange of information and expertise among people without direct face-to-face interaction. The following sections describe some characteristics that can improve and enhance decision making.

- *Design for groups.* The GSS approach acknowledges that special procedures, devices and approaches are needed in group decision-making settings. These procedures must foster creative thinking, effective communications and good group decision-making techniques.
- *Ease of use.* Like an individual DSS, a GSS must be easy to learn and use. Systems that are complex and hard to operate will seldom be used. Many groups have less tolerance than do individual decision makers for poorly developed systems.

- *Flexibility.* Two or more decision makers working on the same problem might have different decision-making styles and preferences. Each manager makes decisions in a unique way, in part because of different experiences and cognitive styles. An effective GSS not only has to support the different approaches that managers use to make decisions but also must find a means to integrate their different perspectives into a common view of the task at hand.

brainstorming A decision-making approach that often consists of members offering ideas 'off the top of their heads'.

group consensus approach A decision-making approach that forces members in the group to reach a unanimous decision.

nominal group technique A decision-making approach that encourages feedback from individual group members, and the final decision is made by voting, similar to the way public officials are elected.

- *Decision-making support.* A GSS can support different decision-making approaches such as **brainstorming**, the **group consensus approach** or the **nominal group technique**.
- *Anonymous input.* Many GSSs allow anonymous input, where group members do not know which of them is giving the input. For example, some organizations use a GSS to help rank the performance of managers. Anonymous input allows the group decision makers to concentrate on the merits of the input without considering who gave it. In other words, input given by a top-level manager is given the same consideration as input from employees or other members of the group. Some studies have shown that groups using anonymous input can make better decisions and have superior results compared with groups that do not use anonymous input. Anonymous input, however, can result in flaming, where an unknown team member posts insults or even obscenities on the GSS.
- *Reduction of negative group behaviour.* One key characteristic of any GSS is the ability to suppress or eliminate group behaviour that is counterproductive or harmful to effective decision making. In some group settings, dominant individuals can take over the discussion, which can prevent other members of the group from presenting creative alternatives. In other cases, one or two group members can sidetrack or subvert the group into areas that are non-productive and do not help solve the problem at hand. Other times, members of a group might assume they have made the right decision without examining alternatives – a phenomenon called 'groupthink'. If group sessions are poorly planned and executed, the result can be a tremendous waste of time. GSS designers are developing software and hardware systems to reduce these types of problems. Procedures for effectively planning and managing group meetings can be incorporated into the GSS approach. A trained meeting facilitator is often employed to help lead the group decision-making process and to avoid groupthink.
- *Parallel communication.* With traditional group meetings, people must take turns addressing various issues. One person normally talks at a time. With a GSS, every group member can address issues or make comments at the same time by entering them into a PC or workstation. These comments and issues are displayed on every group member's PC or workstation immediately. Parallel communication can speed meeting times and result in better decisions.
- *Automated recordkeeping.* Most GSSs can keep detailed records of a meeting automatically. Each comment that is entered into a group member's PC or workstation can be recorded. In some cases, literally hundreds of comments can be stored for future review and analysis. In addition, most GSSs packages have automatic voting and ranking features. After group members vote, the GSS records each vote and makes the appropriate rankings.

8.6 Executive Support Systems

Because top-level executives often require specialised support when making strategic decisions, many companies have developed systems to assist executive decision making. This type of system, called an **executive support system (ESS)**, is a specialized DSS that includes all hardware, software, data, procedures and people used to assist senior-level executives within the organization. In some cases, an ESS, also called an executive information system (EIS), supports decision making of members of the board of directors, who are responsible to stockholders.

executive support system (ESS) Specialized DSS that includes all hardware, software, data, procedures and people used to assist senior-level executives within the organization.

An ESS is a special type of DSS and, like a DSS, an ESS is designed to support higher-level decision making in the organization. The two systems are, however, different in important ways. DSSs provide a variety of modelling and analysis tools to enable users to thoroughly analyze problems – that is, they allow users to answer questions. ESSs present structured information about aspects of the organization that executives consider important. In other words, they allow executives to ask the right questions.

The following are general characteristics of ESSs:

- *Are tailored to individual executives.* ESSs are typically tailored to individual executives; DSSs are not tailored to particular users. They present information in the preferred format of that executive.
- *Are easy to use.* A top-level executive's most critical resource can be his or her time. Thus, an ESS must be easy to learn and use and not overly complex.
- *Have drill-down abilities.* An ESS allows executives to drill down into the company to determine how certain data was produced. Drilling down allows an executive to get more detailed information if needed.
- *Support the need for external data.* The data needed to make effective top-level decisions is often external – information from competitors, the government, trade associations and journals, consultants and so on. An effective ESS can extract data useful to the decision maker from a wide variety of sources, including the Internet and other electronic publishing sources.
- *Can help with situations that have a high degree of uncertainty.* Most executive decisions involve a high degree of uncertainty. Handling these unknown situations using modelling and other ESS procedures helps top-level managers measure the amount of risk in a decision.
- *Have a future orientation.* Executive decisions are future oriented, meaning that decisions will have a broad impact for years or decades. The information sources to support future-oriented decision making are usually informal – from organizing golf partners to tying together members of social clubs or civic organizations.
- *Are linked with value-added business processes.* Like other information systems, executive support systems are linked with executive decision making about value-added business processes.

Capabilities of Executive Support Systems

The responsibility given to top-level executives and decision makers brings unique problems and pressures to their jobs. The following is a discussion of some of the characteristics of executive decision making that are supported through the ESS approach. ESSs take full advantage of data mining, the Internet, blogs, podcasts, executive dashboards and many other technological innovations. As you will note, most of these decisions are related to an organization's overall profitability and direction. An effective ESS should have the capability to support executive decisions with components such as strategic planning and organizing, crisis management and more.

- *Support for defining an overall vision.* One of the key roles of senior executives is to provide a broad vision for the entire organization. This vision includes the organization's major product lines and services, the types of businesses it supports today and in the future, and its overriding goals.

strategic planning Determining long-term objectives by analyzing the strengths and weaknesses of the organization, predicting future trends and projecting the development of new product lines.

- *Support for strategic planning.* ESSs also support **strategic planning**. Strategic planning involves determining long-term objectives by analyzing the strengths and weaknesses of the organization, predicting future trends, and projecting the development of new product lines. It also involves planning the acquisition of new equipment, analyzing merger possibilities, and making difficult decisions concerning downsizing and the sale of assets if required by unfavourable economic conditions.
- *Support for strategic organizing and staffing.* Top-level executives are concerned with organizational structure. For example, decisions concerning the creation of new departments or downsizing the labour force are made by top-level managers. Overall direction for staffing decisions and effective communication with labour unions are also major decision areas for top-level executives. ESSs can be employed to help analyze the impact of staffing decisions, potential pay raises, changes in employee benefits and new work rules.
- *Support for strategic control.* Another type of executive decision relates to strategic control, which involves monitoring and managing the overall operation of the organization. Goal seeking can be done for each major area to determine what performance these areas need to achieve to reach corporate expectations. Effective ESS approaches can help top-level managers make the most of their existing resources and control all aspects of the organization.
- *Support for crisis management.* Even with careful strategic planning, a crisis can occur. Major disasters, including hurricanes, tornadoes, floods, earthquakes, fires, pandemics (such as the COVID-19 global pandemic crisis) and terrorist activities, can totally shut down major parts of the organization. Handling these emergencies is another responsibility for top-level executives. In many cases, strategic emergency plans can be put into place with the help of an ESS. These contingency plans help organizations recover quickly if an emergency or crisis occurs.

Decision making is a vital part of managing businesses strategically. IS systems such as information and decision support, group support and executive support systems help employees by tapping existing databases and providing them with current, accurate information. The increasing integration of all business information systems – from TPS to MIS to DSS to ESS – can help organizations monitor their competitive environment and make better-informed decisions. Organizations can also use specialized business information systems, discussed in the next two chapters, to achieve their goals.

Summary

Good decision-making and problem-solving skills are key to developing effective information and decision support systems. Every organization needs effective decision making and problem solving to reach its objectives and goals. Problem solving begins with decision making. A well-known model developed by Herbert Simon divides the decision-making phase of the problem-solving process into three stages: intelligence, design and choice. During the intelligence stage, potential problems or opportunities are identified and defined. Information is gathered that relates to the cause and scope of the problem. Constraints on the possible solution and the problem environment are investigated. In the design stage, alternative solutions to the problem are developed and explored. In addition, the feasibility and implications of these alternatives are evaluated. Finally, the choice stage involves selecting the best course of action. In this stage, the decision makers evaluate the implementation of the solution to determine whether the anticipated results were achieved and to modify the process in light of new information learned during the implementation stage.

Decision making is a component of problem solving. In addition to the intelligence, design and choice steps of decision making, problem solving also includes implementation and monitoring. Implementation places the solution into effect. After a decision has been implemented, it is monitored and modified if needed.

Decisions can be programmed or non-programmed. Programmed decisions are made using a rule, procedure or quantitative method. Ordering more inventory when the level drops to 100 units or fewer is an example of a programmed decision. A non-programmed decision deals with unusual or exceptional situations. Determining the best training programme for a new employee is an example of a non-programmed decision.

Decisions can use optimization, satisficing or heuristic approaches. Optimization finds the best solution. Optimization problems often have an objective such as maximizing profits given production and material constraints. When a problem is too complex for optimization, satisficing is often used. Satisficing finds a good, but not necessarily the best, decision. Finally, a heuristic is a 'rule of thumb' or commonly used guideline or procedure used to find a good decision.

A management information system (MIS) must provide the right information to the right person in the right format at the right time. A management information system is an integrated collection of people, procedures, databases and devices that provides managers and decision makers with information to help achieve organizational goals. An MIS can help an organization achieve its goals by providing managers with insight into the regular operations of the organization so that they can control, organize and plan more effectively and efficiently. The primary difference between the reports generated by the TPS and those generated by the MIS is that MIS reports support managerial decision making at the higher levels of management.

Data that enters the MIS originates from both internal and external sources. The most significant internal sources of data for the MIS are the organization's various TPS and ERP systems. Data warehouses and data marts also provide important input data for the MIS. External sources of data for the MIS include extranets, customers, suppliers, competitors and stockholders.

The output of most MIS is a collection of reports that are distributed to managers. MIS have a number of common characteristics, including producing scheduled, demand, exception and drill-down reports; producing reports with fixed and standard formats; producing hard-copy and soft-copy reports; using internal data stored in organizational computerized databases; and having reports developed and implemented by IS personnel or end users.

Most MISs are organized along the functional lines of an organization. Typical functional management information systems include financial, manufacturing, marketing, human resources and other specialized systems. Each system is composed of inputs, processing subsystems and outputs.

Decision support systems (DSSs) support decision-making effectiveness when faced with unstructured or semi-structured business problems. DSS characteristics include the ability to handle large amounts of data; obtain and process data from different sources; provide report and presentation flexibility; support drill-down analysis; perform complex statistical analysis; offer textual and graphical orientations; support optimization, satisficing and heuristic approaches; and perform what-if, simulation and goal-seeking analysis.

DSSs provide support assistance through all phases of the problem-solving process. Different decision frequencies also require DSS support. An ad hoc DSS addresses unique, infrequent decision situations; an institutional DSS handles routine decisions. Highly structured problems, semi-structured problems and unstructured problems can be supported by a DSS. A DSS can also support different managerial levels, including strategic, tactical and operational managers. A common database is often the link that ties together a company's TPS, MIS and DSS.

The components of a DSS are the database, model base, user interface or dialogue manager, and a link to external databases, the Internet, the corporate intranet, extranets, networks and other systems. The database can use data warehouses and data marts. Access to other computer-based systems permits the DSS to tie into other powerful systems, including the TPS or function-specific subsystems.

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Specialized support systems, such as group support systems (GSSs) and executive support systems (ESSs), use the overall approach of a DSS in situations such as group and executive decision making. A group support system (GSS) consists of most of the elements in a DSS, plus software to provide effective support in group decision-making settings. GSSs are typically easy to learn and use, and can offer specific or general decision-making support. GSS software, also called 'groupware', is specially designed to help generate lists of decision alternatives and perform data analysis. These packages let people work on joint documents and files over a network.

The frequency of GSS use and the location of the decision makers will influence the GSS alternative chosen. The decision room alternative supports users in a single location who meet infrequently. Local area networks can be used when group members are located in the same geographic area and users meet regularly. Teleconferencing is used when decision frequency is low and the location of group members is distant. A wide area network is used when the decision frequency is high and the location of group members is distant.

Executive support systems (ESSs) are specialized decision support systems designed to meet the needs of senior management. They serve to indicate issues of importance to the organization, indicate new directions the company might take and help executives monitor the company's progress. ESSs are typically easy to use, offer a wide range of computer resources and handle a variety of internal and external data. In addition, the ESS performs sophisticated data analysis, offers a high degree of specialization and provides flexibility and comprehensive communications abilities. An ESS also supports individual decision-making styles. Some of the major decision-making areas that can be supported through an ESS are providing an overall vision, strategic planning and organizing, strategic control and crisis management.

Self-Assessment Test

1. The first stage in decision making is the ___________ stage.
2. A programmed decision can be made by a computer by following a ___________.
3. A model that produces a good enough decision is called ___________.
4. Most of the data for an MIS comes from a ___________.
5. A regular, periodic report is called ___________.
6. An MIS that supports promotional effectiveness is a ___________ MIS.
7. GIS stands for ___________.
8. Making hypothetical changes to data and observing the results is ___________.
9. A GSS supports decision making by a ___________.
10. A decision-making approach that encourages ideas 'off the top' of participants' heads is ___________.

Review Questions

1 Compare and contrast a programmed and non-programmed decision using examples.

2 Outline the main distinguishing features of some of the reports produced by an MIS.

3 What is a satisficing model?

4 Explain the main components of decision making.

5 What is CAD?

6 List some of the characteristics of a decision support system.

7 What is a GSS?

8 Explain what-if analysis and how you could implement it using a spreadsheet.

9 What is a GIS?

10 What is an ESS?

Discussion Questions

1 What functionality would you need to add to a DSS to create a GSS?

2 Should mid-level managers be given numerical data or graphical data? Which is better to use to make decisions?

Web Exercises

1 Search for the website for the European Spreadsheet Risks Interest Group and read through the horror stories section.

2 Search for unusual applications for spreadsheets. To start you off, you could try looking for artificial intelligence and games.

Case One

Smart Meters Capture Big Data For Energy Decisions

Governments all over the world are putting in place laws and regulations to govern the installation of smart meters that send regular information about utility usage back to energy providers. This information could come in from every household as often as once every 30 minutes. Germany, for instance, has mandated that every house must have a smart meter by 2020 to record electricity use. In the UK, the Department of Energy and Climate Change has plans in place for the installation of 53 million electricity smart meters in homes and businesses by 2020. European directive 2009/72/EG lays out the common rules for all EU states regarding the internal market in electricity and requires 'smart grids, which should be built in a way that encourages decentralised generation and energy efficiency'. Similar plans are afoot for metering gas and water.

This represents a huge opportunity for SAP, the German multinational software corporation that creates software to manage business operations, because the energy retailers are turning to partners such as these to help with every aspect of the roll out, from back office planning and field services execution to data management and analytics.

In Turkey, energy use is booming. In response to steadily increasing demand for electricity, the Turkish government has imposed requirements on energy providers to optimize the national energy supply. This includes providing monthly reports to the regulatory authorities on consumption, load peaks and supply interruptions. In response, energy supplier Yedaş turned to SAP. Based in Samsun in north Turkey, Yedaş has a total of 1.5 million electricity customers and took the new statutory requirement as an opportunity to restructure how it collects and processes measurement data from meters installed in customers' homes. They

predicted that the Turkish government would begin to roll out smart meters and wanted to be ready for over a million meter readings coming in every half hour, a daunting amount!

To process these data, Yedaş chose SAP for Utilities, a specialist tool with intelligent meter management software created by SAP partner BTC, a German IT firm. The BTC software maps the billing process from the meter through a communication unit (hub) to the SAP software in an integrated manner. A BTC subsidiary in Istanbul coordinated the installation of the new meters and hubs that would communicate with them. The areas covered by Yedaş are thinly populated and mountainous so it was especially important to immediately establish on site that the installations were successful and operating before the team left – they didn't want to have to come back! This was done by testing communication between the BTC information hub and the meters in near real time using the BTC software. Another tricky task faced by the project team was the inconsistent metering landscape among industrial and commercial customers. Unlike in many countries, customers in Turkey often own their own electricity meters – they do not belong to Yedaş.

Power stations create electricity and it must be used immediately – it cannot be stored at scale. Workers at the stations make educated guesses about how much output the station needs to produce. They have a good idea of when people will get out of bed and will be putting on their kettles in the morning, and will increase output at that time. They keep an eye on when popular TV programmes are on and make sure there is enough energy for everyone to enjoy them. And they know when people go to bed and make reductions accordingly. If they get it wrong, it will either be wasteful or will cause blackouts. Data from smart meters are intended to reduce waste and eliminate blackouts.

Questions

1 Should citizens have a choice in whether a smart meter is installed in their homes?

2 Why was testing so important for Yedaş?

3 How will smart meters make electricity production more efficient?

4 What are some of the privacy concerns with smart meters?

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Case Two

Taking Designs into the Next Dimension

Established in 2002, Avia Technique has become a leading repair centre for aircraft components, with their business director Chris Wright emphasizing their reputation for quality, service and competitiveness. Avia's capabilities are on creating aircraft safety components including engine fire extinguishers, oxygen bottles and masks, emergency locators as well as life jackets and evacuation slides and rafts. The safety requirements are strict and aircraft cannot fly without the proper, certified safety gear. At the same time, every second a plane sits on a runway awaiting parts costs an airline dearly. Avia Technique partners with many airlines throughout the world to ensure that this doesn't happen.

Avia designs its own components. Originally, this was done using Autodesk's AutoCAD LT software, which is a two-dimensional drafting and documenting tool. Designs were therefore available only in 2D and it was difficult for potential customers – who often held non-technical roles – to visualize them. This meant that Avia had to build a prototype even before an order had been won, something which takes time and is costly. The lack of a 3D model had a negative effect on Avia's marketing output too. To produce photos for sales brochures involved more prototypes being built, suitable for a glossy magazine, and hiring a photographer.

Avia turned to Cadline, a company with modelling expertise and a partner of Autodesk. 'Cadline's sales consultant swiftly identified our needs and pinpointed the solutions we required', says Paul Trevena, Avia's Business Development Manager. Together they selected Autodesk Product Design Suite Premium (PDSP) to deliver a 3D modelling and visualization capability and Autodesk Vault Professional to deliver the required data management and collaboration tools. 'PDSP is a real godsend', Mr Trevena says. 'The time it takes us to develop new products, from first concept to final design, has been cut by half. This means development costs are reduced, our route to market is quicker, and it's easier to win new projects. The ease with which we can manipulate designs has improved too. Now that we can create assemblies on screen, we are able to put components together and check that the finished product will work as intended. The Product Design Suite has also helped us to reduce our error rate, which has saved time because we don't have to go back over designs to make corrections'.

Animated, realistic images can be seen by customers on screen, and the software produces photo quality images from designs, rendered to show how the product will look when it is finished. 'The images are so sophisticated that we can use them in our sales brochures', says Mr Trevena. It also means that customers can be involved right from the start and through every aspect of the design process, as they will be able to understand and comment on even early designs. If customers have their own 3D designs of the components they need, these can be imported into PDSP, which means they can be quickly integrated into Avia's own products and any changes required in the customers' designs can be sent to them in detail. 'This is a revelation to our business. We have also been able to reduce the number of visits to suppliers and sub-contractors as we can transfer data electronically instead.'

Questions

1. What is the problem with 2D designs?
2. What are the advantages of 3D designs?
3. Why is it important to Avia that the software can import designs?
4. How could this software 'reduce the error rate'? Does this seem like a legitimate claim?

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Case Three

Using Agent Modelling as a Decision Support Tool

This chapter discussed having decision support systems perform simulations. Simulation can be used for what-if style analysis to estimate what changes or results a particular decision might lead to. A simulation is a model of a situation. The model can be manipulated and changed to see what might happen if the same changes were made to the real situation. This is almost always easier and cheaper than making the real changes. Armed with a model of a city centre for instance, a user can ask: 'what if we open a cafe on that street?' 'What if we change the bus route to go around that corner?' 'What if we make half of the car park into shops?' 'What do these changes do to the way the city operates?'

A spreadsheet is a good tool for making a decision support system, and spreadsheets can be used to create a simulation. However, it is often much better to use specialist simulation software. NetLogo is a good example. NetLogo is open-source software developed at Northwestern University. Its approach to simulation is something called agent modelling. An agent is essentially a procedure or object of software code. The agent represents a discrete decision-making unit, and how it makes decisions is by following the rules in its code. In the city centre example, an agent might represent a pedestrian, a cyclist or a car driver. The decisions that these agents make are how to behave in the city centre. The drivers will (mostly) obey traffic laws; the pedestrians will pause for a gap in traffic when crossing a road; the cyclists will follow the bike routes. When they are created, these agents will be given a destination and then set off on their way. The simulation progresses in discrete time steps. At each time step the agents move forward a bit.

8

The rules agents can be incredibly detailed or very sparse. Modellers create agents by programming the decision rules that they follow. One of the most powerful aspects of agent modelling is that in any particular simulation, there can be many different types of agents and each agent can have its own set of rules; alternatively, it can be useful to have one type of agent with only one set of rules.

If you are interested in learning how to program a computer, agent modelling with NetLogo may be a good place to start. The programs are usually very short because they typically consist of tiny blocks of code that are run many thousands of times (every time one of the many agents makes a decision). So even if there are 1,000 agents, you only need to specify the rules that each type of agent follows once; after you've done that, then all 1,000 agents have been programmed! Also, NetLego is based on a programming language called Logo, which was created for children to use, so it should be as easy as any language to learn. NetLogo comes with dozens of example simulations that can be studied. One of these is called Paths.

Paths is a model about how tracks emerge along commonly travelled routes: paths emerge from routes that many travellers share. People tend to take routes that other travellers have taken before them. You can see this sort of thing in parks where the grass has turned to hard dirt from people repeatedly walking on it. This can be used to determine an ideal set of routes between a set of points of interest without needing a central planner. This has been used on university campuses so that when new buildings are made, paths are initially not created but are left as grass for a time until users of the space have created their own hard dirt tracks. After that happens, the construction crew comes back and fills in those tracks properly with concrete or whatever.

To see the simulation in action, download NetLogo from the Northwestern webpage, install and run it, then select File, Models Library, and search for Paths. Don't worry about any of the options – just click Setup and Go (it can be useful to slow everything down with the Normal Speed slider at the top of the screen, otherwise it all goes very fast). The yellow agents start to move about the screen. Now imagine the green represents your university campus or your city centre. Start to place buildings in it by clicking in the green area. Create at least 20 buildings. The agents should start to create popular paths between the buildings you have placed. Some paths will be used more than others. What happens if you create a new building once the paths have settled? If you click on the Code tab at the top of the screen, you will see the entire program used to create the simulation. This probably won't be very clear but at the same time you might achieve a sense of what it is doing by reading down the code.

Questions

1 How could Paths be changed to study a city centre? (Search NetLogo for its Traffic models for some ideas.)

2 What advantages does an agent model have over a DSS created with a spreadsheet?

3 What behaviour should agents follow in order to create a model of a fire drill from one of your college buildings?

4 What other situations in a college could agent models be used to simulate?

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09

Knowledge Management and Specialized Information Systems

Principles	Learning Objectives
Knowledge management systems allow organizations to share knowledge and experience among their managers and employees.	■ Describe the role of the chief knowledge officer (CKO). ■ List some of the tools and techniques used in knowledge management.
Artificial intelligence systems form a broad and diverse set of systems that can replicate human decision making for certain types of well-defined problems.	■ Define the term 'artificial intelligence' and state the objective of developing artificial intelligence systems. ■ List the characteristics of intelligent behaviour and compare the performance of natural and artificial intelligence systems for each of these characteristics. ■ Identify the major components of the artificial intelligence field and provide one example of each type of system.
Expert systems can enable a novice to perform at the level of an expert, but must be developed and maintained very carefully.	■ List the characteristics and basic components of expert systems. ■ Identify at least three factors to consider in evaluating the development of an expert system. ■ Outline and briefly explain the steps for developing an expert system. ■ Identify the benefits associated with the use of expert systems.
Virtual reality systems can reshape the interface between people and information technology by offering new ways to communicate information, visualize processes and express ideas creatively.	■ Define the term 'virtual reality' and provide three examples of virtual reality applications. ■ Discuss examples of specialized systems for organizational and individual use.

Why Learn About Knowledge Management and Specialized Information Systems?

Knowledge management systems are used in almost every industry. If you are a manager, you might use a knowledge management system to support decisive action to help you correct a problem. If you are a production manager at a car company, you might oversee robots, a specialized information system, that attach windscreens to cars or paint body panels. As a stock trader, you might use a system called a neural network to uncover patterns and make money trading stocks and stock options. As a marketing manager for a PC manufacturer, you might use virtual reality on a website to show customers your latest laptop and desktop computers. If you are in the military, you might use computer simulation as a training tool to prepare you for combat. In a petroleum company, you might use an expert system to determine where to drill for oil and gas. You will see many additional examples of using these information systems throughout this chapter. Learning about these systems will help you discover new ways to use information systems in your day-to-day work.

9.1 Knowledge Management Systems

Defining knowledge is difficult. One definition is that 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. Knowing the procedures for ordering more inventory to avoid running out is an example of knowledge. In a sense, information tells you what has to be done (low inventory levels for some items), while knowledge tells you how to do it (make two important phone calls to the right people to get the needed inventory shipped overnight). A knowledge management system (KMS) is an organized collection of people, procedures, software, databases and devices used to create, store, share and use the organization's knowledge and experience.[1]

Overview of Knowledge Management Systems

Like the other systems discussed throughout this book, KMSs attempt to help organizations achieve their goals. For businesses, this usually means increasing profits or reducing costs. For non-profit organizations, it can mean providing better customer service or providing special needs to people and groups. Many types of firms use KMSs to increase profits or reduce costs.

A KMS stores and processes knowledge. This can involve different types of knowledge. Explicit knowledge is objective and can be measured and documented in reports, papers and rules. For example, knowing the best road to take to minimize drive time from home to the office when a major motorway is closed due to an accident is explicit knowledge. It can be documented in a report or a rule, as in 'If the A453 is closed, take the M1 to junction 25 and from there to the office'. Tacit knowledge, on the other hand, is hard to measure and document and typically is not objective or formalized. Knowing the best way to negotiate with a foreign government about nuclear disarmament or deal with a volatile hostage situation often requires a lifetime of experience and a high level of skill. These are examples of tacit knowledge. It is difficult to write a detailed report or a set of rules that would always work in every hostage situation. Many organizations actively attempt to convert tacit knowledge to explicit knowledge to make the knowledge easier to measure, document and share with others.

In a well-known *Harvard Business Review* paper called 'The Knowledge Creating Company' (from the November–December, 1991 issue), Ikujiro Nonaka describes four ways in which knowledge can be created:

1. When an individual learns directly from another individual, in an apprentice type relationship, tacit knowledge is created from tacit knowledge.
2. When two pieces of explicit knowledge are combined. For example, a website mash-up could be considered an example of this type of new knowledge. (Mash-ups were described in Chapter 6 as the combining of information from two or more web pages into one web page.)
3. When an expert writes a book teaching others, explicit knowledge is being created from tacit knowledge.
4. When someone reads that book and (eventually) becomes an expert themselves, tacit knowledge has been created by explicit knowledge.

A diverse set of technologies can help capture, create and share knowledge. Expert systems (this chapter) can be used to share explicit knowledge. Blogs (Chapter 10) can be used to share tacit knowledge. Data mining algorithms (Chapter 5) can be used to discover new knowledge.

Obtaining, Storing, Sharing and Using Knowledge

Knowledge workers are people who create, use and disseminate knowledge. They are usually professionals in science, engineering or business, and belong to professional organizations. Other examples of knowledge workers include writers, researchers, educators and corporate designers. The **chief knowledge officer (CKO)** is a top-level executive who helps the organization work with a KMS to create, store and use knowledge to achieve organizational goals. The CKO is responsible for the organization's KMS and typically works with other executives and directors, including the managing director, finance director and others. Obtaining, storing, sharing and using knowledge is the key to any KMS.[2] Using a KMS often leads to additional knowledge creation, storage, sharing and usage. A meteorologist, for example, might develop sophisticated mathematical models to predict the path and intensity of hurricanes. Business professors often conduct research in marketing strategies, management practices, corporate and individual investments and finance, effective accounting and auditing practices, and much more. Drug companies and medical researchers invest billions of euros in creating knowledge on cures for diseases. Although knowledge workers can act alone, they often work in teams to create or obtain knowledge.

chief knowledge officer (CKO) A top-level executive who helps the organization use a KMS to create, store and use knowledge to achieve organizational goals.

After knowledge is created, it is often stored in a 'knowledge repository'. The knowledge repository can be located both inside and outside the organization. Some types of software can store and share knowledge contained in documents and reports. Adobe Acrobat PDF files, for example, allow you to store corporate reports, tax returns and other documents, and send them to others over the Internet. You can use hardware devices and software to store and share audio and video material.[3] Traditional databases and data warehouses, discussed in Chapter 5, are often used to store the organization's knowledge. Specialized knowledge bases in expert systems, discussed later in the chapter, can also be used.

Because knowledge workers often work in groups or teams, they can use collaborative work software and group support systems to share knowledge. Intranets and password-protected Internet sites also provide ways to share knowledge. Many universities and colleges use an intranet as a learning management system to distribute class notes, monitor attendance, submit reports and essays, and return marks. A good example is the open-source software Moodle, but alternatives are available. Intoweb in South Africa has developed their College Learner Management System to assist in online distance learning.[4] Because knowledge can be critical in maintaining a competitive advantage, businesses should be careful in how they share it. Although they want important decision makers inside and outside the organization to have complete and easy access to knowledge, they also need to protect knowledge from competitors and others who shouldn't see it. As a result, many businesses use patents, copyrights, trade secrets, Internet firewalls and other measures to keep prying eyes from seeing important knowledge that is often expensive and hard to create.

In addition to using information systems and collaborative software tools to share knowledge, some organizations use non-technical approaches. These include corporate retreats and gatherings, sporting events, informal knowledge worker lounges or meeting places, kitchen facilities, day-care centres and comfortable workout centres.

Using a knowledge management system begins with locating the organization's knowledge. This is often done using a knowledge map or directory that points the knowledge worker to the needed knowledge. Drug companies have sophisticated knowledge maps that include database and file systems to allow scientists and drug researchers to locate previous medical studies. Lawyers can use powerful online knowledge maps, such as the legal section of Lexis-Nexis, to research legal opinions and the outcomes of previous cases. Medical researchers, university professors and even textbook authors use Lexis-Nexis to locate important knowledge. Organizations often use the Internet or corporate web portals to help their knowledge workers find knowledge stored in documents and reports. The following are examples of profit and non-profit organizations that use knowledge and knowledge management systems.

HomeAway rents holiday homes in over 190 countries. They use knowledge management software from Bloomfire to organize information for their customer support employees. The software allows a searchable database of knowledge to be built up over time and kept up to date. Support personnel can query it via a Q&A style interface to quickly assist with customer enquires.[5]

Scenechronize is a software tool aimed at Hollywood production companies, used to manage scripts and prevent them from being leaked online. Actors and the production team can read their scripts and related notes, but the text disappears as soon as they do. The software was famously used by the *Game of Thrones* production team and infamously complained about by the actors involved. Scenechronize can also help manage and communicate production schedules. The software can be considered a knowledge management system as it allows knowledge workers to create, manage and share knowledge about a production.[6]

Technology to Support Knowledge Management

KMSs use a number of tools discussed throughout this book. In Chapter 2, for example, we explored the importance of organizational learning and organizational change. An effective KMS is based on learning new knowledge and changing procedures and approaches as a result.[7] A manufacturing company, for example, might learn new ways to program robots on the factory floor to improve accuracy and reduce defective parts. The new knowledge will likely cause the manufacturing company to change how it programs and uses its robots. In Chapter 5 on database systems, we investigated the use of data mining and business intelligence. These powerful tools can be important in capturing and using knowledge. Enterprise resource planning tools, such as SAP, include knowledge management features.[8] We have also seen how groupware could improve group decision making and collaboration. Groupware can also be used to help capture, store and use knowledge. In the next chapter, we will examine more technology that could be used to share knowledge. Lastly, of course, hardware, software, databases, telecommunications and the Internet, discussed in Part 2, are important technologies used to support KMSs.

Many companies provide specific KM products and services aimed at commercial organizations. In addition, many educators and software developers have created learning support systems to facilitate knowledge management in schools, colleges and universities. Indian software developer Zoho, for example, helps companies share knowledge with their customers. Their Desk software has a 'self-service portal' feature which creates a searchable database of product help, which appears to customers as a familiar FAQ list. Desk is designed to be used by customers, not employees. Called Help Centre, Zoho boasts that it provides faster answers to customer queries, a shorter waiting list of customers needing help and happier customers. If desired, access can be limited to premium customers only, to all customers, or it can be given to the general public. The portal can also be customized with the company's own branding.[9]

Collective Knowledge is an open source collaborative framework designed to allow users to share knowledge. The knowledge to be shared comes in the form of computer programs called 'automation tasks' or actions. The framework makes it easy for others to install and use these programs. Part of what makes this so clever is that the automatic installation process includes detecting and installing all the relevant software, downloading datasets and models (which might be statistical or mathematical models that describe relationships within the data), assembling all of this together and running it. One popular use of Collective Knowledge is in sharing and demonstrating data analyses of scientific data. For instance, a scientist collects data, analyzes it and publishes it in an academic journal. Collective Knowledge can be used to share that data with anyone who wants it along with the analyses that were carried out, in the form of computer programs. The programs, which can be edited, can be run on the data to see exactly what the scientist did and verify it. Anyone can reproduce the work. Often, even the code used to produce a particular figure or diagram is included, as well as code to create the statistical results that were published.[10]

In addition to these tools, several artificial intelligence systems, discussed next, can be used in a KMS.

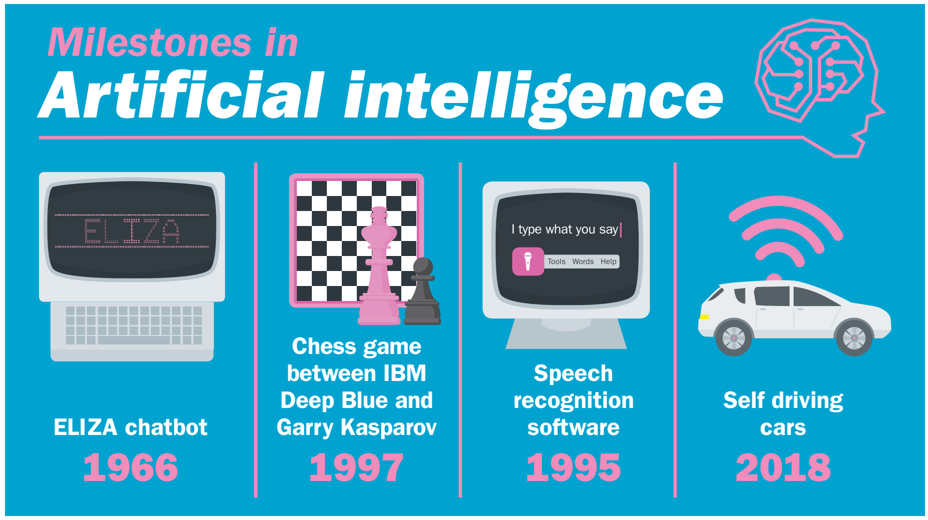
9.2 Artificial Intelligence

At a Dartmouth College conference in 1956, John McCarthy proposed the use of the term artificial intelligence (AI) to describe computers with the ability to mimic or duplicate the functions of the human brain. Advances in AI have since led to systems that recognize complex patterns.[11] Many AI pioneers attended this first conference; a few predicted that computers would be as 'smart' as people by the 1960s. This prediction has not yet been realized and there is a debate about whether it actually ever could be; however, the benefits of AI in business and research can be seen today, and the research continues.

Artificial intelligence systems include the people, procedures, hardware, software, data and knowledge needed to develop computer systems and machines that demonstrate characteristics of intelligence. Researchers, scientists and experts on how human beings think are often involved in developing these systems.

artificial intelligence systems People, procedures, hardware, software, data and knowledge needed to develop computer systems and machines that demonstrate characteristics of intelligence.

Milestones in Artificial Intelligence
Many major milestones in artificial intelligence have been passed. This trend is likely to increase.



The Nature of Intelligence

intelligent behaviour The ability to learn from experiences and apply knowledge acquired from experience, handle complex situations, solve problems when important information is missing, determine what is important, react quickly and correctly to a new situation, understand visual images, process and manipulate symbols, be creative and imaginative, and use heuristics.

From the early AI pioneering stage, the research emphasis has been on developing machines with **intelligent behaviour**. Machine intelligence, however, is hard to achieve. Some of the specific characteristics of intelligent behaviour include the ability to do the following:

- *Learn from experience and apply the knowledge acquired from experience*. Learning from past situations and events is a key component of intelligent behaviour and is a natural ability of humans, who learn by trial and error. This ability, however, must be carefully programmed into a computer system. Today, researchers are developing systems that can learn from experience. In 2019, a poker-playing AI program called Pluribus beat five professional human poker players in a game of 'no-limit Texas hold 'em poker'. It was the first time that an AI has beaten elite human players at a game that has more than two players. The move from two-player games – where there is often a clear winning strategy, even if it is difficult to find, as in chess – to multiplayer games increases the complexity of the task as there are competing interests and no clear win–lose conditions.[12, 13]
- *Handle complex situations.* People are often involved in complex situations. World leaders face difficult political decisions regarding terrorism, conflict, global economic conditions, hunger and poverty. In a business setting, top-level managers and executives must handle a complex market, challenging competitors, intricate government regulations and a demanding workforce. Even human experts make mistakes in dealing with these situations. Developing computer systems that can handle perplexing situations requires careful planning and elaborate computer programming.
- *Solve problems when important information is missing.* The essence of decision making is dealing with uncertainty. Often, decisions must be made with too little information or inaccurate information because obtaining complete information is too costly or even impossible. Today, AI systems can make important calculations, comparisons and decisions even when information is missing.

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- *Determine what is important.* Knowing what is truly important is the mark of a good decision maker. Developing programs and approaches to allow computer systems and machines to identify important information is not a simple task.
- *React quickly and correctly to a new situation.* A small child, for example, can look over a ledge or a drop-off and know not to venture too close. The child reacts quickly and correctly to a new situation. Computers, on the other hand, do not have this ability without complex programming.
- *Understand visual images.* Interpreting visual images can be extremely difficult, even for sophisticated computers. Moving through a room of chairs, tables and other objects can be trivial for people but extremely complex for machines, robots and computers. Such machines require an extension of understanding visual images, called a **perceptive system**. Having a perceptive system allows a machine to approximate the way a person sees, hears and feels objects. Military robots, for example, use cameras and perceptive systems to conduct reconnaissance missions to detect enemy weapons and soldiers. Detecting and destroying them can save lives.

perceptive system A system that approximates the way a person sees, hears and feels objects.

- *Process and manipulate symbols.* People see, manipulate and process symbols every day. Visual images provide a constant stream of information to our brains. By contrast, computers have difficulty handling symbolic processing and reasoning. Although computers excel at numerical calculations, they aren't as good at dealing with symbols and 3D objects. Recent developments in machine-vision hardware and software, however, allow some computers to process and manipulate symbols on a limited basis.
- *Be creative and imaginative.* Throughout history, people have turned difficult situations into advantages by being creative and imaginative. For instance, when defective mints with holes in the middle were shipped, an enterprising entrepreneur decided to market these new mints as 'LifeSavers' instead of returning them to the manufacturer. Ice-cream cones were invented at the St Louis World's Fair when an imaginative store owner decided to wrap ice cream with a waffle from his grill for portability. Developing new and exciting products and services from an existing (perhaps negative) situation is a human characteristic. Computers cannot be imaginative or creative in this way, although software has been developed to enable a computer to write short stories.
- *Use heuristics.* For some decisions, people use heuristics (rules of thumb arising from experience) or even guesses. In searching for a job, you might rank the companies you are considering according to profits per employee. Today, some computer systems, given the right programs, obtain good solutions that use approximations instead of trying to search for an optimal solution, which would be technically difficult or too time consuming.

This list of traits only partially defines intelligence. Unlike the terminology used in virtually every other field of IS research in which the objectives can be clearly defined, the term 'intelligence' is a formidable stumbling block. One of the problems in AI is arriving at a working definition of real intelligence against which to compare the performance of an AI system.

The Difference Between Natural and Artificial Intelligence

Since the term 'artificial intelligence' was defined in the 1950s, experts have disagreed about the difference between natural and artificial intelligence. Can computers be programmed to have common sense? Profound differences separate natural from artificial intelligence, but they are declining in number (see Table 9.1). One of the driving forces behind AI research is an attempt to understand how people actually reason and think. Creating machines that can reason is possible only when we truly understand our own processes for doing so.

Table 9.1 A Comparison of Natural and Artificial Intelligence

Ability to	Natural Intelligence (Human)		Artificial Intelligence (Machine)	
	Low	High	Low	High
Use sensors (see hear, touch, smell)		√	√	
Be creative and imaginative		√	√	
Learn from experience		√	√	
Adapt to new situations		√	√	
Afford the cost of acquiring intelligence		√	√	
Acquire a large amount of external information		√		√
Use a variety of information sources		√		√
Make complex calculations	√			√
Transfer information	√			√
Make a series of calculations rapidly and accurately	√			√

Information Systems @ Work

Playing with Atoms

ScienceAtHome, based at Aarhus University in Denmark, creates fun games with the aim of revolutionizing scientific research and teaching through game-play. The team includes scientists, game developers, designers and visual artists. One of their games, Quantum Moves, aims to help build a working quantum computer.

Quantum computers have been mentioned before in this text (see the Information Systems @ Work case in Chapter 5). They attempt to use the strange behaviour of small particles (photons or electrons) to compute. In a quantum computer, a single atom is used in place of a single bit (it's called a qubit for quantum binary digit). A bit can take on a value of 1 or 0; an atom acting as a bit can take on a value of 1 and 0 at the same time. This means that long complex calculations can be represented with far fewer 'bits' as all possible values are processed simultaneously.

One problem is that atoms are very excited and move about a lot, which makes them hard to handle. To slow them down, they are cooled to extreme temperatures and then trapped by shining a laser on them. According to ScienceAtHome, this is like an egg tray of atoms. To perform calculations, the atoms must interact. They are moved in the egg tray by devices called optical tweezers which manipulate the laser that has trapped the atom. The problem is that no one knows how best to move the atoms. That's where the game comes in. Players manipulate the tweezers and a simulated atom reacts based on accurate quantum mechanics calculated by the game engine. 'Why not gamify these complicated problems and ask players all around the world to help us?' asks physicist Jacob Sherson.

Soon after its release, almost 2,000 players were tackling Quantum Moves and generating a lot of data for ScienceAtHome. The player base is extremely diverse – for instance, two top players are a female accountant and a male taxi driver. Each time the game is played, one atom trajectory is created. They already have over 300,000. 'What's more', says ScienceAtHome, 'player data showed exactly what Jacob's first idea hinted at. Humans can solve the quantum problem more efficiently than computers!' You can see the current leaderboard and play the game at: www.scienceathome.org/games/quantum-moves-2/about-quantum-moves-2/. ScienceAtHome has also contributed to social science. In 2016 this leaderboard broke down, just as nearly 5,000 new players joined after the publication of a high profile paper on Quantum Moves was published. For a time there was no leaderboard, then an all-time top 5 leaderboard, and then a personal leaderboard showing individual players how they were ranked in the entire community of players. The impact of this on gamer behaviour was studied by social scientists at Aarhus University. It was previously believed that a leaderboard creates more competitive behaviour and enhanced gamer performance, but the results of this study did not support this.

Questions

1 What do you think would motivate someone to play a ScienceAtHome game?

2 What are the benefits of ScienceAtHome for the research team?

3 Are there any business problems that could be gamified? To start the ideas off, could routing passengers through an airport be a possibility?

4 If quantum computers are going to be as powerful as scientists predict, should governments intervene now to control their development?

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The Major Branches of Artificial Intelligence

AI is a broad field that includes several specialty areas, such as expert systems, robotics, vision systems, natural language processing, learning systems and neural networks. Many of these areas are related; advances in one can occur simultaneously with, or result in, advances in others.

Expert Systems

An **expert system** consists of hardware and software that stores knowledge and makes inferences, similar to those of a human expert. Because of their many business applications, expert systems are discussed in more detail in their own section later in this chapter.

expert system Hardware and software that stores knowledge and makes inferences, similar to a human expert.

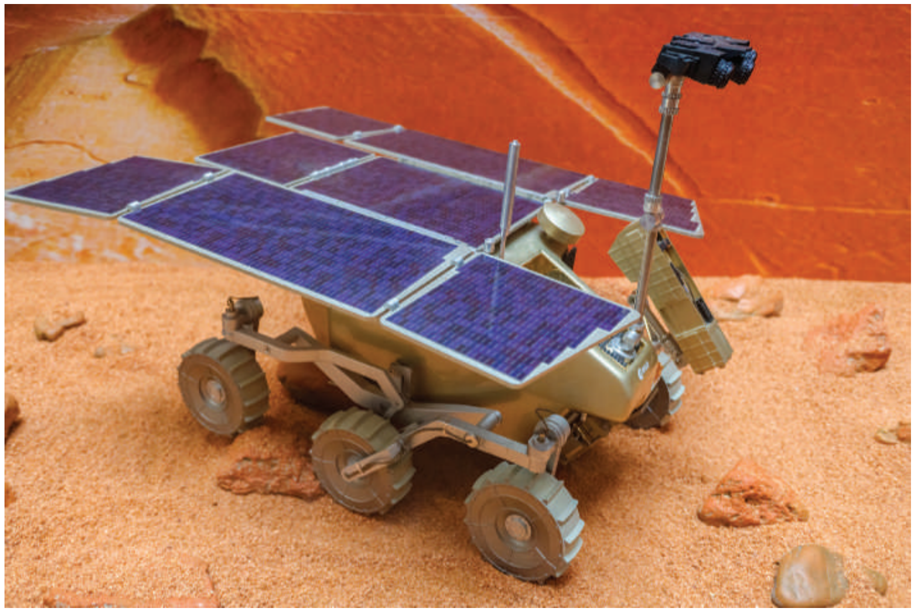
Robotics

Robotics involves developing mechanical or computer devices that can paint cars, make precision welds and perform other tasks that require a high degree of precision or that are tedious or hazardous for human beings. Some robots are mechanical devices that don't use the AI features discussed in this chapter. Others are sophisticated systems that use one or more AI features or characteristics, such as the vision systems, learning systems or neural networks, discussed later in the chapter. For many businesses, robots are used to do the 'three Ds' – dull, dirty and dangerous jobs.[14, 15] Manufacturers use robots to assemble and paint products. The NASA shuttle crash of the early 2000s, for example, has led some people to recommend using robots instead of people to explore space and perform scientific research (see Figure 9.1). Some

robotics Mechanical or computer devices that perform tasks requiring a high degree of precision or that are tedious or hazardous for humans.

robots, such as Sony's Aibo, can be used for companionship. Contemporary robotics combine both high-precision machine capabilities and sophisticated controlling software. The controlling software in robots is what is most important in terms of AI.

Figure 9.1 Robots in Space *Madrid, Spain, 28 August 2019: Scale reproduction of the ESA ExoMars Rover, Mars Exploration Robot.*



The field of robotics has many applications, and research into these unique devices continues. The following are a few examples:

- IRobot is a company that builds a number of robots, including the Roomba Floorvac for cleaning floors and the PackBot, an unmanned vehicle used to assist and protect soldiers.[16]
- The Porter Adventist Hospital in Denver, Colorado, uses a €67,959 Da Vinci Surgical System to perform surgery on prostate cancer patients.[17] The robot has multiple arms that hold surgical tools. According to one doctor at Porter, 'The biggest advantage is it improves recovery time. Instead of having an eight-inch incision, the patient has a "band-aid" incision. It's much quicker'.
- DARPA (the Defence Advanced Research Project Agency) sponsors the DARPA Grand Challenge, a 212 km (132 mile) race over rugged terrain for computer-controlled cars.[18]
- Because of an age limit on camel jockeys, the state of Qatar decided to use robots in its camel races.[19] Developed in Switzerland, the robots have a human shape and only weigh 27 kg (59 lb). The robots use global positioning systems (GPS), a microphone to deliver voice commands to the camel and cameras. A camel trainer uses a joystick to control the robot's movements on the camel. Camel racing is very popular in Qatar.
- In military applications, robots are becoming real weapons. The US Air Force is developing a smart robotic jet fighter. Often called 'unmanned combat air vehicles' (UCAVs), these robotic war machines, such as the X-45A, will be able to identify and destroy targets without human pilots. UCAVs send pictures and information to a central command centre and can be directed to strike military targets. These new machines extend the current Predator and Global Hawk technologies the military used in Afghanistan after the 11 September 2001 terrorist attacks.[20]

- Disney Imagineering has created stunt robots that can be flung into the air, twist and turn in exciting ways (similar to how computer generated characters move in Disney movies) and land at speeds faster than any human could survive. The plan is to use them in Disney parks' live shows.[21]
- Boston Dynamics is at the cutting edge of robotics. Their robot dog, available in a range of sizes, can climb stairs, navigate rough terrain and can be used for exploration.[22]

Although robots are essential components of today's automated manufacturing and military systems, future robots will find wider applications in banks, restaurants, homes, doctors' offices and hazardous working environments such as nuclear stations. The Repliee Q1 and Q2 robots from Japan are ultra-humanlike robots or androids that can blink, gesture, speak and even appear to breathe.[23] Microrobotics is a developing area. Also called micro-electro-mechanical systems (MEMSs), microrobots are the size of a grain of salt [24, 25] and can be used in a person's blood to monitor the body, and for other purposes in air bags, mobile phones, refrigerators and more.

If you would like to try to make a robot, LEGO Mindstorms is a good place to start (Figure 9.2).

Figure 9.2 **Lego Mindstorms** *This LEGO kit contains programmable bricks, motors and sensors so that users can build their own robots. The robot can be programmed in a range of languages, including Java and Visual Basic, as well as LEGO's own easy to use graphical environment.*

Vision Systems

Another area of AI involves **vision systems**. Vision systems include hardware and software that permit computers to capture, store and manipulate visual images.

vision systems The hardware and software that permit computers to capture, store and manipulate visual images.

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For example, vision systems can be used with robots to give these machines 'sight'. Factory robots typically perform mechanical tasks with no visual stimuli. Robotic vision extends the capability of these systems, allowing the robot to make decisions based on visual input. Generally, robots with vision systems can recognize black and white and some grey shades but do not have good colour or 3D vision. Other systems concentrate on only a few key features in an image, ignoring the rest. Another potential application of a vision system is fingerprint analysis.

Even with recent breakthroughs in vision systems, computers cannot see and understand visual images the way people can.

Natural Language Processing and Voice Recognition

As discussed in Chapter 4, **natural language processing** allows a computer to understand and react to statements and commands made in a 'natural' language, such as English. In some cases, voice recognition is used with natural language processing. Voice recognition involves converting sound waves into

natural language processing Processing that allows the computer to understand and react to statements and commands made in a 'natural' language, such as English.

words. Dragon Systems' Naturally Speaking uses continuous voice recognition, or natural speech, allowing the user to input data into the computer by speaking at a normal pace without pausing between words. The spoken words are transcribed immediately onto the computer screen. After converting sounds into words, natural language processing systems can be used to react to the words or commands by performing a variety of tasks. Brokerage services are a perfect fit for voice-recognition and natural language processing technology to replace the existing 'press 1 to buy or sell shares' touchpad telephone menu system. People buying and selling use a vocabulary too varied for easy access through menus and touchpads, but still small enough for software to process in real time. Several brokerages – including Charles Schwab & Company, Fidelity Investments, DLJdirect and TD Waterhouse Group – offer these services. These systems use voice recognition and natural language processing to let customers access pension accounts, check balances and find stock quotes. Eventually, the technology may allow people to make transactions using voice commands over the phone and to use search engines to have their questions answered through the brokerage firm's call centre. One of the big advantages is that the number of calls routed to the customer service department drops considerably after new voice features are added. That is desirable to brokerages because it helps them staff their call centres correctly – even in volatile markets. Whereas a typical person uses a vocabulary of about 20,000 words or less, voice-recognition software can have a built-in vocabulary of 85,000 words. Some companies claim that voice-recognition and natural language processing software is so good that customers forget they are talking to a computer and start discussing the weather or sports results.

Google Duplex is a Google project that pulls together many technologies, one of which is natural language processing. Duplex allows Google computers to call and talk to businesses, acting as a personal assistant to a user. It can be used to book a hair appointment or reserve a table for lunch. The system might even have called you! Duplex regularly passes the famous Turing test, as the employee who answers the phone rarely realizes they are speaking to a computer. To do this it uses tricks such as saying 'erm' down the phone if there are any time lags in its processing.[26]

Another form of natural language processing involves reading text rather than understanding speech. The author Carl Malamud has assembled a huge store of scientific articles that are usually hidden behind publisher paywalls, and plans to make them available for scientists to 'mine' for new insights. At no time can the scientists themselves read or download the papers (which would break copyright law) but instead a computer bot can scan the text, develop an understanding from it, and suggest knowledge gaps or other research avenues.[27]

Learning Systems

learning systems A combination of software and hardware that allows the computer to change how it functions or reacts to situations based on feedback it receives.

Another part of AI deals with **learning systems**, a combination of software and hardware that allows a computer to change how it functions or reacts to situations based on feedback it receives. For example, some computerized games have learning abilities. If the computer does not win a game, it remembers not to make the same moves under the same conditions again. Tom Mitchell, director of the Center for Automated Learning and Discovery at Carnegie Mellon University, is experimenting with two learning software packages that help each other learn.[28] He believes that two learning software packages that cooperate are better than separate learning packages. Mitchell's learning software helps Internet search engines do a better job of finding information. Learning systems software requires feedback on the results of actions or decisions. As a minimum, the feedback needs to indicate whether the results are desirable (winning a game) or undesirable (losing a game). The feedback is then used to alter what the system will do in the future.

An increasingly important aspect of AI involves **neural networks**, also called 'neural nets'. A neural network is a computer system that can act like or simulate the functioning of a human brain. The systems use massive parallel processors in an architecture that is based on the human brain's own mesh-like structure. In addition, neural network software simulates a neural network using standard computers. Neural networks can process many pieces of data at the same time and learn to recognize patterns. Some of the specific abilities of neural networks include discovering relationships and trends in large databases, and solving complex problems for which all the information is not present.

neural networks A computer system that attempts to simulate the functioning of a human brain.

A particular skill of neural nets is analyzing detailed trends. Large amusement parks and banks use neural networks to determine staffing needs based on customer traffic – a task that requires precise analysis, down to the half-hour. Increasingly, businesses are using neural nets to help them navigate ever-thicker forests of data and make sense of myriad customer traits and buying habits. One application, for example, would be to track the habits of insurance customers and predict which ones will not renew a policy. Staff could then suggest to an insurance agent what changes to make in the policy to persuade the consumer to renew it. Some pattern-recognition software uses neural networks to analyze hundreds of millions of bank, brokerage and insurance accounts involving a trillion euros to uncover money laundering and other suspicious money transfers.

Other Artificial Intelligence Applications

A few other artificial intelligence applications exist in addition to those just discussed. A **genetic algorithm**, also called a genetic program, is an approach to solving large, complex problems in which many repeated operations or models change and evolve until the best one emerges. The first step is to change or vary competing solutions to the problem. This can be done by changing the parts of a program or by combining different program segments into a new program. The second step is to select only the best models or algorithms, which continue to evolve. Programs or program segments that are not as good as others are discarded, similar to natural selection or 'survival of the fittest', in which only the best species survive. This process of variation and natural selection continues until the genetic algorithm yields the best possible solution to the original problem. For example, some investment firms use genetic algorithms to help select the best stocks or bonds. Genetic algorithms are also used in computer science and mathematics. Genetic algorithms can help companies determine which orders to accept for maximum profit. This approach helps companies select the orders that will increase profits and take full advantage of the company's production facilities. Genetic algorithms are also being used to make better decisions in developing inputs to neural networks.

genetic algorithm An approach to solving large, complex problems in which a number of related operations or models change and evolve until the best one emerges.

An **intelligent agent** (also called an 'intelligent robot' or 'bot') consists of programs and a knowledge base used to perform a specific task for a person, a process or another program. Like a sports agent who searches for the best sponsorship deals for a top athlete, an intelligent agent often searches to find the best price, schedule or solution to a problem. The programs used by an intelligent agent can search large amounts of data as the knowledge base refines the search or accommodates user preferences. Often used to search the vast resources of the Internet, intelligent agents can help people find information on an important topic or the best price for a new digital camera. Intelligent agents can also be used to make travel arrangements, monitor incoming email for viruses or junk mail, and coordinate meetings and schedules of busy executives. In the human resources field, intelligent agents help with online training. The software can look ahead in training materials and know what to start next.

intelligent agent Programs and a knowledge base used to perform a specific task for a person, a process or another program; also called intelligent robot or bot.

Ethical and Societal Issues

Augmented Reality's Killer App

Very often, when a new technology appears, a few pioneers will experiment with it, creating different product ideas to see if any of them take off. The one that does gets to introduce the technology to the general public, and often – for a time at least – use of it really explodes. Sometimes this is called the technology's 'killer app'. In the next chapter we will see that wearable computing is still waiting for its killer app. If and when it arrives, you will see wearables everywhere, almost overnight. For a long time, augmented reality awaited its killer app. It may just have arrived.

Augmented reality is the integration of digital information alongside the user's real environment, in real time. In other words, digital glasses overlay virtual content on top of whatever the user is looking at in the real world. (Augmented reality doesn't have to be visual, but so far that's all that has really been explored.) Unlike virtual reality, which creates a totally artificial environment, augmented reality mixes real and virtual content. A typical example is displaying navigational directions through an eyetap (a tiny computer screen that you wear on one eye like half a pair of glasses). Then when the user walks along, they can see reality through one eye and the directions through the other. A more sophisticated version would display a line that the wearer could follow rather than instructions in text. The line would adjust as the wearer moved their head so that it always appeared on the ground where the person needs to walk. Something similar is available for cars where the route is displayed on the windscreen. The driver can see reality (the road) and the route at the same time, with the route overlaid on top of the road. There have been other ideas. For example, copyrights and other information on artworks that are visible only to electronic cameras have been suggested (that way if someone photographs your painting, the copyright notice appears in the photo), as has displaying information to engineers about parts of a complex machine that is being repaired.

In summer 2016, a new mobile app appeared that brought augmented reality to masses of game players. Pokémon Go mixes the characters of Pokémon with the real world, encouraging players to get out and about to capture the virtual creatures. The Pokémon appear as augmented reality – they are overlaid on the image captured by the players' smartphone/tablet cameras. The Pokémon website advises players to 'get on your feet and step outside to find and catch wild Pokémon. Explore cities and towns around where you live and even around the globe to capture as many Pokémon as you can. As you move around, your smartphone will vibrate to let you know you're near a Pokémon. Once you've encountered a Pokémon, take aim on your smartphone's touch screen and throw a Poké Ball to catch it. Be careful when you try to catch it, or it might run away! Also look for PokéStops located at interesting places, such as public art installations, historical markers, and monuments, where you can collect more Poké Balls and other items'.

For a time at least, Pokémon Go was a massive success, with many players becoming almost addicted to the game overnight. However, some players took it too far. Users have been involved in car accidents while playing the game, wandered into traffic and been robbed. The game has led players to some strange places too, including cemeteries and strip clubs. Two men fell off a cliff in San Diego while trying to catch a Pokémon. Both ended up in hospital.

Turkey and Israel have both warned players of the dangers of too much sun exposure while playing, and in Bosnia, a nongovernmental agency warned citizens in a Facebook post of the dangers of playing the game in dangerous areas, citing the risk of wandering onto old landmines that have existed since the 1992 Bosnian War. Nineteen-year-old Shayla Wiggins from Wyoming was trying to find a Pokémon in a well but instead found a man's corpse. 'I was walking towards the bridge along the shore when I saw something in the water', she told *County 10 News*. 'I had to take a second look and I realized it was a body.'

Questions

1 Could the app developers have been more socially responsible about sending users out into the real world?

2 Is this game popular because it involves going outside, or is it just because it's Pokémon? What else might explain its success?

3 What other applications can you think of for augmented reality?

4 This app involves getting out and about around the world. What data could users pick up along the way that might help with traffic planning or nature conservation?

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9.3 Expert Systems

An expert system outputs a recommendation based on answers given to it by users (who are not experts in the field). The intention of the system is to capture the expert's knowledge and make it available to those who lack this knowledge. Expert systems have been developed to diagnose medical conditions, resolve engineering problems and solve energy problems. They have also been used to design new products and systems, develop innovative insurance products, determine the best use of timber and increase the quality of healthcare. Like human experts, expert systems use heuristics, or rules of thumb, to arrive at conclusions or make suggestions. The research conducted in AI since the mid-1990s is resulting in expert systems that explore new business possibilities, increase overall profitability, reduce costs and provide superior service to customers and clients.

When to Use Expert Systems

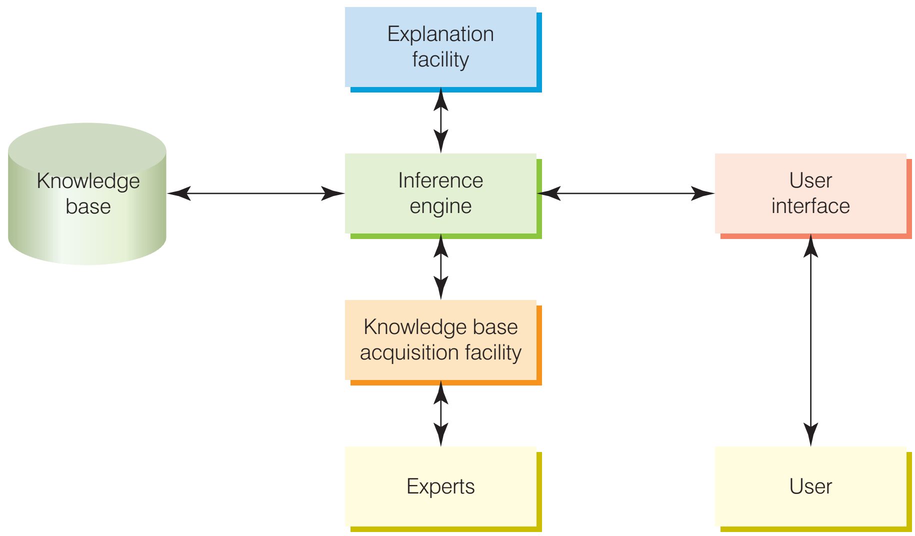
Sophisticated expert systems can be difficult, expensive and time consuming to develop. The following is a list of factors that normally make expert systems worth the expenditure of time and money. Develop an expert system if it can do any of the following:

- Provide a high potential payoff or significantly reduce downside risk.
- Capture and preserve irreplaceable human expertise.
- Solve a problem that is not easily solved using traditional programming techniques.
- Develop a system which is more consistent than human experts.
- Provide expertise needed at a number of locations at the same time or in a hostile environment that is dangerous to human health.
- Provide expertise that is expensive or rare.
- Develop a solution faster than human experts can.
- Provide expertise needed for training and development to share the wisdom and experience of human experts with many people.

Components of Expert Systems

An expert system consists of a collection of integrated and related components, including a knowledge base, an inference engine, an explanation facility, a knowledge base acquisition facility and a user interface. A diagram of a typical expert system is shown in Figure 9.3.

Figure 9.3 **Components of an Expert System**



The Knowledge Base

knowledge base A component of an expert system that stores all relevant information, data, rules, cases and relationships used by the expert system.

The **knowledge base** stores all relevant information, data, rules, cases and relationships that the expert system uses. A knowledge base is a natural extension of a database (presented in Chapter 5) and an information and decision support system (presented in Chapter 8). A knowledge base must be developed for each unique application. For example, a medical expert system contains facts about diseases and symptoms. The following are some tools and techniques that can be used to create a knowledge base.

- *Assembling human experts.* One challenge in developing a knowledge base is to assemble the knowledge of multiple human experts. Typically, the objective in building a knowledge base is to integrate the knowledge of people with similar expertise (for example, many doctors might contribute to a medical diagnostics knowledge base).
- *Fuzzy logic.* Another challenge for expert system designers and developers is capturing knowledge and relationships that are not precise or exact. Instead of the yes/no, or true/false conditions of typical computer decisions, fuzzy logic allows shades of grey, or what are known as 'fuzzy sets'. Fuzzy logic rules help computers evaluate the imperfect or imprecise conditions they encounter and make educated guesses based on the probability of correctness of the decision.
- *Rules.* A rule is a conditional statement that links conditions to actions or outcomes. In many instances, these rules are stored as **IF-THEN statements**, such as 'IF a certain set of network conditions exists, THEN a certain network problem diagnosis is appropriate'. In an expert system for a weather forecasting

IF-THEN statements Rules that suggest certain conclusions.

operation, for example, the rules could state that if certain temperature patterns exist with a given barometric pressure and certain previous weather patterns over the last 24 hours, then a specific forecast will be made, including temperatures, cloud coverage and wind-chill factor. Figure 9.4 shows how to use expert system rules in determining whether a person should receive a mortgage loan from a bank. These rules can be placed in almost any standard program language discussed in Chapter 4 using 'IF-THEN' statements or into special expert systems shells, discussed later in the chapter. In general, as the number of rules that an expert system knows increases, the precision of the expert system also increases.

- *Cases.* An expert system can use cases in developing a solution to a current problem or situation. This process involves (1) finding cases stored in the knowledge base that are similar to the problem or situation at hand, and (2) modifying the solutions to the cases to fit or accommodate the current problem or situation.

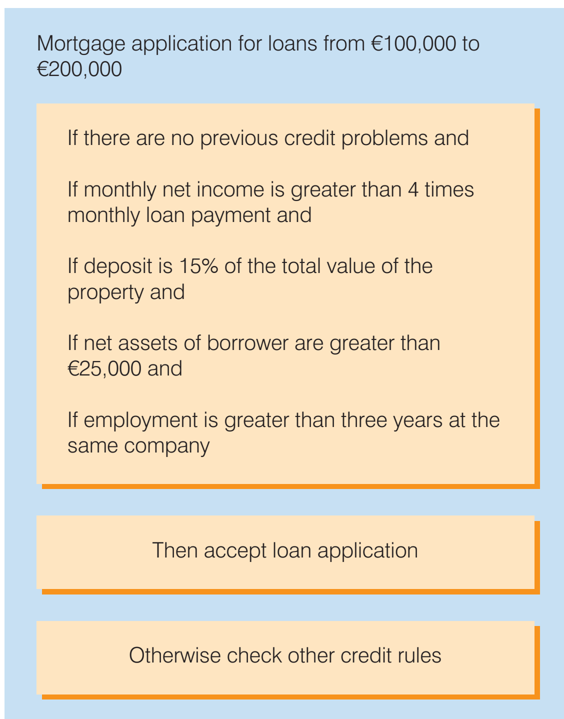


Figure 9.4 Rules for a Credit Application

The Inference Engine

The overall purpose of an **inference engine** is to seek information and relationships from the knowledge base and to provide answers, predictions and suggestions the way a human expert would. In other words, the inference engine is the component that delivers the expert advice. To provide answers and give advice, expert systems can use backward and forward chaining. **Backward chaining** is the process of starting with conclusions and working backwards to the supporting facts. If the facts do not support the conclusion, another conclusion is selected and tested. This process is continued until the

inference engine Part of the expert system that seeks information and relationships from the knowledge base and provides answers, predictions and suggestions the way a human expert would.

backward chaining The process of starting with conclusions and working backwards to the supporting facts.

forward chaining The process of starting with the facts and working forwards to the conclusions.

correct conclusion is identified. **Forward chaining** starts with the facts and works forwards to the conclusions. Consider the expert system that forecasts future sales for a product. Forward chaining starts with a fact such as 'The demand for the product last month was 20,000 units'. With the forward-chaining approach, the expert system searches for rules that contain a reference to product demand. For example, 'IF product demand is over 15,000 units, THEN check the demand for competing products'. As a result of this process, the expert system might use information on the demand for competitive products. Next, after searching additional rules, the expert system might use information on personal income or national inflation rates. This process continues until the expert system can reach a conclusion using the data supplied by the user and the rules that apply in the knowledge base.

The Explanation Facility

explanation facility Component of an expert system that allows a user or decision maker to understand how the expert system arrived at certain conclusions or results.

An important part of an expert system is the **explanation facility**, which allows a user or decision maker to understand how the expert system arrived at certain conclusions or results. A medical expert system, for example, might reach the conclusion that a patient has a defective heart valve given certain symptoms and the results of tests on the patient. The explanation facility allows a doctor to find out the logic or rationale of the diagnosis made by the expert system. The expert system, using the explanation facility, can indicate all the facts and rules that were used in reaching the conclusion. This facility allows doctors to determine whether the expert system is processing the data and information correctly and logically.

The Knowledge Acquisition Facility

A difficult task in developing an expert system is the process of creating and updating the knowledge base. In the past, when more traditional programming languages were used, developing a knowledge base was tedious and time consuming. Each fact, relationship and rule had to be programmed into the knowledge base. In most cases, an experienced programmer had to create and update the knowledge base.

knowledge acquisition facility Part of the expert system that provides convenient and efficient means of capturing and storing all the components of the knowledge base.

Today, specialized software allows users and decision makers to create and modify their own knowledge bases through the **knowledge acquisition facility**. The purpose of the knowledge acquisition facility is to provide a convenient and efficient means for capturing and storing all components of the knowledge base. Knowledge acquisition software can present users and decision makers with easy-to-use menus. After entering the appropriate attributes, the knowledge acquisition facility correctly stores information and relationships in the knowledge base, making the knowledge base easier and less expensive to set up and maintain. Knowledge acquisition can be a manual process or a mixture of manual and automated procedures. Regardless of how the knowledge is acquired, the knowledge base must be validated and updated frequently to make sure that it is still accurate.

The User Interface

Specialized user interface software is employed for designing, creating, updating and using expert systems. The main purpose of the user interface is to make an expert system easier for users and decision makers to develop and use. At one time, skilled computer personnel created and operated most expert systems; today, the user interface permits decision makers to develop and use their own expert systems. Because expert systems place more emphasis on directing user activities than do other types of systems, text-oriented user interfaces (using menus, forms and scripts) might be more common in expert systems than the graphical interfaces often used with DSS. A typical user interface between a user and the expert system for a credit application is as follows:

Expert System: Are there any previous credit problems?
User: No.
Expert System: Is the applicant's net income greater than four times the monthly loan payment?
User: Yes.
Expert System: Is the deposit greater than 15 per cent of the property value?
User: Yes.
Expert System: Are the net assets of the borrower greater than €25,000?
User: Yes.
Expert System: Has the borrower worked more than three years at the same company?
User: Yes.
Expert System: Accept the loan application.

Expert Systems Development

Like other computer systems, expert systems require a systematic development approach for best results. This approach includes determining the requirements for the expert system, identifying one or more experts in the area or discipline under investigation, constructing the components of the expert system, implementing the results, and maintaining and reviewing the complete system.

Participants in Developing and Using Expert Systems

Because of the time and effort involved in the task, an expert system is developed to address only a specific area of knowledge. This area of knowledge is called the **domain**. The **domain expert** is the person or group with the expertise or knowledge the expert system is trying to capture. The domain expert (individual or group) can usually do the following:

domain The area of knowledge addressed by the expert system.

domain expert The individual or group who has the expertise or knowledge one is trying to capture in the expert system.

- Recognize the real problem.
- Develop a general framework for problem solving.
- Formulate theories about the situation.
- Develop and use general rules to solve a problem.
- Know when to break the rules or general principles.
- Solve problems quickly and efficiently.
- Learn from experience.
- Know what is and is not important in solving a problem.
- Explain the situation and solutions of problems to others.

A **knowledge engineer** is a person who has training or experience in the design, development, implementation and maintenance of an expert system, including training or experience with expert system shells. The **knowledge user** is the person or group who uses and benefits from the expert system. Knowledge users do not need any previous training in computers or expert systems.

knowledge engineer A person who has training or experience in the design, development, implementation and maintenance of an expert system.

knowledge user The person or group that uses and benefits from the expert system.

Expert Systems Development Tools and Techniques

Theoretically, expert systems can be developed from any programming language. Since the introduction of computer systems, programming languages have become easier to use, more powerful and increasingly able to handle specialized requirements. In the early days of expert systems development, traditional high-level languages, including Pascal, FORTRAN and COBOL, were used (see Figure 9.5). LISP was one of the first special languages developed and used for expert system applications. PROLOG was also developed to build expert systems. Since the 1990s, however, other expert system products (such as shells) have become available that remove the burden of programming, allowing non-programmers to develop and benefit from the use of expert systems.

An expert system shell is a collection of software packages and tools used to design, develop, implement and maintain expert systems. Expert system shells are available for both personal computers and mainframe systems. Some shells are inexpensive, costing less than €400. In addition, off-the-shelf expert system shells are complete and ready to run. The user enters the appropriate data or parameters, and the expert system provides output to the problem or situation.

Some expert system products can analyze LAN networks, monitor air quality in commercial buildings, and evaluate oil and drilling operations. Table 9.2 lists a few expert system products.

Figure 9.5 **Expert Systems Development**

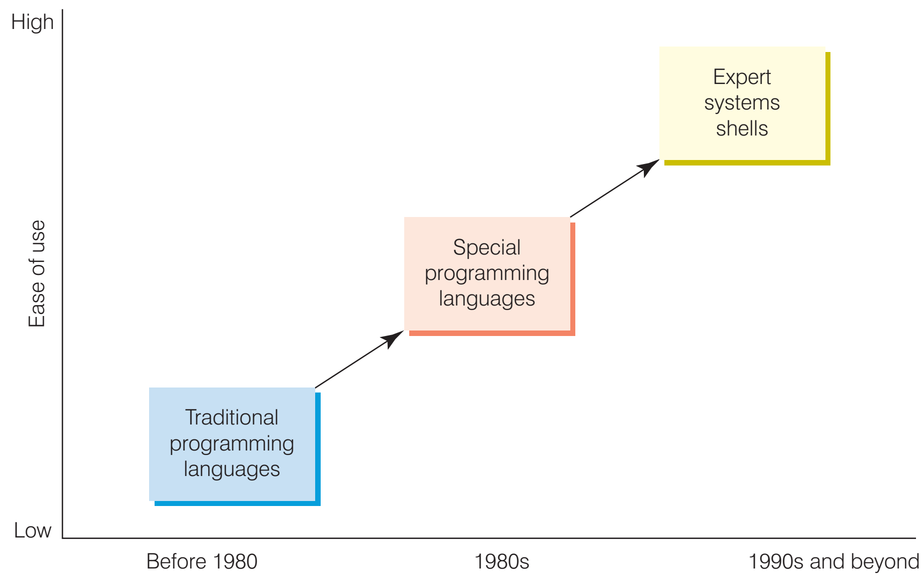


Table 9.2 Popular Expert System Products

Name of Product	Application and Capabilities
Financial Adviser	Analyzes financial investments in new equipment, facilities and the like; requests the appropriate data and performs a complete financial analysis
G2	Assists in oil and gas operations. Transco, a British company, uses it to help in the transport of gas to more than 20 million commercial and domestic customers
HazMat Loader	Analyzes hazardous materials in truck shipments
LSI Indicator	Helps determine property values; developed by one of the largest residential title and closing companies
MindWizard	Enables development of compact expert systems ranging from simple models that incorporate business decision rules to highly sophisticated models; PC-based and inexpensive
RAMPART	Analyzes risk. The US General Services Administration uses it to analyze risk to the approximately 8,000 federal buildings it manages

Applications of Expert Systems and Artificial Intelligence

Expert systems and artificial intelligence have wide applications in business and government. A list of applications, some of which have already been mentioned, is given next:

- *Credit granting and loan analysis.* Many banks employ expert systems to review a customer's credit application and credit history data from credit bureaus to make a decision on whether to grant a loan or approve a transaction.
- *Stock picking.* Some expert systems help investment professionals pick stocks and other investments.
- *Catching cheats and terrorists.* Some gambling casinos use expert system software to catch cheats. The CIA is testing the software to see whether it can detect possible terrorists when they make hotel or airline reservations.
- *Budgeting.* Car companies can use expert systems to help budget, plan and coordinate prototype testing programs to save hundreds of millions of euros.
- *Games.* Some expert systems are used for entertainment. For example, 20Q (www.20Q.net).
- *Information management and retrieval.* The explosive growth of information available to decision makers has created a demand for devices to help manage the information. Bots can aid this process. Businesses might use a bot to retrieve information from large distributed databases or a vast network like the Internet.
- *AI and expert systems embedded in products.* The antilock braking system on today's cars is an example of a rudimentary expert system. A processor senses when the tyres are beginning to skid and releases the brakes for a fraction of a second to prevent the skid. AI researchers are also finding ways to use neural networks and robotics in everyday devices, such as toasters, alarm clocks and televisions.
- *Plant layout and manufacturing.* FLEXPERT is an expert system that uses fuzzy logic to perform plant layout. The software helps companies determine the best placement for equipment and manufacturing facilities. Expert systems can also spot defective welds during the manufacturing process. The expert system analyzes radiographic images and suggests which welds could be flawed.
- *Hospitals and medical facilities.* Some hospitals use expert systems to determine a patient's likelihood of contracting cancer or other diseases. Hospitals, pharmacies and other healthcare providers can use CaseAlert by MEDecision to determine possible high-risk or high-cost patients. MYCIN is an early expert system developed at Stanford University to analyze blood infections. UpToDate is another expert system used to diagnose patients. To help doctors in the diagnosis of thoracic pain, MatheMEDics has developed THORASK, a straightforward, easy-to-use program, requiring only the input of carefully obtained clinical information. The program helps the less experienced to distinguish the three principal categories of chest pain from each other. It does what a true medical expert system should do without the need for complicated user input. The user answers basic questions about the patient's history and directed physical findings, and the program immediately displays a list of diagnoses. The diagnoses are presented in decreasing order of likelihood, together with their estimated probabilities. The program also provides concise descriptions of relevant clinical conditions and their presentations, as well as brief suggestions for diagnostic approaches.
- *Help desk and assistance.* Customer service help desks use expert systems to provide timely and accurate assistance. The automated help desk frees up staff to handle more complex needs while still providing more timely assistance for routine calls.
- *Employee performance evaluation.* An expert system developed by Austin-Hayne, called Employee Appraiser, provides managers with expert advice for use in employee performance reviews and career development.

- *Virus detection.* IBM is using neural network technology to help create more advanced software for eradicating computer viruses, a major problem in businesses. IBM's neural network software deals with 'boot sector' viruses, the most prevalent type, using a form of artificial intelligence that generalizes by looking at examples. It requires a vast number of training samples, which in the case of antivirus software are fragments of virus code.
- *Repair and maintenance.* ACE is an expert system used by AT&T to analyze the maintenance of telephone networks. IET-Intelligent Electronics uses an expert system to diagnose maintenance problems related to aerospace equipment. General Electric Aircraft Engine Group uses an expert system to enhance maintenance performance levels at all sites and improve diagnostic accuracy.
- *Shipping.* CARGEX cargo expert system is used by Lufthansa, a German airline, to help determine the best shipping routes.
- *Marketing.* CoverStory is an expert system that extracts marketing information from a database and automatically writes marketing reports.
- *Warehouse optimization.* United Distillers uses an expert system to determine the best combinations of liquor stocks to produce its blends of Scotch whisky. This information is then supplemented with information about the location of the casks for each blend. The system optimizes the selection of required casks, keeping to a minimum the number of 'doors' (warehouse sections) from which the casks must be taken and the number of casks that need to be moved to clear the way. Other constraints must be satisfied, such as the current working capacity of each warehouse, and the maintenance and restocking work that may be in progress.
- *Diagnosis*. Expert systems in the medical profession and in diagnosis in relation to the COVID-19 pandemic.

9.4 Virtual Reality

The term 'virtual reality' was initially coined by Jaron Lanier, founder of VPL Research, in 1989. Originally, the term referred to immersive virtual reality in which the user becomes fully immersed in an artificial, 3D world that is completely generated by a computer. Immersive virtual reality can represent any 3D setting, real or abstract, such as a building, an archaeological excavation site, human anatomy, a sculpture or a crime scene reconstruction. Through immersion, the user can gain a deeper understanding of the virtual world's behaviour and functionality.

A virtual reality system enables one or more users to move and react in a computer-simulated environment. Virtual reality simulations require special interface devices that transmit the sights, sounds and sensations of the simulated world to the user. These devices can also record and send the speech and movements of the participants to the simulation program, enabling users to sense and manipulate virtual objects much as they would real objects. This natural style of interaction gives the participants the feeling that they are immersed in the simulated world. For example, a car manufacturer can use virtual reality to help it simulate and design factories.

A related term is 'augmented reality', which refers to the combination of computer generated data (images, sounds, etc.) with stimuli from the real world. For example, an augmented reality system might project instructions onto the user's eye, on top of the real-world images they are seeing, so they could look at both at the same time.

Interface Devices

To see in a virtual world, often the user wears a head-mounted display (HMD) with screens directed at each eye. The HMD also contains a position tracker to monitor the location of the user's head and the direction in which the user is looking. Using this information, a computer generates images of the virtual world – a slightly different view for each eye – to match the direction that the user is looking and displays these images on the HMD. Many companies sell or rent virtual-reality interface devices, including Virtual Realities (www.vrealities.com), Amusitronix (www.amusitronix.com), Mindflux (www.mindflux.com.au) and others. With current technology, virtual-world scenes must be kept relatively simple so that the computer can update the visual imagery quickly enough (at least ten times per second) to prevent the user's view from appearing jerky and from lagging behind the user's movements.

The Electronic Visualization Laboratory at the University of Illinois at Chicago introduced a room constructed of large screens on three walls and the floor on which the graphics are projected. The CAVE®, as this room is called, provides the illusion of immersion by projecting stereo images on the walls and floor of a room-sized cube. Several persons wearing lightweight stereo glasses can enter and walk freely inside the CAVE®. A head-tracking system continuously adjusts the stereo projection to the current position of the leading viewer.

Users hear sounds in the virtual world through speakers mounted above or behind the screens. Spatial audio is possible, allowing for position tracking. When a sound source in virtual space is not directly in front of or behind the user, the computer transmits sounds to arrive at one ear a little earlier or later than at the other and to be a little louder or softer and slightly different in pitch.

The haptic interface, which relays the sense of touch and other physical sensations in the virtual world, is the least developed and perhaps the most challenging to create. Currently, with the use of a glove and position tracker, the computer locates the user's hand and measures finger movements. The user can reach into the virtual world and handle objects; however, it is difficult to realize sensations of a person tapping a hard surface, picking up an object or running a finger across a textured surface. Touch sensations also have to be synchronized with the sights and sounds of the user's experience.

Forms of Virtual Reality

Aside from immersive virtual reality, 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.

Some virtual reality applications allow views of real environments with superimposed virtual objects. Motion trackers monitor the movements of dancers or athletes for subsequent studies in immersive virtual reality. Telepresence systems (such as telemedicine and telerobotics) immerse a viewer in a real world that is captured by video cameras at a distant location and allow for the remote manipulation of real objects via robot arms and manipulators. Many believe that virtual reality will reshape the interface between people and information technology by offering new ways to communicate information, visualize processes and express ideas creatively.

Virtual Reality Applications

There are many applications for virtual reality in gaming, medicine and education. Probably the most likely place school children will have used VR is in computer games but companies like Class VR develop educational content aimed at younger school children. The material is intended to encourage students to be more focused in class, although research into this claim is warranted.[29]

Summary

Knowledge management systems allow organizations to share knowledge and experience among their managers and employees. Knowledge is an 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. A knowledge management system (KMS) is an organized collection of people, procedures, software, databases and devices used to create, store, share and use the organization's knowledge and experience. Explicit knowledge is objective and can be measured and documented in reports, papers and rules. Tacit knowledge is hard to measure and document and is typically not objective or formalized.

Knowledge workers are people who create, use and disseminate knowledge. They are usually professionals in science, engineering, business and other areas. The chief knowledge officer (CKO) is a top-level executive who helps the organization use a KMS to create, store and use knowledge to achieve organizational goals. Obtaining, storing, sharing and using knowledge is the key to any KMS. The use of a KMS often leads to additional knowledge creation, storage, sharing and usage. Many tools and techniques can be used to create, store and use knowledge. These tools and techniques are available from IBM, Microsoft and other organizations.

9 **Artificial intelligence systems form a broad and diverse set of systems that can replicate human decision making for certain types of well-defined problems.** The term artificial intelligence is used to describe computers with the ability to mimic or duplicate the functions of the human brain. The objective of building AI systems is not to replace human decision making completely but to replicate it for certain types of well-defined problems.

Intelligent behaviour encompasses several characteristics, including the abilities to learn from experience and apply this knowledge to new experiences; handle complex situations and solve problems for which pieces of information might be missing; determine relevant information in a given situation; think in a logical and rational manner and give a quick and correct response; and understand visual images and process symbols. Computers are better than people at transferring information, making a series of calculations rapidly and accurately, and making complex calculations, but human beings are better than computers at all other attributes of intelligence.

Artificial intelligence is a broad field that includes several key components, such as expert systems, robotics, vision systems, natural language processing, learning systems and neural networks. An expert system consists of the hardware and software used to produce systems that behave as a human expert would in a specialized field or area (e.g. credit analysis). Robotics uses mechanical or computer devices to perform tasks that require a high degree of precision or are tedious or hazardous for humans (e.g. stacking cartons on a pallet). Vision systems include hardware and software that permit computers to capture, store and manipulate images and pictures (e.g. face-recognition software). Natural language processing allows the computer to understand and react to statements and commands made in a 'natural' language, such as English. Learning systems use a combination of software and hardware to allow a computer to change how it functions or reacts to situations based on feedback it receives (e.g. a computerized chess game). A neural network is a computer system that can simulate the functioning of a human brain (e.g. disease diagnostics system). A genetic algorithm is an approach to solving large, complex problems in which a number of related operations or models change until the best one emerges.

Expert systems can enable a novice to perform at the level of an expert, but must be developed and maintained very carefully. An expert system consists of a collection of integrated and related components, including a knowledge base, an inference engine, an explanation facility, a knowledge acquisition facility and a user interface. The knowledge base is an extension of a database, discussed in Chapter 5, and an information and decision support system, discussed in Chapter 8. It contains all the relevant data, rules and relationships used in the expert system. The rules are often composed of IF-THEN statements, which are used for drawing conclusions. Fuzzy logic allows expert systems to incorporate facts and relationships into expert system knowledge bases that might be imprecise or unknown.

The inference engine processes the rules, data and relationships stored in the knowledge base to provide answers, predictions and suggestions the way a human expert would. Two common methods for processing include backward and forward chaining. Backward chaining starts with a conclusion, then searches for facts to support it; forward chaining starts with a fact, then searches for a conclusion to support it.

The explanation facility of an expert system allows the user to understand what rules were used in arriving at a decision. The knowledge acquisition facility helps the user add or update knowledge in the knowledge base. The user interface makes it easier to develop and use the expert system.

The people involved in the development of an expert system include the domain expert, the knowledge engineer and the knowledge users. The domain expert is the person or group who has the expertise or knowledge being captured for the system. The knowledge engineer is the developer whose job is to extract the expertise from the domain expert. The knowledge user is the person who benefits from the use of the developed system.

The steps involved in the development of an expert system include: determining requirements, identifying experts, constructing expert system components, implementing results, and maintaining and reviewing the system.

Expert systems can be implemented in several ways. A fast way to acquire an expert system is to purchase an expert system shell or existing package. The shell program is a collection of software packages and tools used to design, develop, implement and maintain expert systems.

The benefits of using an expert system go beyond the typical reasons for using a computerized processing solution. Expert systems display 'intelligent' behaviour, manipulate symbolic information and draw conclusions, provide portable knowledge and can deal with uncertainty. Expert systems can be used to solve problems in many fields or disciplines and can assist in all stages of the problem-solving process.

Virtual reality systems can reshape the interface between people and information technology by offering new ways to communicate information, visualize processes and express ideas creatively. A virtual reality system enables one or more users to move and react in a computer-simulated environment. Virtual reality simulations require special interface devices that transmit the sights, sounds and sensations of the simulated world to the user. These devices can also record and send the speech and movements of the participants to the simulation program. Thus, users can sense and manipulate virtual objects much as they would real objects. This natural style of interaction gives the participants the feeling that they are immersed in the simulated world.

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. Some virtual reality applications allow views of real environments with superimposed virtual objects. Virtual reality applications are found in medicine, education and training, and entertainment.

Self-Assessment Test

1. AI systems demonstrate characteristics of ________.
2. Two branches of AI are ______ and ________.
3. Research into robots that are the size of a grain of salt is called _________.
4. Systems like a Google search on a smartphone that allow users to give voice input are examples of _____________________.
5. The component of an expert system that stores relevant data and rules is the _________.
6. An application for an expert system is ____________.
7. HMD stands for ____________.
8. A program that solves a problem by evolving new solutions repeatedly is a __________.
9. A program that attempts to simulate a human brain is a _________.
10. A system that attempts to approximate the way a person feels is ________.

Review Questions

1. Compare and contrast human and machine intelligence.
2. Explain the main elements of an expert system.
3. Give a definition of intelligent behaviour.
4. What is the difference between a domain expert and a knowledge engineer?

5 What is augmented reality?

6 List some applications for robots.

7 Explain the term 'natural language processing'.

8 What is a CKO?

9 What could an organization do with virtual reality?

10 What does an expert system interface l ook like?

Discussion Questions

1 List some areas where artificial intelligence is outperforming human intelligence.

2 List some applications for expert systems in your university or college.

Web Exercises

1 Search for some of the more serious Lego Mindstorms models that have been created.

2 Search for a game of 20 Questions where you play against a computer. Can you beat the machine?

Case One

A 'Soft' Octopus Robot

When you think of robots, the images that come to mind are probably heavy bomb disposal units, expensive NASA equipment on Mars or even the Lego Mindstorms kit that was mentioned in this chapter. Octobot (Figure 9.6) is nothing like these. Its designers have eschewed conventional electronics and power sources to create a pliable robot that operates without rigid parts. Less than 10 cm long and 2 cm tall, Octobot is made of silicone rubber and is intended to squeeze into tight spaces, mould to its surroundings and handle delicate objects safely. Robot researcher Michael Wehner said that Octobot could 'either handle something that's very delicate, or move the body around to get into tight spaces in search and rescue, or maybe internal medicine. Something that's soft like an earthworm could crawl through the body better than something that's rigid, like a crab'. One key feat that has been achieved by the team, based at Harvard University, is to create soft versions of the processors and batteries, which are usually hard. 'This work is new and really exciting', says roboticist Daniela Rus.

To achieve this, Octobot is powered by liquid fuel, made mostly from hydrogen peroxide. When this is exposed to platinum infused into two segments of the robot's internal network, it converts into water and oxygen. This oxygen inflates segments of Octobot and extends one of its arms before exiting through exhaust vents. This is repeated to create movement in a similar way to how a snake moves (note that Octobot doesn't attempt to mimic the motions of a real octopus). The robot can run for 8 minutes on 1 millilitre of fuel. As for the processor, the robot is controlled with microfluidic logic that autonomously regulates the chemical reactions and fluid flow. Microfluidic logic uses fluid to create versions of logic gates from the surface tension of the liquid and its resistance to pressure. Flow equates to the movement of electrons around a conventional computer, and bits are stored by using the presence of a droplet at a location to represent a value of 1 and the absence of a droplet to represent 0.

The channels in the fluid logic gates and the body of the robot were created using 3D printing. Professor Jennifer A. Lewis, the co-leader of the research said, 'Through our hybrid assembly approach, we were able to 3D print each of the functional components required within the soft robot body, including the fuel storage, power, and actuation, in a rapid manner. The octobot is a simple embodiment designed to demonstrate our integrated design and additive fabrication strategy for embedding autonomous functionality'.

Octobot was intended to showcase the technology – it was not designed with a specific task in mind. Materials engineer Robert Shepherd says, 'What needs to happen next is work out how to reprogram it to perform different actions'.

Figure 9.6 Octobot

Questions

1. Octobot is at least partly inspired by octopi. What other aspects of nature could inspire robot design and what would each of your ideas bring to robotics?
2. Why do you think the team used 3D printing technology?
3. What are the advantages and disadvantages of microfluidic logic?
4. What applications can you think of for Octobot?

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Case Two

360° Video Makes Virtual Reality Accessible

There is a lot of jargon in the IT industry and most of it is not 'owned' by anyone. So when someone starts to redefine a term, who can say if they are right or wrong? In addition, many technologies naturally evolve into something that sometimes doesn't look much like the original idea. So it is with virtual reality. The original definition was a technology that fully immerses a user in an artificial, 3D world that is completely generated by computer. This immersion is typically created by wearing a headset that sends images to the user's eyes and adjusts these depending on the angle of the user's head. But what if the user was viewing the 3D computer generated world on an ordinary 2D monitor – would that count as VR? Or if instead of a computer generated world, what if the scene was a video recording from the real world? The term VR has been co-opted by some to encompass both of these, and as was said in the first line – who is to say if they are right or wrong? Either way, use of the technologies that are making all of this happen are bringing mass use of full VR closer and closer.

The 360° videos are taken by special cameras that record a 360° degree view of a scene. So if one was placed on a tripod in the middle of a room it would record the entire room. The 360° videos can be viewed on a normal computer monitor. The interface has a direction button which the user can click to move the direction of view. Many people have experienced 360° photographs on Google StreetView, which were taken with expensive technology. However, now cameras that can do this cost from as little as €300 and are being used to capture parties, weddings and travel adventures. (These cameras record a horizontal wraparound view. To take vertical up and down views still requires more expensive gear.)

Whether this all takes off is still an unanswered question, but the option to upload 360° videos to YouTube has helped. Once the video has been made, it can be published on YouTube with only a little additional work than a normal video. (YouTube explains that a 360° video needs to include additional metadata to be enabled, but this is easy to do.) Adoption by big content providers such as the *New York Times* will also help. They have created NYT VR, a mobile app that can be used to simulate richly immersive scenes from across the globe. Their first series presents three portraits of children driven from their homes by war and persecution. 'This new filmmaking technology enables an uncanny feeling of connection with people whose lives are far from our own', said editor Jake Silverstein. NYT VR can be viewed on a normal computer monitor, tablet or a smartphone, or users can opt to fold together Google Cardboard to get a 3D view.

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Created by Google engineers, David Coz and Damien Henry, using time given to Google employees for their own personal innovative projects, Google Cardboard is a holder for a smartphone that when viewed through one end shows half of the screen to one eye and half to the other. This means that software on the device can be used to split the screen in two and create a 3D image for the viewer. Made, as the name suggests, from cardboard, the product comes flat packed and users must fold the thing together. Google advertises the product as a fun and affordable way to experience virtual reality. In the meantime, and further up the cost scale, Sony is pushing VR technology for its Playstation console. For over €300, players can purchase a headset that runs on a standard PlayStation 4, although a PlayStation Camera is also required, with no complex setup. Early reviews suggest the system is physically comfortable, robust and secure even after several hours' play.

Questions

1. What do you think is holding back full VR?
2. Could Google Cardboard help bring VR to the general public?
3. What applications can you think of for 360° video?
4. Why does Google allow employees to spend time on personal projects?

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Case Three

Game-Show-Winning AI Now Diagnoses Rare Diseases

On 14 February 2011, a contestant unlike any other took to the stage of the popular US gameshow *Jeopardy!* In an amazing show of computational strength, IBM's artificial intelligence Watson challenged and beat the game's existing champions. The computer was not connected to the Internet and had to process the host's questions just as the other contestants did. It was not a push over, but Watson eventually won. IBM immediately started asking, what next?

The researchers behind Watson have been quick to say that Watson does not actually think. 'The goal is not to model the human brain', said David Ferrucci from IBM Research. 'The goal is to build a computer that can be more effective in understanding and interacting in natural language, but not necessarily the same way humans do it'. To win *Jeopardy!* Watson had to assemble different pieces of unstructured information from a variety of sources to produce its answer – the exact answer to any question is unlikely to be on any web page. IBM explains that for each possible answer Watson considers, it finds evidence that may support or refute that answer. So for each of hundreds of possible answers, it finds hundreds of bits of evidence and then with hundreds of algorithms scores the degree to which the evidence supports the answer. The answer with the best evidence assessment will earn the most confidence. The highest-ranking answer becomes the answer Watson gives.

These skills are useful in many applications. Watson is now at work with doctors in Germany at the Undiagnosed and Rare Diseases Centre at the University Hospital in Marburg, attempting to diagnose complex medical cases. The hospital has more than 6,000 patients on its waiting list. 'That number is almost a nightmare', says the head of the medical team, Professor Dr Jurgen Schafer. 'We need new ideas and new technology.' It is not unusual for the patients who come to the hospital to have been seen by up to 40 other doctors who have failed to diagnose them. 'It is not uncommon for our patients to have thousands of medical documents, leaving us overwhelmed not only by the large number of patients, but also by the huge amount of data we have to review', Professor Schafer said. 'Our work is often like looking for the proverbial needle in the haystack – even the smallest piece of information could lead to an accurate diagnosis.' The Watson computer 'reads' the patients' medical files alongside vast amounts of medical literature to offer a series of ranked diagnoses.

Pricing information for using Watson has not been disclosed, but hospitals and healthcare networks who want will be able to buy or rent Watson's advice either using IBM's cloud service or by running it on their own servers. Since the *Jeopardy!* win, IBM's researchers have shrunk Watson to a pizza-box-sized server that can fit in any data centre. And they have improved its processing speed by 240 per cent. What was once a fun project has morphed into an essential healthcare tool and it won't stop there. Most information is unstructured and Watson will find employment analyzing it in a wide variety of sectors.

Questions

1. Why would IBM bother to try to win a TV gameshow?
2. What fears might people have about Watson and are any of them justified in your opinion?
3. Why is Watson suitable for diagnosing rare diseases?
4. What other applications can you think of for Watson?

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10

Pervasive Computing

Principles

The term 'computing' no longer refers to a computer on a desk. Mobile devices are letting employees access information from wherever they happen to be. In addition, these same technologies are allowing customers to interact with businesses in new ways.

Teams made up of people living in different geographical regions are able to work together efficiently and effectively, without ever having to meet. This work is facilitated by a range of technologies.

E-commerce and m-commerce can be used in many innovative ways to improve the operation of an organization.

Learning Objectives

- Identify the range of devices that now incorporate computing power.
- Describe the business benefits of mobile devices.
- Discuss and evaluate the technologies that can be used to support teamwork when team members are separated by time and/or space.
- Describe how to select mobile systems to support business objectives.

Why Learn About Pervasive Computing?

The move of information systems from the office desktop into every aspect of our lives is well underway. Many businesses are exploiting this to their advantage, as are their customers. A mobile sales force can stay in touch with head office easily and submit orders faster than before. Employees can take work with them on the plane or train and remain in full contact using text, audio and video. Potential customers are starting to expect to be able to communicate with companies in a number of ways, and if a business fails to recognize this fact, it could lose customers to competitors who offer these communication channels. In addition, customers who have experienced poor service from a company are willing and able to communicate those experiences to other potential customers.

This chapter examines some of the technologies that are enabling all of this to happen. New ones are being introduced almost every month. It is important that businesses understand the potential benefits they can bring.

10.1 Introduction

Information systems are no longer tied to a desk in an office. As we saw in the chapter on hardware, mobile devices are allowing computing power to be taken on the move. Increasingly, computers look more like the picture shown in Figure 10.1. This change is moving in two directions. New devices are being developed that people are happy to carry with them – tiny devices such as the iPod or a smartphone. Such devices do not have the functionality of a PC, but they are more convenient and can be taken anywhere. The other direction is that rather than a new device, computing power is being incorporated into existing devices and objects that are already well known to us, such as a jacket, a pair of glasses or a car. This move away from the desktop is known as **pervasive computing**, or ubiquitous computing: ubiquitous because computers are all around us, even if we don't always realize it. Perhaps from where you are

pervasive computing A term meaning the move of the computer away from the desktop and towards something that is all around us, all the time.

Figure 10.1 **The Conventional View of a Computer** *The idea that computers must have a monitor, keyboard and mouse is being challenged by pervasive computing.*

sitting you can see a laptop, smartphone and a tablet computer. On any one of these devices you could read or post a blog entry, access the web, and pay for goods and services. People are using these devices to do all sorts of things on the move – buy cinema tickets to avoid queuing for them, check in for a flight, pay for a taxi journey. In this chapter we will look at some of these technologies and examine their business potential. We will also meet a particular class of system use, called **computer supported cooperative work**, which is allowing teams to work together on projects, regardless of where they happen to be. Many of the technologies described in this chapter are waiting for a 'killer application' that will allow them to take off. Maybe you'll be able to think of one!

computer supported cooperative work A term that refers to technologies which allow groups to work together to achieve goals.

10.2 Wireless Internet Access

Central to being able to access information 'on the move' is wireless Internet access. The range of options available for wireless communication was described in Chapter 6, but for many people the options they have currently are wi-fi and 4G with 5G rapidly being rolled out. In the UK, as in other countries, 5G access is currently patchy but even when it is available many users will have to purchase new devices to be able to use it.[1] A wi-fi **hotspot** is an area where wireless access is available. Many bars and cafés provide their customers with wi-fi. T-Mobile has set up wi-fi hotspots in many airports, coffee houses and bookshops.[2] This is useful for employees who are away from the office a lot. BT Fon uses wi-fi routers in its customer's homes to allow others to connect to the Internet. Fon works by having its routers broadcast two wi-fi signals – one private, just for use by the customer who owns the the router, and one public and accessible to registered members of the Fon community.[3] A wireless service is now expected by customers in major hotels. Many city centres have free wi-fi access. In the UK, most cities have free wi-fi, as do other cities throughout Europe, such as Oulu in Finland.[4] In Norwich, over 200 antennae are used to provide a hotspot blanket over the city.[5] As a user walks out of range of one antenna and into the range of another, the system seamlessly hands over access between the two, in the same way that the mobile phone network does. Wi-fi access speeds are slightly slower than broadband, although this is perhaps made up for in convenience. The first entire nation to be given free wireless Internet access was the tiny Polynesian island of Niue with a population of just 2,000.[6] The local authorities in the town of Knysna in South Africa have installed wi-fi to allow access to residents who have historically been cut off from Internet access because the town is so remote. Computers have been installed in the local library to give access to those who can't afford wi-fi-enabled devices.

hotspot An area where wi-fi wireless Internet access is available.

The business benefits of wi-fi are clear – mobile access to information; employees away on business can easily send and receive email, using any one of a number of devices, some of which are discussed next. They can access information on company websites or read about local conditions on news services. They could also access sensitive information on company extranets.

10.3 Mobile Devices

The list of devices that can make use of wi-fi hotspots is growing. It now includes desktop computers (useful if you happen to live within a hotspot), laptops, tablet PCs, mobile phones, mobile game consoles such as the Nintendo DS, pocket PCs, VoIP phones, smartwatches, e-readers and fitness monitors. As we will see, other mobile devices are stand-alone and do not require Internet access to make them useful.

Smartphone

Smartphones and tablet computers are now a viable alternative to laptops. These tiny devices are cheaper and more robust than laptops and can be combined with a range of accessories to increase their functionality.

Possibly the most useful accessory is a keyboard that can be attached to the smartphone so that data can be entered into it, as it could into a laptop or PC. Both fold up and roll up versions are available. These keyboards can be attached by a cable or wirelessly using the bluetooth protocol described in Chapter 6. South Korean company Celluon manufactures a device that projects a laser keyboard onto a surface such as the tray table on a plane, and detects when you press one of the virtual keys.[7] Attaching a keyboard to a smartphone provides an extremely portable word processor. Many workers in the western world would not be satisfied with such a tiny screen; however, such miniature devices are common in the Far East. It is true that you are unlikely to want to type at a smartphone for as long as you would a laptop; however, many people do prefer the light weight of a smartphone and keyboard to that of a laptop. If a smartphone and keyboard are combined with wi-fi access, the smartphone becomes a powerful tool to access all Internet services. Without the keyboard, a smartphone can be cumbersome to use.

Another useful accessory is a cable to enable the smartphone to be attached to a projector. Portable projectors[8] can be used to project Microsoft PowerPoint slides from a smartphone. The system even comes with a remote control so that the speaker can progress from one slide to the next without having to be beside the device – functionality that few PCs provide. This is an extremely convenient way for business people to take a presentation with them. For example, a salesperson could present to clients all over the world and only have to carry a smartphone with accessories and, unless one was available at each location, a data projector.

One drawback to using a smartphone to give presentations is that it is difficult to create or edit PowerPoint slides on them. Therefore they only become an alternative to carrying a laptop if the presentation is not going to change. If it is known that the presentation will not change, and it is known that there is the appropriate hardware at the presentation location, it becomes more convenient to simply carry the presentation files on a flash drive, or even simply upload them to the web, where they can be downloaded for the presentation.

global positioning system (GPS) A navigation system that enables a receiver to determine its precise location.

By connecting a **global positioning system (GPS)** receiver and installing map software such as TomTom,[9] a smartphone can be used as a powerful navigational aid, either in a car or, if the GPS receiver is wireless (again using the Bluetooth protocol), on foot. Fleet operators use GPS for vehicle tracking, safety and performance monitoring. GPS is also used by breakdown agencies such as the RAC and AA – the location of a broken down vehicle is fed into an information system which uses GPS information on the whereabouts of the fleet to make the decision on which patrol to send to the rescue. The AA now allows stranded motorists to track where their mechanic is via their smartphone.[10]

A smartphone can also be used to play audio and video files. Many people use one instead of a dedicated music device such as an MP3 player. Some people download news clips each night from a provider such as the BBC, and watch them on the train on the way to work the next morning. YouTube users can download videos to their device when they have a strong wi-fi signal to watch later if Internet access is unavailable. YouTube Premium users can do this via the YouTube app, but others can use third-party software (although note that doing it this way breaks the YouTube terms of service).[11]

Watching news programmes in this way could replace the traditional activity of reading the morning newspaper, plus it takes up less space on crowded public transport than a newspaper, is cleaner, and arguably easier to digest and more interesting.

Wearable Technology

Miniaturizing smartphone technology further allows it to become part of the clothes we wear, for example a jacket or belt. Coupled with other things we are comfortable wearing, for instance glasses with which to receive visual information or earphones for audio information, computing power can become something we routinely take with us and use everywhere. The term 'wearable technology' usually refers to computers that are worn on the body, although it could also be used to encompass non-computing technology such as mechanical watches and glasses. The term **wearable computing** is used to distinguish between the two.

wearable computing A term that refers to computers and computing technology that are worn on the body.

If a smartphone is attached to a user's belt, it is being 'worn' by that user. However, wearable computing refers to something more than this. The term really means the use of largely invisible computing technology, to seamlessly augment a human's task. So far, there are few everyday applications for wearable computing, and many of the commercial examples available have more novelty value than business value. However, one application which is often mentioned is navigation, where the clothes you wear somehow tell you where to go. For example, a GPS receiver could be built into a special jacket, which could apply pressure on one side of the body to guide the wearer in the opposite direction, just like a gentle hand was pushing them that way. The interface for telling the jacket where you want to go could be a smartphone with a Bluetooth link between it and the jacket. A research group at the Massachusetts Institute of Technology (MIT) developed an early platform which was used to experiment with potential applications. MIThril had a number of ways of interacting with the body.

Suggested uses for MIThril included navigation and accessing the Internet on the move. However, neither of these take the unique nature of wearable computing into account, and using it like this gives little advantage over a smartphone. Google has experimented with wearable computing. Their most famous example is Google Glass, a pair of glasses they thought would replace the smartphone. They haven't fully given up on this product yet, but it is not currently generally available. Apple has launched a smartwatch which has been described as an iPhone on the wrist. The launch follows a similar product from Samsung.

Some other potential applications for wearable computing are recording what the wearer sees and hears and how they move, and transmitting personal information between people, rather like an electronic business card. Indeed another device from MIT, the UberBadge, does exactly that. It can be worn as a name badge and used to transmit personal information. For instance, the system could be used at a business conference to collect information about all the people a delegate has spoken to throughout the day. The same device can collect information useful to conference organizers about where people spent the most time throughout the day. A business could adapt this to be able to locate its employees within its building, so that phone calls could be routed to the nearest phone. Perhaps wearable technology could be used to help judge a fencing or martial arts competition, or for recording dance moves, something that has been difficult in the past. There could also be applications for teaching – gloves that help teach someone how to play the piano. Another technology to come out of MIT, called Kameraflage, allows digital cameras to photograph colours in fabrics that the human eye cannot see. One possible use of this technology is to replace staff cards with invisible markers – a security guard could easily identify people who do not have authority to be in a certain area, by looking at his or her video monitor, which would pick up the marks on their clothes. A wearable application is shown in Figure 10.2.

Figure 10.2
Smartwatch *Modern smartwatches can be used to make and receive calls and can also run mobile apps.*

Ethical and Societal Issues

Pay Up Or Your Data Gets It!

Your files won't open. Everything appears to be corrupted. In the centre of the misery a dangerous-looking red screen appears in front of you with the following message: 'The hard disks of your computer have been encrypted with a military grade encryption algorithm. There is no way to restore your data without a special key. To purchase your key and restore your data please following these three easy steps'. You have become the victim of ransomware.

As the Microsoft Malware Protection Centre explains it, 'ransomware stops you from using your PC. It holds your PC or files for "ransom". Ransomware will demand that you pay money to get access to your PC or files. There is no guarantee that paying the fine or doing what the ransomware tells you will give access to your PC or files again'.

Ransomware is a particularly frustrating virus. To deal with it, victims have to interact directly with the criminals who caused their misery and the police will be powerless to help. In 2016, the Hollywood Presbyterian Medical Center was infected and computer systems were unusable for more than a week until they finally paid about €10,000 to restore access. The hospital was quick to reassure patients that medical records had not been accessed by the criminals, which is probably true – all that the criminals did was to make it so that the data could not be accessed by anyone. 'The quickest and most efficient way to restore our systems and administrative functions was to pay the ransom and obtain the decryption key', said Allen Stefanek, the hospital's chief executive.

Firms can pick up ransomware from a variety of sources, but all involve tricking a user or user's computer into installing malicious software. A common line of attack is an email attachment. The email might announce that the user has won money and that to open an attached file for instructions on how to claim. Another common route to infection is to visit a website that installs it. Again the user might receive an email tempting them to click on a link. Sometimes you can pick it up from an infected USB drive, or it could be downloaded with other software, although often this is pirated software.

(*continued*)

Security firm Kaspersky has acknowledged what it calls a 'bitter fact' – 'unless precautions are taken, victims may not be able to recover their data in any other way than by paying the demanded ransom'.

IT security writer Brian Krebs has published a guide on how to minimize the chances of becoming a victim. The backbone of a good defence is data back-ups. You have to be careful here as you want to back-up the data and not the ransomware along with it. Rather than using automated systems that back-up all files, a more thoughtful approach might be needed. If a computer is infected, back-ups may be the best way to recover the critical data. The back-ups should be secured, perhaps by physically storing them offline (unconnected to a networked computer). Krebs says you should scrutinize links contained in emails and do not open attachments included in unsolicited emails. You should also only download software from trusted sites and keep all operating systems and application software up to date by installing the latest patches from the software vendor. Businesses should not forget the social aspects of computer viruses. Awareness training should be given to employees. Because end users are often targeted, employees should be made aware of the threat of ransomware, how it is delivered and trained on information security principles and techniques. Access should be configured to allow only those with a need for access to actually have access. On the plus side, and quite astonishingly, there have been reports that the helplines offered by the criminals to assist with paying the ransom and getting the data restored, rival the service in the best call centres provided by global companies.

Questions

1 If a firm was infected with ransomware, what would your advice be?

2 If your computer was infected, would you pay up?

3 Why can the police do nothing to help?

4 Outline a policy you could use in an organization to minimize the threat of ransomware.

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Information Systems @ Work

The Blockchain Creates Tamper-Proof Transactions

With a value greater than €10 billion, it is amazing to many people that not one cent has been directly pumped into the virtual currency Bitcoin. So where did the €10 billion come from? The simplest answer is that electricity has been turned into this thing called bitcoin that has value and can be traded for real goods and services. But we'll get to that in a moment.

Bitcoin consists of two elements. Multiple copies of both are stored on computers all over the world. The 'ledger' stores details on transactions, that is data

(*continued*)

on the money (bitcoins) that has been spent (how much and from where to where). We're not going to discuss the ledger here. The second is known as the 'blockchain'. Blockchain technology is having an enormous impact beyond the virtual currency as a means of creating a record of transactions that is tamper-proof: it is impossible to re-write its history.

Bitcoin is described as a cryptocurrency, which is to say it relies on cryptography. All we need to know about cryptography now is that plain text gets turned into meaningless text and that the process is one way. It is impossible (or at least impossible within any sensible timeframe) to go from the meaningless text to the plain text without the correct cryptography keys. People are rewarded with bitcoins (which is to say bitcoins are created and given to them) in exchange for 'processing' the blockchain. This is known as 'mining bitcoins' and requires electricity to run the computers needed to do the processing (hence why we said 'turning electricity into money'). This process of mining creates the blockchain, the secure record of transactions. Here's how.

Each transaction has a unique identifier – a string of text that is different from the string of text used by all other transactions. Who the transaction is from and to, and how much it is for, are stored elsewhere in the ledger – all that happens in the blockchain is the processing of these identifiers. A bunch of transaction identifiers (those belonging to the most recent, unprocessed transactions) are grabbed by the computer of a bitcoin miner. The identifiers are in plain text. Two things are added to this: another item of plain text which we'll call PREVIOUS for now, and a random string of text which is referred to as the NONCE. All of this is run through standard encryption software to produce output. Any computer output can be represented as a number, and so the output is a number. If that number is less than X, then the miner is given their bitcoins worth many thousands of euros, and the transactions are processed. That's it!

There are a few points to note. First, the number X is created by the bitcoin community so that not too many or too few bitcoins are created. They adjust this every two weeks. Second, it's much more likely that the output will be greater than X. When it is, the miner must adjust the NONCE (randomly) and go again. This process is repeated many millions of times before a successful output is produced. This is why some people say that bitcoin is wasteful – those millions of calculations are wasted in the sense that they don't produce anything useful in and of themselves. Last, the PREVIOUS text is the output from the last set of processed transactions. This is the key element. It means that no one can go back to a processed transaction from last week and delete it. If they did then none of the later processed transactions would match up and everyone would immediately know that the chain had been tampered with. Today's processed transactions depend on yesterday's processed transactions, which depend on the day before yesterday's and so on back to 2009 when bitcoin was introduced. This is the blockchain and copies are stored on thousands of different computers.

Why does this have value? Anything has value if someone (or enough people) believe it has value. Let's not say anything more about that here. Certainly the value of bitcoin has fluctuated widely. The technology is perhaps more interesting to us – it could be used to produce a tamper-proof record. Wikileaks for instance have expressed an interest in using it to make their leaks tamper-proof. Notice that the inventor or inventors (no one knows who he, she or they are!) of bitcoin did not invent anything – they used what already existed in new ways.

Questions

1. Would bitcoin be a sensible financial investment? Explain your answer.
2. Is becoming a bitcoin miner a sensible career? Explain your answer.
3. Could we (humanity) make better use of the wasted calculations?
4. What applications for the blockchain in a large organization can you think of?

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E-Money

e-money The transfer of funds electronically rather than by handing over physical coins and notes.

E-money refers to the transfer of funds happening electronically rather than by handing over physical coins and notes. It can be implemented in a number of ways. The most common is paying for goods and services over the Internet; however, it does take other forms. Mobile phones are now also being used to pay for goods and services. Contactless payment using near field communication, as described in Chapter 6, is becoming more common. Barclays Bank now offers customers a PayTag which they can stick on their wallet or phone and can be used to pay for goods costing less than about €20. The same technology is used to pay for public transport. An example is Hong Kong's Octopus card, originally intended to be used to pay for public transport, but now used throughout Hong Kong in a range of shops. When used on the city's train service, a passenger 'swipes' their card when they enter the train station and they 'swipe' it again when they leave. The correct fare is then debited from their prepaid account. 'Swiping' the card merely involves waving it near a reader – direct contact is not required. In fact the card doesn't even have to be removed from the passenger's wallet! Octopus gadgets are now available such as the Octopus watch or Octopus ornaments. Whether using the card or a gadget, a chip in the device stores the amount that has been paid into the account. Similar systems have now been implemented throughout Europe and elsewhere, for example the Oyster Card in London. Systems such as these that implement the concept of e-money make paying for goods fast and convenient. LUUP[12] is a payment system (the developers call it a 'digital wallet') that works using the text feature on mobile phones to transfer funds from buyer to seller (see Figure 10.3). The buyer sends LUUP a text with the format 'PAY USERNAME AMOUNT'. LUUP then transfers the specified amount from the buyer's account to the seller's account. For example a buyer might text 'PAY 10943933 EUR10'. This would cause a transfer of €10 to be transferred to account 10943933. Both buyer and seller then receive a text message when payment has been made. Contactless payment (and its flexibilities) proved vital during the COVID-19 pandemic to minimize direct contact between people.

LUUP and systems like it have the potential to negate the need for exact change when paying for things like taxi journeys. In Norway, where the system was developed, users can pay for food, public transport and shopping bills.

Figure 10.3
Contactless Payment
Payment is made just by holding a smartphone near the reader.

10

A similar system is being used in developing countries to provide financial services to the least well off. While the physical infrastructure in Kenya (road and rail) is in a poor state, in contrast the country has excellent mobile phone coverage, provided by two companies, Celtel and Safricom. Safricom, part owned by Vodafone, provides a service called M-Pesa. M-Pesa lets customers borrow, withdraw and pay money using text messaging. In a culture where many people are unable to open bank accounts and must therefore carry cash, it has the potential to revolutionize lives.[13] The system gives security, and allows easy and safe transfer of cash from relatives in the developed world. According to the World Bank, money sent to low- and middle-income countries reached a record high in 2018.[14]

Another form of e-money is virtual currency such as bitcoin. There is a debate whether virtual currencies are a form of money or more like valuable collectibles – like old Star Wars toys or bottles of wine or similar objects you might collect and trade. Some big websites do accept bitcoins as a form of payment. Basically users are given bitcoins in exchange for using their computer to process the system that records bitcoin transactions. There is no physical unit – a bitcoin is literally just an entry in the transaction log (it's called a 'blockchain'). Whether these actually have any value is decided by the market, and bitcoins have seen huge swings in what they are worth, leading some economists to warn against them.

E-money has two implications for businesses. There is the convenience of employees using it themselves when on business trips. Perhaps more importantly, depending on the type of business, it may be that customers will come to expect to be able to pay for goods and services using e-money in the future. When this happens, the retailer needs to be ready for it.

Tangible Media

A new and interesting way to represent information stored on a computer is through the use of physical objects. Very few applications are currently commercially available; however, imagine that you have a bowl of plastic pebbles in your living room and each represents one of your favourite films. To view the film, you pick up one of the pebbles and wave it at your television screen. A moment later the film starts. This is more an artistic application than something most people would want; however, a 'killer application' is perhaps just around the corner which will make this technology take off. Perhaps you could think of one yourself and capitalize on your idea.

Most people are comfortable with the concept of icons. An icon on your computer screen represents a file. The icon isn't the same thing as the file, it's more like a pointer to it. Double clicking on the icon opens up the file.

phicon Phicon stands for 'physical icon' and is a physical representation of digital data, in the same way that an icon on a computer screen represents a file.

The plastic pebble representing the film is the same idea, only the pebble is a physical icon, or **phicon** (pronounced fi-con). The technology has been available for several years, but a 'killer application' for phicons has not yet been found. Some ideas are a business card which opens a personal home page automatically whenever it is held near a computer. Or a brochure, marketing literature for instance, that also contains additional electronic information within it. In the future your lecture handouts could also contain electronic resources built into them! This research area is known as tangible media.

Some companies are experimenting with sending touch over long distances. Such devices currently only have novelty value, but perhaps someone will soon come up with a useful business application. The Kiss Communicator and the Hug Shirt are two such devices. The Kiss Communicator allows you to blow a kiss to someone wherever they are. The Hug Shirt allows you to send them a hug. To do this requires two hug shirts. You put on one of them and hug yourself. Sensors in the shirt detect what you have done and send the information needed to recreate this feeling via Bluetooth, to your mobile phone. Your phone then transmits the information as a text message to the receiver of the hug. They get a text asking if they want to accept the hug. If they do, the signal gets passed to their hug shirt, again via Bluetooth, which squeezes them in the same way that you hugged your own shirt. These devices both represent new ways of connecting people.

Personal Robotics

Robotics has been mentioned before in this text, mostly in the context of assembly plants, manufacturing and space exploration. In this section, we will look at some of the robots that are used, and could be used, in our everyday lives.

The Roomba is a robotic vacuum cleaner costing around €250. It can be released into a home where it spends its time continuously cleaning. When it needs a battery recharge, it can go to a base station and recharge itself. It cannot yet, however, empty itself, although it can navigate around furniture and other obstacles. A potential business application of this technology is in cleaning offices – an army of Roombas could be let loose overnight. However, at present, the technology is not really good enough for this. Those interested in studying robotics should consider that the Roomba gives a cheap platform to experiment with – the makers of the Roomba, who are products of MIT's Artificial Intelligence Lab, have made it so that you can install your own software on it and modify its behaviour.

Quite a few attempts have been made to develop robots that have personality, to give them a more natural interface to interact with people. Minerva was a talking robot designed to accommodate people in public spaces. She was active in 1998 offering people at the Smithsonian's National Museum of American History tours and leading them from exhibit to exhibit. Minerva had moods – she could be happy and sing or get frustrated and blare her horn.

Minerva was a personal robot. One of the world's leading centres in **personal robotics** is the Robotic Life Group (also known as the Personal Robotics Group) at MIT, led by Cynthia Breazeal. This team builds robots to study our socialization with them. The term personal robotics refers to robots that become part of our everday lives. While currently of little relevance to most businesses, we shall see in the next section that this might change, when we examine, among other things, one of the most loved personal robots, Sony's Aibo.

personal robotics A term which refers to robotic companions that people socialize with.

Virtual Pets

During the late 1990s, Sony released Aibo, a robotic puppy intended as a replacement for a real puppy. Aibo explored its environment, and got tried, hungry, grumpy and sleepy. It sometimes craved attention and could get over excited. Sony sadly no longer manufactures Aibo, but many cheaper versions inspired by it remain on the market. Aibo is an example of a virtual pet.

Virtual pets started to gain worldwide popularity in the late 1990s when Japanese toy manufacturer Bandai released the Tamagotchi. About the size of a key ring, a typical Tamagotchi had a small black and white screen, three buttons, a speaker, a motion sensor and a microphone. Users could feed, clean and play with their Tamagotchi, call it via the microphone and chase away predators by shaking the unit. The pet would evolve over time and would eventually either die or fly away. Many users became emotionally attached to their pet, which was the ultimate goal of the software designers.

virtual pets An artificial companion. Could be screen based, i.e. the pet is animated on a computer monitor, or a robot.

Virtual pets are perhaps unique among information systems in that their goal is to get users to feel a sense of responsibility towards the system and become attached in some way to it. Virtual pets are very popular at the moment. One of the most popular games for the Nintendo DS mobile games console is Nintendogs, which is essentially a more sophisticated version of the Tamagotchi.

So why might businesses be interested in virtual pets? Some business tools (or at least software that could be used by businesses) have a 'virtual-pet-like' personality built into them. 'Clippy' or 'Clipit', the Microsoft help agent, was one of the first. Clippy would cheerfully offer to help users with their tasks. It was almost universally hated, but it is clear that Microsoft and others have not yet given up on software with personality. Other attempts have been made to infuse personality into everyday software. PostPet by Sony was an email application where an on-screen puppy would fetch your mail, just as some real dogs do for their owners, but only if you were nice to it. The Nabaztag Rabbit is a personal companion that sits beside you and reads you the news and tells you when you have a new email. Mrs Dewey was a human interface to the Windows Live Search who would tell jokes to the user while they were running their search. Virtual pet designers are still trying to find new applications for them. Case One in this chapter showcases a recent example, and other developers are experimenting with using them as companions for the elderly.

It is clear that some software developers are interested in giving their products personality. It is also clear that today's teenagers are perfectly comfortable interacting with devices that have personality. It may be that in the future when they become employees, they will expect their business software to come with personality built in.

10.4 Computer Supported Cooperative Work

Computer supported cooperative work (CSCW) refers to technologies that allow groups to work together to achieve goals. Individuals in the groups can be co-located (in the same place) or geographically separated. The work can happen synchronously (individuals at work at the same time) or asynchronously (they work at different times). Different CSCW technologies exist to support these different modes of work. In global companies, CSCW technology is a powerful tool enabling a company to make the best of its human resources no matter where they are located. In this section, we will look at some CSCW tools.

Videoconferencing

videoconference A simultaneous communication between two or more parties where they both see and hear each other.

For a long time in science fiction, the public has seen the future of the telephone call where both audio and video are transmitted. The technology now exists to achieve this easily and cheaply, Skype and Zoom being two examples of this. A **videoconference** is a simultaneous communication between two or more parties where they both see and hear each other. A videoconference can be set up using instant messaging software. For businesses, videoconferences are useful to hold global meetings. Visual cues are available to help everyone understand what other people are really feeling – a yawn, a nod of the head, a smile, etc. None of these can be transmitted down a telephone line. However, running a videoconference does take discipline as it is easy for more than one person to talk at once and even a slight delay in transmission time can cause chaos. When COVID-19 became a pandemic, businesses, universities, schools and individuals immediately switched to meet via videoconferencing, with Google Hangouts, Google Meetings, Microsoft Teams, Whereby and Zoom rapidly becoming very popular. During the 2020 "lockdowns" prompted by the COVID-19 pandemic, technologies such as Zoom (the free videoconferencing platform) suddenly became a phenomenon and household name, with families and businesses all using it to interact with one another. Even pop and rock artists used it to create music videos for their fans.

Messaging

Messaging technology includes email, instant messaging and web chat rooms. Email has been discussed before. It is useful for asynchronous text-based communication. Instant messaging is used for synchronous communication – two (or more) people are communicating at the same time, usually typing short sentences to build up a conversation. Instant messaging is extremely useful and can be used by employees to work on a problem together. Instant messaging versus a telephone call is largely a matter of personal preference. One advantage messaging has is that the text can be easily saved and re-read at a later date. A chat room is a facility that enables two or more people to engage in interactive 'conversations' over the web. When you participate in a chat room, dozens of people might be participating from around the world. Multi-person chats are usually organized around specific topics, and participants often adopt nicknames to maintain anonymity.

Instant messaging technology is now being used by a diverse range of companies including Zurich Insurance and Ikea, as an alternative to making customers telephone a call centre. Customers often prefer clicking on the chat icon on a company website and waiting for the 'operator' to respond, than having to phone and wait in a queue. When phoning a call centre you often have to hold the phone to your ear, so at least one hand is tied up, and listen to (usually awful) music until someone answers. With messaging technology you can continue working at your computer until someone answers. You know when this happens as the task bar on your computer screen will start flashing.

Interactive Whiteboards

Essentially, an **interactive whiteboard** is a combination of a whiteboard and a PC. It can be used in a number of ways. Users can write on the whiteboard and then save what has been written as an image on their computer. This negates the need to take notes about what has been written after a meeting has finished. What is saved on the PC needn't be a static image – it could be an animation of everything that was written, including things that were rubbed out. Alternatively, two whiteboards at different locations could be used by people at these different locations to see what the other is writing. Combined with videoconferencing, this can be a powerful way of running meetings when not everyone is present. An interactive whiteboard is shown in Figure 10.4.

interactive whiteboard This term can be used to mean slightly different technologies, but essentially it is a combination of a whiteboard and a desktop computer.

Figure 10.4 Interactive Whiteboard *What gets written on the board can be saved, printed and sent to other whiteboards.*

Wikis

wiki A web page that can be edited by anyone with the proper authority.

A **wiki** is a web page that can be edited by anyone with the proper authority. The most famous example is Wikipedia, which can be edited by any web user – very few restrictions are put in place. To see the usefulness of wikis, have a look at Wikipedia. Its content is breathtaking, considering that all of it was created by volunteers. There are strict protocols to follow and very militant moderators who police Wikipedia and flag up or revert changes that are suspect or do not meet strict criteria. Having said that, there is no guarantee that erroneous material will not get through. You might try editing an article you know something about; however, consider this: there is no way to know if the information has been edited by an expert or by a joker, so think twice before you rely on anything you read there.

Wikis are clearly a good way of sharing knowledge and are being used by a large number of research groups and businesses to allow employees to share their thoughts and ideas, and post up good practice.

MMOGs

virtual worlds A computer-based environment where users' avatars can interact.

Look for information about MMOGs using a search engine and you may be hit with a confusing array of acronyms including MMORTS, MMOFPS and MMORPGs. MMOG stands for 'massively multiplayer online game'. They have a long history, but today they exist as 3D **virtual worlds**. Users are represented in the world by an avatar, which interacts with other avatars typically by text, but voice is starting to be used. From a business point of view, we are not primarily interested in virtual worlds as games, but as a platform for holding meetings and for their marketing potential. Probably the best virtual world for these activities is Second Life.

Owned by San Francisco-based Linden Lab, Second Life is a huge virtual world where residents meet socially and commercially. It has its own currency, the Linden dollar, which has a floating exchange rate with the US dollar. This means you can make (and spend) real money in Second Life. Several people are making a good living there (mostly by land speculation and by creating and selling animations), and big businesses are starting to get involved. IBM and Dell have already held global meetings in Second Life, and you can test drive Toyota cars there.[15] (Note, however, that IBM and Dell were researching the usefulness of using this platform to hold meetings – they were not actually holding a board meeting there; that has yet to happen.) Some commentators are saying that 3D interfaces such as this will become the main way we access information over the Internet in the future. As an example of the direction Linden Lab may be planning for their technology, Jeff Bezos, the founder of Amazon, is one of the financial backers of Second Life, and Philip Rosedale, CEO of Linden Lab, has pointed out that whenever someone visits Amazon, there are thousands of other shoppers on the site with them. He has expressed the opinion that it would be a good thing if all those shoppers could both see and interact with each other. Business uses of virtual worlds have tailed off recently as the initial hype has worn off, but some commentators are still predicting they will play a part in future business communications.[16]

Blogs, Podcasts and Live Streaming

blog An online diary, a combination of the words 'web' and 'log'.

While not strictly a CSCW technology, blogs still allow for the sharing of information from one to many people. A **blog**, short for 'weblog', is a website that people create and use to write about their observations, experiences and feelings on a wide range of topics. Technically, it is identical to any other web page, although the content of a blog is updated much more frequently, typically every day. The community of blogs and bloggers is often called the 'blogosphere'. A 'blogger' is a person who creates a blog, while 'blogging' refers to the process of placing entries or 'posts' on a blog site. A blog is like a diary. When people post information to a blog, it is placed at the top of the blog. Blogs can contain links to other material, and people can usually comment on posts. Blogs are easy to post to, but they can cause problems when people tell or share too much. People have been fired for blogging about work, and the daughter of a politician embarrassed her father when she made personal confessions on her blog.[17]

Blog sites, such as www.blogger.com, include information and tools to help people create and use weblogs. The way blogs are structured, with the most recent post appearing at the top, can make it extremely difficult to read and understand what it is all about – imagine you visit a blog, which you know (from an Internet search) talks about a product you are having problems with. Let's say the first post you come to starts: 'Today's fresh hell – ABC company rep John replied and said it would work. I tried it and ended up breaking the stupid thing. Just my luck'. The blogger is presumably making reference to something written about yesterday or before. It may take you a while to track down what they did to break the product, something you probably want to know about to avoid doing yourself. Go to blogger.com, select a blog at random (there is a feature to do this) and you will see the problem – it can be difficult to start reading a blog. If you keep a blog, you might want to think about this and how you can keep new and irregular readers interested.

Microblogs are currently extremely popular, with Twitter being the most common example. They have much the same goals as the blogs described above except that posts are limited in size. In the case of Twitter's, the limit is 280 characters. Microblogs have many uses. They are often used by celebrities to keep in close contact with their fans.

A **podcast** is an audio broadcast over the Internet. The term 'podcast' comes from the word iPod, Apple's portable music player, and the word 'broadcast'. A podcast is essentially an audio blog, like a personal radio station on the Internet, and extends blogging by adding audio messages. Using a computer and microphone, you can record audio messages and place them on the Internet. You can then listen to the podcasts on your computer or download the audio material to a music player, such as Apple's iPod. You can also use podcasting to listen to TV programmes, your favourite radio personalities, music and messages from your friends and family at any time and place. Finding good podcasts, however, can be challenging. Apple's new version of iTunes allows you to download free software to search for podcasts by keyword.

podcast An audio broadcast over the Internet.

People and corporations can use podcasts to listen to audio material, increase revenues or advertise products and services.[18] Colleges and universities often use blogs and podcasts to deliver course material to students.

Many blogs and podcasts offer automatic updates to a computer using a technology called Really Simple Syndication (RSS). RSS is a collection of web formats to help provide web content or summaries of web content. With RSS, you can get a blog update without actually visiting the blog website. RSS can also be used to get other updates on the Internet from news websites and podcasts.

Live streaming technology allows users to record and publish videos at the same time, essentially creating a live broadcast. YouTube, Facebook, Amazon and Twitter all have live streaming facilities or apps. YouTube live streams allow viewers to comment in real time on what they are seeing and there is an option for viewers to donate money to the video's creators, again all in real time. The donation appears on the video for everyone – the video makers and the video viewers – to see. It can be fun to watch the creator's reaction when it appears. Live streaming technology has many applications in entertainment and education.

Cloud Tools

Cloud computing software spans much of what has been discussed up to this point in this chapter. Users access this software via a browser on any of their devices making it fully mobile, and the software connects users allowing computer supported cooperative work. The software can do this because of strong web standards – if developers created web browsers to work any way they wished, one person's browser could not interface with another person's web tool (as it is, popular browsers follow the World Wide Web Consortium standards to different amounts).

A good example of cloud software is G Suite, Google's package of productivity tools.[19] For example, Google Slides allows users to store their presentations in one place and access them from anywhere on any Internet connected device that runs a browser. Documents can be shared with other users allowing two or more people to work together on one set of slides. G Suite includes a full package of office applications (as well as slides there is a word processor (Docs) and spreadsheet (Sheets) package), a calendar (Calendar), email client (Gmail), video conferencing (Hangouts) and storage (Drive).

Other software developers have similar products. Microsoft Office 365, and Zoho by Zoho Cooperation are well known competitors to G Suite. Although they may compete, again the existence of standards is good for users. Mobafone is a media and technology company that develops mobile apps. They use Zoho Books as an accounting solution that manages multiple accounts through multiple countries. The software also easily shares data with G Suite, which is important as the company mostly uses Google software.

10.5 More Applications of Electronic and Mobile Commerce

Lastly in this chapter we will examine how e-commerce and m-commerce are being used in innovative and exciting ways. This section examines a few of the many B2B, B2C, C2C and m-commerce applications in the retail and wholesale, manufacturing, marketing, investment and finance, and auction arenas.

Retail and Wholesale

electronic retailing (e-tailing) The direct sale from business to consumer through electronic storefronts, typically designed around an electronic catalogue and shopping cart model.

E-commerce is being used extensively in retailing and wholesaling. **Electronic retailing**, sometimes called e-tailing, is the direct sale of products or services by businesses to consumers through electronic shops, which are typically designed around the familiar electronic catalogue and shopping cart model. Tens of thousands of electronic retail websites sell a wide range. In addition, cyber shopping centres, or 'cybermalls', are another means to support retail shopping. A cybermall is a single website that offers many products and services at one Internet location. An Internet cybermall pulls multiple buyers and sellers into one virtual place, easily reachable through a web browser.

A key sector of wholesale e-commerce is spending on manufacturing, repair and operations (MRO) of goods and services – from simple office supplies to mission-critical equipment, such as the motors, pumps, compressors and instruments that keep manufacturing facilities running smoothly. MRO purchases often approach 40 per cent of a manufacturing company's total revenues, but the purchasing system can be haphazard, without automated controls. In addition to these external purchase costs, companies face significant internal costs resulting from outdated and cumbersome MRO management processes. For example, studies show that a high percentage of manufacturing downtime is often caused by not having the right part at the right time in the right place. The result is lost productivity and capacity. E-commerce software for plant operations provides powerful comparative searching capabilities to enable managers to identify functionally equivalent items, helping them spot opportunities to combine purchases for cost savings. Comparing various suppliers, coupled with consolidating more spending with fewer suppliers, leads to decreased costs. In addition, automated workflows are typically based on industry best practices, which can streamline processes.

Manufacturing

One approach taken by many manufacturers to raise profitability and improve customer service is to move their supply chain operations onto the Internet. Here they can form an

electronic exchange to join with competitors and suppliers alike, using computers and websites to buy and sell goods, trade market information and run back-office operations, such as inventory control, as shown in Figure 10.5. With such an exchange, the business centre is not a physical building but a network-based location where business interactions occur. This approach has greatly speeded up the movement of raw materials and finished products among all members of the business community, thus reducing the amount of inventory that must be maintained. It has also led to a much more competitive marketplace and lower prices. Private exchanges are owned and operated by a single company. The owner uses the exchange to trade exclusively with established business partners. Public exchanges are owned and operated by industry groups. They provide services and a common technology platform to their members and are open, usually for a fee, to any company that wants to use them.

electronic exchange An electronic forum where manufacturers, suppliers and competitors buy and sell goods, trade market information and run back-office operations.

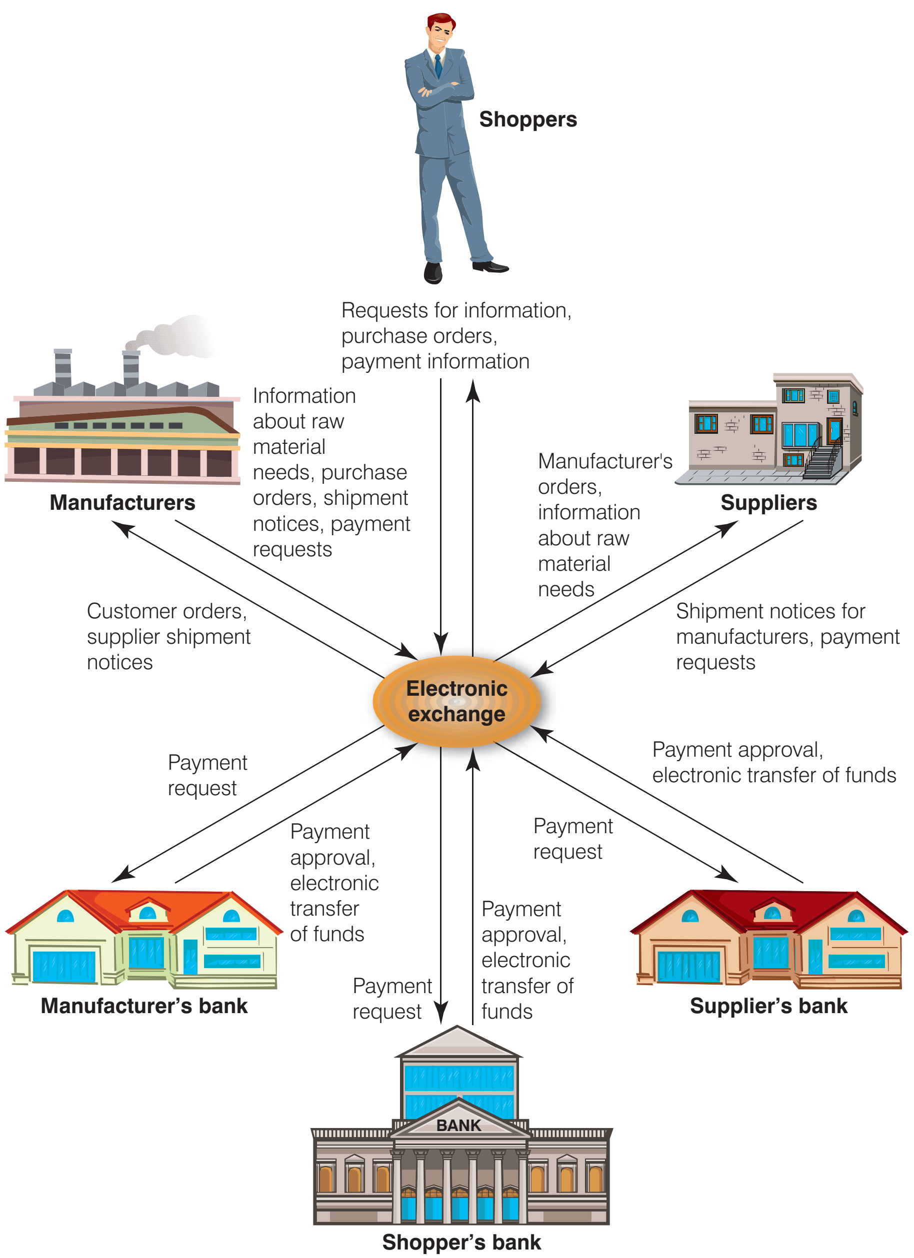

Figure 10.5 Model of an Electronic Exchange

Several strategic and competitive issues are associated with the use of exchanges. Many companies distrust their corporate rivals and fear they might lose trade secrets through participation in such exchanges. Suppliers worry that the online marketplaces and their auctions will drive down the prices of goods and favour buyers. Suppliers also can spend a great deal of money in the setup to participate in multiple exchanges. For example, more than a dozen new exchanges have appeared in the oil industry, and the printing industry has more than 20 online marketplaces. Until a clear winner emerges in particular industries, suppliers are more or less forced to sign on to several or all of them. Yet another issue is potential government scrutiny of exchange participants – when competitors get together to share information, it raises questions of collusion or antitrust behaviour.

Many companies that already use the Internet for their private exchanges have no desire to share their expertise with competitors. At the US shopping giant Walmart, the world's number-one retail chain, executives turned down several invitations to join exchanges in the retail and consumer goods industries. Walmart is pleased with its in-house exchange, Retail Link, which connects the company to 7,000 worldwide suppliers that sell everything from toothpaste to furniture.

Marketing

The nature of the web allows firms to gather much more information about customer behaviour and preferences than they could using other marketing approaches. Marketing organizations can measure many online activities as customers and potential customers gather information and make their purchase decisions. Analysis of this data is complicated because of the web's interactivity and because each visitor voluntarily provides or refuses to provide personal data such as name, address, email address, telephone number and demographic data. Internet advertisers use the data they gather to identify specific portions of their markets and target them with tailored advertising messages. This practice, called **market segmentation**, divides the pool of potential customers into subgroups, which are usually defined in terms of demographic characteristics, such as age, gender, marital status, income level and geographic location.

market segmentation The identification of specific markets to target them with advertising messages.

technology-enabled relationship management Occurs when a firm obtains detailed information about a customer's behaviour, preferences, needs and buying patterns, and uses that information to set prices, negotiate terms, tailor promotions, add product features and otherwise customize its entire relationship with that customer.

Technology-enabled relationship management is a new twist on establishing direct customer relationships made possible when firms promote and sell on the web. Technology-enabled relationship management occurs when a firm obtains detailed information about a customer's behaviour, preferences, needs and buying patterns, and uses that information to set prices, negotiate terms, tailor promotions, add product features and otherwise customize its entire relationship with that customer.

DoubleClick is a leading global Internet advertising company that leverages technology and media expertise to help advertisers use the power of the web to build relationships with customers. The DoubleClick Network is its flagship product, a collection of high-traffic and well-recognized sites on the web, including MSN, Sports Illustrated, Continental Airlines, the Washington Post, CBS and more than 1,500 others. This network of sites is coupled with DoubleClick's proprietary DART targeting technology, which allows advertisers to target their best prospects based on the most precise profiling criteria available. DoubleClick then places a company's ad in front of those best prospects. DART powers over 60 billion ads per month and is trusted by top advertising agencies. Comprehensive online reporting lets advertisers know how their campaign is performing and what type of users are seeing and clicking on their ads. This high-level targeting and real-time reporting provide speed and efficiency not available in any other medium. The system is also designed to track advertising transactions, such as impressions and clicks, to summarize these transactions in the form of reports and to compute DoubleClick Network member compensation.

Investment and Finance

The Internet has revolutionized the world of investment and finance. Perhaps the changes have been so great because this industry had so many built-in inefficiencies and so much opportunity for improvement.

The brokerage business adapted to the Internet faster than any other arm of finance. The allure of online trading that enables investors to do quick, thorough research and then buy shares in any company in a few seconds and at a fraction of the cost of a full-commission firm has brought many investors to the web. In spite of the wealth of information available online, the average consumer buys stocks based on a tip or a recommendation rather than as the result of research and analysis. It is the more sophisticated investor that really takes advantage of the data and tools available on the Internet.[20]

Online banking customers can check balances of their savings, current and loan/mortgage accounts; transfer money between accounts; and pay their bills. These customers enjoy the convenience of not writing cheques by hand, tracking their current balances and reducing expenditure on envelopes and stamps.

A country's major banks and many of its smaller banks enable their customers to pay bills online; many support bill payment via a mobile phone or other wireless device. Banks are eager to gain more customers who pay bills online because such customers tend to stay with the bank longer, have higher cash balances and use more of the bank's products.

The next advance in online bill paying is **electronic bill presentment**, which eliminates all paper, right down to the bill itself. With this process, the vendor posts an image of your statement on the Internet and alerts you by email that your bill has arrived. You then direct your bank to pay it.

electronic bill presentment A method of billing whereby a vendor posts an image of your statement on the Internet and alerts you by email that your bill has arrived.

Auctions

eBay has become synonymous with online auctions for both private sellers and small companies. However, hundreds of online auction sites cater to newcomers to online auctions and to unhappy eBay customers. The most frequent complaints are increases in fees and problems with unscrupulous buyers. As a result, eBay is constantly trying to expand and improve its services. eBay spent €1.8 billion to acquire Skype, a pioneer in voice over IP (VoIP) services with the goal of improving communications between sellers and potential buyers for 'high-involvement' items such as cars, business equipment and high-end collectibles. eBay might also provide a pay-for-call service to provide a lead generation service for sellers based on the Skype technology. eBay purchased the payment gateway system of security company VeriSign to provide a payment solution to tens of thousands of new SME businesses. Under the deal, eBay will also receive 2 million VeriSign security tokens, physical devices like keychain-sized USB plug-ins, that are used to create two-factor security where users must provide both a security password and the physical token.[21]

Anywhere, Anytime Applications of Mobile Commerce

Because m-commerce devices usually have a single user, they are ideal for accessing personal information and receiving targeted messages for a particular consumer. Through m-commerce, companies can reach individual consumers to establish one-to-one marketing relationships and communicate whenever it is convenient – in short, anytime and anywhere. The following are just a few examples of potential m-commerce applications:

- Banking customers can use their wireless handheld devices to access their accounts and pay their bills.
- Clients of brokerage firms can view stock prices and company research as well as conduct trades to fit their schedules.

- Information services such as financial news, sports information and traffic updates can be delivered to people whenever they want.
- On-the-move retail consumers can place and pay for orders instantaneously.
- Telecommunications service users can view service changes, pay bills and customize their services.
- Retailers and service providers can send potential customers advertising, promotions or coupons to entice them to try their services as they move past their place of business.

The most successful m-commerce applications suit local conditions and people's habits and preferences. Most people do their research online and then buy offline at a local retailer. As a result, a growing market for local search engines is designed to answer the question, 'Where do I buy product *x* at a brick-and-mortar retailer near me?' Consumers provide their post code and begin by asking a basic question, 'What local stores carry a particular category of items' (e.g. flat-screen televisions). Consumers typically don't start searching knowing that they want a specific model of Panasonic flat-screen TV. The local search engine then provides a list of local stores, including those with a website and those without, which sell this item.

As with any new technology, m-commerce will only succeed if it provides users with real benefits. Companies involved in m-commerce must think through their strategies carefully and ensure that they provide services that truly meet customers' needs.

Advantages of Electronic and Mobile Commerce

According to the Council of Supply Chain Management Professionals, 'Supply Chain Management encompasses the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third-party service providers, and customers'.[22] Conversion to an e-commerce-driven supply chain provides businesses with an opportunity to achieve operational excellence by enabling consumers and companies to gain a global reach to worldwide markets, reduce the cost of doing business, speed the flow of goods and information, increase the accuracy of order processing and order fulfilment, and improve the level of customer service:

- *Global reach.* E-commerce offers enormous opportunities. It allows manufacturers to buy at a low cost worldwide, and it offers enterprises the chance to sell to a global market right from the very start-up of their business. Moreover, e-commerce offers great promise for developing countries, helping them to enter the prosperous global marketplace and hence helping reduce the gap between rich and poor countries.
- *Reduce costs.* By eliminating or reducing time-consuming and labour-intensive steps throughout the order and delivery process, more sales can be completed in the same period and with increased accuracy. With increased speed and accuracy of customer order information, companies can reduce the need for inventory – from raw materials, to safety stocks, to finished goods – at all the intermediate manufacturing, storage and transportation points.
- *Speed the flow of goods and information.* When organizations are connected via e-commerce, the flow of information is accelerated because of the already established electronic connections and communications processes. As a result, information can flow easily, directly and rapidly from buyer to seller.
- *Increased accuracy*. By enabling buyers to enter their own product specifications and order information directly, human data-entry error on the part of the supplier is eliminated.
- *Improve customer service*. Increased and more detailed information about delivery dates and current status can increase customer loyalty. In addition, the ability to consistently meet customers' desired delivery dates with high-quality goods and services eliminates any incentive for customers to seek other sources of supply.

Teleworking

At the time of writing, the entire world is in lockdown (Europe and Australia), going into lockdown (Africa) or slowly starting to come out of lockdown (China), all due to the COVID-19 pandemic. Everyone who can work from home is being asked or told to do so. Universities and colleges have moved their teaching and administration online and tutors are searching for, and learning about, appropriate technologies, many of which are mentioned in this chapter. Learning management systems such as Moodle are being pushed to their limit. Collaborative tools such as Microsoft Teams are hastily being deployed. Teams is relatively new – it was announced in 2016 – and was not that well known until the outbreak. It allows groups of people to share text messages, files and have video and audio calls with over 100 people. Other platforms such as Zoom, Hangouts and Whereby rapidly became part of daily working life for many people who had not heard of them before. It remains to be seen if technologies such as these will remain popular after the world recovers. It could be that the virus will permanently change the way we work and perhaps people will travel less. This may in fact be a silver lining to the crisis as almost immediately after lockdown, the air quality in many cities noticeably improved.[23]

Summary

The term 'computing' no longer refers to a computer on a desk. Mobile devices are letting employees access information from wherever they happen to be. In addition, the same technologies are allowing customers to interact with businesses in new ways. A computer no longer has to look like a huge box with wires attached to a keyboard, monitor and mouse. People probably carry around several computer devices with them everyday – a smartphone and iPod are just two examples. Others include laptops and pocket PCs. Few people are using wearable technology, where computing power is built into, for example, the clothes that we wear. However, several research groups are interested in this area, and if and when a company produces a 'killer application' for wearable technology, the market will grow substantially.

Central to any mobile computing is wireless networking, with wi-fi hotspots being an area where wireless access is available. Many bars and cafés provide their customers with wi-fi. Tangible media takes concepts from the computer screen and embodies them. Phicons, or physical icons, are one early example. Phicons are used to represent something in the same way that icons on a computer screen represent a computer file. One example of phicons is using them to represent landmarks that can be used to interact with an electronic map.

Personal robotics attempts to make social robots that people want to interact with, as opposed to manufacturing robots which are used to assemble products. Again, several research groups have an interest in this area, but it has not yet really taken off. The robot puppy Aibo is an example of a personal robot. It is also an example of a virtual pet. Virtual pets are perhaps unique among information systems in that their goal is to get users to feel a sense of responsibility towards their pet and become attached in some way to them. Virtual pets are very popular at the moment. They are of interest to businesses as already we are seeing software tools that have been given personality by their developers. In the future, employees will be comfortable interacting with devices that have personality.

Teams made up of people living in different geographical regions are able to work together efficiently and effectively, without ever having to meet. This work is facilitated by a range of technologies. Computer supported cooperative work (CSCW) refers to technologies that allow groups to work together to achieve goals. Individuals in the groups can be co-located (in the same place) or geographically separated. The work can happen synchronously (individuals work at the same time) or asynchronously (they work at different times). Different CSCW technologies exist to support these different modes of work. In global companies, CSCW technology is a powerful tool enabling the company to make the best of its human resources no matter where it is located.

A videoconference is a simultaneous communication between two or more parties where they both see and hear each other. A videoconference can be set up easily and cheaply using instant messaging. Videoconferencing is a powerful application, especially when combined with other CSCW tools, allowing people to hold useful meetings when they are geographically distant. Messaging technology includes email, instant messaging and web chat rooms. Each of these is used to communicate via text.

An interactive whiteboard is a combination of a whiteboard and a computer. Users can write on the whiteboard and then save what has been written as an image on their computer. This negates the need to take a note of what has been written after a meeting has finished. Two interactive whiteboards can be used to let people who are separated see what the others have written, and add to it. A wiki is a web page that can be edited by anyone with the proper authority. The most famous example is Wikipedia, which can be edited by any web user – very few restrictions are put in place. Wikis are clearly a good way of knowledge sharing. Virtual worlds are 3D environments populated by avatars. Second Life is a good example.

Second Life has been used to host global business meetings, and some large firms are now marketing their products there. Blogs and podcasts are another useful way of sharing knowledge. A blog is an online diary. A podcast is an audio broadcast over the Internet.

E-commerce and m-commerce can be used in many innovative ways to improve the operations of an organization. Electronic retailing (e-tailing) is the direct sale from a business to consumers through electronic storefronts designed around an electronic catalogue and shopping cart model.

A cybermall is a single website that offers many products and services at one Internet location.

Manufacturers are joining electronic exchanges, where they can work with competitors and suppliers to use computers and websites to buy and sell goods, trade market information and run back-office operations such as inventory control. They are also using e-commerce to improve the efficiency of the selling process by moving customer queries about product availability and prices online.

The web allows firms to gather much more information about customer behaviour and preferences than they could using other marketing approaches. This new technology has greatly enhanced the practice of market segmentation and enabled companies to establish closer relationships with their customers. Detailed information about a customer's behaviour, preferences, needs and buying patterns allow companies to set prices, negotiate terms, tailor promotions, add product features and otherwise customize a relationship with a customer.

The Internet has also revolutionized the world of investment and finance, especially online stock trading and online banking. The Internet has also created many options for electronic auctions, where geographically dispersed buyers and sellers can come together.

M-commerce transactions can be used in all these application arenas. M-commerce provides a unique opportunity to establish one-on-one marketing relationships and support communications anytime and anywhere.

Self-Assessment Test

1. What is a hotspot?
2. 'Smart shoes' would be an example of __________.
3. Paying without cash is often labelled __________.
4. M-Pesa is attempting to replace a bank account with a __________.
5. A __________ attempts to get a user to feel emotionally attached to it and so continue to interact with it.
6. CSCW stands for __________.
7. A device that allows notes on a whiteboard to be saved is an __________.
8. An online diary is often called a __________.
9. 'On the move retail' is sometimes called __________.
10. Advertising to particular market segments is known as __________.

Review Questions

1 Explain three examples of CSCW technologies.

2 Explain two examples of e-money.

3 What applications exist for wearable technology?

4 Why would a business offer free wi-fi?

5 List three mobile devices that can access wi-fi.

6 What is a blog?

7 What is an electronic exchange?

8 What are some of the advantages of e-commerce?

9 What is a phicon?

10 What are some of the problems when running a video conference?

Discussion Questions

1 What applications can you think of for a smart umbrella?

2 How could wikis be used on a module at your university or college?

Web Exercises

1 Go to the Wikipedia entry for your university or college and edit it to add some updates/new information.

2 Search for applications developers have tried out for virtual pets. Why do you think they failed?

Case One

Someone to Share a Journey With

Over the years, a number of companies have tried to create artificial companions. Attempts have included an on-screen dog that fetches your email, the Tamagotchi game and Sony's beautiful Aibo robot puppy. The latest comes from car maker Toyota. The Kirobo Mini is described as a 'communication partner' capable of holding a basic conversation. It is embodied and can make hand gestures, and can recognize and respond to human emotion. About the size of an apple and looking like a character from an anime movie, it seems to be primarily intended for use as a travel companion on car journeys, to give users who are driving alone someone to talk to.

On its own the device doesn't do much. To enable it to communicate requires a Bluetooth connection to a smartphone which has the Kirobo app installed. The app is not free and requires a paid subscription. With the phone's help, Kirobo understands what its user is saying and through a camera recognizes the user's facial responses and reacts accordingly, adjusting its gestures and tone of voice to match the conversation. Kirobo also recalls past events and tailors its interactions accordingly, as if it is getting to know its user. In this way, it makes its chat more relevant to the user. It also gets to know the car, gaining information from the vehicle to feed into a conversation, perhaps something along the lines of 'remember the last time we were here – you said you were going to stop to get cucumbers?' At present all of this is exclusively in Japanese. Toyota plans to sell the robot through its car dealerships for around €300.

The design goal is to make the user enjoy interacting with Kirobo. As long as a user enjoys the experience they will keep using Kirobo; when the enjoyment is gone, so is Kirobo! BBC reporter Matthew Phenix says the device is capable of 'engaging in some fairly elaborate and highly animated small talk … His gaze will follow

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the movement of his owner's head during the conversation, and his glowing eyes will "blink" to remind the human that she is talking to a sentient being and not, say, an electric toothbrush'. Toyota's vision for Kirobo Mini, called the Heart Project, is a world where humans and artificial intelligence work together. Their initial marketing for the project, a video published on YouTube, shows a job hunter asking Kirobo for interview advice and a woman who takes it with her on a date.

Questions

1 Let's say Kirobo detects that its user is angry. How should it respond? Should it attempt to soothe and calm them, or stoke the anger with a 'best to get it all out' attitude?

2 Is your answer to Question 1 dependent on the context of use – does it matter if a user is in a car, on a date or just about to go into an interview?

3 Thinking about any reaction made by Kirobo, how would designers know what the 'right' response is? Is there even a right response? Is there a wrong response?

4 What else could technology such as Kirobo be used for?

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Case Two

Kids Finally Get a Real Magic Wand at Disney

OK it's not a wand, it's a wrist band, but it still feels magic. Called the MagicBand, it is the central part of Disney's MyMagic+ system. MyMagic+ is a tool for planning and enhancing guest experiences. It is built around three technologies: a smartphone app, the FastPass+ system and the MagicBand. With typical Disney colourful style and stamped with their ubiquitous Mickey Mouse logo, the band is wearable technology – a bracelet – that contains a Radio Frequency ID (RFID) tag to uniquely identify each guest that wears one.

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RFID is the use of radio waves to read and capture information stored on a tag attached to an object, in this case the magic band. A reader sends a signal to a band essentially asking 'who's there' and the band then replies with 'I am'. Often RFID tags don't have any power of their own but pick up power wirelessly from the reader. In fact, this is not the case with the MagicBand. It has a battery and a powerful antennae, which means it doesn't have to be right next to a reader, so readers spaced around the park can tell where the guest is at any time. This can be used to give each guest a seamless experience. It can reduce or eliminate all paperwork and guest wallets. To do this, the MagicBand acts as the guest's park ticket – wave it in front of the gate on the way in and the gate opens. It can be linked to a guest's credit card so there's no need to bring a wallet – the band can be used to pay for food and merchandise. The smartphone app can be used to reserve tables at the restaurants and even pre-order food. Then a reader close to the restaurant door alerts the maitre d' and the chef that you are coming – you *personally*. Staff will greet you by name, allow you to choose your own table and a few moments later, if you have pre-ordered, your food arrives – all as if by magic!

The bracelet links to FastPass+, a queue management system. Visitors can beat a limited number of queues by holding their band near FastPass+ readers, then come back later in the day (the app will remind them of times) to go straight to the front of the line. (The app itself also contains links to FastPass+ and can allow guests to use the system without having to go to a reader.) Also included is an interactive map that lets guests see where they are in the park at all times. The app could potentially show guests which are currently the shortest ride queues, although Disney has not done this yet. Lastly, the Magic Band also acts as the door key in the Disney hotels.

For visitors, the MagicBand integrates several aspects of being in the park – dining and FastPass+ – into one paperless device, full of Disney whimsy. For Disney, the MagicBand allows for speedier service at rides and restaurants, and should allow guests to be tracked through the park. This is useful for park planning and could be used to identify and respond to bottlenecks in real time. It could also identify areas as opportunities for new content.

Questions

1. Why a bracelet and not a magic wand? How else could the RFID tag be packaged?
2. What could Disney do with data on how people move around their parks?
3. What could another organization do with this technology?
4. Why do you think Disney does not identify the current shortest ride queues on the app? Is there any way they could introduce the feature, but deal with any objections you have listed?

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Case Three

Let's Play and Become Famous

To many people, watching someone play a video game might not sound all that appealing. Having said that, if a player becomes stuck on a certain level and needs help, then they may appreciate watching someone do a walkthrough of the game. 'Let's Play' is different. Let's Play videos show gaming as a personal experience, featuring the mistakes, frustrations and successes of the player. Swedish video gamer Felix Kjellberg has managed to turn Let's Play first into a job, then into a career and now into a multi-million euro fortune.

YouTube allows anyone to upload and share videos – it puts very few restrictions on what those videos can contain. It generates revenue from adverts on the site, and shares some of that revenue with its content creators – the people who make the videos. How much gets shared is a closely guarded secret, but it clearly depends on how popular their videos are. Starting in 2010, Kjellberg uploaded videos of himself playing video games, not as an expert but as an ordinary player exploring the game often seemingly for the first time, accompanied by a running commentary of him making fun of the game and of his performance in it. The name of his YouTube channel was PewDie, but he forgot his password and had to start another. By 2013, his PewDiePie channel had racked up an amazing 2.2 billion video views. The following year he was YouTube's most popular star with over 4 billion views and 33 million subscribers. At the time of writing, this has risen to over 48 million. The *Wall Street Journal* estimated his income in 2014 to be around a million euros. He even made it onto *Time*'s list of the 30 most influential people on the Internet.

We can only speculate why PewDiePie is so popular, but it will come as no surprise that his popularity is skewed towards younger viewers. His commentary is splashed with profanity and in fact this may be part of its appeal – younger children will not see or hear anything like him on their television screens. When asked about this by *Icon* Magazine, Kjellberg said that, 'I don't want to tell jokes that are too crude, although I [swear] quite a bit. The [swearing] has turned into a thing of its own. Even when I don't really feel like [swearing], it just happens. Since my audience comes from all over the world, I also try to avoid issues like religion or making fun of a specific country. But there are always people who misunderstand, perhaps they're too young. At the same time – it's just videos'. As for the games, Kjellberg says, 'the games that are the best suited for YouTube are the really terrible games – if you want to be nice you could call them diamonds in the rough'. However, he also says he tries to keep everything positive and doesn't criticize the games. Games companies quickly took notice and Kjellberg now receives advance copies of titles to include in his videos. This is shrewd marketing on their part.

Of his popularity, he says, 'many people see me as a friend they can chill with for 15 minutes a day'. He adds that 'the difference between having 100,000 followers and several millions is not that big. It's such a huge number of individuals and on the web, those figures become hard to grasp, and hard to relate to'. He says he is continually amazed that he is able to live off YouTube but is not out to maximize his profit. He has, however, used his fame to raise money for charity. He gave away the prize money he received from having the most popular YouTube channel to the World Wildlife Fund and has helped raise money for Save The Children. 'It is amazing to be able to help people help others', he says.

Questions

1. How does YouTube fame rival the fame that can be achieved in movies, TV and by pop stars? Are the same sorts of people becoming successful?
2. Should YouTube content creators be given any control over the products and companies that are allowed to advertise on their channel?
3. Can YouTube success be engineered or is it 'pure luck'?
4. Investigate the most popular YouTube channels. Are there any niches that are missing that you think might be successful?

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World Views Case

Information Systems at Damelin, South Africa

Mathias Imbayarwo and Paul Abanda
Damelin, South Africa

Damelin is the biggest private higher education college in the Educor group (South Africa) whose other brands constitute City Varsity, Lyceum, Damelin Correspondence, Intec College, ICESA and Central Technical College. The Damelin brand has stood the test of time for a period in excess of 70 years with 17 branches located in almost all South African provinces. Damelin's mission is to provide learner focused education, to introduce innovative programmes with a commitment to the needs of the community and to observe the educational regulations, while at the same time exceeding quality expectations. In order to fulfil its mission statement, Damelin offers innovative private college further education and training (FET) and higher education and training (HET) qualifications which vary from short and skills programmes to higher certificates, diplomas and degrees. In 2015, Damelin rolled out new degree programmes in Bachelor of Commerce in Business Management and Bachelor of Applied Social Science in Community Service.

Historically, Damelin used to rely on paper work in order to keep track of students' registration, payments, class attendance, library use and results. The current technological developments in the Information, Communication and Technology (ICT) sector have transformed the manner in which Damelin handles Big Data from the 17 sites. At the click of a button, it is now possible to retrieve student information without involving a lot of effort.

To efficiently administer private education, Damelin makes use of the Integrated Academic System (ICAS), which constitutes a number of modules, namely:

The student registration module: This module is managed by the sales department where during registration, students' details are capture on ICAS. These details include the student's name, surname, gender, identity number, parent/guardian, contact details, nationality, the course to be studied, name of the sale agent involved, previous academic results and the generated student number. At this point it is crucial to ensure that correct student details are meticulously captured and uploaded on ICAS. Failure to capture the correct details will create challenges when tracking the student's academic progress.

The accounts module: The accounts module enables proper management and monitoring of students' payments. ICAS's accounts module facilitates the invoicing process for the students according to the details uploaded during the registration process. Students are billed according to the programmes they register for on an annual basis. The accounts supervisor can easily establish whether a given student is up to date with their payments. ICAS assists the debt collection department by alerting them to those students lagging behind with payment, triggering the debt collection process.

The library module: The librarian is responsible for uploading all library book titles and ISBNs on ICAS for a quick check on which books were borrowed by which students and which ones are still available. It is also easy for the librarian to keep a track on whether all the books were returned on time, unlike the old manual system that required a lot of work to do so. The manual records could easily get lost making it difficult for the librarian to recover all the books on time. In addition, the system facilitates the librarian's ability to speedily identify and stock books, journals and magazines that are on demand in the library for the benefit of the students.

The students' attendance module: Lecturers are responsible for capturing students' class attendance on ICAS at the end of each day. Students are required to attend at least 80 per cent of classes to be allowed to sit for final exams. Students that are at risk of failing due to poor attendance are red-flagged for follow-ups with parents and guardians. Intervention measures such as peer tutoring and extra practice questions are instituted based on the attendance reports. ICAS in this instance comes in handy as it assists in managing students' risk of failing due to non-attendance.

The students' results module: Both formative (assignments and tests) and summative (exams) are captured on ICAS by academic administrators. At the end of each assessment, students' results are retrieved and printed from ICAS. Upon completion of the studies by students, ICAS enables the printing of students' transcripts and certificates. The system makes it easy to know the subjects/modules that any given student has not passed.

ICAS comes with a multitude of benefits to Damelin. The fact that many reports can be generated at the click of a button makes it easy to manage and correctly deploy resources for operations' purposes. Furthermore, reports can be generated for the Department of Higher Education on statistical data covering total student numbers, number of students by gender, nationality and race. The system clearly presents opportunities for economies of scale, enhanced market competitiveness and higher capabilities of embracing the digital business ecosystems.

Questions

1. Discuss with your colleagues the disadvantages of a paper system of recordkeeping that Damelin could have experienced before adopting a new ICAS system.
2. Why is it important to ensure that student details are correctly captured during the registration process?
3. Why is it important for Damelin to adopt the latest technological developments?
4. Briefly explain how the ICAS system assists Damelin in controlling its financial resources.
5. Highlight possible challenges that Damelin is likely to experience from the adopted ICT system.

PART 4

Systems Development

11

Systems Analysis

Principles

Effective systems development requires a team effort from stakeholders, users, managers, systems development specialists and various support personnel, and it starts with careful planning.

Learning Objectives

- Identify the key participants in the systems development process and discuss their roles.
- Define the term 'information systems' and 'planning' and list several reasons for initiating a systems project.
- Discuss three trends that illustrate the impact of enterprise resource planning software packages on systems development.

Systems development often uses tools to select, implement and monitor projects, including prototyping, rapid application development, CASE tools and object-oriented development.

- Discuss the key features, advantages and disadvantages of the traditional, prototyping, rapid application development and end-user systems development lifecycles.
- Identify several factors that influence the success or failure of a systems development project.
- Discuss the use of CASE tools and the object-oriented approach to systems development.

Systems development starts with investigation and analysis of existing systems.

- State the purpose of systems investigation.
- Discuss the importance of performance and cost objectives.
- State the purpose of systems analysis and discuss some of the tools and techniques used in this phase of systems development.

Why Learn About Systems Analysis?

Throughout this book, you have seen many examples of the use of information systems. But where do these systems come from? How can you work with IS personnel, such as systems analysts and computer programmers, to get what you need to succeed on the job? This chapter, the first of two chapters on systems development, gives you the answer. You will see how managers can initiate the systems development process and analyze end users' needs with the help of IS personnel. Systems investigation and systems analysis are the first two steps of the systems development process. This chapter provides specific examples of how new or modified systems are initiated and analyzed in a number of industries. In this chapter, you will learn how your project can be planned, aligned with corporate goals, rapidly developed and much more. The main thrust of this chapter and the next is about a company building its own information systems from scratch. However, in the next chapter we will look at alternatives to this – buying in a system that someone else has already built.

We start with an overview of the systems development process.

11.1 An Overview of Systems Development

In today's businesses, managers and employees in all functional areas work together and use business information systems. Because they are central to project success, users are helping with development and, in many cases, leading the way. Users might request that a systems development team determine whether they should purchase a few PCs, update an existing order processing system, develop a new medical diagnostic or design and implement a new website. In other cases, systems development might involve purchasing or leasing a system such as an enterprise resource planning (ERP) package (discussed in Chapter 7).

This chapter and the next provide you with a deeper appreciation of the systems development process and show how businesses can avoid costly failures. Calculating the cost of an IT project is difficult and a number of high-profile mistakes have been made. Most of these are from the public sector (as any mistakes from the private sector are quickly covered up!). In the UK there have been IT problems and soaring costs with the system for issuing passports, the system managing benefit payments and the system managing patient data in the National Health Service. Not all of these problems have been technical. The new National Health Service information sharing system was delayed because of problems caused by a lack of communication with patients.[1] There was widespread criticism that the public had been left in the dark about the project. Participants in systems development, in this case government health ministers, hospital managers, doctors and patient groups, are critical to systems development success.

Participants in Systems Development

Effective systems development requires a team effort. The team usually consists of users, managers, systems development specialists, various support personnel and other stakeholders. This team, called the development team, is responsible for determining the objectives of the new information system and delivering a system that meets these objectives. Many development teams use a project manager to head the systems development effort and to help coordinate the systems development process. A project is a planned collection of activities that achieves a goal, such as constructing a new manufacturing plant or developing a new decision support system.[2] All projects should have a defined starting point and ending point, normally given as a specific date. Most have a set budget, such as €150,000. The project manager is responsible for coordinating all people and resources needed to complete the project on time. In systems development, the project manager can be an IS person inside the organization or an external consultant hired to see the project to completion. Project managers need technical, business and people skills. In addition to completing the project on time and within the specified budget, the project manager is usually responsible for controlling project quality, training personnel, facilitating communication, managing risks and acquiring any necessary equipment, including office supplies and sophisticated computer systems. One study reported that almost 80 per cent of responding IS managers believe that it is critical to keep project planning skills in-house instead of outsourcing them.[3] Research studies have shown that project management success factors include good leadership from executives and project managers, a high level of trust in the project and its potential benefits, and the commitment of the project team and organization to successfully complete the project and implement its results.

In the context of systems development, stakeholders are people who, either themselves or through the area of the organization they represent, ultimately benefit from the systems development project. Users are people who will interact with the system regularly. They can be employees, managers or suppliers. For large-scale systems development projects, where the investment in and value of a system can be high, it is common for senior-level managers, including the heads of functional areas (finance, marketing and so on), to be part of the development team.

Depending on the nature of the systems project, the development team might include systems analysts and programmers, among others. A systems analyst is a professional who specializes in analyzing and designing business systems. Systems analysts play various roles while interacting with the users, management, vendors and suppliers, external companies, programmers and other IS support personnel (see Figure 11.1). Sometimes systems analysts work with specialist business analysts, experts in the business who try to identify ways in which new information systems can improve the current business processes. Like an architect developing blueprints for a new building, a systems analyst develops detailed plans for the new or modified system. The programmer is responsible for modifying or developing programs to satisfy user requirements. Like a contractor constructing a new building or renovating an existing one, the programmer takes the plans from the systems analyst and builds or modifies the necessary software.

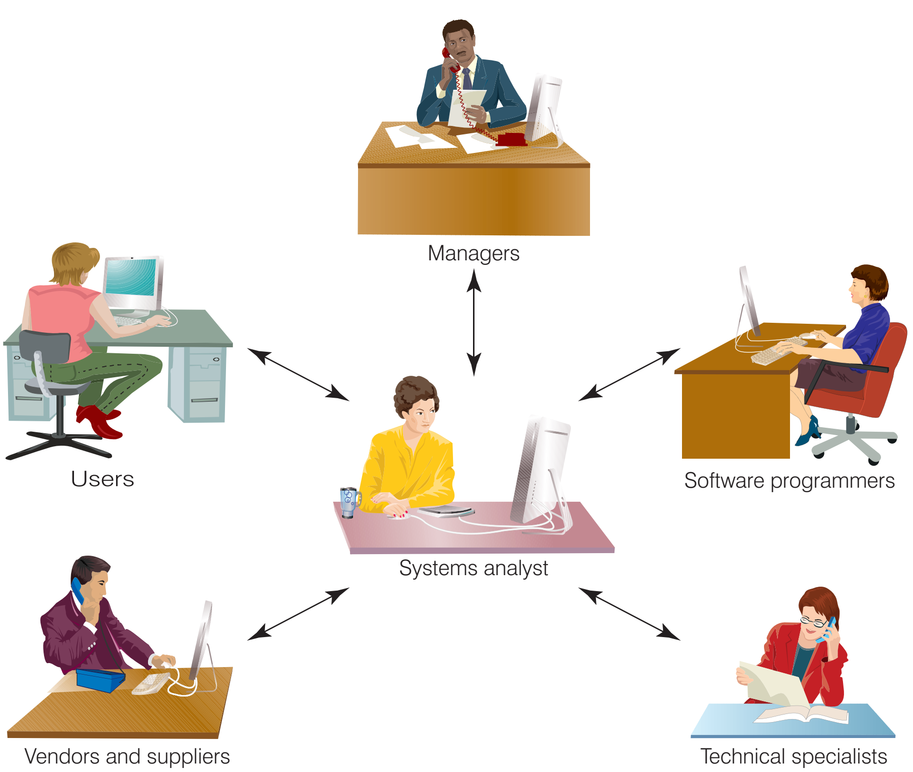

Figure 11.1 Role of the Systems Analyst
The systems analyst plays an important role in the development team and is often the only person who sees the system in its totality. The systems analyst is often called on to be a facilitator, moderator, negotiator and interpreter for development activities.

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The other support personnel on the development team are mostly technical specialists, including database and telecommunications experts, hardware engineers and supplier representatives. One or more of these roles might be outsourced to outside experts. Depending on the magnitude of the systems development project and the number of IS systems development specialists on the team, one or more IS managers might also belong to the team. The composition of a development team can vary over time and from project to project. For small businesses, the development team might consist of a systems analyst and the business owner as the primary stakeholder. For larger organizations, IS staff can include hundreds of people involved in a variety of activities, including systems development. Every development team should have a team leader. This person can be from the IS department, a manager from the company or a consultant from outside the company. The team leader needs both technical and people skills.

Regardless of the specific nature of a project, systems development creates or modifies systems, which ultimately means change. Managing this change effectively requires development team members to communicate well. Because you probably will participate in systems development during your career, you must learn communication skills. You might even be the individual who initiates systems development. Typical reasons for initiating IS projects are given in Table 11.1.

Table 11.1 Typical Reasons to Initiate a Systems Development Project

Reason	Example
Problems with existing system	Not processing orders fast enough
Desire to exploit new opportunities	M-commerce
Increasing competition	New competitor enters industry
Desire to make more effective use of information	Wanting to set up a customer relationship management system to expand and exploit information stored on customers
Organizational growth	Expanding customer base
Merger or acquisition	Buying out a competitor
Change in the environment	New regulations imposed by government

Information Systems Planning and Aligning Organization and IS Goals

The term information systems planning refers to translating strategic and organizational goals into systems development initiatives. The chief information officer (CIO) of the Marriott Hotel chain, for example, attends board meetings and other top-level management meetings so that he is familiar with, and can contribute to, the firm's strategic plan. According to Doug Lewis, former CIO for many Fortune 100 companies, 'strategic goals must be finite, measurable and tangible'. Proper IS planning ensures that specific systems development objectives support organizational goals.

Aligning organizational goals and IS goals is critical for any successful systems development effort.[4] Because information systems support other business activities, IS staff and people in other departments need to understand each other's responsibilities and tasks. Determining whether organizational and IS goals are aligned can be difficult.

One of the primary benefits of IS planning and alignment of business goals is a long-range view of information systems use in the organization. The IS plan should guide the development of the IS infrastructure over time. IS planning should ensure better use of IS resources – including funds, personnel and time for scheduling specific projects. The steps of IS planning are shown in Figure 11.2.

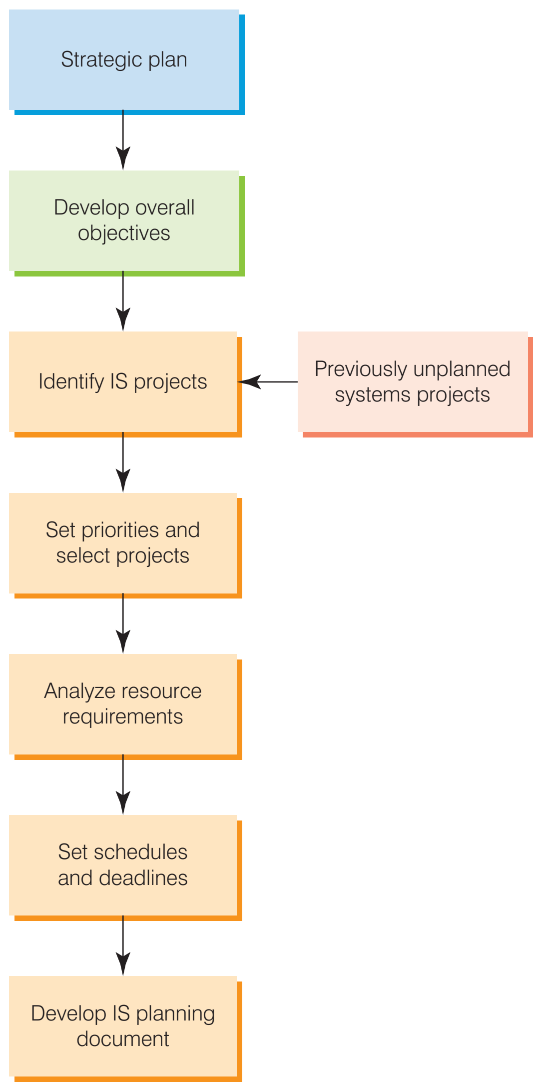


Figure 11.2 The Steps of IS Planning *Some projects are identified through overall IS objectives, whereas additional projects, called 'unplanned projects', are identified from other sources. All identified projects are then evaluated in terms of their organizational priority.*

In today's business environment, many companies seek systems development projects that will provide them with a competitive advantage. Thinking competitively usually requires creative and critical analysis. For example, a company might want to achieve a competitive advantage by improving its customer–supplier relationship. Linking customers and suppliers electronically can result in more efficient communication and, ultimately, superior products and services. By looking at problems in new or different ways and by introducing innovative methods to solve them, many organizations have gained significant advantages. In some cases, these new solutions are inspired by people and things not directly related to the problem.

creative analysis The investigation of new approaches to existing problems.

critical analysis The unbiased and careful questioning of whether system elements are related in the most effective ways.

Creative analysis involves investigating new approaches to existing problems. Typically, new solutions are inspired by people and events not directly related to the problem. **Critical analysis** requires unbiased and careful questioning of whether system elements are related in the most effective ways. It involves considering the establishment of new or different relationships between system elements and perhaps introducing new elements into the system. Critical analysis in systems development involves the following actions:

- *Questioning statements and assumptions.* Questioning users about their needs and clarifying their initial responses can result in better systems and more accurate predictions. Too often, stakeholders and users specify certain system requirements because they assume that their needs can only be met that way. Often, an alternative approach would be better. For example, a stakeholder might be concerned because there is always too much of certain items in stock and not enough of other items. So, the stakeholder might request a new and improved inventory control system. An alternative approach is to identify the root cause of poor inventory management. This latter approach might determine that sales forecasting is inaccurate and needs improvement or that production cannot meet the set production schedule. All too often, solutions are selected before understanding the complete nature of the problem.
- *Identifying and resolving objectives and orientations that conflict.* Each department in an organization can have different objectives and orientations. The buying department might want to minimize the cost of spare parts by always buying from the lowest-cost supplier, but engineering might want to buy more expensive, higher quality spare parts to reduce the frequency of replacement. These differences must be identified and resolved before a new purchasing system is developed or an existing one modified.

Establishing Objectives for Systems Development

The overall objective of systems development is to achieve business goals, not technical goals, by delivering the right information to the right person at the right time. The impact a particular system has on an organization's ability to meet its goals determines the true value of that system to the organization. Although all systems should support business goals, some systems are more pivotal in continued operations and goal attainment than others. These systems are called 'key operational'. An order processing system, for example, is key operational. Without it, few organizations could continue daily activities, and they clearly would not meet set goals.

The goals defined for an organization also define the objectives that are set for a system. A manufacturing plant, for example, might determine that minimizing the total cost of owning and operating its equipment is critical to meeting production and profit goals. Critical success factors (CSFs) are factors that are essential to the success of certain functional areas of an organization. The CSF for manufacturing – minimizing equipment maintenance and operating costs – would be converted into specific objectives for a proposed system. One specific objective might be to alert maintenance planners when a piece of equipment is due for routine preventative maintenance (e.g. cleaning and lubrication). Another objective might be to alert the maintenance planners when the necessary cleaning materials, lubrication oils or spare parts inventory levels are below specified limits. These objectives could be accomplished either through automatic stock replenishment or through the use of exception reports.

Regardless of the particular systems development effort, the development process should define a system with specific performance and cost objectives. The success or failure of the systems development effort will be measured against these objectives.

Performance Objectives

The extent to which a system performs as desired can be measured through its performance objectives. System performance is usually determined by factors such as the following:

- *The quality or usefulness of the output.* Is the system generating the right information for a value-added business process or a goal-oriented decision maker?
- *The accuracy of the output.* Is the output accurate and does it reflect the true situation? As a result of the Enron accounting scandal in the USA and similar instances when some companies overstated revenues or understated expenses, accuracy is becoming more important, and business leaders throughout the world are being held responsible for the accuracy of all corporate reports.
- *The quality or usefulness of the format of the output.* Is the output generated in a form that is usable and easily understood? For example, objectives often concern the legibility of screen displays, the appearance of documents and the adherence to certain naming conventions.
- *The speed at which output is generated.* Is the system generating output in time to meet organizational goals and operational objectives? Objectives such as customer response time, the time to determine product availability and throughput time are examples.
- *The scalability of the resulting system.* Scalability allows an information system to handle business growth and increased business volume. For example, if a mid-sized business realizes an annual 10 per cent growth in sales for several years, an information system that is scalable will be able to efficiently handle the increase by adding processing, storage, software, database, telecommunications and other information systems resources to handle the growth.
- *The degree to which business risk is reduced.* One important objective of many systems development projects is to reduce risk.[5] The BRE Bank in Poland, for example, used systems development to create a model-based decision support system to analyze and reduce loan risk and a variety of related risks associated with bank transactions. The new project uses a mathematical algorithm, called FIRST (financial institutions risk scenario trends), to reduce risk.

In some cases, the achievement of performance objectives can be easily measured (e.g. by tracking the time it takes to determine product availability). In other cases, it is sometimes more difficult to ascertain in the short term. For example, it might be difficult to determine how many customers are lost because of slow responses to customer enquiries regarding product availability. These outcomes, however, are often closely associated with business goals and are vital to the long-term success of the organization. Senior management usually dictates their attainment.

Cost Objectives

Organizations can spend more than is necessary during a systems development project. The benefits of achieving performance goals should be balanced with all costs associated with the system, including the following:

- *Development costs.* All costs required to get the system up and running should be included. Some computer vendors give cash rewards to companies using their systems to reduce costs and as an incentive.[6]
- *Costs related to the uniqueness of the system application.* A system's uniqueness has a profound effect on its cost. An expensive but reusable system might be preferable to a less costly system with limited use.
- *Fixed investments in hardware and related equipment.* Developers should consider costs of such items as computers, network-related equipment and environmentally controlled data centres in which to operate the equipment.
- *Ongoing operating costs of the system.* Operating costs include costs for personnel, software, supplies and resources such as the electricity required to run the system.

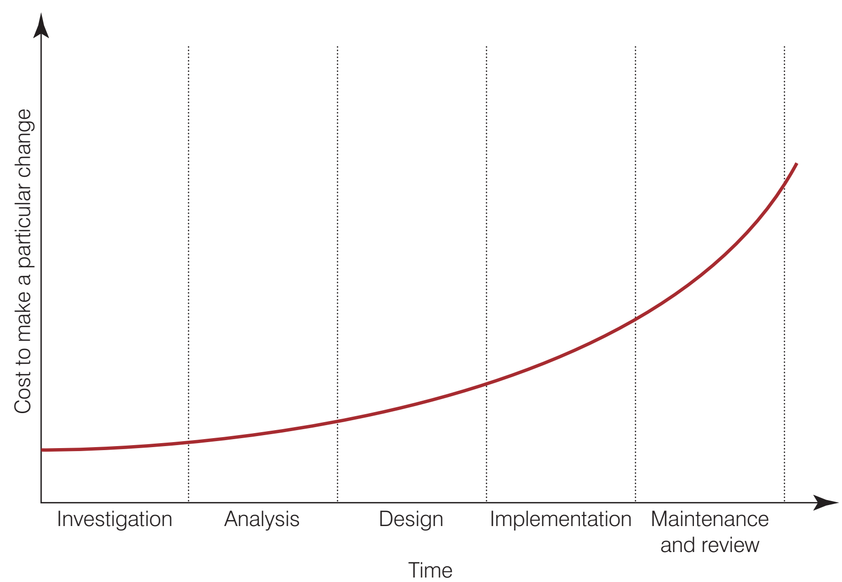
Balancing performance and cost objectives within the overall framework of organizational goals can be challenging. Setting objectives is important, however, because they allow an organization to allocate resources effectively and measure the success of a systems development effort.

11.2 Systems Development Lifecycles

The systems development process is also called the 'systems development lifecycle' (SDLC) because the activities associated with it are ongoing. As each system is built, the project has timelines and deadlines until the system is installed and accepted. The life of the system then continues as it is maintained and reviewed. If the system needs significant improvement beyond the scope of maintenance, or if it needs to be replaced because of a new generation of technology, or if the IS needs of the organization change significantly, a new project will be initiated and the cycle will start over.

A key fact of systems development is that the later in the SDLC an error is detected, the more expensive it is to correct (see Figure 11.3). One reason for the mounting costs is that if an error which occurred in a early stage of the SDLC isn't found until a later phase, the previous phases must be reworked to some extent. Another reason is that the errors found late in the SDLC affect more people. For example, an error found after a system is installed might require retraining users when a 'work-around' to the problem has been found. Thus, experienced systems developers prefer an approach that will catch errors early in the project lifecycle.

Figure 11.3
Relationship Between Timing of Errors and Costs *The later that system changes are made in the SDLC, the more expensive these changes become.*



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Several common systems development lifecycles exist: the traditional or waterfall approach, prototyping, rapid application development (RAD) and end-user development. In addition, companies can outsource the systems development process. With many companies and most public sector organizations, these approaches are formalized and documented so that systems developers have a well-defined process to follow; in other companies, less formalized approaches are used. Keep Figure 11.3 in mind as you are introduced to alternative SDLCs in the sections that follow.

The Traditional Systems Development Lifecycle

Traditional systems development efforts can range from a small project, such as purchasing an inexpensive computer program, to a major undertaking. The steps of traditional systems development might vary from one company to the next, but most approaches have five common phases: investigation, analysis, design, implementation, and maintenance and review (see Figure 11.4). Traditional systems development is also known as the waterfall approach.

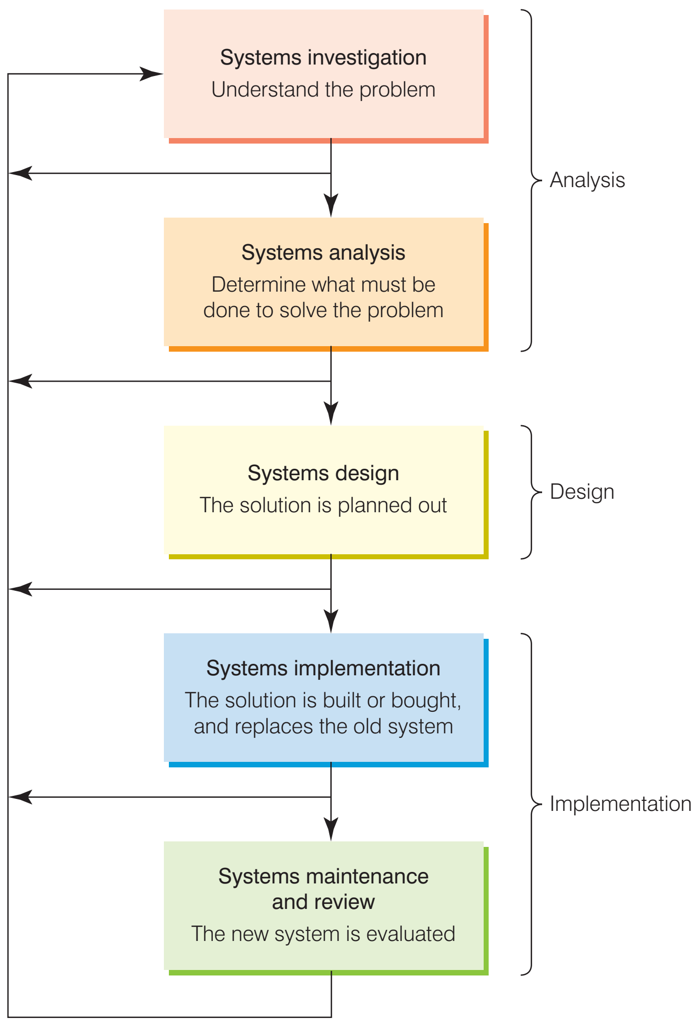

Figure 11.4 The Traditional Systems Development Lifecycle *Sometimes information learned in a particular phase requires cycling back to a previous phase.*

In the systems investigation phase, potential problems and opportunities are identified and considered in light of the goals of the business. Systems investigation attempts to answer the questions, 'What is the problem?' and 'Is it worth solving?' The primary result of this phase is a defined development project for which business problems or opportunity statements have been created, to which some organizational resources have been committed, and for which systems analysis is recommended. Systems analysis attempts to answer the question, 'What must the information system do to solve the problem?' This phase involves studying existing systems and work processes to identify strengths, weaknesses and opportunities for improvement. The major outcome of systems analysis is a list of requirements and priorities. Systems design seeks to answer the question, 'How will the information system do what it must do to obtain the problem solution?' The primary result of this phase is a technical design that either describes the new system or describes how existing systems will be modified. The system design details system outputs, inputs and user interfaces; specifies hardware, software, database, telecommunications, personnel and procedure components; and shows how these components are related. Systems implementation involves creating or buying the various system components detailed in the systems design, assembling them and placing the new or modified system into operation. An important task during this phase is to train the users. Systems implementation results in an installed, operational information system that meets the business needs for which it was developed. The purpose of systems maintenance and review is to ensure that the system operates as intended and to modify the system so that it continues to meet changing business needs. As shown in Figure 11.4, a system under development moves from one phase of the traditional SDLC to the next.

The traditional SDLC allows for a large degree of management control. However, a major problem is that the user does not use the solution until the system is nearly complete. Table 11.2 lists advantages and disadvantages of the traditional SDLC.

Table 11.2 Advantages and Disadvantages of Traditional SDLC

Advantages	Disadvantages
Formal review at the end of each phase allows maximum management control	Users get a system that meets the needs as understood by the developers; this might not be what is really needed
This approach creates considerable system documentation	Documentation is expensive and time consuming to create. It is also difficult to keep current
Formal documentation ensures that system requirements can be traced back to stated business needs	Often, user needs go unstated or are misunderstood
It produces many intermediate products that can be reviewed to see whether they meet the users' needs and conform to standards	Users cannot easily review intermediate products and evaluate whether a particular product (e.g. a data-flow diagram) meets their business requirements

Prototyping

Prototyping, also known as the evolutionary lifecycle, takes an iterative approach to the systems development process. During each iteration, requirements and alternative solutions to the problem are identified and analyzed, new solutions are designed and a portion of the system is implemented. Users are then encouraged to try the prototype and provide feedback (see Figure 11.5). Prototyping begins with creating a preliminary model of a major subsystem or a scaled-down version of the entire system. For example, a prototype might show sample report formats and input screens. After they are developed and refined, the prototypical reports and input screens are used as models for the actual system, which can be developed using an end-user programming language such as Visual Basic. The first preliminary model is refined to form the second- and third-generation models and so on until the complete system is developed. One potential problem with prototyping is knowing when the system is finished as people can always think of extra refinements they would like.

Prototypes can be classified as operational or non-operational. An operational prototype is a prototype that has functionality – it does something towards solving the problem. It may accept input, partially process it and output the results. Then, perhaps in the second iteration, the processing is refined and expanded. A non-operational prototype is a mock-up or model. It typically includes output and input specifications and formats. The outputs include mocked up reports and the inputs include the layout of the user interface either on paper or on a computer screen. The primary advantage of a non-operational prototype is that it can be developed much faster than an operational prototype. Non-operational prototypes can be discarded, and a fully operational system can be built based on what was learned from the prototypes.

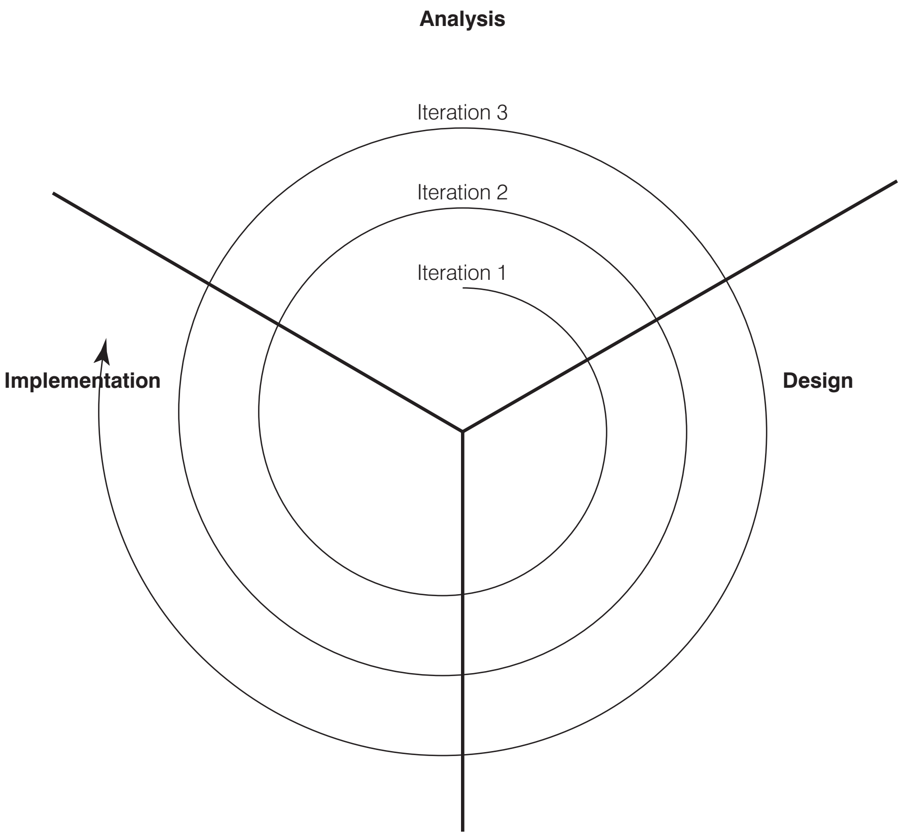

Figure 11.5 Prototyping
Prototyping is an iterative approach to systems development.

The advantages and disadvantages of prototyping are summarized in Table 11.3. Prototypes can be useful communication tools – imagine asking a user what they need the new system to do. Many people may find it difficult to verbalize what they want. However, if you show them a prototype, they will soon be able to say what is right and wrong with it.

Table 11.3 Advantages and Disadvantages of Prototyping

Advantages	Disadvantages
Users can try the system and provide constructive feedback during development	Each iteration builds on the previous one. The final solution might be only incrementally better than the initial solution
An operational prototype can be produced in weeks	Formal end-of-phase reviews might not occur. Thus, it is very difficult to contain the scope of the prototype, and the project never seems to end
As solutions emerge, users become more positive about the process and the results	System documentation is often absent or incomplete because the primary focus is on development of the prototype
Prototyping enables early detection of errors and omissions	System back-up and recovery, performance and security issues can be overlooked in the haste to develop a prototype

11

Information Systems @ Work

Open-Source Software Conquers Data Science

R is a specialist programming language designed to handle statistics and the creation of statistical graphs. It is open source and has rapidly become one of the most popular computer languages for data manipulation. The R developers describe it as an 'environment', by which they mean it is a full computer language that allows users to add additional functionality by writing their own functions and code. These can be written in R itself, but R also has features that easily allow it to run code written in C and several other languages. The real power of R for many users, is that it has an online repository where the best functions are shared (they are called 'packages'). R has tools built in that make it exceptionally easy for anyone to install these packages.

For example, let's say a user in Australia writes a new package to analyze geographic data. They use it themselves for a few months and decide that it is useful. So they give it a name (let's say 'geo') and submit it to the repository. It then undergoes some quality checks and if it passes, is added to the list. Then if anyone wants to use it, all they have to do is open R and type: install.packages ('geo'). The breadth and length of the list of packages is impressive. It is a beautiful system.

As has been said, R is open source. This means that users can see – and if they wanted to, change – the code of the language. More usefully to most users, however, is that it also means they can see the code of the packages written by others. So a few weeks after the geo package went online, dozens of R users – many of whom are world-class statisticians and programmers – will have assessed it and reported back any problems that they find. The Australian developer can then fix them. In very little time at all, the code is very high quality.

Initially, not everyone appreciated this. In a famous *New York Times* interview, director of technology product marketing at software developer SAS, Anne Milley said, 'I think [R] addresses a niche market for high-end data analysts that want free, readily available code. We have customers who build engines for aircraft. I am happy they are not using freeware when I get on a jet'.

Her view seems to be shared by others in industry who prefer to use proprietary software. Perhaps they genuinely do not see the benefit of having code that has been read, tested and vetted by a community of users. Or perhaps industry just wants to be able to sue somebody if it all goes wrong (like all open-source software, R comes with absolutely no warranty of any kind, a message that is displayed prominently every time it is opened). However, SAS later seemed to soften their attitude to R. They have changed their software to add support for R, allowing data to flow between R and SAS programs, and they began work on an interface to use R from within SAS.

Questions

1. Is R a threat to software developers like SAS?
2. Which code would you trust more when flying in a jet: proprietary or open source?
3. How can open source software be quality software?
4. Should businesses use R?

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Rapid Application Development, Agile Development, Joint Application Development and Other Systems Development Approaches

Rapid application development (RAD) employs tools, techniques and methodologies designed to speed up application development. Some people consider it to be the same as prototyping. Vendors, such as Computer Associates International, IBM and Oracle, market products targeting the RAD market. Rational Software, a division of IBM, has a RAD tool, called Rational Rapid Developer, to make developing large Java programs and applications easier and faster. Locus Systems, a program developer, used a RAD tool called OptimalJ to generate more than 60 per cent of the computer code for three applications it developed. Advantage Gen is a RAD tool from Computer Associates International. It can be used to rapidly generate computer code from business models and specifications.

rapid application development (RAD) A systems development approach that employs tools, techniques and methodologies designed to speed application development.

RAD reduces paper-based documentation, automatically generates program source code and facilitates user participation in design and development activities. It makes adapting to changing system requirements easier.

Other approaches to rapid development, such as agile development, allow the systems to change as they are being developed. Agile development requires frequent face-to-face meetings with the systems developers and users as they modify, refine and test how the system meets users' needs and what its capabilities are. Extreme programming (XP), a form of agile development, uses pairs of programmers who work together to design, test and code parts of the systems they develop. The iterative nature of XP helps companies develop robust systems, with fewer errors.

RAD makes extensive use of the joint application development (JAD) process for data collection and requirements analysis. Originally developed by IBM Canada in the 1970s, JAD involves group meetings in which users, stakeholders and IS professionals work together to analyze existing systems, propose possible solutions and define the requirements of a new or modified system. JAD groups consist of both problem holders and solution providers. A group normally requires one or more top-level executives who initiate the JAD process, a group leader for the meetings, potential users and one or more individuals who act as secretaries and clerks to record what is accomplished and to provide general support for the sessions. Many companies have found that groups can develop better requirements than individuals working independently and have assessed JAD as a very successful development technique. Today, JAD often uses group support systems (GSS) software to foster positive group interactions, while suppressing negative group behaviour.

RAD should not be used on every software development project. In general, it is best suited for DSSs and MISs and less well suited for TPS. During a RAD project, the level of participation of stakeholders and users is much higher than in other approaches. Table 11.4 lists advantages and disadvantages of RAD.

Table 11.4 Advantages and Disadvantages of RAD

Advantages	Disadvantages
For appropriate projects, this approach puts an application into production sooner than any other approach	This intense SDLC can burn out systems developers and other project participants
Documentation is produced as a by-product of completing project tasks	This approach requires systems analysts and users to be skilled in RAD systems development tools and RAD techniques
RAD forces teamwork and lots of interaction between users and stakeholders	RAD requires a larger percentage of stakeholders' and users' time than other approaches

The End-User Systems Development Lifecycle

The term end-user systems development describes any systems development project in which business managers and users assume the primary effort. Rather than ignoring these initiatives, astute IS professionals encourage them by offering guidance and support. Providing technical assistance, communicating standards and sharing 'best practices' throughout the organization are some ways IS professionals work with motivated managers and employees undertaking their own systems development. In this way, end-user-developed systems can be structured as complementary to, rather than in conflict with, existing and emerging information systems. In addition, this open communication among IS professionals, managers of the affected business area and users allows the IS professionals to identify specific initiatives so that additional organizational resources, beyond those available to business managers or users, are provided for its development.

User-developed systems range from the very small (such as a software routine to merge data from Microsoft Excel into Microsoft Word to produce a personalized letter for customers) to those of significant organizational value (such as a customer contact database). Initially, IS professionals discounted the value of these projects. As the number and magnitude of these projects increased, however, IS professionals began to realize that for the good of the entire organization, their involvement with these projects needed to increase.

End-user systems development does have some disadvantages. Some end users don't have the training to effectively develop and test a system. Expensive mistakes can be made using faulty spreadsheets, for example, that have never been tested. Most end-user systems are also poorly documented and therefore difficult to maintain. When these systems are updated, problems can be introduced that make the systems error-prone. In addition, some end users spend time and corporate resources developing systems that are already available.

A survey of South African employers found that the IS skills they want in their new employees are the ability to type, create documents and having a basic working knowledge of computer applications.

Outsourcing and On-Demand Computing

Many companies hire an outside consulting firm or computer company that specializes in systems development to take over some or all of its development and operations activities.[7] Some companies, such as General Electric, have their own outsourcing subunits or have spun off their outsourcing subunits as separate companies.[8] Outsourcing can be a good idea under the following circumstances:

- When a company believes it can cut costs.
- When a firm has limited opportunity to distinguish itself competitively through a particular IS operation or application.
- When uninterrupted IS service is not crucial.
- When outsourcing does not strip the company of technical know-how required for future IS innovation.
- When the firm's existing IS capabilities are limited, ineffective or technically inferior.
- When a firm is downsizing.

The decision to outsource systems development is often a response to downsizing, which reduces the number of employees or managers, equipment and systems, and even functions and departments. Outsourcing allows companies to downsize their IS department and alleviate difficult financial situations by reducing payroll and other expenses.

Organizations can outsource any aspect of their information system, including hardware maintenance and management, software development, database systems, networks and telecommunications, Internet and intranet operations, hiring and staffing, and the development of procedures and rules regarding the information system.[9] Eurostar, for example, hired the outsourcing company Occam to develop a new website and back-end database to give its travel customers greater travel information.[10] According to Scott Logie, managing director of Occam, 'The quality and volume of data that Eurostar possesses is extremely valuable. By working together we will allow the firm to develop real insight into its customers. This can be used to drive a strong customer acquisitions strategy, which will enhance its business and customer relationships'.

Reducing costs, obtaining state-of-the-art technology, eliminating staffing and personnel problems, and increasing technological flexibility are reasons that companies have used in the outsourcing and on-demand computing approaches.[11] A number of companies offer outsourcing and on-demand computing services – from general systems development to specialized services. IBM's Global Services, for example, is one of the largest full-service outsourcing and consulting services.[12] IBM has consultants located in offices around the world. Electronic Data Systems (EDS) is another large company that specializes in consulting and outsourcing.[13] EDS has approximately 140,000 employees in almost 60 countries and more than 9,000 clients worldwide. Accenture is another company that specializes in consulting and outsourcing.[14] The company has more than 75,000 employees in 47 countries.

Organizations can use a number of guidelines to make outsourcing a success, including the following:[15]

- Keep tight controls on the outsourcing project.
- Treat outsourcing companies as partners.
- Start with smaller outsourcing jobs.
- Create effective communications channels between the organization and the outsourcing company.
- Carefully review legal outsourcing contracts, including rights and remedies clauses.[16]

Old Mutual South Africa has outsourced its IS infrastructure to T-Systems, to control its costs and access T-System's expertise.

Outsourcing has some disadvantages, however. Internal expertise can be lost and loyalty can suffer under an outsourcing arrangement. When a company outsources, key IS personnel with expertise in technical and business functions are no longer needed. When these IS employees leave, their experience with the organization and expertise in information systems are lost. For some companies, it can be difficult to achieve a competitive advantage when competitors are using the same computer or consulting company. When the outsourcing or on-demand computing is done offshore or in a foreign country, some people have raised security concerns. How will important data and trade secrets be guarded?

Genetic Programming

Instead of having a software engineer write the software, or getting end users to develop their own systems, or giving the job to a third party, an active area of research involves having a computer write its own code. Called **Genetic Programming**, this approach draws on principles of natural selection from biology to evolve code that solves a set problem. While not ready yet to tackle most business problems, and still seen mainly in university labs, genetic programming has already created programs that can compete with a human doing the same task. A typical setup works as follows. The system starts with a set of computer programs that have been randomly created. Each program is run and tested to see how close it gets to solving the problem. This testing is the most difficult part of using genetic programming and involves a human creating what is known as a fitness function to rate how good each program is. The random program that is best gets copied to create a new set of programs, now less random than the first set. Then the testing happens again. The copying introduces random mutations into the code – in the same way that a human child is not exactly the same as its parents, the next generation of computer code is not exactly the same as the previous generation. This continues over time until a good enough solution (you can never say if it is the best solution) evolves.

Genetic Programming An approach to creating computer code based on natural selection. Initially random code evolves through numerous iterations to become a program that solves a set problem.

11.3 Factors Affecting System Development Success

Successful systems development means delivering a system that meets user and organizational needs – on time and within budget. There is no formula for achieving this, but the following factors are known to have an impact on success.

Involvement

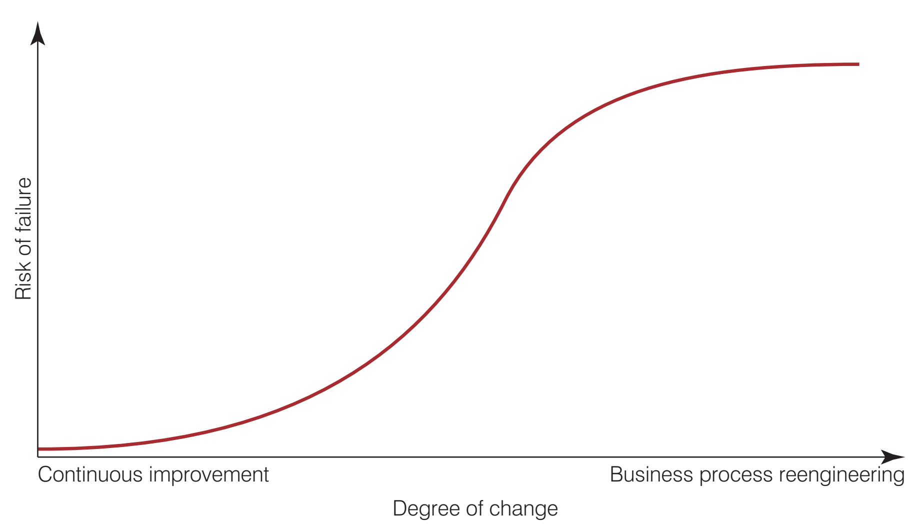
Getting users and other stakeholders involved in systems development is critical for most systems development projects. Having the support of top-level managers is also important. The involvement of users throughout the development will mean they are less likely to resist the software when it is delivered. Historically, communication between people on the domain side (users, managers and other stakeholders) and on the systems side (systems analysts, programmers and other technical people) has been problematic, with there being little common ground between them. Each group has its own set of terminology and its own culture. Getting users and managers involved in systems development is one way of building bridges between the two and kick-starting dialogue. This may be done simply by inviting them to development meetings, organizing social gatherings, producing a questionnaire to survey user views, running interviews, etc. or by using joint application development. If users have been involved throughout development, they will be less likely to resist the changes the new system brings when it is implemented.

Degree of Change

A major factor that affects the quality of systems development is the degree of change associated with the project. The scope can vary from implementing minor enhancements to an existing system, up to major reengineering. The project team needs to recognize where they are on this spectrum of change.

As discussed in Chapter 2, continuous improvement projects do not require significant business process or IS changes, or retraining of people; thus, they have a high degree of success. Typically, because continuous improvement involves minor improvements, these projects also have relatively modest benefits. On the other hand, reengineering involves fundamental changes in how the organization conducts business and completes tasks. The factors associated with successful reengineering are similar to those of any development effort, including top management support, clearly defined corporate goals and systems development objectives, and careful management of change. Major reengineering projects tend to have a high degree of risk but also a high potential for major business benefits (see Figure 11.6).

Figure 11.6 Degree of Change *The degree of change can greatly affect the probability of a project's success.*



Managing Change

The ability to manage change is critical to the success of systems development. New systems inevitably cause change. For example, the work environment and habits of users are invariably affected by the development of a new information system. Unfortunately, not everyone adapts easily, and the increasing complexity of systems can multiply the problems. Managing change requires the ability to recognize existing or potential problems (particularly the concerns of users) and deal with them before they become a serious threat to the success of the new or modified system. Here are several of the most common problems:

- Fear that the employee will lose his or her job, power or influence within the organization.
- Belief that the proposed system will create more work than it eliminates.
- Reluctance to work with ‘computer people’.
- Anxiety that the proposed system will negatively alter the structure of the organization.
- Belief that other problems are more pressing than those solved by the proposed system or that the system is being developed by people unfamiliar with ‘the way things need to get done’.
- Unwillingness to learn new procedures or approaches.

Preventing or dealing with these types of problems requires a coordinated effort from stakeholders and users, managers and IS personnel. One remedy is simply to talk with all people concerned and learn what their biggest concerns are. Management can then deal with those concerns and try to eliminate them. After immediate concerns are addressed, people can become part of the project team.

Quality and Standards

Another key success factor is the quality of project planning. The bigger the project, the more likely that poor planning will lead to significant problems. Many companies find that large systems projects fall behind schedule, go over budget and do not meet expectations. A systems development project for the UK Child Support Agency, for example, fell behind schedule and over £250 million over budget.[17] When it was delivered, two years late, there were problems – screens took too long to refresh and there was no delete key to undo accidental typing mistakes; staff training was also ineffective and inappropriate. The delayed project may have hurt the agency’s ability to deliver important services to children. Although proper planning cannot guarantee that these types of problems will be avoided, it can minimize the likelihood of their occurrence. Good systems development is not automatic. Certain factors contribute to the failure of systems development projects. These factors and countermeasures to eliminate or alleviate the problem are summarized in Table 11.5.

The development of information systems requires a constant trade-off of schedule and cost versus quality. Historically, the development of application software has overemphasized schedule and cost to the detriment of quality. Techniques, such as use of the ISO 9001 standards, have been developed to improve the quality of information systems. ISO 9001 is a set of international quality standards originally developed in Europe in 1987. These standards address customer satisfaction and are the only standards in the ISO 9001 family where third-party certification can be achieved. Adherence to ISO 9001 is a requirement in many international markets[18] (see Figure 11.7).

Table 11.5 Project Planning Issues Frequently Contributing to Project Failure

Factor	Countermeasure
Solving the wrong problem	Establish a clear connection between the project and organizational goals
Poor problem definition and analysis	Follow a standard systems development approach
Poor communication	There is no easy answer to this common problem
Project is too ambitious	Narrow the project focus to address only the most important business opportunities
Lack of top management support	Identify the senior manager who has the most to gain from the success of the project and recruit this person to champion the project
Lack of management and user involvement	Identify and recruit key stakeholders to be active participants in the project
Inadequate or improper system design	Follow a standard systems development approach
Lack of standards	Implement a standards system, such as ISO 9001
Poor testing and implementation	Plan sufficient time for this activity
Users cannot use the system effectively	Develop a rigorous user training programme and budget sufficient time in the schedule to execute it
Lack of concern for maintenance	Include an estimate of employee effort and costs for maintenance in the original project justification

Figure 11.7 ISO Home Page *ISO 9001 is a set of international quality standards used by IS and other organizations to ensure the quality of products and services.*

This screenshot, taken from the ISO webstore, is reproduced with the permission of the International Organization for Standardization, ISO. It can be obtained from the website of the ISO Central Secretariat under: www.iso.org. Copyright remains with ISO.

Organizational experience with the systems development process is also a key factor in systems development success.[19] The capability maturity model (CMM) is one way to measure this experience.[20] It is based on research done at Carnegie Mellon University and work by the Software Engineering Institute (SEI).[21] CMM is a measure of the maturity of the software development process in an organization. CMM grades an organization's systems development maturity using five levels: initial, repeatable, defined, managed and optimized.

Use of Project Management Tools

Project management involves planning, scheduling, directing and controlling human, financial and technological resources for a defined task whose result is achievement of specific goals and objectives. Even small systems development projects must employ some type of project management.[22]

A project schedule is a detailed description of what is to be done. Each project activity, the use of personnel and other resources, and expected completion dates are described. A project milestone is a critical date for the completion of a major part of the project. The completion of program design, coding, testing and release are examples of milestones for a programming project. The project deadline is the date the entire project is to be completed and operational – when the organization can expect to begin to reap the benefits of the project.

In systems development, each activity has an earliest start time, earliest finish time and slack time, which is the amount of time an activity can be delayed without delaying the entire project. The critical path consists of all activities that, if delayed, would delay the entire project. These activities have zero slack time. Any problems with critical-path activities will cause problems for the entire project. To ensure that critical-path activities are completed in a timely fashion, formalized project management approaches have been developed. Tools such as Microsoft Project are available to help compute these critical project attributes.

Although the steps of systems development seem straightforward, larger projects can become complex, requiring hundreds or thousands of separate activities. For these systems development efforts, formal project management methods and tools become essential. A formalized approach called the **program evaluation and review technique (PERT)** creates three time estimates for an activity: shortest possible time, most likely time and longest possible time. A formula is then applied to determine a single PERT time estimate. A **Gantt chart** is a graphical tool used for planning, monitoring and coordinating projects; it is essentially a grid that lists activities and deadlines. Each time a task is completed, a marker such as a darkened line is placed in the proper grid cell to indicate the completion of a task (see Figure 11.8).

program evaluation and review technique (PERT) A formalized approach for developing a project schedule.

Gantt chart A graphical tool used for planning, monitoring and coordinating projects.

Both PERT and Gantt techniques can be automated using project management software. Several project management software packages are identified in Table 11.6. This software monitors all project activities and determines whether activities and the entire project are on time and within budget. Project management software also has workgroup capabilities to handle multiple projects and to allow a team to interact with the same software. Project management software helps managers determine the best way to reduce project completion time at the least cost. Many project managers, however, fear that the quality of a systems development project will suffer with shortened deadlines and think that slack time should be added back to the schedule as a result.

Figure 11.8 **Sample Gantt Chart** *A Gantt chart shows progress through systems development activities by putting a bar through appropriate cells.*

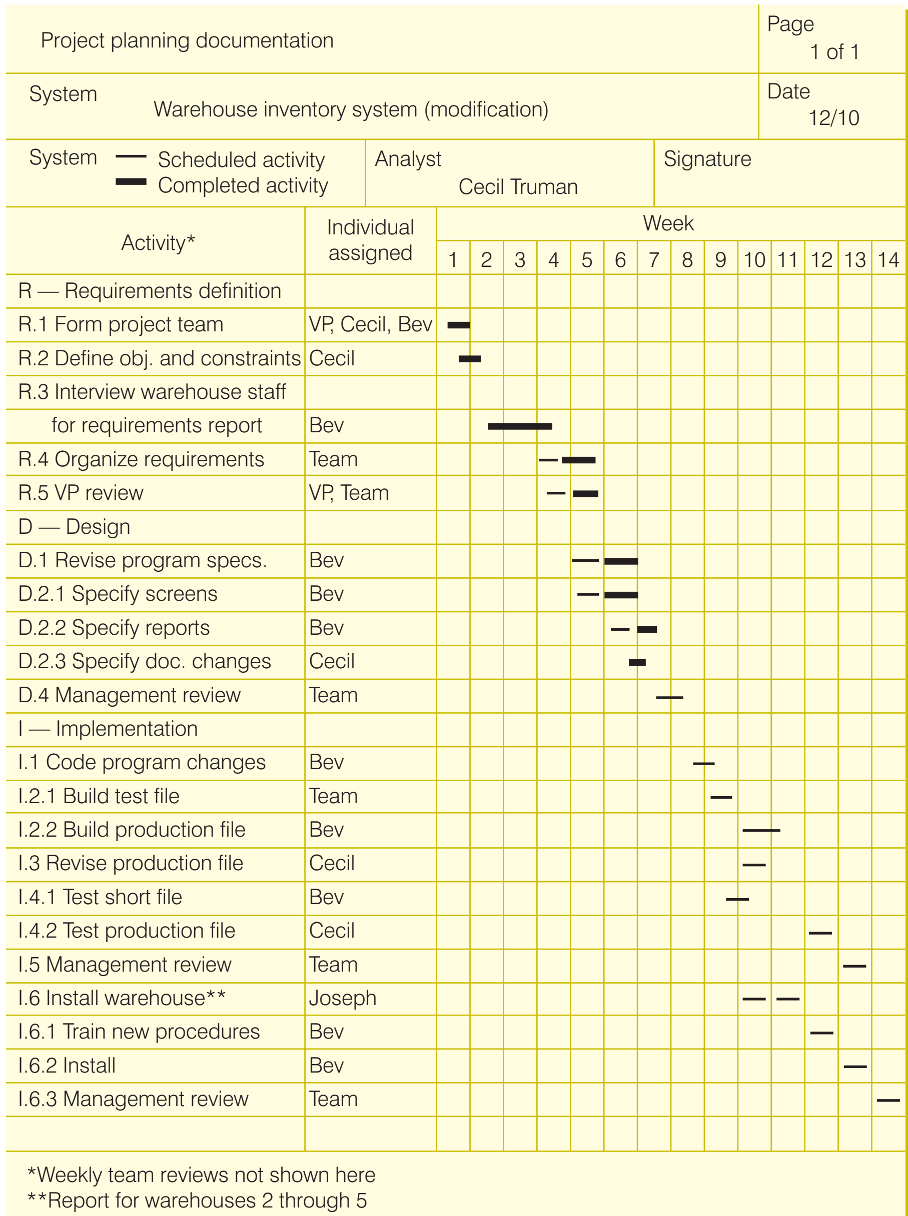


Table 11.6 Selected Project Management Software Packages

Software	Vendor
AboutTime	NetSQL Partners
Job Order	Management Software
OpenPlan	Welcom
Microsoft Project	Microsoft
Project Scheduler	Scitor
Super Project	Computer Associates

Use of Computer-Aided Software Engineering (CASE) Tools

Computer-aided software engineering (CASE) tools automate many of the tasks required in a systems development effort and encourage adherence to the SDLC, thus instilling a high degree of rigour and standardization to the entire systems development process. VRCASE, for example, is a CASE tool that a team of developers can use when developing applications in C++ and other languages. Prover Technology has developed a CASE tool that searches for programming bugs. The CASE tool searches for all possible design scenarios to make sure that the program is error free. Other CASE tools include Visible Systems (www.visible.com) and Bubble Software (www.bubble.is). Bubble is a specialist language for creating web applications and is designed for users with zero programming knowledge. Other CASE-related tools include Rational Rose from IBM and Visio, a charting and graphics program from Microsoft. Other companies that produce CASE tools include Accenture and Oracle. Oracle Designer and Developer CASE tools, for example, can help systems analysts automate and simplify the development process for database systems. See Table 11.7 for a list of CASE tools and their providers. The advantages and disadvantages of CASE tools are listed in Table 11.8. CASE tools that focus on activities associated with the early stages of systems development are often called 'upper-CASE tools'. These packages provide automated tools to assist with systems investigation, analysis and design activities. Other CASE packages, called 'lower-CASE tools', focus on the later implementation stage of systems development and can automatically generate structured program code.

computer-aided software engineering (CASE) Tools that automate many of the tasks required in a systems development effort and encourage adherence to the SDLC.

Table 11.7 Typical CASE Tools

CASE Tool	Vendor
Oracle Designer	Oracle Corporation www.oracle.com
Visible Analyst	Visible Systems Corporation www.visible.com
Rational Rose	Rational Software www.ibm.com
Embarcadero Describe	Embarcadero Describe www.embarcadero.com

Table 11.8 Advantages and Disadvantages of CASE Tools

Advantages	Disadvantages
Produce systems with a longer effective operational life	Increase the initial costs of building and maintaining systems
Produce systems that more closely meet user needs and requirements	Require more extensive and accurate definition of user needs and requirements
Produce systems with excellent documentation	Can be difficult to customize
Produce systems that need less systems support	Require more training of maintenance staff
Produce more flexible systems	Can be difficult to use with existing systems

11.4 Systems Investigation

As discussed earlier in the chapter, systems investigation is the first phase in the traditional SDLC of a new or modified business information system. The purpose is to identify potential problems and opportunities and consider them in light of the goals of the company. In general, systems investigation attempts to uncover answers to the following questions:

- What primary problems is the new system required to solve?
- What opportunities might a new or enhanced system provide?
- What new hardware, software, databases, telecommunications, personnel or procedures will improve an existing system or are required in a new system?
- What are the potential costs (variable and fixed)?
- What are the associated risks?

Initiating Systems Investigation

Because systems development requests can require considerable time and effort to implement, many organizations have adopted a formal procedure for initiating systems development, beginning with systems investigation. The systems request form is a document that is filled out by someone who wants the IS department to initiate systems investigation. This form typically includes the following information:

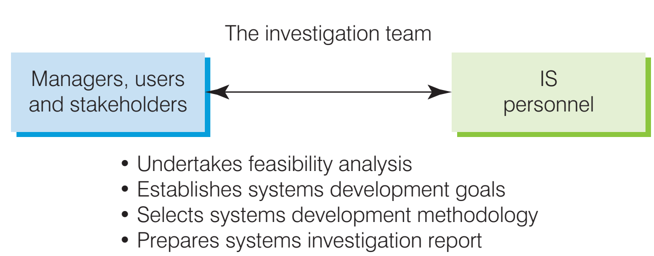
- Problems with or opportunities for the system.
- Objectives of systems investigation.
- Overview of the proposed system.
- Expected costs and benefits of the proposed system.

The information in the systems request form helps to rationalize and prioritize the activities of the IS department. Based on the overall IS plan, the organization's needs and goals, and the estimated value and priority of the proposed projects, managers make decisions regarding the initiation of each systems investigation for such projects.

Participants in Systems Investigation

After a decision has been made to initiate systems investigation, the first step is to determine what members of the development team should participate in the investigation phase of the project. Members of the development team change from phase to phase (see Figure 11.9).

Figure 11.9 The Systems Investigation Team *The team consists of upper- and middle-level managers, a project manager, IS personnel, users and stakeholders.*



Ideally, functional managers are heavily involved during the investigation phase. Other members could include users or stakeholders outside management, such as an employee who helps initiate systems development. The technical and financial expertise of others participating in investigation help the team to determine whether the problem is worth solving.

The members of the development team who participate in investigation are then responsible for gathering and analyzing data, preparing a report justifying systems development and presenting the results to top-level managers.

Feasibility Analysis

A key step of the systems investigation phase is **feasibility analysis**, which assesses technical, economic, legal, operational and schedule feasibility. **Technical feasibility** is concerned with whether the hardware, software and other system components can be acquired or developed to solve the problem.

feasibility analysis Assessment of the technical, economic, legal, operational and schedule feasibility of a project.

technical feasibility Assessment of whether the hardware, software and other system components can be acquired or developed to solve the problem.

Economic feasibility determines whether the project makes financial sense and whether predicted benefits offset the cost and time needed to obtain them. One securities company, for example, investigated the economic feasibility of sending research reports electronically instead of through the mail. Economic analysis revealed that the new approach could save the company up to €370,000 per year. Economic feasibility can involve cash flow analysis, such as that done in net present value or internal rate of return (IRR) calculations.

economic feasibility The determination of whether the project makes financial sense and whether predicted benefits offset the cost and time needed to obtain them.

Net present value is an often-used approach for ranking competing projects and for determining economic feasibility. The net present value represents the net amount by which project savings exceed project expenses, after allowing for the cost of capital and the passage of time. The cost of capital is the average cost of funds used to finance the operations of the business. Net present value takes into account that a euro returned at a later date is not worth as much as one received today, because the euro in hand can be invested to earn profits or interest in the interim. Spreadsheet programs, such as Lotus and Microsoft Excel, have built-in functions to compute the net present value and internal rate of return.

net present value The preferred approach for ranking competing projects and determining economic feasibility.

Legal feasibility determines whether laws or regulations can prevent or limit a systems development project. For example, some music sharing websites got into trouble for infringing of copyright. If legal feasibility had been conducted, it would have identified this vulnerability during the website development phase. Legal feasibility involves an analysis of existing and future laws to determine the likelihood of legal action against the systems development project and the possible consequences.

legal feasibility The determination of whether laws or regulations may prevent or limit a systems development project.

Operational feasibility is a measure of whether the project can be put into action or operation. It can include logistical and motivational (acceptance of change) considerations. Motivational considerations are important because new systems affect people and data flows and can have unintended consequences. As a result, power and politics might come into play, and some people might resist the new system. On the other hand, recall that a new system can help avoid major problems. For example, because of deadly hospital errors, a healthcare consortium looks into the operational feasibility of developing a new computerized physician order-entry system to require that all prescriptions and every order a doctor gives to staff be entered into the computer. The computer then checks for drug allergies and interactions between drugs. If operationally feasible, the new system could save lives and help avoid lawsuits.

operational feasibility The measure of whether the project can be put into action or operation.

Schedule feasibility determines whether the project can be completed in a reasonable amount of time – a process that involves balancing the time and resource requirements of the project with other projects.

schedule feasibility The determination of whether the project can be completed in a reasonable amount of time.

The Systems Investigation Report

The primary outcome of systems investigation is a **systems investigation report**, also called a feasibility study. This report summarizes the results of

systems investigation report A summary of the results of the systems investigation and the process of feasibility analysis and recommendation of a course of action.

systems investigation and the process of feasibility analysis and recommends a course of action: continue on into systems analysis, modify the project in some manner or drop it. A typical table of contents for the systems investigation report is shown in Figure 11.10.

Figure 11.10 A Typical Table of Contents for a Systems Investigation Report

Ethical and Societal Issues

The Very Last Step in Systems Development

Ultimately, the stage that happens last in any system's lifecycle is the dismantling: the software is archived, destroyed or sometimes just lost; and hardware is discarded to be replaced by something new. Between 2009 and 2014, the weight of computers, telephones, televisions and other electronic appliances that were discarded each year doubled to 42 million tonnes. Most of this makes its way to China, India and Africa. Some of the components inside these machines are scarce, which makes them valuable. They can be reused, but getting at them can cause harm to both the environment and human health through the release of materials such as lead. According to *Nature* magazine, children in one Chinese town where a disposal plant was located had on average three times the safe limit of lead in their blood, a level set by the US Center for Disease Control and Prevention.

In Europe, several directives have come into force to govern all of this. The first, aiming to increase recycling and re-use, created collection schemes where consumers can return their waste electrical and electronic equipment free of charge. Later, legislation was put into place to restrict the use of hazardous substances in electrical and electronic equipment in the first place. That legislation requires that heavy metals such as lead, mercury and cadmium, and flame retardants, be substituted for safer alternatives. But Europe only holds onto 12 per cent of the electronic waste it creates, and the countries where most of the waste ends up are not as well regulated.

Disposing of waste properly is always more expensive than just dumping it, and so in many places illegal dumping has become a lucrative business. One of the worst hit is the area of Agbogbloshie in Ghana. This has been called the world's largest electronic waste dump. On this open site, waste is burned, circuit boards are raided to salvage computer chips, copper and other saleable metals are extracted from unwanted devices and plastics are washed with dirty water before being dried and sold to buyers who turn them into plastic bags. Any saleable goods are bought either by local manufacturers or manufacturers in China.

A number of steps need to be taken to fix this, but some of the responsibility lies with consumers.

In Japan, legislation requires consumers to take no-longer-wanted products back to their manufacturers for proper disposal, and customers must pay a recycling fee. In response, councils could create eWaste re-cycling bins like those already in use in many places for plastics and garden waste. Harvard University advises its students to consider whether they really need another gadget, and to buy protective cases to prolong the life of existing electronics. They also suggest that students buy environmentally friendly technology in the first place and recycle or donate used gadgets.

Questions

1. List the electronic gadgets that you own. Can any of them do the same thing as any of the others?
2. How would you advise electronic manufacturers who wanted to make sure that none of their used equipment ends up at Agbogbloshie?
3. Should councils collect e-waste separately? Who should pay for this?
4. How would you convince users to purchase 'green gadgets', given that they are typically more expensive?

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The systems investigation report is reviewed by senior management, often organized as an advisory committee, or **steering committee**, consisting of senior management and users from the IS department and other functional areas. These people help IS personnel with their decisions about the use of information systems in the business and give authorization to pursue further systems development activities. After review, the steering committee might agree with the recommendation of the systems development team or suggest a change in project focus to concentrate more directly on meeting a specific company objective. Another alternative is that everyone might decide that the project is not feasible and cancel the project.

steering committee An advisory group consisting of senior management and users from the IS department and other functional areas.

11.5 Systems Analysis

After a project has been approved for further study, the next step is to answer the question, 'What must the information system do to solve the problem?' The process needs to go beyond mere computerization of existing systems. The entire system, and the business process with which it is associated, should be evaluated. Often, a firm can make great gains if it restructures both business activities and the related information system simultaneously. The overall emphasis of analysis is gathering data on the existing system, determining the requirements for the new system, considering alternatives within these constraints and investigating the feasibility of the solutions. The primary outcome of systems analysis is a prioritized list of systems requirements.

General Considerations

Systems analysis starts by clarifying the overall goals of the organization and determining how the existing or proposed information system helps meet them. A manufacturing company, for example, might want to reduce the number of equipment breakdowns. This goal can be translated into one or more informational needs. One need might be to create and maintain an accurate list of each piece of equipment and a schedule for preventative maintenance. Another need might be a list of equipment failures and their causes.

Analysis of a small company's information system can be fairly straightforward. On the other hand, evaluating an existing information system for a large company can be a long, tedious process. As a result, large organizations evaluating a major information system normally follow a formalized analysis procedure, involving these steps:

1 Assembling the participants for systems analysis.
2 Collecting appropriate data and requirements.
3 Analyzing the data and requirements.
4 Preparing a report on the existing system, new system requirements and project priorities.

Participants in Systems Analysis

The first step in formal analysis is to assemble a team to study the existing system. This group includes members of the original investigation team – from users and stakeholders to IS personnel and management. Most organizations usually allow key members of the development team not only to analyze the condition of the existing system but also to perform other aspects of systems development, such as design and implementation.

After the participants in systems analysis are assembled, this group develops a list of specific objectives and activities. A schedule for meeting the objectives and completing the specific activities is also devised, along with deadlines for each stage and a statement of the resources required at each stage, such as administrative personnel, supplies and so forth. Major milestones are normally established to help the team monitor progress and determine whether problems or delays occur in performing systems analysis.

Data Collection and Analysis

The purpose of data collection is to seek additional information about the problems or needs identified in the systems investigation report. During this process, the strengths and weaknesses of the existing system are emphasized.

Data collection begins by identifying and locating the various sources of data, including both internal and external sources (see Figure 11.11).

After data sources have been identified, data collection begins. Figure 11.12 shows the steps involved. Data collection might require a number of tools and techniques, such as interviews, **direct observation** and **questionnaires**.

Interviews can either be structured or unstructured. In a **structured interview**, the questions are written in advance. In an **unstructured interview**, the questions are not written in advance; the interviewer relies on experience in asking the best questions to uncover the inherent problems of the existing system. An advantage of the unstructured interview is that it allows the interviewer to ask follow-up or clarifying questions immediately.

direct observation Watching the existing system in action by one or more members of the analysis team.

questionnaires A method of gathering data when the data sources are spread over a wide geographic area.

structured interview An interview where the questions are prepared in advance.

unstructured interview An interview where the questions are not prepared in advance.

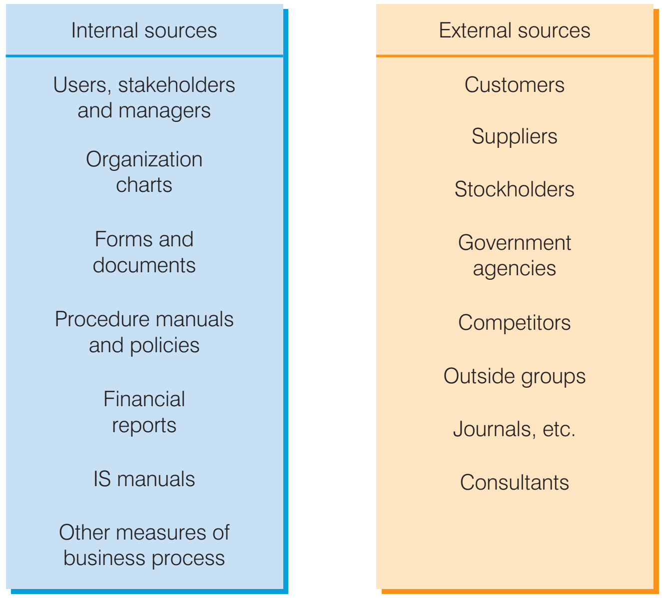


Figure 11.11 Internal and External Sources of Data for Systems Analysis

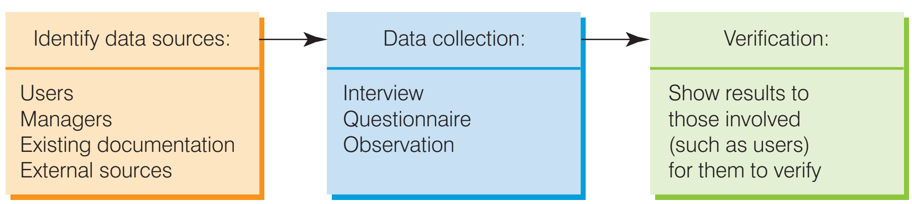


Figure 11.12 The Steps in Data Collection

With direct observation, one or more members of the analysis team directly observe the existing system in action. One of the best ways to understand how the existing system functions is to work with the users to discover how data flows in certain business tasks. Determining the data flow entails direct observation of users' work procedures, their reports, current screens (if automated already) and so on. From this observation, members of the analysis team determine which forms and procedures are adequate and which are inadequate and need improvement. Direct observation requires a certain amount of skill. The observer must be able to see what is really happening and not be influenced by attitudes or feelings. In addition, many people don't like being observed and may change their behaviour when they are. However, observation can reveal important problems and opportunities that would be difficult to obtain using other data collection methods.

When many data sources are spread over a wide geographic area, questionnaires sent to all stakeholders might be the best method. Like interviews, questionnaires can be either structured or unstructured. In most cases, a pilot study is conducted to fine-tune the questionnaire. A follow-up questionnaire can also capture the opinions of those who do not respond to the original questionnaire. Questionnaires can be used to collect data from a large number of users and make them feel part of systems development. As stated earlier, this feeling of involvement will make users less likely to resist the new system when it is installed.

Other data collection techniques can also be employed. In some cases, telephone calls are an excellent method. Activities can also be simulated to see how the existing system reacts. Thus, fake sales orders, stock shortages, customer complaints and data-flow bottlenecks can be recreated to see how the existing system responds to these situations. **Statistical sampling**, which involves taking a

statistical sampling Selecting a random sample of data and applying the characteristics of the sample to the whole group.

random sample of data, is another technique. For example, suppose that you want to collect data that describes 10,000 sales orders received over the last few years. Because it is too time consuming to analyze each of the 10,000 sales orders, you could collect a random sample of around 200 sales orders from the entire batch. You can assume that the characteristics of this sample apply to all 10,000 orders.

Data Analysis

The data collected in its raw form is usually not adequate to determine the effectiveness of the existing system or the requirements of the new system. The next step is to manipulate the collected data so that the development team members who are participating in systems analysis can use the data. This manipulation is called **data analysis**. Data and activity modelling and using data-flow diagrams and entity-relationship diagrams are useful during data analysis to show data flows and the relationships between various objects, associations and activities. Other common tools and techniques for data analysis include application flowcharts, grid charts, CASE tools and the object-oriented approach. Often two versions of the models are created – a version showing how things happen currently in the organization and another showing how they will happen after the new system has been installed.

data analysis The manipulation of collected data so that the development team members who are participating in systems analysis can use the data.

Data Modelling

Data modelling was explained in Chapter 5, along with a technique you can use to create a data model. The purpose of this model is to visualize and structure the data that the organization stores. An example data model is shown in Figure 11.13a.

Activity (or Process) Modelling

To fully describe a business problem or solution, the related objects, associations and activities must be described. Activities in this sense are events or items that are necessary to fulfil the business relationship or that can be associated with the business relationship in a meaningful way.

Activity modelling is sometimes accomplished through the use of data-flow diagrams or use case models. A **data-flow diagram (DFD)** models objects, associations and activities by describing how data can flow between and around various objects. DFDs work on the premise that every activity involves some communication, transference or flow that can be described as a data element. DFDs describe the activities that fulfil a business relationship or accomplish a business task, not how these activities are to be performed. That is, DFDs show the logical sequence of associations and activities, not the physical processes. A system modelled with a DFD could operate manually or could be computer based; if computer based, the system could operate with a variety of technologies.

data-flow diagram (DFD) A model of objects, associations and activities that describes how data can flow between and around various objects.

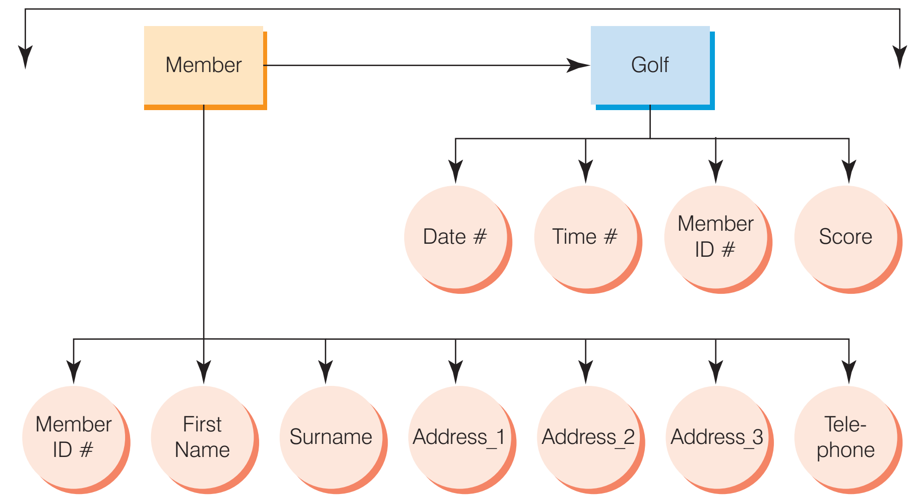
A use case model consists of two parts – a diagram showing each process and the 'actors' who use them. An actor is someone who gets something out of the process. Typical actors are customers and suppliers. 'Buy a product' is a typical process, or 'Reorder stock'. The second part of the model is a text description of each process broken down into numbered steps.

Comparing entity-relationship diagrams with data-flow diagrams provides insight into the concept of top-down design. Figures 11.13a and b show a data model and a data-flow diagram for the same business relationship – namely, a member of a golf club playing golf. Figure 11.13c provides a brief description of the business relationship for clarification.

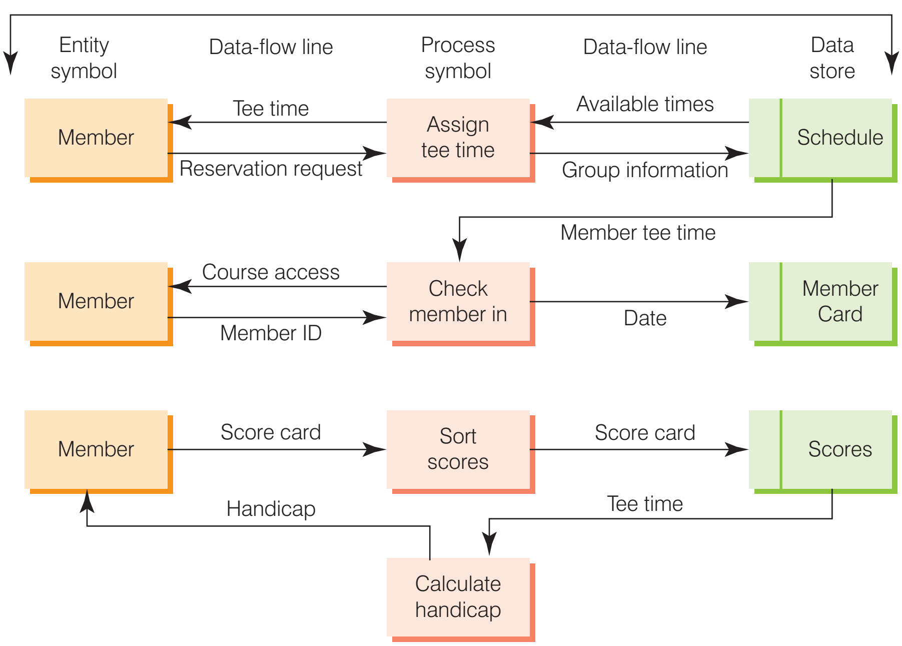
Application Flowcharts

Application flowcharts show the relationships between applications or systems. Let's say that a small business has collected data about its order processing, inventory control, invoicing

(a)



(b)



(c)

To play golf at the course, you must first pay a fee to become a member of the golf club. Members are issued with member cards and are assigned member ID numbers. To reserve a tee time (a time to play golf), a member calls the club house at the golf course and arranges an available time slot with the reception clerk. The reception clerk reserves the tee time by writing the member's name and number of players in the group on the course schedule. When a member arrives at the course, he or she checks in at the reception desk where the reception clerk checks the course schedule and notes the date on the member's card. After a round of golf has been completed, the members leave their score cards with the reception clerk. Member scores are tracked and member handicaps are updated on a monthly basis.

Figure 11.13 Sample Data Model, Data-Flow Diagram and Description *This model shows a data model, data-flow diagram and brief description of the business relationship for a member of a golf club playing golf.*

and marketing analysis applications. Management is thinking of modifying the inventory control application. The raw facts collected, however, do not help in determining how the applications are related to each other and the databases required for each. These relationships are established through data analysis with an application flowchart (see Figure 11.14). Using this tool for data analysis makes clear the relationships between the order processing functions.

In the simplified application flowchart in Figure 11.14, you can see that the telephone order administrator provides important data to the system about items such as versions, quantities and prices. The system calculates sales tax and order totals. Any changes made to this order processing system could affect the company's other systems, such as inventory control and marketing.

Grid Charts

A grid chart is a table that shows relationships between various aspects of a systems development effort. For example, a grid chart can reveal the databases used by the various applications (see Figure 11.15).

The simplified grid chart in Figure 11.15 shows that the customer database is used by the order processing, marketing analysis and invoicing applications. The inventory database is used by the order processing, inventory control and marketing analysis applications. The supplier database is used by the inventory control application, and the accounts receivable database is used by the invoicing application. This grid chart shows which applications use common databases and reveals that, for example, any changes to the inventory control application must investigate the inventory and supplier databases.

CASE Tools

As discussed earlier, many systems development projects use CASE tools to complete analysis tasks. Most CASE tools have generalized graphics programs that can generate a variety of diagrams and figures. Entity-relationship diagrams, data-flow diagrams, application flowcharts and other diagrams can be developed using CASE graphics programs to help describe the existing system. During the analysis phase, a CASE repository – a database of system descriptions, parameters and objectives – will be developed.

Requirements Analysis

The overall purpose of requirements analysis is to determine user, stakeholder and organizational needs. For an accounts receivable application, the stakeholders could include suppliers and members of the purchasing department. An accounts manager might want a better procedure for tracking the amount owed by customers. Specifically, the manager wants a weekly report that shows all customers who owe more than €1,000 and are more than 90 days past due on their account. A financial manager might need a report that summarizes total amount owed by customers to consider whether to loosen or tighten credit limits. A sales manager might want to review the amount owed by a key customer relative to sales to that same customer. The purpose of requirements analysis is to capture these requests in detail. Questions that should be asked during requirements analysis include the following:

- Are these stakeholders satisfied with the current accounts application?
- What improvements could be made to satisfy suppliers and help the purchasing department?

One of the most difficult procedures in systems analysis is confirming user or systems requirements. In some cases, communications problems can interfere with determining these requirements. Numerous tools and techniques can be used to capture systems requirements. In addition to the data collection techniques already discussed (interview, questionnaire, etc.), others can be used in the context of a JAD session to determine system requirements.

Figure 11.14 A Telephone Order Process Application Flowchart

The flowchart shows the relationships between various processes.

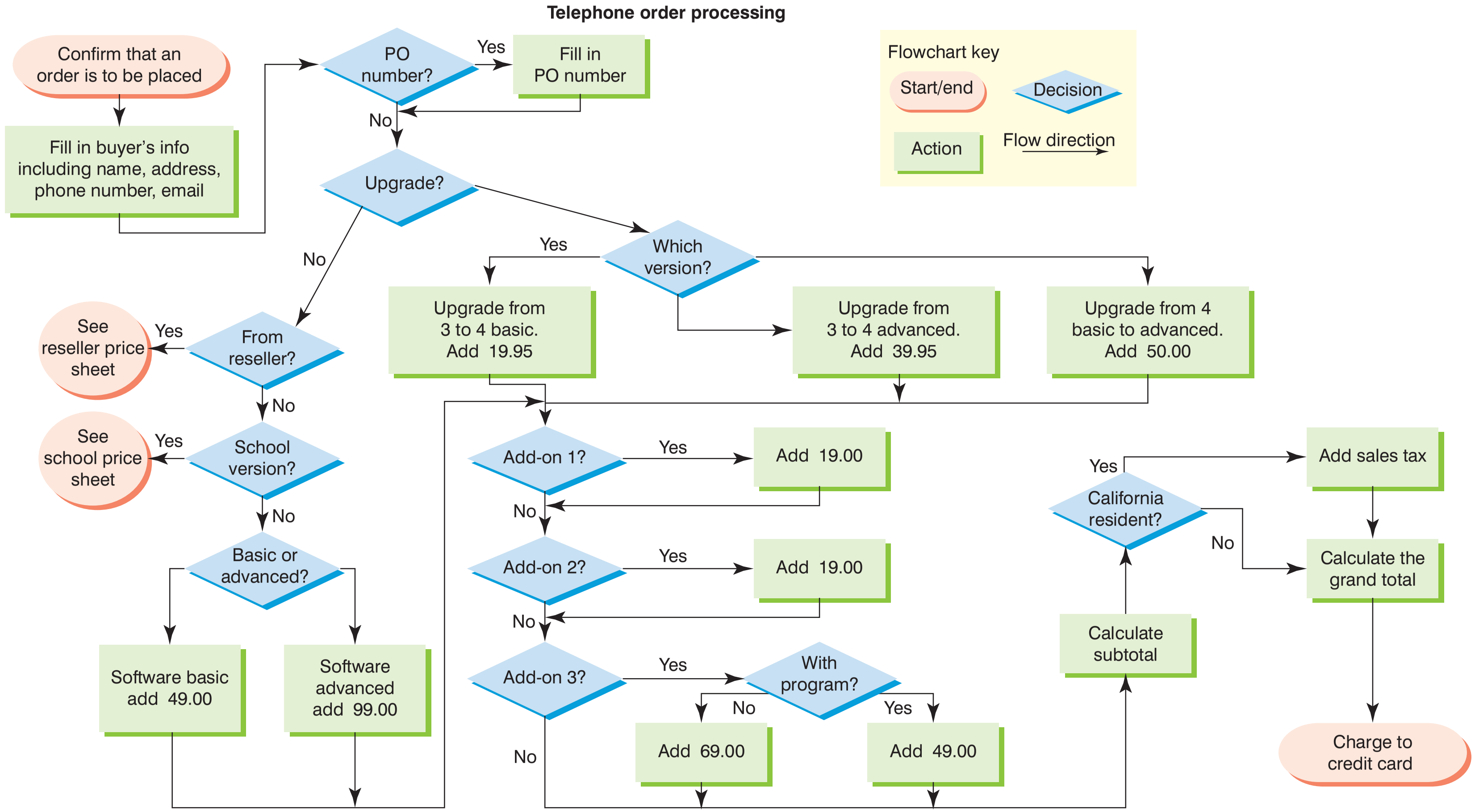


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Figure 11.15 A Grid Chart *The chart shows the relationships between applications and databases.*

Databases → / Applications ↓	Customer database	Inventory database	Supplier database	Accounts receivable database
Order processing application	X	X		
Inventory control application		X	X	
Marketing analysis application	X	X		
Invoicing application	X			X

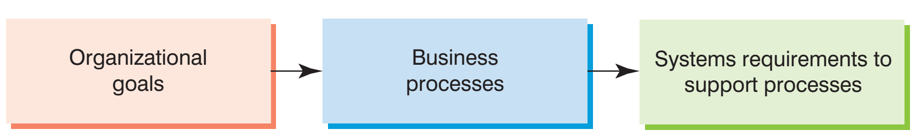
Critical Success Factors

Managers and decision makers are asked to list only the factors that are critical to the success of their area of the organization. A critical success factor (CSF) for a production manager might be adequate raw materials from suppliers; a CSF for a sales representative could be a list of customers currently buying a certain type of product. Starting from these CSFs, the system inputs, outputs, performance and other specific requirements can be determined.

The IS Plan

As we have seen, the IS plan translates strategic and organizational goals into systems development initiatives. The IS planning process often generates strategic planning documents that can be used to define systems requirements. Working from these documents ensures that requirements analysis will address the goals set by top-level managers and decision makers (see Figure 11.16). There are unique benefits to applying the IS plan to define systems requirements. Because the IS plan takes a long-range approach to using information technology within the organization, the requirements for a system analyzed in terms of the IS plan are more likely to be compatible with future systems development initiatives.

Figure 11.16 Converting Organizational Goals into Systems Requirements



Screen and Report Layout

Developing formats for printed reports and screens to capture data and display information are some of the common tasks associated with developing systems. Screens and reports relating to systems output are specified first to verify that the desired solution is being delivered. Manual or computerized screen and report layout facilities are used to capture both input and output requirements.

Using a screen layout, a designer can quickly and efficiently design the features, layout and format of a display screen. In general, users who interact with the screen frequently can be presented with more data and less descriptive information; infrequent users should have more descriptive information presented to explain the data they are viewing (see Figure 11.17).

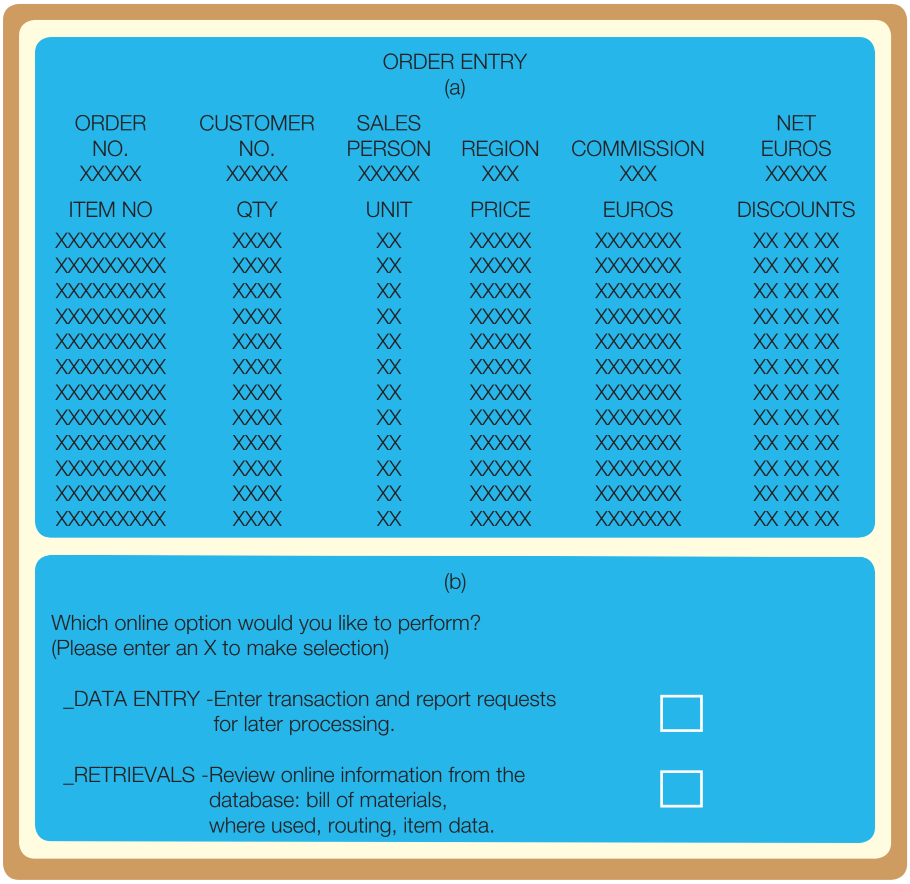


Figure 11.17 Screen Layouts *(a) A screen layout chart for frequent users who require little descriptive information. (b) A screen layout chart for infrequent users who require more descriptive information.*

Report layout allows designers to diagram and format printed reports. Reports can contain data, graphs or both. Graphic presentations allow managers and executives to quickly view trends and take appropriate action, if necessary.

Screen layout diagrams can document the screens, users, and the desire for the new or modified application. Report layout charts reveal the format and content of various reports that the application will prepare. Other diagrams and charts can be developed to reveal the relationship between the application and outputs from the application.

Requirements Analysis Tools

A number of tools can be used to document requirements analysis, including CASE tools. As requirements are developed and agreed on, entity-relationship diagrams, data-flow diagrams, screen and report layout forms, and other types of documentation are stored in the CASE repository. These requirements might also be used later as a reference during the rest of systems development or for a different systems development project.

Object-Oriented Systems Analysis

An alternative to analyzing the existing system using data-flow diagrams and flowcharts is the object-oriented approach to systems analysis. Like traditional analysis, problems or potential opportunities are identified during object-oriented analysis. Identifying key participants and collecting data are still performed.

With the object-oriented approach, systems analysts are looking for classes – things within the system that have data and action – rather than entities (see Chapter 5). These classes are then modelled with the messages and data that flow between them, and this model is used to capture the requirements of the new system. An order processing administrator might be a class – they have data (the order) and action (they input the data into the computer). The term 'object' refers to an instance of a class; in this case, the class is the order processing administrator, whereas 'Bill Jones', who happens to be an order processing administrator, is an object.

In object-oriented systems analysis, all the classes in the system are identified and how they work together to solve a problem is documented. A class could be a piece of software or a human.

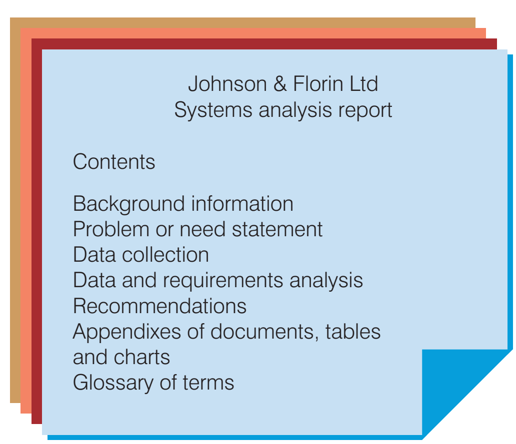
The Systems Analysis Report

Systems analysis concludes with a formal systems analysis report. It should cover the following elements:

- The strengths and weaknesses of the existing system from a stakeholder's perspective.
- The user/stakeholder requirements for the new system (also called the functional requirements).
- The organizational requirements for the new system.
- A description of what the new information system should do to solve the problem.

Suppose analysis reveals that a marketing manager thinks a weakness of the existing system is its inability to provide accurate reports on product availability. These requirements and a preliminary list of the corporate objectives for the new system will be in the systems analysis report. Particular attention is placed on areas of the existing system that could be improved to meet user requirements. The table of contents for a typical report is shown in Figure 11.18.

Figure 11.18 **A Typical Table of Contents for a Report on an Existing System**



The systems analysis report gives managers a good understanding of the problems and strengths of the existing system. If the existing system is operating better than expected or the necessary changes are too expensive relative to the benefits of a new or modified system, the systems development process can be stopped at this stage. If the report shows that changes to another part of the system might be the best solution, the development process might start over, beginning again with systems investigation. Or, if the systems analysis report shows that it will be beneficial to develop one or more new systems or to make changes to existing ones, systems design, which is discussed in the next chapter, begins.

Understanding Software Bias

The world's big employers tour universities each year looking for the most talented graduates to employ. Each employer receives thousands of applications every year and must assess each fairly to choose between them. It is an expensive, time-consuming process. Consumer goods manufacturer Unilever, for example, has a Future Leaders Programme which selects recent university graduates and offers them a career. Unilever is looking for 800 individuals from a pool of 250,000 applicants.

In a controversial move, employers like this are turning to artificial intelligence to help. Unilever now videos its interviews. The videos are then assessed by an AI. The AI examines facial expression, body language and word choice and predicts which candidates are destined for job success. Candidates are given full disclosure about the system before their interview and currently they can choose whether they want to be assessed by a human or a computer, although in either case a human is involved. The system was developed by a company called Hire Vue, who said, 'Candidates received and provided feedback at each step of the process, even if they were not ultimately selected for a position. In just one year, the Unilever team saved over £1 million, reduced recruiting time by 75%, and hired their most ethnically and gender diverse class to date'.[23]

The point about ethnicity and gender is timely. There are currently major concerns about whether the decisions made by automatic classification systems are racist or sexist. First of all, why would they be? There are two main ways that AIs gain their intelligence: supervised and unsupervised learning. With supervised learning, the AI is given data that contains the correct answer to a series of questions. In the case of a company wanting to assess job candidates, the AI would be shown candidates from previous years and told whether each was offered a job. Here the question is 'should we offer a job?' and the correct answer is either 'yes' or 'no'; but what if the human interviewers had for all those years been biased themselves? What if the interviewer had a preference to hire white men? This bias would then be in the training data and the AI would learn to be biased itself. This is a big enough problem that Google has initiated a Machine Learning Fairness initiative to openly explain what it is doing to deal with this issue.[24]

Summary

Effective systems development requires a team effort from stakeholders, users, managers, systems development specialists and various support personnel, and it starts with careful planning. The systems development team consists of stakeholders: users, managers, systems development specialists and various support personnel. The development team determines the objectives of the information system and delivers to the organization a system that meets its objectives.

A systems analyst is a professional who specializes in analyzing and designing business systems. The programmer is responsible for modifying or developing programs to satisfy user requirements. Other support personnel on the development team include technical specialists, either IS department employees or outside consultants. Depending on the magnitude of the systems development project and the number of IS development specialists on the team, the team might also include one or more IS managers. At some point in your career, you will likely be a participant in systems development. You could be involved in a systems development team as a user, as a manager of a business area or project team, as a member of the IS department, or maybe even as a CIO.

Systems development projects are initiated for many reasons, including the need to solve problems with an existing system, to exploit opportunities to gain competitive advantage, to increase competition, to make use of effective information, to create organizational growth, to settle a merger or corporate acquisition, or to address a change in the market or external environment. External pressures, such as potential lawsuits or terrorist attacks, can also prompt an organization to initiate systems development.

Information systems planning refers to the translation of strategic and organizational goals into systems development initiatives. Benefits of IS planning include a long-range view of information technology use and better use of IS resources. Planning requires developing overall IS objectives; identifying IS projects; setting priorities and selecting projects; analyzing resource requirements; setting schedules, milestones and deadlines; and developing the IS planning document. IS planning can result in a competitive advantage through creative and critical analysis.

Establishing objectives for systems development is a key aspect of any successful development project. Critical success factors (CSFs) can identify important objectives. Systems development objectives can include performance goals (quality and usefulness of the output and the speed at which output is generated) and cost objectives (development costs, fixed costs and ongoing investment costs).

Systems development often uses tools to select, implement and monitor projects, including prototyping, rapid application development, CASE tools and object-oriented development. The five phases of the traditional SDLC are investigation, analysis, design, implementation, and maintenance and review. Systems investigation identifies potential problems and opportunities and considers them in light of organizational goals. Systems analysis seeks a general understanding of the solution required to solve the problem; the existing system is studied in detail and weaknesses are identified. Systems design creates new, or modifies existing, systems requirements. Systems implementation encompasses programming, testing, training, conversion and operation of the system. Systems maintenance and review entails monitoring the system and performing enhancements or repairs.

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Advantages of the traditional SDLC include the following: it provides for maximum management control, creates considerable system documentation, ensures that system requirements can be traced back to stated business needs and produces many intermediate products for review. Its disadvantages include the following: users may get a system that meets the needs as understood by the developers, the documentation is expensive and difficult to maintain, users' needs go unstated or might not be met, and users cannot easily review the many intermediate products produced.

Prototyping is an iterative approach that involves defining the problem, building the initial version, having users work with and evaluate the initial version, providing feedback and incorporating suggestions into the second version. Prototypes can be fully operational or non-operational, depending on how critical the system under development is and how much time and money the organization has to spend on prototyping.

Rapid application development (RAD) uses tools and techniques designed to speed application development. Its use reduces paper-based documentation, automates program source code generation and facilitates user participation in development activities. RAD can use newer programming techniques, such as agile development or extreme programming. RAD makes extensive use of the joint application development (JAD) process to gather data and perform requirements analysis. JAD involves group meetings in which users, stakeholders and IS professionals work together to analyze existing systems, propose possible solutions and define the requirements for a new or modified system.

The term 'end-user systems development' describes any systems development project in which the primary effort is undertaken by a combination of business managers and users.

Many companies hire an outside consulting firm that specializes in systems development to take over some or all of its systems development activities. This approach is called 'outsourcing'. Reasons for outsourcing include a company's belief that they can cut costs, achieve a competitive advantage without having the necessary IS personnel in-house, obtain state-of-the-art technology, increase their technological flexibility and proceed with development despite downsizing. Many companies offer outsourcing services, including computer vendors and specialized consulting companies.

A number of factors affect systems development success. The degree of change introduced by the project, continuous improvement and reengineering, the use of quality programs and standards, organizational experience with systems development, the use of project management tools, and the use of CASE tools and the object-oriented approach are all factors that affect the success of a project. The greater the amount of change a system will endure, the greater the degree of risk and often the amount of reward. Continuous improvement projects do not require significant business process or IS changes, while reengineering involves fundamental changes in how the organization conducts business and completes tasks. Successful systems development projects often involve such factors as support from top management, strong user involvement, use of a proven methodology, clear project goals and objectives, concentration on key problems and straightforward designs, staying on schedule and within budget, good user training, and solid review and maintenance programs. Quality standards, such as ISO 9001, can also be used during the systems development process.

The use of automated project management tools enables detailed development, tracking and control of the project schedule. Effective use of a quality assurance process enables the project manager to deliver a high-quality system and to make intelligent trade-offs between cost, schedule and quality. CASE tools automate many of the systems development tasks, thus reducing an analyst's time and effort while ensuring good documentation. Object-oriented systems development can also be an important success factor. With the object-oriented systems development (OOSD) approach, a project can be broken down into a group of objects that interact. Instead of requiring thousands or millions of lines of detailed computer instructions or code, the systems development project might require a few dozen or maybe a hundred objects.

Systems development starts with investigation and analysis of existing systems. In most organizations, a systems request form initiates the investigation process. The systems investigation is designed to assess the feasibility of implementing solutions for business problems, including technical, economic, legal, operations and schedule feasibility. Net present value analysis is often used to help determine a project's economic feasibility. An investigation team follows up on the request and performs a feasibility analysis that addresses technical, economic, legal, operational and schedule feasibility.

If the project under investigation is feasible, major goals are set for the system's development, including performance, cost, managerial goals and procedural goals. Many companies choose a popular methodology so that new IS employees, outside specialists and vendors will be familiar with the systems development tasks set forth in the approach. A systems development methodology must be selected. Object-oriented systems investigation is being used to a greater extent today.

Systems analysis is the examination of existing systems, which begins after a team receives approval for further study from management. Additional study of a selected system allows those involved to further understand the system's weaknesses and potential areas for improvement. An analysis team is assembled to collect and analyze data on the existing system.

Data collection methods include observation, interviews, questionnaires and statistical sampling. Data analysis manipulates the collected data to provide information. The analysis includes grid charts, application flowcharts and CASE tools. The overall purpose of requirements analysis is to determine user and organizational needs.

Data analysis and modelling is used to model organizational objects and associations using text and graphical diagrams. It is most often accomplished through the use of entity-relationship (ER) diagrams. Activity modelling is often accomplished through the use of data-flow diagrams (DFD) that model objects, associations and activities by describing how data can flow between and around various objects. DFD use symbols for data flows, processing, entities and data stores. Application flowcharts, grid charts and CASE tools are also used during systems analysis.

Requirements analysis determines the needs of users, stakeholders and the organization in general. Asking directly, using CSFs and determining requirements from the IS plan can be used. Often, screen and report layout charts are used to document requirements during systems analysis.

Like traditional analysis, problems or potential opportunities are identified during object-oriented analysis.

Self-Assessment Test

1. __________ is the activity of creating or modifying existing business systems. It refers to all aspects of the process – from identifying problems to be solved or opportunities to be exploited, to the implementation and refinement of the chosen solution.
2. Which of the following people ultimately benefit from a systems development project?
   a. computer programmers
   b. systems analysts
   c. stakeholders
   d. senior-level manager
3. What factors are essential to the success of certain functional areas of an organization?
   a. critical success factors
   b. systems analysis factors
   c. creative goal factors
   d. systems development factors
4. What employs tools, techniques and methodologies designed to speed application development?
   a. rapid application development
   b. joint optimization
   c. prototyping
   d. extended application development
5. System performance is usually determined by factors such as fixed investments in hardware and related equipment. True or false?
6. __________ takes an iterative approach to the systems development process. During each iteration, requirements and alternative solutions to the problem are identified and analyzed, new solutions are designed and a portion of the system is implemented.
7. Joint application development involves group meetings in which users, stakeholders and IS professionals work together to analyze existing systems, propose possible solutions and define the requirements for a new or modified system. True or false?
8. Feasibility analysis is typically done during which systems development stage?
   a. investigation
   b. analysis
   c. design
   d. implementation
9. Data modelling is most often accomplished through the use of __________, whereas activity modelling is often accomplished through the use of __________.
10. The overall purpose of requirements analysis is to determine user, stakeholder and organizational needs. True or false?

Review Questions

1. What is an IS stakeholder?
2. What is the goal of IS planning? What steps are involved in IS planning?
3. What are the typical reasons to initiate systems development?
4. What is the difference between a programmer and a systems analyst?
5. Why is it important to identify and remove errors early in the systems development lifecycle?
6. Identify four reasons that a systems development project might be initiated.
7. List factors that have a strong influence on project success.
8. What is the difference between systems investigation and systems analysis?
9. How does the JAD technique support the RAD systems development lifecycle?
10. Describe some of the models that are used to document systems analysis.

Discussion Questions

1 What are some of the challenges facing software engineers developing software for businesses?

2 How might a prototype improve communication between developers and users?

Web Exercises

1 Search for information about IT failures in the public sector. Write a short report detailing what went wrong.

2 Search for current entry level systems analyst jobs. What skills are employers looking for?

Case One

Hackathon Culture

A large room – a bit like (or perhaps exactly like) a school gym – is full of tables laden with laptops and empty cans of Red Bull. People – invariably young people – are sleeping against the walls and in corners while others are tapping at keyboards, like they have been since 10 am. It's now 2.30 am. the following morning and there's still a long way to go before the final pitch. There have been social activities to ease the stress, but not now. Now is the time to code, assuming you still can. This is a 'hackathon'.

'It's a big party', says Mr Rajagopalan, who directs the University of Michigan's hackathon, MHacks. 'At MHacks, we had therapy dogs come just so people could pet puppies.' Hackathons have evolved and continue to do so, but most commonly they are software contests: pitch, program and present a working system in a matter of hours.

Starting as educational events to encourage interest in software development, hackathons have become common even among professional developers, emerging as prime places for networking, job recruiting, entrepreneurial pitching and, in many cases, winning funding. One hackathon which was sponsored by the technology company Salesforce, famously gave $1 million to the team with the best project, and a famous event was recreated in the Facebook film *The Social Network*. Weekend hackathons are now common and each has its own goal. BeMyApp aims to develop a mobile app in 48 hours. Others have a civil theme, to make use of open government data and improve healthcare. Software created in this category has included apps to remind people to take medication, and apps to provide health professionals with access to drug dosage information through their mobile phones. In 2017, Salesforce organized a hackathon for teenagers to design housing solutions using virtual reality. Based in Switzerland, the event was timed to coincide with the World Economic Forum.

It's rare, but sometimes a hackathon will be a life-changing event for an attendee. Universities have hosted events that perversely have led to their students dropping out to focus on their software full time. 'I'm kind of bummed 'cause I couldn't work on it as much as I wanted because of homework and college applications', says Veeral Patel, author of a best-selling iPhone app at MHacks. Mr Patel has been admitted to Stanford University. Some universities informally cater to the kinds of students who participate in hackathons, either by allowing a gap year or providing less structured learning which allows coding to be fitted in.

Questions

1. Why would professional developers get involved in hackathons?
2. Other than producing software, what else could hackathons produce?
3. Is the event not desperately unhealthy?
4. Would this be a good way to recruit other roles, not just developers?

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Case Two

Failover from Amazon

As one of the most recognized Internet brands in the world, Amazon's web technology has to be as bullet proof as it possibly can be. With two decades of experience delivering this, Amazon's Relational Database Service brings their technology and expertise to other companies. Amazon RDS is a web service that allows customers to set up, operate and scale a relational database in the Amazon cloud. It provides a cost-efficient, resizeable capacity for an industry-standard relational database and manages common database administration tasks. There are no setup fees and customers are charged based on the amount of storage and number of read/write requests per month.

If a crucial database fails, a back-up should kick in immediately, something referred to as 'failover'. Failover automatically switches to a synchronized standby database in the event of the loss of the primary database. Amazon RDS automatically provides and maintains a synchronous standby replica in a different Availability Zone. Amazon's cloud services are housed in data centres all over the world, and each of them, called an Availability Zone, is independent of all the others. Storing databases in separate Availability Zones protects them from failure in a single location.

The way that failover works is that a piece of software referred to as the Observer monitors two databases at all times looking for problems with either of them. Problems include input/output errors, loss of network connection such that the Observer can no longer communicate with them, or a database shutdown. If a problem is detected with the primary database, the Observer first of all checks that the standby database is fully synchronized, that is, it's fully up to date. If it's not fully up to date, for instance if it doesn't store the most recent transaction, then that transaction would be lost after failover. If the standby database is synchronized, then failover goes ahead. If it's not, then failover does not happen and the engineers are alerted.

Following failover, the Observer periodically attempts to contact the old primary database. If a reconnection to the old primary database is made, the Observer automatically reinstates the old primary database so that it can become a new standby database to the new primary database. This quickly restores high availability to the data guard configuration.

An automatic failover system is important when information technology is critical – where any downtime results in lost production, lost business, lost revenue generation and reduced customer satisfaction. Services like RDS provide good business continuity.

Questions

1 Why would you want to store databases in physically separate zones?

2 List some industries where automatic failover is important.

3 What are some of the problems Amazon would face if their databases went down?

4 Do you think this system would be suitable for small businesses?

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Case Three

The Internet of Bananas 1.0

Mitchel Resnick is the LEGO Papert Professor of Learning Research at the MIT Media Lab and spends his time developing new technologies and activities to encourage people of all ages – but especially children – to engage in creative learning experiences. He heads up MIT's Lifelong Kindergarten group. 'Unfortunately, most children don't get the opportunity to engage in ... creative activities', he says. 'In school, they learn specific facts and skills, but rarely get the opportunity to design things, or to learn about the process of designing things. Outside school, they interact with electronic toys and games, but they don't learn how to invent new ones.'

The Lifelong Kindergarten group is trying to change that. Their goal is to build a world full of playfully creative people who are constantly inventing new opportunities for themselves and their communities.

Professor Resnick was doctoral supervisor to two students, Jay Silver and Eric Rosenbaum, who wanted to enable people to, in their words, 'create the future and change the world'. They decided to dedicate their lives to making easy-to-use invention kits.

Their first is the Makey Makey (see Figure 11.19). It started out as Lifelong Kindergarten research but has turned into both a business and a project with thousands of community collaborators. It's a little circuit board that sends signals to a computer as if they were coming from any normal USB keyboard. It can generate the same signals that the space bar and arrow keys send. The unit works through opening and closing circuits, just like any other button. The difference is that objects are connected to the circuit board with alligator clips and wires. If the object is conducive enough, when someone touches it, it sends a signal to the computer.

So let's say a child hooks up a tin can with a clip and attaches the other end of the wire to the space

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bar signal generator. Then every time someone touches the can, it's as if they pressed the space bar on their keyboard. The space bar and arrow keys give enough functionality to experiment with the unit, and in fact many games can be played using only these keys. Any number of objects can be connected, including fruit, so bananas can now be connected to the Internet!

Makey Makey works on Windows, Mac, Chromebook and Linux, and is very safe. A lot of Makey Makey projects involve water, and that is OK because it is powered by a USB connection and not from mains electricity. A lot of projects hook up Makey Makey to a drum generator, so they can play beats by touching different objects. People have even drawn a drum kit on paper using a graphite pencil and started to play! You could connect some to your feet to play drum beats as you dance.

Questions

1 What would you do with Makey Makey?

2 Can you think of any serious applications for Makey Makey?

3 What basic skills do you think inventors of the future need?

4 What use is 'play' when developing a serious application?

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Figure 11.19 Makey Makey

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12

Systems Design and Implementation

Principles

Designing new systems or modifying existing ones should always help an organization achieve its goals.

Learning Objectives

- State the purpose of systems design and discuss the differences between logical and physical systems design.
- Describe some considerations in design modelling and the diagrams used during object-oriented design.
- Outline key considerations in interface design and control and system security and control.
- Define the term 'RFP' and discuss how this document is used to drive the acquisition of hardware and software.
- Describe the techniques used to make systems selection evaluations.

The primary emphasis of systems implementation is to make sure that the right information is delivered to the right person in the right format at the right time.

- State the purpose of systems implementation and discuss the activities associated with this phase of systems development.
- List the advantages and disadvantages of purchasing versus developing software.
- Discuss the software development process and some of the tools used in this process, including object-oriented program development tools.

Maintenance and review add to the useful life of a system but can consume large amounts of resources. These activities can benefit from the same rigorous methods and project management techniques applied to systems development.

- State the importance of systems and software maintenance and discuss the activities involved.
- Describe the systems review process.

Why Learn About Systems Design and Implementation?

The previous chapter talked about how problems are analyzed. This chapter looks at how this analysis can be used to design and build IT solutions. The chapter mainly looks at developing a new system but also examines solving a problem by buying an existing information system that has already been developed.

Information systems are used in every industry and almost every career. A manager at a hotel chain can use an information system to look up client preferences. An accountant at a manufacturing company can use an information system to analyze the costs of a new plant. A computer engineer can use an information system to help determine why a computer system is running slowly. This chapter shows how you can be involved in designing and implementing an information system that will directly benefit you, and the options your company has for acquiring a new IS. It also shows how to avoid errors or recover from disasters. The way an information system is designed, implemented and maintained profoundly affects the daily functioning of an organization. Like systems investigation and analysis covered in the last chapter, design, implementation, maintenance and review (all covered in this chapter) strive to achieve organizational goals, such as reducing costs, increasing profits or improving customer service. The goal is to develop a new or modified system to deliver the right information to the right person at the right time.

12.1 Systems Design

systems design A stage of systems development where a solution to the problem is planned out and documented.

The purpose of **systems design** is to answer the question 'How will the information system solve the problem?' The primary result of the systems design phase is a technical design that details system inputs and the processing required to produce outputs, user interfaces, hardware, software, databases, telecommunications, personnel and procedures, and shows how these components are related.[1] The system that is designed should meet all the requirements specified during the analysis phase (explained in the previous chapter), overcome the shortcomings of the existing system and help the organization achieve its goals. Two key aspects of systems design are logical and physical design.

logical design A description of the functional requirements of a system.

The **logical design** refers to what the system will do. Logical design describes the functional requirements of a system. That is, it conceptualizes what the system will do to solve the problems identified through earlier analysis. Without this step, the technical details of the system (such as which hardware devices should be acquired) often obscure the best solution. Logical design involves planning the purpose of each system element, independent of hardware and software considerations. The logical design specifications that are determined and documented include output, input, process, file and database, telecommunications, procedures, controls and security, and personnel and job requirements.

physical design The specification of the characteristics of the system components necessary to put the logical design into action.

The **physical design** refers to how the tasks are accomplished, including how the components work together and what each component does. Physical design specifies the characteristics of the system components necessary to put the logical design into action. In this phase, the characteristics of the hardware, software, database, telecommunications, personnel, and procedure and control specifications must be detailed.

There are a number of notations that can be used to document the design stage. Data-flow diagrams and class diagrams (mentioned in the previous chapter) are used, as is the notation shown in Chapter 5 for illustrating a data model. Sequence diagrams are used in object-oriented systems design to illustrate how messages pass between objects and to show the sequence of events in a process. Programmers use various notations to design the code that they will write.

Interface Design and Controls

Some special system characteristics should be considered during both logical and physical design. These characteristics relate to how users access and interact with the system. For example, with a **menu-driven system** (see Figure 12.1), users simply pick what they want to do from a list of alternatives. Most people can easily operate these types of systems and are familiar with them. They select an option or respond to questions (or prompts) from the system, and the system does the rest. An alternative is a command line interface such as that shown in Figure 12.2. **Command line interfaces** involve users typing commands at a prompt. For example, typing the name of a software package opens it.

menu-driven system A system in which users simply pick what they want to do from a list of alternatives.

command line interfaces An interface where the user types text commands to the computer.

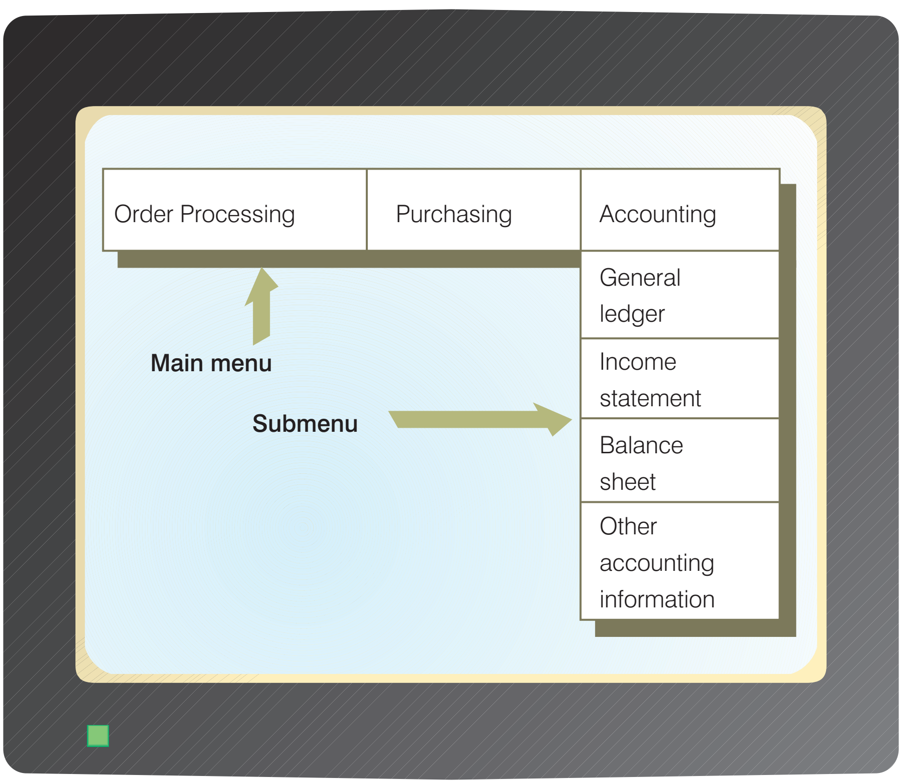
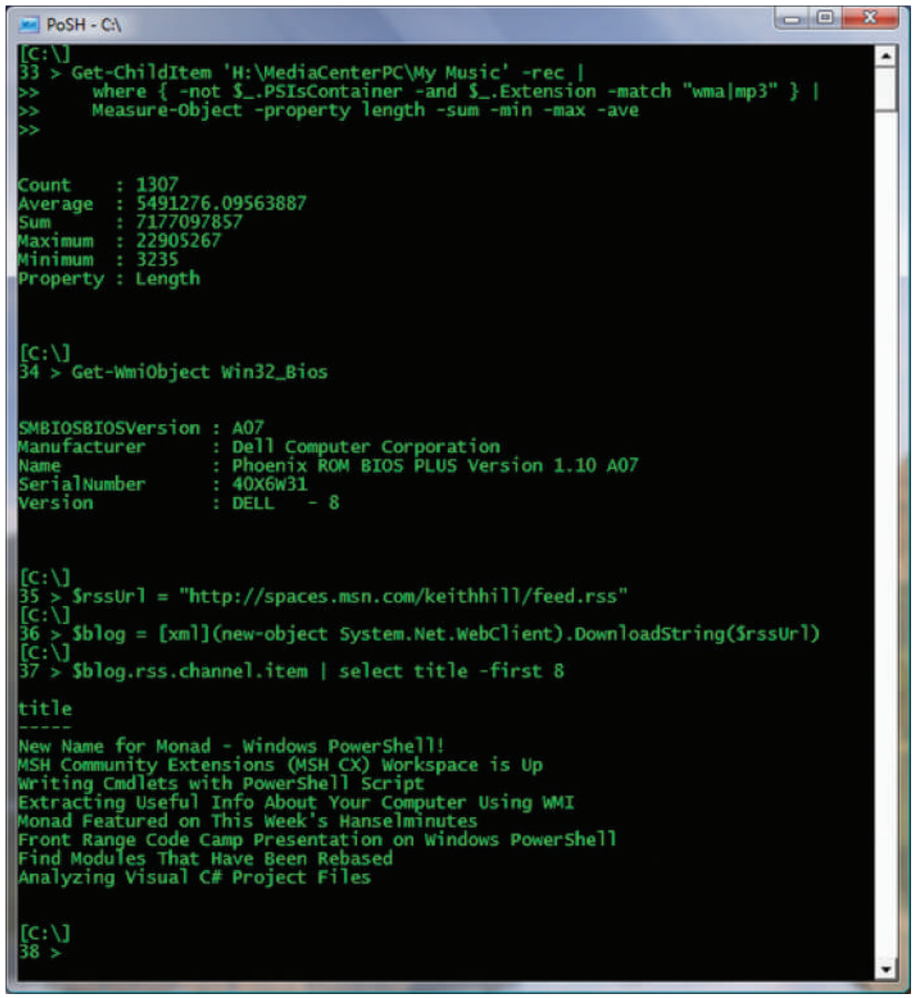


Figure 12.1
Menu-Driven System

Some other interface considerations are whether or not to include interactive help, whether the interface should be 2D or 3D, whether or not to use virtual reality, a touch screen or a keyboard, and whether to include procedures to help with data entry. Such procedures include spell checking and lookup tables. For example, if you are entering a sales order for a company, you can type its abbreviation, such as ABCO. The program will then go to the customer table, normally stored on a disc, and look up all the information pertaining to the company abbreviated ABCO that you need to complete the sales order. Other data entry control includes a presence check, which you may have experienced when you've tried to submit an order to an e-commerce website but forgot to enter your email address – the system makes you enter this information before it lets you proceed, and a range check which makes sure the data you enter is within a sensible range, perhaps disallowing any year of birth before 1910.

Figure 12.2 Command Line Interface



The interface can be documented simply with a drawing of what it is to look like. Designing a good interface is an art that few people seem to possess. It's easy to find numerous examples of bad (annoying, frustrating, non-intuitive) interface design. Table 12.1 lists some characteristics that many interfaces should have. This list, however, does not apply to all systems. For example, in Chapter 10 we looked at virtual pets – to keep the user interested, a virtual pet should not consistently have the same response time or respect for the user.

12

Design of System Security and Controls

In addition to considering the system's interface and user interactions, designers must also develop system security and controls for all aspects of the system, including hardware, software, database systems, telecommunications and Internet operations.[2] These key considerations involve error prevention, detection and correction; system controls; and disaster planning and recovery.[3]

Table 12.1 The Elements of Good Interactive Dialogue

Element	Description
Clarity	The computer system should ask for information using easily understood language. Whenever possible, the users themselves should help select the words and phrases used for dialogue with the computer system
Response time	Ideally, responses from the computer system should approximate a normal response time from a human being carrying on the same sort of dialogue
Consistency	The system should use the same commands, phrases, words and function keys for all applications. After a user learns one application, all others will then be easier to use
Format	The system should use an attractive format and layout for all screens. The use of colour, highlighting and the position of information on the screen should be considered carefully and applied consistently
Jargon	All dialogue should be written in easy-to-understand terms. Avoid jargon known only to IS specialists
Respect	All dialogue should be developed professionally and with respect. Dialogue should not talk down to or insult the user. Avoid statements such as 'You have made a fatal error'

Error Prevention, Detection and Correction

A new information system can be designed to check for certain errors itself. When users input values, the system can check that the values entered make sense and if not the user is alerted. For instance, the system can check whether the user enters a word when the system is expecting a number. Or if the user enters a number, the computer can check it lies within a sensible range – that small items don't cost over €10,000 or that customers weren't born in the 18th century, for example. In these cases the user must fix the error themselves.

An alternative is to avoid the user entering data themselves. In a factory and many shops, for instance, workers will rarely enter product numbers manually – the number can be read from a barcode or an RFID chip. If the reader doesn't detect the number properly the user is alerted and must scan the item again – this will have happened to you many times at a supermarket check-out.

Disaster Planning and Recovery

Disaster planning is the process of anticipating and providing for disasters. A disaster can be an act of nature (a flood, fire or earthquake) or a human act (terrorism, error or a deliberate sabotage by a disgruntled employee). Disaster planning often focuses primarily on two issues: maintaining the integrity of corporate information, and keeping the information system running until normal operations can be resumed. **Disaster recovery** is the implementation of the disaster plan.[4] When Hurricane Katrina hit New Orleans in the USA, investment and trading company Howard Weil Inc. had a plan to keep the firm operating[5] – it would move its employees to Houston, Texas. But when Houston also had to be evacuated, the company had to move its employees to another location – Stamford, Connecticut – according to its disaster plan. The company was able to rapidly recreate its trading desk and IS infrastructure to continue trading. According to Jefferson Parker, president of Howard Weil, 'You don't normally develop a backup plan for the backup plan'.

disaster planning The process of anticipating and providing for disasters.

disaster recovery The implementation of the disaster plan.

Although companies have known about the importance of disaster planning and recovery for decades, many do not adequately prepare. The primary tools used in disaster planning and recovery are back-ups. Hardware, software and data can all be 'backed up'.

hot site A duplicate, operational hardware system or immediate access to one through a specialized vendor.

For example, hot and cold sites can be used to back-up hardware and software. A **hot site** is a space, usually some distance away from the main operation, where spare computers with the appropriate telecommunication links are set up and software installed, along with any associated pereriphals such as printers, in case some problem occurs to disrupt the technology in the main location. The hot site is physically separate in case the problem is something like a flood, which would damage a wide area. If a disaster occurs, all that is needed is transportation to take staff to the hot site, along with the latest data back-up. As soon as the data is uploaded, operations can continue. Another approach is to use a **cold site**, also called a shell, which is a computer environment that includes rooms, electrical service, telecommunication links but no hardware. If a primary computer has a problem, back-up computer hardware is brought into the cold site, and the complete system is made operational. A warm site sits somewhere between the two (see Figure 12.3).

cold site A computer environment that includes rooms, electrical service, telecommunications links, data storage devices and the like; also called a shell.

Figure 12.3 **A Hot Site**
A hot site waits, ready for action, in case it is needed.

Databases can be backed up by making a copy of all files and databases changed during the last few days or the last week, a technique called **incremental back-up**. One approach to back-up uses a transaction log, which is a separate file that contains only changes to the database and is backed up more frequently than the database itself (which is much bigger). If a problem occurs with a current database, the transaction log and the last back-up of the database can be used to recreate the current database. The impact of the COVID-19 pandemic on many businesses has led to new developments in disaster planning and recovery.

incremental back-up Making a back-up copy of all files changed during the last few days or the last week.

12

Systems Controls

Security lapses, fraud and the invasion of privacy can present disastrous problems. For example, because of an inadequate security and control system, a futures and options trader for a British bank lost almost £1 billion. A simple systems control might have prevented a problem that caused the 200-year-old Barings Bank to collapse. In addition, from time to time, tax officials have been caught looking at the returns of celebrities and others. Preventing and detecting these problems is an important part of systems design. Prevention includes the following:

- Determining potential problems.
- Ranking the importance of these problems.
- Planning the best place and approach to prevent problems.
- Deciding the best way to handle problems if they occur.

Every effort should be made to prevent problems, but companies must establish procedures to handle problems if they occur, including **system controls**.

systems controls Rules and procedures to maintain data security.

Most IS departments establish tight systems controls to maintain data security. Systems controls can help prevent computer misuse, crime and fraud by managers, employees and others. The accounting scandals in the early 2000s caused many IS departments to develop systems controls to make it more difficult for executives to mislead investors and employees. Some of these scandals involved billions of euros.

Most IS departments have a set of general operating rules that help protect the system. Some of these are listed below.

- *Input controls.* Maintain input integrity and security. Their purpose is to reduce errors while protecting the computer system against improper or fraudulent input. Input controls range from using standardized input forms to eliminating data-entry errors and using tight password and identification controls.
- *Processing controls.* Deal with all aspects of processing and storage. The use of passwords and identification numbers, back-up copies of data and storage rooms that have tight security systems are examples of processing and storage controls.
- *Output controls.* Ensure that output is handled correctly. In many cases, output generated from the computer system is recorded in a file that indicates the reports and documents that were generated, the time they were generated and their final destinations.
- *Database controls.* Deal with ensuring an efficient and effective database system. These controls include the use of identification numbers and passwords, without which a user is denied access to certain data and information. Many of these controls are provided by database management systems.
- *Telecommunications controls.* Provide accurate and reliable data and information transfer between systems. Telecommunications controls include firewalls and encryption to ensure correct communication while eliminating the potential for fraud and crime.
- *Personnel controls.* Make sure that only authorized personnel have access to certain systems to help prevent computer-related mistakes and crime. Personnel controls can involve the use of identification numbers and passwords that allow only certain people access to particular data and information. ID badges and other security devices (such as smart cards) can prevent unauthorized people from entering strategic areas in the information systems facility.

Generating Systems Design Alternatives

The development team will want to generate different designs. One approach is to come up with a basic, cheaper solution; or a top-of-the-range solution at the edge of what can be afforded; or a mixed solution sitting somewhere between the two. If the new system is complex, it might want to involve personnel from inside and outside the firm in generating alternative designs. If new hardware and software are to be acquired from an outside vendor, a formal **request for proposal (RFP)** can be made.

request for proposal (RFP) A document that specifies in detail required resources such as hardware and software.

Request for Proposal

The RFP is an important document for many organizations involved with large, complex systems development efforts. Smaller, less complex systems often do not require an RFP. A company that is purchasing an inexpensive piece of software that will run on existing hardware, for example, might not need to go through a formal RFP process.

When an RFP is used, it often results in a formal bid that is used to determine who gets a contract for new or modified systems. The RFP specifies in detail the required resources such as hardware and software.[6] Although it can take time and money to develop a high-quality RFP, it can save a company in the long run. Companies that frequently generate RFPs can automate the process. Software such as the RFP Machine from Pragmatech Software can be used to improve the quality of RFPs and reduce the time it takes to produce them. The RFP Machine stores important data needed to generate RFPs and automates the process of producing RFP documents.

In some cases, separate RFPs are developed for different needs. For example, a company might develop separate RFPs for hardware, software and database systems. The RFP also communicates these needs to one or more vendors, and it provides a way to evaluate whether the vendor has delivered what was expected. In some cases, the RFP is part of the vendor contract. The table of contents for a typical RFP is shown in Figure 12.4.

Figure 12.4 A Typical Table of Contents for a Request for Proposal

Johnson & Florin Ltd
Request for proposal

Contents

Cover page (with company name and contact person)
Brief description of the company
Overview of the existing computer system
Summary of computer-related needs and/or problems
Objectives of the project
Description of what is needed
Hardware requirements
Personnel requirements
Communications requirements
Procedures to be developed
Training requirements
Maintenance requirements
Evaluation procedures (how vendors will be judged)
Proposal format (how vendors should respond)
Important dates (when tasks are to be completed)
Summary

Financial Options

When acquiring computer systems, several choices are available, including purchase, lease or rent. Cost objectives and constraints set for the system play a significant role in the choice, as do the advantages and disadvantages of each. In addition, traditional financial tools, including net present value and internal rate of return, can be used. Table 12.2 summarizes the advantages and disadvantages of these financial options.

Determining which option is best for a particular company in a given situation can be difficult. Financial considerations, tax laws, the organization's policies, its sales and transaction growth, marketplace dynamics and the organization's financial resources are all important factors. In some cases, lease or rental fees can amount to more than the original purchase price after a few years. As a result, some companies prefer to purchase their equipment.

Table 12.2 Advantages and Disadvantages of Acquisition Options

Renting (Short-Term Option)	
Advantages	**Disadvantages**
No risk of obsolescence	No ownership of equipment
No long-term financial investment	High monthly costs
No initial investment of funds	Restrictive rental agreements
Maintenance usually included	
Leasing (Longer-Term Option)	
Advantages	**Disadvantages**
No risk of obsolescence	High cost of cancelling lease
No long-term financial investment	Longer time commitment than renting
No initial investment of funds	No ownership of equipment
Less expensive than renting	
Purchasing	
Advantages	**Disadvantages**
Total control over equipment	High initial investment
Can sell equipment at any time	Additional cost of maintenance
Can depreciate equipment (which is a tax advantage)	Possibility of obsolescence
Low cost if owned for a number of years	Other expenses, including taxes and insurance

On the other hand, constant advances in technology can make purchasing risky. A company would not want to purchase a new multimillion-euro computer only to have newer and more powerful computers available a few months later at a lower price, unless the computer can be easily and inexpensively upgraded. Some servers, for example, are designed to be scalable to allow processors to be added or swapped, memory to be upgraded and peripheral devices to be installed. Companies often employ several people to determine the best option based on all the factors. This staff can also help negotiate purchase, lease or rental contracts.

Evaluating and Selecting a Systems Design

The final step in systems design is to evaluate the various alternatives and select the one that will offer the best solution for organizational goals. Depending on their weight, any one of these objectives might result in the selection of one design over another. For example, financial concerns might make a company choose rental over equipment purchase. Specific performance objectives – for example, that the new system must perform online data processing – might result in a complex network design for which control procedures must be established. Evaluating and selecting the best design involves achieving a balance of system objectives that will best support organizational goals. Normally, evaluation and selection involve both a preliminary and a final evaluation before a design is selected.

The Preliminary Evaluation

preliminary evaluation An initial assessment whose purpose is to dismiss the unwanted proposals; begins after all proposals have been submitted.

A **preliminary evaluation** begins after all design proposals have been submitted. The purpose of this evaluation is to dismiss unwanted proposals. If external vendors have submitted proposals, some of them can usually be eliminated by investigating their proposals and comparing them with the original criteria. Those that compare favourably are often asked to make a formal presentation to the analysis team. The vendors should also be asked to supply a list of companies that use their equipment for a similar purpose. The organization then contacts these references and asks them to evaluate their hardware, their software and the vendor.

The Final Evaluation

final evaluation A detailed investigation of the proposals offered by the vendors remaining after the preliminary evaluation.

The **final evaluation** begins with a detailed investigation of the proposals offered by the remaining vendors. The vendors should be asked to make a final presentation and to fully demonstrate the system. The demonstration should be as close to actual operating conditions as possible. Applications such as payroll, inventory control and billing should be tested using a large amount of test data.

After the final presentations and demonstrations have been given, the organization makes the final evaluation and selection. Cost comparisons, hardware performance, delivery dates, price, flexibility, back-up facilities, availability of software training and maintenance factors are considered. In addition to comparing computer speeds, storage capacities and other similar characteristics, companies should also carefully analyze whether the characteristics of the proposed systems meet the company's objectives. In most cases, the RFP captures these objectives and goals.

Group Consensus Evaluation

group consensus Decision making by a group that is appointed and given the responsibility of making the final evaluation and selection.

In **group consensus**, a decision-making group is appointed and given the responsibility of making the final evaluation and selection. Usually, this group includes the members of the development team who participated in either systems analysis or systems design. This approach might be used to evaluate which of several screen layouts or report formats is best.

Cost–Benefit Analysis Evaluation

cost–benefit analysis An approach that lists the costs and benefits of each proposed system. After they are expressed in monetary terms, all the costs are compared with all the benefits.

Cost–benefit analysis is an approach that lists the costs and benefits of each proposed system. After they are expressed in monetary terms, all the costs are compared with all the benefits. Table 12.3 lists some of the typical costs and benefits associated with the evaluation and selection procedure. This approach is used to evaluate options whose costs can be quantified, such as which hardware or software vendor to select.

Benchmark Test Evaluation

benchmark test An examination that compares computer systems operating under the same conditions.

A **benchmark test** is an examination that compares computer systems operating under the same conditions. Most computer companies publish their own benchmark tests, but some forbid disclosure of benchmark tests without prior written approval. Thus, one of the best approaches is for an organization to develop its own tests and then use them to compare the equipment it is considering. This approach might be used to compare the end-user system response time on two similar systems. Several independent companies also rate computer systems. *Computerworld*, *PC Mag* and many other publications, for example, not only summarize various systems but also evaluate and compare computer systems and manufacturers according to a number of criteria.

Table 12.3 Cost–Benefit Analysis Table

Costs	Benefits
Development costs	Reduced costs
Personnel	Fewer personnel
Computer resources	Reduced manufacturing costs Reduced inventory costs More efficient use of equipment Faster response time Reduced downtime or crash time Less spoilage
Fixed costs	**Increased Revenues**
Computer equipment	New products and services
Software	New customers
One-time licence fees for software and maintenance	More business from existing customers Higher price as a result of better products and services
Operating costs	**Intangible benefits**
Equipment lease and/or rental fees	Better public image for the organization
Computer personnel (including salaries, benefits, etc.)	Higher employee morale Better service for new and existing customers
Electric and other utilities	The ability to recruit better employees
Computer paper, tape and discs	Position as a leader in the industry
Other computer supplies	System easier for programmers and users
Maintenance costs	
Insurance	

Point Evaluation

One of the disadvantages of cost–benefit analysis is the difficulty of determining the monetary values for all the benefits. An approach that does not employ monetary values is a **point evaluation system**. Each evaluation factor is assigned a weight, in percentage points, based on importance. Then each proposed information system is evaluated in terms of this factor and given a score, such as one ranging from 0 to 100, where 0 means that the alternative does not address the feature at all and 100 means that the alternative addresses that feature perfectly. The scores are totalled, and the system with the greatest total score is selected. When using point evaluation, an organization can list and evaluate literally hundreds of factors. Figure 12.5 shows a simplified version of this process. This approach is used when there are many options to be evaluated, such as which software best matches a particular business's needs.

point evaluation system An evaluation process in which each evaluation factor is assigned a weight, in percentage points, based on importance. Then each proposed system is evaluated in terms of this factor and given a score ranging from 0 to 100. The scores are totalled and the system with the greatest total score is selected.

Figure 12.5 An Illustration of the Point Evaluation System *In this example, software has been given the most weight (40 per cent), compared with hardware (35 per cent) and vendor support (25 per cent). When system A is evaluated, the total of the three factors amounts to 82.5 per cent. System B's rating, on the other hand, totals 86.75 per cent, which is closer to 100 per cent. Therefore, the firm chooses system B.*

		System A				System B		
Factor's importance		Evaluation		Weighted evaluation	Evaluation		Weighted evaluation
Hardware	35%	95	35%	33.25	75	35%	26.25
Software	40%	70	40%	28.00	95	40%	38.00
Vendor support	25%	85	25%	21.25	90	25%	22.50
Totals	100%			82.50			86.75

Freezing Design Specifications

Near the end of the design stage, some organizations prohibit further changes in the design of the system. Freezing systems design specifications means that the users agrees in writing that the design is acceptable. Other organizations, however, allow or even encourage design changes. These organizations often use the rapid systems development approaches, introduced in Chapter 11.

The Contract

One of the most important steps in systems design, if new computer facilities are being acquired, is to develop a good contract. Finding the best terms where everyone makes a profit can be difficult. Most computer vendors provide standard contracts; however, such contracts are designed to protect the vendor, not necessarily the organization buying the computer equipment.

Organizations often use outside consultants and legal firms to help them develop their contracts. Such contracts stipulate exactly what they expect from the system vendor and what interaction will occur between the vendor and the organization. All equipment specifications, software, training, installation, maintenance and so on are clearly stated. Also, the contract stipulates deadlines for the various stages or milestones of installation and implementation, as well as actions that the vendor will take in case of delays or problems. Some organizations include penalty clauses in the contract in case the vendor does not meet its obligation by the specified date. Typically, the request for proposal becomes part of the contract. This saves a considerable amount of time in developing the contract, because the RFP specifies in detail what is expected from the vendors.

The Design Report

System specifications are the final results of systems design. They include a technical description that details system outputs, inputs and user interfaces, as well as all hardware, software, databases, telecommunications, personnel and procedure components, and the way these components are related. The specifications are contained in a **design report**, which is the primary result of systems design. The design report reflects the decisions made for systems design and prepares the way for systems implementation.

design report The primary result of systems design, reflecting the decisions made and preparing the way for systems implementation.

Information Systems @ Work

Creating Computer Games Without Needing to Program

Many modern games have credit lists that read like something from the end of a Hollywood movie. Some even have budgets to match too. With increased pressure to generate more titles with more cool effects, game developers need every tool they can get to speed production, maintain quality and keep costs down.

A game engine is a software framework that helps with game development. It's called a framework because it gives developers the infrastructure within which to create their content. The engine takes care of the core elements that all games have, such as graphics and audio. Games companies put a lot of effort into creating the engine because they know they are going to use it over and over – all of their future titles are going to need graphics. Alternatively, smaller companies may buy an existing engine rather than write one themselves. Using an engine means that titles can be developed more rapidly and more cheaply than if all the code was written from scratch. Specialist engines have been created too that handle things like networking to allow multiple users to play together, and artificial intelligence to create more interesting non-player characters. Many other specialist engines exist. As an example of what one does, a graphics engine takes care of graphics tasks such as loading objects into memory and deleting them again when they are no longer needed.

Several free game engines are available. One of the easiest to use is Game Maker from YoYo Games. You can use it to create a simple game without having to write any computer code at all. It has a graphical interface where you can use menu options to tell the engine how you want your game to behave, then it will write the code for you behind the scenes. Using it to create a title your friends will enjoy is a great lesson in how creativity and imagination matter more than advanced graphics, fancy lighting and audio effects in creating a well-loved game. YoYo says that 'making games development accessible to everyone means taking away the barriers to getting started. Using our intuitive "Drag and Drop" development environment you can have your game up and running in a matter of minutes without ever having to write any code!' Game Maker can also show you the code that it generates: 'Game Maker's built-in language (GML) helps you learn to program as you go and not jump in at the deep end of coding'.

Another engine is Unreal Engine 4, which was developed for professionals, but now a version is available for anyone to use for free, although any games created with it are subject to a 5 per cent royalty fee. There are many tutorials available online to get you started with it or Game Maker.

Questions

1. Why are game engines needed?
2. Do 'engines' also exist for business applications, and can you name any of them? (They won't be called engines but will do a similar job.)
3. Why is Unreal available for free?
4. How would Game Maker help someone to learn to program?

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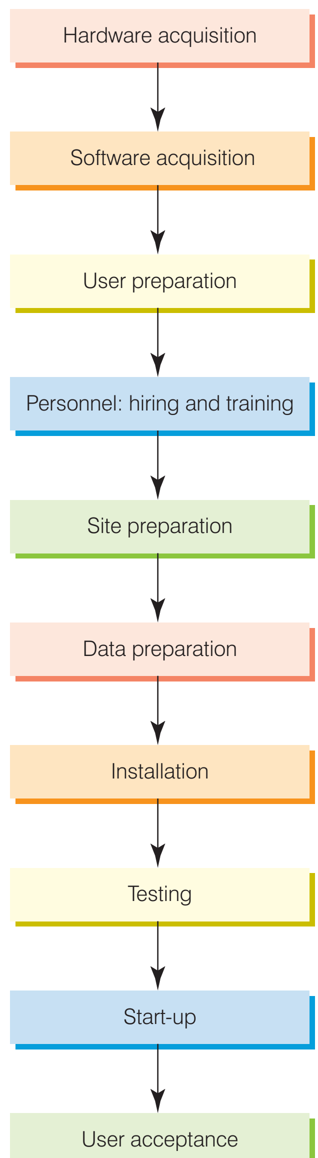
12.2 Systems Implementation

systems implementation A stage of systems development that includes hardware acquisition, software acquisition or development, user preparation, hiring and training of personnel, site and data preparation, installation, testing, start-up and user acceptance.

After the information system has been designed, **systems implementation** involves a number of tasks which lead to the system being installed and ready to operate.[7] These include hardware acquisition, software acquisition or development (programming), user preparation, documentation preparation, hiring and training of personnel, site and data preparation, installation, testing, start-up and user acceptance. Spending on systems implementation is on the rise.[8]

The typical sequence of systems implementation activities is shown in Figure 12.6.

Figure 12.6 Typical Steps in Systems Implementation



Acquiring Hardware from an IS Vendor

To obtain the components for an information system, organizations can purchase, lease or rent computer hardware and other resources from an IS vendor.[9] An IS vendor is a company that offers hardware, software, telecommunications systems, databases, IS personnel or other computer-related resources. Types of IS vendors include general computer manufacturers (such as IBM and Hewlett-Packard), small computer manufacturers (such as Dell and Gateway), peripheral equipment manufacturers (such as Epson and Canon), computer dealers and distributors (such as PC World) and leasing companies (such as Hamilton Rentals and Hire Intelligence).

In addition to buying, leasing or renting computer hardware, companies can pay only for the computing services that they use. Called 'pay-as-you-go', 'on-demand' or 'utility' computing, this approach requires an organization to pay only for the computer power it uses, as it would pay for a utility such as electricity. Hewlett-Packard offers its clients a 'capacity-on-demand' approach, in which organizations pay according to the computer resources actually used, including processors, storage devices and network facilities.

Companies can also purchase used computer equipment. This option is especially attractive to firms that are experiencing an economic slowdown. Companies often use traditional Internet auctions to locate used or refurbished equipment. Popular Internet auction sites sometimes sell millions of euros of computer-related equipment annually. However, buyers need to beware: prices are not always low and equipment selection can be limited on Internet auction sites.

In addition, companies are increasingly turning to service providers to implement some or all of the systems they need. As discussed in Chapter 4, an application service provider (ASP) can help companies implement software and other systems. The ASP can provide both user support and the computers on which to run the software. ASPs often focus on high-end applications, such as database systems and enterprise resource planning packages. As mentioned in Chapter 6, an Internet service provider (ISP) assists a company in gaining access to the Internet. ISPs can also help a company in setting up an Internet site. Some service providers specialize in specific systems or areas, such as marketing, finance or manufacturing.

Acquiring Software: Make or Buy?

As with hardware, application software can be acquired in several ways. As previously mentioned, it can be purchased from external developers or developed in-house.[10] This decision is often called the **make-or-buy decision**. A comparison of the two approaches is shown in Table 12.4. Today, most software is purchased 'off the shelf'. SAP, the large international software company headquartered in Germany, produces modular software which it sells to a variety of companies. The approach gives its customers using the software more flexibility in what they use and what they pay for SAP's modules.[11] The key is how the purchased systems are integrated into an effective system.

make-or-buy decision The decision whether to obtain the necessary software from internal or external sources.

Off the shelf software should be of higher quality than developed, or 'bespoke', software, as it will have been tested 'in the field' by other users. Often those users form an online community, which can be of help to new users. New users often go to online discussion groups to ask questions about the software, rather than calling the developer's own hotline. The audio software Cakewalk, for example, used by amateur and professional musicians, has a thriving forum where beginners and experienced users can post questions and answer other peoples' questions. Off the shelf software will likely be better documented than bespoke software.

In some cases, companies use a blend of external and internal software development. That is, in-house personnel modify or customize off the shelf or proprietary software programs. Software can also be rented. Salesforce.com, for example, rents software online that helps organizations manage their sales force and internal staff. Increasingly, software is being viewed as a utility or service, not a product you purchase.

Table 12.4 Comparison of Off the Shelf and Developed Software

Factor	Off the Shelf (Buy)	Bespoke (Make)
Cost	Lower cost	Higher cost
Needs	Might not exactly match needs	Software should exactly match needs
Quality	Usually high quality	Quality can vary depending on the programming team
Speed	Can acquire it now	Can take years to develop
Competitive advantage	Other organizations can have the same software and same advantage	Can develop a competitive advantage with good software

System software, such as operating systems or utilities, is typically purchased from a software company. Increasingly, however, companies are obtaining open-source systems software, such as the Linux operating system, which can be obtained free or for a low cost.

Externally Acquired Software

A company planning to purchase or lease software from an outside company has many options. Commercial off the shelf (COTS) development is often used. The COTS development process involves the use of commonly available products from software vendors. It combines software from various vendors into a finished system. In many cases, it is necessary to write some original software from scratch and combine it with purchased or leased software. For example, a company can purchase or lease software from several software vendors and combine it into a finished software program. COTS can be less expensive than developing an application from scratch. It can streamline and shorten the time needed to develop software. The other steps of the systems development lifecycle, such as requirements analysis, testing and implementation, must still be carefully done. A major challenge with COTS development is integrating all the off the shelf components into a unified software package. Other potential problems of the COTS development approach can include no access to the source code, the inability to make changes or updates, and the possibility of quality and security problems concerning the COTS software or components.

Developing Software

Another option is to develop software internally or hire a software house to develop it. Some advantages inherent with developing software include meeting user and organizational requirements and having more features and increased flexibility in terms of customization and changes. Such software programs also have greater potential for providing a competitive advantage because competitors cannot easily duplicate them in the short term.

If software is to be developed, there should be a **chief programmer team**. The chief programmer team is a group of skilled IS professionals with the task of designing and implementing a set of programs. This team has total responsibility for building the best software possible. Individuals on a chief programmer team often have excellent programming skills.

The following tools and techniques may also be used:

- *CASE and object-oriented approaches* (mentioned in Chapter 11).
- *Cross-platform development.* One software development technique, called **cross-platform development**, allows programmers to develop programs that can run on computer systems that have different

chief programmer team A group of skilled IS professionals who design and implement a set of programs.

cross-platform development A development technique that allows programmers to develop programs that can run on computer systems having different hardware and operating systems or platforms.

hardware and operating systems or platforms. Web service tools, such as .NET by Microsoft, are examples. With cross-platform development, for example, the same program can run on both a PC and a mainframe or on two different types of PCs.

- *Integrated development environment.* **Integrated development environments (IDEs)** combine the tools needed for programming with a programming language in one integrated package. An IDE allows programmers to use simple screens, customized pull-down menus and graphical user interfaces. Visual Studio 2005 from Microsoft is an example of an IDE. Oracle Designer, which is used with Oracle's database system, is another example of an IDE.
- *Structured walkthroughs.* As shown in Figure 12.7, a **structured walkthrough** is a planned and pre-announced review of the progress of a program or program module. The walkthrough helps team members review and evaluate the progress of components of a project. The structured walkthrough approach is also useful for programming projects that do not use the structured design approach.

integrated development environments (IDEs) A development approach that combines the tools needed for programming with a programming language in one integrated package.

structured walkthrough A planned and pre-announced review of the progress of a program module.

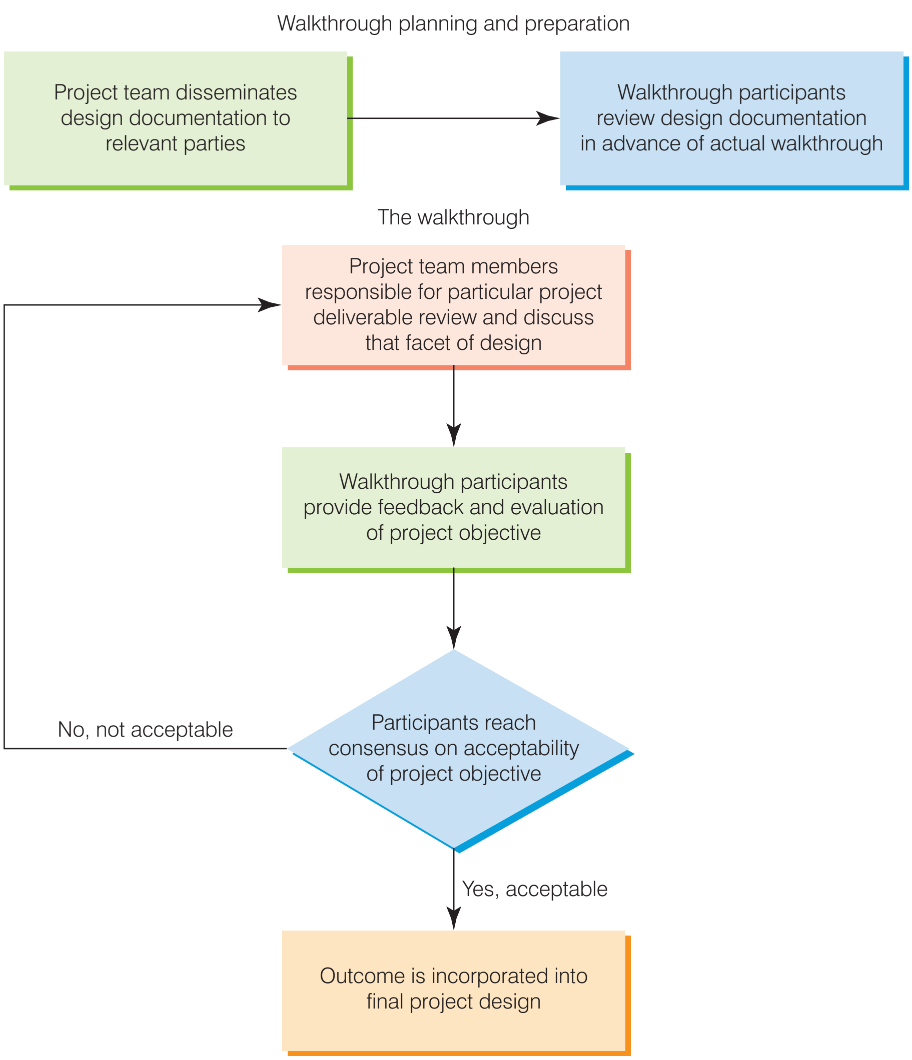


Figure 12.7 Structured Walkthrough *A structured walkthrough is a planned, pre-announced review of the progress of a particular project objective.*

technical documentation Written details used by computer operators to execute the program, and by analysts and programmers to solve problems or modify the program.

- *Documentation.* With developed software, documentation is always important. **Technical documentation** is used by computer operators to execute the program, and by analysts and programmers to solve problems or modify the program. In technical documentation, the purpose of every major piece of computer code is written out and explained. Key variables are also described. User documentation might be developed for the people who use the program. This type of documentation shows users, in easy-to-understand terms, how the program can and should be used, although an alternative such as a demonstration video may be created instead.

Acquiring Database and Telecommunications Systems

Because databases are a blend of hardware and software, many of the approaches discussed earlier for acquiring hardware and software also apply to database systems. For example, an upgraded inventory control system might require database capabilities, including more hard disc storage or a new DBMS. If so, additional storage hardware will have to be acquired from an IS vendor. New or upgraded software might also be purchased or developed in-house. With the increased use of e-commerce, the Internet, intranets and extranets, telecommunications is one of the fastest-growing applications for today's businesses and people. Like database systems, telecommunications systems require a blend of hardware and software. Again, the earlier discussion on acquiring hardware and software also applies to the acquisition of telecommunications hardware and software.

User Preparation

user preparation The process of readying managers, decision makers, employees, other users and stakeholders for new systems.

User preparation is the process of readying managers, decision makers, employees, other users and stakeholders for the new systems. This activity is an important but often ignored area of systems implementation. For example, if a small airline does not adequately train employees with a new software package, the result could be a grounding of most of its flights and the need to find hotel rooms to accommodate unhappy travellers who are stranded.

Without question, training users is an essential part of user preparation, whether they are trained by internal personnel or by external training firms. In some cases, companies that provide software also train users at no charge or at a reasonable price. The cost of training can be negotiated during the selection of new software. Other companies conduct user training throughout the systems development process. Concerns and apprehensions about the new system must be eliminated through these training programmes. Employees should be acquainted with the system's capabilities and limitations by the time they are ready to use it.

IS Personnel: Hiring and Training

Depending on the size of the new system, an organization might have to hire and, in some cases, train new IS personnel. An IS manager, systems analysts, computer programmers, data-entry operators and similar personnel might be needed for the new system.

The eventual success of any system depends on how it is used by the IS personnel within the organization. Training programmes should be conducted for the IS personnel who will be looking after the new computer system. These programs are similar to those for the users, although they can be more detailed in the technical aspects of the systems. Effective training will help IS personnel use the new system to perform their jobs and support other users in the organization.

Site Preparation

The location of the new system needs to be prepared, a process called **site preparation**. For a small system, site preparation can be as simple as rearranging the furniture in an office to make room for a computer. With a larger system, this process is not so easy because it can require special wiring and air conditioning. One or two rooms might have to be completely renovated, and additional furniture might have to be purchased. A special floor might have to be built, under which the cables connecting the various computer components are placed, and a new security system might be needed to protect the equipment. For larger systems, additional power circuits might also be required.

site preparation Preparation of the location of a new system.

Data Preparation

Data preparation, or data conversion, involves making sure that all files and databases are ready to be used with the new computer software and systems. If an organization is installing a new payroll program, for instance, the old employee payroll data might have to be converted into a format that can be used by the new computer software or system. After the data has been prepared or converted, the computerized database system or other software will then be used to maintain and update the computer files.

data preparation (data conversion) Ensuring all files and databases are ready to be used with new computer software and systems.

Installation

Installation is the process of physically placing the computer equipment on the site and making it operational. Although normally the hardware manufacturer is responsible for installing computer equipment, someone from the organization (usually the IS manager) should oversee the process, making sure that all equipment specified in the contract is installed at the proper location. After the system is installed, the manufacturer performs several tests to ensure that the equipment is operating as it should. After this, the acquired software can be installed on the new hardware and the system is again tested.

installation The process of physically placing the computer equipment on the site and making it operational.

Testing

Good testing procedures are essential to make sure that the new or modified information system operates as intended. Inadequate testing can result in mistakes and problems. A popular tax return preparation company in the US, for example, implemented a web-based tax return preparation system, but people could see one another's tax returns. The president of the tax return preparation company called it 'our worst-case scenario'. Better testing can prevent these types of problems.

Several forms of testing should be used, including testing each program (**unit testing**), testing the entire system of programs (**system testing**), testing the application with a large amount of data (**volume testing**) and testing all related systems together (**integration testing**), as well as conducting any tests required by the user (**acceptance testing**).

Alpha testing involves testing an incomplete or early version of the system, while **beta testing** involves testing a complete and stable system by end-users. Alpha-unit testing, for example, is testing an individual program before it is completely finished. Beta-unit testing, on the other hand, is performed after alpha testing, when the individual program is complete and ready for use by end-users.

Unit testing is accomplished by developing test data that will force the computer to execute every statement in the program. In addition, each program is tested with abnormal data to determine how it will handle problems.

unit testing Testing of individual programs.

system testing Testing the entire system of programs.

volume testing Testing the application with a large amount of data.

integration testing Testing all related systems together.

acceptance testing Conducting any tests required by the user.

alpha testing Testing an incomplete or early version of the system.

beta testing Testing a complete and stable system by end-users.

System testing requires the testing of all the programs together. It is not uncommon for the output from one program to become the input for another. So, system testing ensures that the output from one program can be used as input for another program within the system. Volume testing ensures that the entire system can handle a large amount of data under normal operating conditions. Integration testing ensures that the new programs can interact with other major applications. It also ensures that data flows efficiently and without error to other applications. For example, a new inventory control application might require data input from an older order processing application. Integration testing would be done to ensure smooth data flow between the new and existing applications. Integration testing is typically done after unit and system testing. Metaserver, a software company for the insurance industry, has developed a tool called iConnect to perform integration testing for different insurance applications and databases.

Ethical and Societal Issues

Modelling a Mass Shooting

On 1 January 2017 at 1.30 am a gunman opened fire in a packed nightclub in Istanbul. Killing the policeman who was standing guard outside first, he entered the club and began firing indiscriminately, eventually killing 39 people and injuring dozens of others during a seven-minute long attack.

In the USA, the National Rifle Association is fond of saying that ‘the only thing that can kill a bad guy with a gun, is a good guy with a gun’. One counter argument to this is that the more people who have guns, the more people will die from shootings, including accidental shootings. In the USA in 2015, for example, 43 people were shot by toddlers who managed to get their hands on a gun. These statistics obviously apply to gun ownership over time; but what if there was a ‘good guy with a gun’ inside a nightclub where a mass shooting started to take place? During the attack, would more people die or would lives be saved? And how would this change as the number of good guys increased? Some people would predict that the more guns there are in the club, the greater the blood bath would be, but could we test this?

A good approach would be to use an agent-based model. An agent-based model simulates the actions of, and interactions between, a set of autonomous agents in order to see what collective behaviour emerges. Agent models have been used to study swarming behaviour in animals and employee behaviour in organizations. Perhaps one could be used to study mass shootings.

In fact, the behaviour of panicking humans has been well studied and several agent-based models already exist that capture how people flee from a building. For the shooting model, we could start with one of them. Then all we need to do is add in a shooter agent that the others run from before trying to flee the building, plus as many ‘good guy shooters’ as are required. Shooting accuracy needs to be modelled, but again, the basic research has already been done. For instance, William Lewinski and colleagues have studied the level of shooting accuracy demonstrated by law enforcement recruits upon completion of their firearms training in comparison with novice shooters, and their data can be used to give our agents some sort of realistic shooting accuracy.

Netlogo is a suitable programming language to develop this model. It is a multi-agent programmable modelling environment, and the original programming language which it uses was designed for children to learn, so it’s quite straightforward to use. Once the model has been built it can be experimented on. The two main variables we would want to explore are the number of good guy shooters and their shooting accuracy.

In fact, when one of the authors built this model, even a very inaccurate good guy saved lives, although this was an overall figure – the good guy managed to kill a few other good guys before finally hitting the bad guy.

Questions

1. Could this model be used to inform policy?
2. Does this model prove anything?

3 What does it mean for 'behaviour to emerge'?
4 What other applications can you think of for agent-based models?

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Finally, acceptance testing makes sure that the new or modified system is operating as intended. Run times, the amount of memory required, disc access methods and more can be tested during this phase. Acceptance testing ensures that all performance objectives defined for the system or application are satisfied. Involving users in acceptance testing can help them understand and effectively interact with the new system. Acceptance testing is the final check of the system before start-up.

Start-Up

start-up The process of making the final tested information system fully operational.

Start-up, also called cutover, begins with the final tested information system. When start-up is finished, the system is fully operational. Start-up can be critical to the success of the organization. If not done properly, the results can be disastrous. One of the authors is aware of a small manufacturing company that decided to stop an accounting service used to send out bills on the same day they were going to start their own program to send out bills to customers. The manufacturing company wanted to save money by using their own billing program developed by an employee of the company. The new program didn't work, the accounting service wouldn't help because they were upset about being terminated, and the manufacturing company wasn't able to send out any bills to customers for more than three months. The company almost went bankrupt.

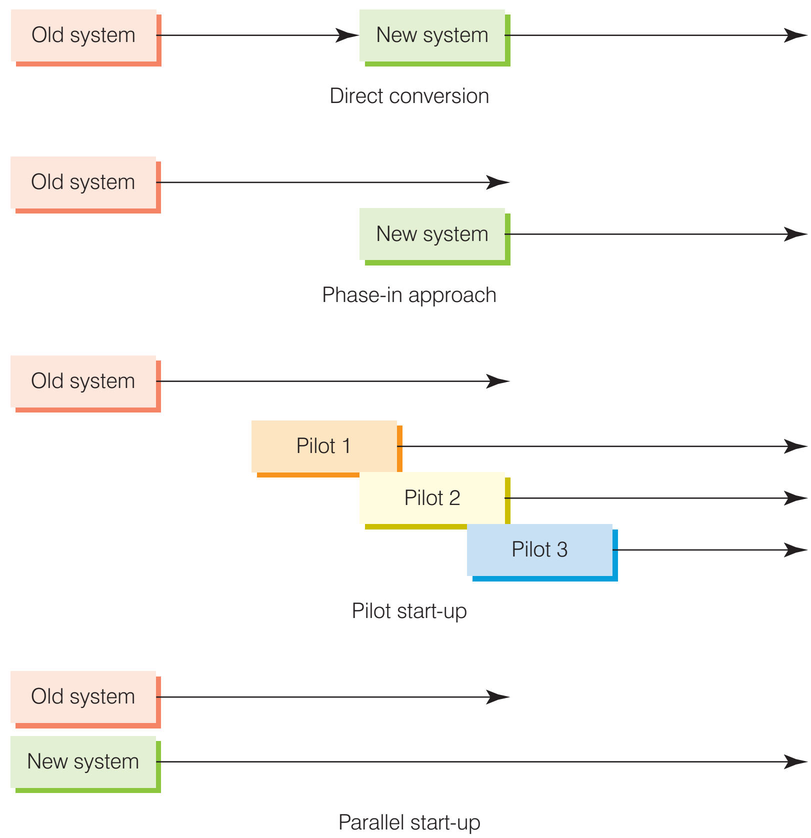
direct conversion Stopping the old system and starting the new system on a given date.

phase-in approach Slowly replacing components of the old system with those of the new one. This process is repeated for each application until the new system is running every application and performing as expected; also called a piecemeal approach.

Various start-up approaches are available (see Figure 12.8). **Direct conversion** (also called plunge, big bang or direct cutover) involves stopping the old system and starting the new system on a given date. Direct conversion is usually the least desirable approach because of the potential for problems and errors when the old system is shut off and the new system is turned on at the same instant.

The **phase-in approach** is a popular technique preferred by many organizations. In this approach, sometimes called a piecemeal approach, components of the new system are slowly phased in while components of the old one are slowly phased out. When everyone is confident that the new system is performing as expected, the old system is completely phased out. This gradual replacement is repeated for each application until the new system is running every application. In some cases, the phase-in approach can take months or years.

Figure 12.8 Start-Up Approaches



pilot running Introducing the new system by direct conversion for one group of users rather than all users.

Pilot running involves introducing the new system with direct conversion for one group of users rather than all users. For example, a manufacturing company with many retail outlets throughout the country could use the pilot start-up approach and install a new inventory control system at one of the retail outlets. When this pilot retail outlet runs without problems, the new inventory control system can be implemented at other retail outlets. The National Health Service Cancer Registry in England, for example, used a pilot start-up approach to implement and test a new system to manage and integrate hundreds of cancer-related data sources.[12]

parallel running Running both the old and the new systems for a period of time.

Parallel running involves running both the old and new systems for a period of time. The output of the new system is compared closely with the output of the old system, and any differences are reconciled. When users are comfortable that the new system is working correctly, the old system is eliminated.

User Acceptance

user acceptance document A formal agreement signed by the user that states that a phase of the installation or the complete system is approved.

12

Most mainframe computer manufacturers use a formal **user acceptance document** – a formal agreement the user signs stating that a phase of the installation or the complete system is approved. This is a legal document that usually removes or reduces the IS vendor's liability for problems that occur after the user acceptance document has been signed. Because this document is so important, many companies get legal assistance before they sign it. Stakeholders can also be involved in acceptance testing to make sure that the benefits to them are indeed realized.

12.3 Systems Operation and Maintenance

systems operation Use of a new or modified system.

Systems operation involves all aspects of using the new or modified system in all kinds of operating conditions. Getting the most out of a new or modified system during its operation is the most important aspect of systems operations for many organizations. Throughout this book, we have seen many examples of information systems operating in a variety of settings and industries. Thus, we will not cover the operation of an information system in detail in this section. The operation of any information system, however, does require adequate training and support before the system is used and continual support while the system is being operated. This training and support is required for all stakeholders, including employees, customers and others. Companies typically provide training through seminars, manuals and online documentation. To provide adequate support, many companies use a formal help desk. A help desk consists of people with technical expertise, computer systems, manuals and other resources needed to solve problems and give accurate answers to questions. With today's advances in telecommunications, help desks can be located around the world. If you are having trouble with your PC and call a freephone number for assistance, you might reach a help desk in India or China. For most organizations, operations costs over the life of a system are much greater than the development costs.

systems maintenance and review The systems development phase that ensures the system operates as intended and modifies the system so that it continues to meet changing business needs.

Systems maintenance and review involves checking, changing and enhancing the system to make it more useful in achieving user and organizational goals.[13] Maintenance is important for individuals, groups and organizations.[14] Organizations often have personnel dedicated to maintenance.

The maintenance process can be especially difficult for older software. A legacy system is an old system that might have been patched or modified repeatedly over time. An old payroll program written in COBOL decades ago and frequently changed is an example of a legacy system. Legacy systems can be very expensive to maintain. At some point, it becomes less expensive to switch to new programs and applications than to repair and maintain the legacy system. Maintenance costs for older legacy systems can be 50 per cent of the total operating costs in some cases.

Software maintenance is a major concern for organizations. In some cases, organizations encounter major problems that require recycling the entire systems development process. In other situations, minor modifications are sufficient to remedy problems. Hardware maintenance is also important. Companies such as IBM have investigated autonomic computing, in which computers will be able to manage and maintain themselves.[15] The goal is for computers to be self-configuring, self-protecting, self-healing and self-optimizing. Being self-configuring allows a computer to handle new hardware, software or other changes to its operating environment. Being self-protecting means a computer can identify potential attacks, prevent them when possible and recover from attacks if they occur. Attacks can include viruses, worms, identity theft and industrial espionage. Being 'self-healing' means a computer can fix problems when they occur, and being 'self-optimizing' allows a computer to run faster and get more done in less time. Getting rid of old equipment is an important part of maintenance. The options include selling it on web auction sites such as eBay, recycling the equipment at a computer recycling centre, and donating it to a charitable organization, such as a school, library or religious organization. When discarding old computer systems, it is always a good idea to permanently remove sensitive files and programs. Companies, including McAfee, have software to help people remove data and programs from old computers and transfer them to new ones.[16]

Reasons for Maintenance

After a program is written, it will need ongoing maintenance. To some extent, a program is similar to a car that needs oil changes, tune-ups and repairs at certain times. Experience shows that frequent, minor maintenance to a program, if properly done, can prevent major system failures later. Some of the reasons for program maintenance are the following:

- Changes in business processes.
- New requests from stakeholders, users and managers.
- Bugs or errors in the program.
- Technical and hardware problems.
- Corporate mergers and acquisitions.
- Government regulations.
- Change in the operating system or hardware on which the application runs.
- Unexpected events, such as severe weather or terrorist attacks.

Most companies modify their existing programs instead of developing new ones because existing software performs many important functions, and companies can have millions of euros invested in their old legacy systems. So, as new systems needs are identified, the burden of fulfilling the needs most often falls on the existing system. Old programs are repeatedly modified to meet ever-changing needs. Yet, over time, repeated modifications tend to interfere with the system's overall structure, reducing its efficiency and making further modifications more burdensome.

Types of Maintenance

slipstream upgrade A minor upgrade – typically a code adjustment or minor bug fix – not worth announcing. It usually requires recompiling all the code and, in so doing, it can create entirely new bugs.

patch A minor change to correct a problem or make a small enhancement. It is usually an addition to an existing program.

release A significant program change that often requires changes in the documentation of the software.

version A major program change, typically encompassing many new features.

Software companies and many other organizations use four generally accepted categories to signify the amount of change involved in maintenance. A **slipstream upgrade** is a minor upgrade – typically a code adjustment or minor bug fix. Many companies don't announce to users that a slipstream upgrade has been made. A slipstream upgrade usually requires recompiling all the code, so it can sometimes create entirely new bugs. This maintenance practice can explain why the same computers sometimes work differently with what is supposedly the same software. A **patch** is a minor change to correct a problem or make a small enhancement. It is usually an addition to an existing program. That is, the programming code representing the system enhancement is usually 'patched into', or added to, the existing code. Although slipstream upgrades and patches are minor changes, they can cause users and support personnel big problems if the programs do not run as before. A new **release** is a significant program change that often requires changes in the documentation of the software. Finally, a new **version** is a major program change, typically encompassing many new features.

The Request for Maintenance Form

request for maintenance form A form authorizing modification of programs.

Because of the amount of effort that can be spent on maintenance, many organizations require a **request for maintenance form** to authorize modification of programs. This form is usually signed by a business manager, who documents the need for the change and identifies the priority of the change relative to other work that has been requested. The IS group reviews the form and identifies the programs to be changed, determines the programmer who will be assigned to the project, estimates the expected completion date and develops a technical description of the change. A cost–benefit analysis might be required if the change requires substantial resources.

Performing Maintenance

Depending on organizational policies, the people who perform systems maintenance vary. In some cases, the team who designs and builds the system also performs maintenance. This ongoing responsibility gives the designers and programmers an incentive to build systems well from the outset: if there are problems, they will have to fix them. In other cases, organizations have a separate **maintenance team**. This team is responsible for modifying, fixing and updating existing software.

maintenance team A special IS team responsible for modifying, fixing and updating existing software.

In the past, companies had to maintain each computer system or server separately. With hundreds or thousands of computers scattered throughout an organization, this task could be very costly and time consuming. Today, the maintenance function is becoming more automated. Some companies, for example, use maintenance tools and software that will allow them to maintain and upgrade software centrally.

A number of vendors have developed tools to ease the software maintenance burden. Relativity Technologies has developed RescueWare, a product that converts third-generation code such as COBOL to highly maintainable C++, Java or Visual Basic object-oriented code. Using RescueWare, maintenance personnel download mainframe code to Windows NT or Windows 2000 workstations. They then use the product's graphical tools to analyze the original system's inner workings. RescueWare lets a programmer see the original system as a set of object views, which visually illustrate module functioning and program structures. IS personnel can choose one of three levels of transformation: revamping the user interface, converting the database access and transforming procedure logic.

The Financial Implications of Maintenance

The cost of maintenance is staggering. For older programs, the total cost of maintenance can be up to five times greater than the total cost of development. In other words, a program that originally cost €25,000 to develop might cost €125,000 to maintain over its lifetime. The average programmers can spend more than half their time on maintaining existing programs instead of developing new ones. In addition, as programs get older, total maintenance expenditures in time and money increase. With the use of newer programming languages and approaches, including object-oriented programming, maintenance costs are expected to decline. Even so, many organizations have literally millions of euros invested in applications written in older languages (such as COBOL), which are both expensive and time consuming to maintain. The financial implications of maintenance mean companies must keep track of why systems are maintained, instead of simply keeping cost figures. This is another reason that documentation of maintenance tasks is so crucial. A determining factor in the decision to replace a system is the point at which it is costing more to fix it than to replace it.

The Relationship Between Maintenance and Design

Programs are expensive to develop, but they are even more expensive to maintain. Programs that are well designed and documented to be efficient, structured and flexible are less expensive to maintain in later years. Thus, there is a direct relationship between design and maintenance. More time spent on design up front can mean less time spent on maintenance later.

In most cases, it is worth the extra time and expense to design a good system. Consider a system that costs €250,000 to develop. Spending 10 per cent more on design would cost an additional €25,000, bringing the total design cost to €275,000. Maintenance costs over the life of the program could be €1,000,000. If this additional design expense can reduce maintenance costs by 10 per cent, the savings in maintenance costs would be €100,000. Over the life of the program, the net savings would be €75,000 (€100,000 – €25,000).

The need for good design goes beyond mere costs. Companies risk ignoring small system problems when they arise, but these small problems can become large in the future. As mentioned earlier, because maintenance programmers spend an estimated 50 per cent or more of their time deciphering poorly written, undocumented program code, they have little time to spend on developing new, more effective systems. If put to good use, the tools and techniques discussed in this chapter will allow organizations to build longer-lasting, more reliable systems.

12.4 Systems Review

systems review The final step of systems development, involving the analysis of systems to make sure that they are operating as intended.

Systems review, the final step of systems development, is the process of analyzing systems to make sure that they are operating as intended. This process often compares the performance and benefits of the system as it was designed with the actual performance and benefits of the system in operation.[17] A payroll application being developed for the Irish Health Service, for example, was almost €120 million over budget.[18] As a result, work on the application that serves about 37,000 workers was halted so the entire project could be reviewed in detail. The purpose of the systems review is to make sure that any additional work will result in a program that will work as intended.

Problems and opportunities uncovered during systems reviews trigger systems development and begin the process anew. For example, as the number of users of an interactive system increases, it is not unusual for system response time to increase. If the increase in response time is too great, it might be necessary to redesign some of the system, modify databases or increase the power of the computer hardware. When faced with a possible patent infringement problem, RIM, the maker of the popular BlackBerry phone and email service, developed back-up software that could be used in case the courts ruled against the company.[19] Even though RIM was able to settle the suit out of court, BlackBerry users were happy that the company had a back-up plan.

Internal employees, external consultants, or both, can perform a systems review. When the problems or opportunities are industry-wide, people from several firms can get together. In some cases, they collaborate at an IS conference or in a private meeting involving several firms.

Types of Review Procedures

event-driven review A review triggered by a problem or opportunity such as an error, a corporate merger or a new market for products.

There are two types of review procedures: event-driven and time-driven (see Table 12.5). An **event-driven review** is triggered by a problem or opportunity such as an error, a corporate merger or a new market for products.[20] Natural disasters often revealed flaws in older systems, causing many companies and organizations to review their existing systems. Recent floods in the UK, for example, caused insurance companies to introduce flood maps to their quotation systems.

Table 12.5 Examples of Review Types

Event-Driven	Time-Driven
Problem with an existing system	Monthly review
Merger	Yearly review
New accounting system	Review every few years
Executive decision that an upgraded Internet site is needed to stay competitive	Five-year review

In contrast, some companies use a continuous improvement approach to systems development. With this approach, an organization makes changes to a system even when small problems or opportunities occur. Although continuous improvement can keep the system current and responsive, repeatedly designing and implementing changes can be both time consuming and expensive.

A **time-driven review** is performed after a specified amount of time. Many application programs are reviewed every six months to one year. With this approach, an existing system is monitored on a schedule. If problems or opportunities are uncovered, a new systems development cycle can be initiated. A payroll application, for example, can be reviewed once a year to make sure that it is still operating as expected. If it is not, changes are made.

time-driven review Review performed after a specified amount of time.

Most companies use both approaches. A billing application, for example, might be reviewed once a year for errors, inefficiencies and opportunities to reduce operating costs. This is a time-driven approach. In addition, the billing application might be redone after a corporate merger if one or more new managers require different information or reports, or if laws on bill collecting and privacy change. This is an event-driven approach.

Factors to Consider During Systems Review

Systems review should investigate a number of important factors, such as the following:

- *Mission.* Is the computer system helping the organization achieve its overall mission? Are stakeholder needs and desires satisfied or exceeded with the new or modified system?
- *Organizational goals.* Does the computer system support the specific goals of the various areas and departments of the organization?
- *Hardware and software.* Are hardware and software up to date and adequate to handle current and future processing needs?
- *Database.* Is the current database up to date and accurate? Is database storage space adequate to handle current and future needs?
- *Telecommunications.* Is the current telecommunications system fast enough, and does it allow managers and workers to send and receive timely messages? Does it allow for fast order processing and effective customer service?
- *Information systems personnel.* Are there sufficient IS personnel to perform current and projected processing tasks?
- *Control.* Are rules and procedures for system use and access acceptable? Are the existing control procedures adequate to protect against errors, invasion of privacy, fraud and other potential problems?
- *Training.* Are there adequate training programmes and provisions for both users and IS personnel?
- *Costs.* Are development and operating costs in line with what is expected? Is there an adequate IS budget to support the organization?
- *Complexity.* Is the system overly complex and difficult to operate and maintain?
- *Reliability.* Is the system reliable? What is the mean time between failures (MTBF)?
- *Efficiency.* Is the computer system efficient? Are system outputs generated by the right amount of inputs, including personnel, hardware, software, budget and others?
- *Response time.* How long does it take the system to respond to users during peak processing times?
- *Documentation.* Is the documentation still valid? Are changes in documentation needed to reflect the current situation?

System Performance Measurement

system performance measurement Monitoring the system – the number of errors encountered, the amount of memory required, the amount of processing or CPU time needed and other problems.

system performance products Software that measures all components of the computer-based information system, including hardware, software, database, telecommunications and network systems.

Systems reviews often involve monitoring the system, called **system performance measurement**. The number of errors encountered, the amount of memory required, the amount of processing or CPU time needed and other problems should be closely observed.[21] If a particular system is not performing as expected, it should be modified, or a new system should be developed or acquired.

Setting up benchmarks for performance measurement can be critical. **System performance products** have been developed to measure all components of the information system, including hardware, software, database, telecommunications and network systems. When properly used, system performance products can quickly and efficiently locate actual or potential problems.

A number of products have been developed to assist in assessing system performance. OMEGAMON from IBM can monitor system performance in real time. Precise Software Solutions has system performance products that provide around-the-clock performance monitoring for Oracle database applications. Mercury Interactive offers a software tool called Diagnostic to help companies analyze the performance of their computer systems, diagnose potential problems and take corrective action if needed.[22]

Measuring a system is, in effect, the final task of systems development. The results of this process can bring the development team back to the beginning of the development lifecycle, where the process begins again.

Summary

Designing new systems or modifying existing ones should always help an organization achieve its goals. The purpose of systems design is to prepare the detailed design needs for a new system or modifications to the existing system. Logical systems design refers to the way that the various components of an information system will work together. The logical design includes data requirements for output and input, processing, files and databases, telecommunications, procedures, personnel and job design, and controls and security design. Physical systems design refers to the specification of the actual physical components. The physical design must specify characteristics for hardware and software design, database and telecommunications, and personnel and procedures design.

Logical and physical design can be accomplished using the traditional systems development lifecycle or the object-oriented approach. Using the object-oriented approach, analysts design key objects and classes of objects in the new or updated system. The sequence of events that a new or modified system requires is often called a scenario, which can be diagrammed in a sequence diagram.

A number of special design considerations should be taken into account during both logical and physical system design. Interface design and control relates to how users access and interact with the system. A sign-on procedure consists of identification numbers, passwords and other safeguards needed for individuals to gain access to computer resources. If the system under development is interactive, the design must consider menus, help facilities, table lookup facilities and restart procedures. A good interactive dialogue will ask for information in a clear manner, respond rapidly, be consistent between applications and use an attractive format. Also, it will avoid use of computer jargon and treat the user with respect.

System security and control involves many aspects. Error prevention, detection and correction should be part of the system design process. Causes of errors include human activities, natural phenomena and technical problems. Designers should be alert to prevention of fraud and invasion of privacy.

Disaster recovery is an important aspect of systems design. Disaster planning is the process of anticipating and providing for disasters. A disaster can be an act of nature (a flood, fire or earthquake) or a human act (terrorism, error, labour unrest, or erasure of an important file). The primary tools used in disaster planning and recovery are hardware, software, database, telecommunications and personnel back-up.

Security, fraud and the invasion of privacy are also important design considerations. Most IS departments establish tight systems controls to maintain data security. Systems controls can help prevent computer misuse, crime and fraud by employees and others. Systems controls include input, output, processing, database, telecommunications and personnel controls.

Whether an individual is purchasing a personal computer or an experienced company is acquiring an expensive mainframe computer, the system could be obtained from one or more vendors. Some of the factors to consider in selecting a vendor are the vendor's reliability and financial stability, the type of service offered after the sale, the goods and services the vendor offers and keeps in stock, the vendor's willingness to demonstrate its products, the vendor's ability to repair hardware, the vendor's ability to modify its software, the availability of vendor-offered training of IS personnel and system users, and evaluations of the vendor by independent organizations.

If new hardware or software will be purchased from a vendor, a formal request for proposal (RFP) is needed. The RFP outlines the company's needs; in response, the vendor provides a written reply. Financial options to consider include purchase, lease and rent.

RFPs from various vendors are reviewed and narrowed down to the few most likely candidates. In the final evaluation, a variety of techniques – including group consensus, cost–benefit analysis, point evaluation and benchmark tests – can be used. In group consensus, a decision-making group is appointed and given responsibility for making the final evaluation and selection. With cost–benefit analysis, all costs and benefits of the alternatives are expressed in monetary terms. Benchmarking involves comparing computer systems operating under the same condition. Point evaluation assigns weights to evaluation factors, and each alternative is evaluated in terms of each factor and given a score from 0 to 100. After the vendor is chosen, contract negotiations can begin.

One of the most important steps in systems design is to develop a good contract if new computer facilities are being acquired. A final design report is developed at the end of the systems design phase.

The primary emphasis of systems implementation is to make sure that the right information is delivered to the right person in the right format at the right time. The purpose of systems implementation is to install the system and make everything, including users, ready for its operation. Systems implementation includes hardware acquisition, software acquisition or development, user preparation, hiring and training of personnel, site and data preparation, installation, testing, start-up and user acceptance. Hardware acquisition requires purchasing, leasing or renting computer resources from an IS vendor. Hardware is typically obtained from a computer hardware vendor.

Software can be purchased from vendors or developed in-house – a decision termed the make-or-buy decision. A purchased software package usually has a lower cost, less risk regarding the features and performance, and easy installation. The amount of development effort is also less when software is purchased. Developing software can result in a system that more closely meets the business's needs and has increased flexibility in terms of customization and changes. Developing software also has greater potential for providing a competitive advantage. Increasingly, companies are using service providers to acquire software, Internet access and other IS resources. Software development is often performed by a chief programmer team – a group of IS professionals who design, develop and implement a software program. Structured design is a philosophy of designing and developing application software. Other tools, such as cross-platform development and integrated development environments (IDEs), make software development easier and more thorough. CASE tools are often used to automate some of these techniques.

Database and telecommunications software development involves acquiring the necessary databases, networks, telecommunications and Internet facilities. Companies have a wide array of choices, including newer object-oriented database systems.

Implementation must address personnel requirements. User preparation involves readying managers, employees and other users for the new system. New IS personnel might need to be hired, and users must be well trained in the system's functions. Preparation of the physical site of the system must be done, and any existing data to be used in the new system will require conversion to the new format. Hardware installation is done during the implementation step, as is testing. Testing includes program (unit) testing, systems testing, volume testing, integration testing and acceptance testing.

Start-up begins with the final tested information system. When start-up is finished, the system is fully operational. There are a number of different start-up approaches. Direct conversion involves stopping the old system and starting the new system on a given date. With the phase-in approach, sometimes called a piecemeal approach, components of the new system are slowly phased in while components of the old one are slowly phased out. When everyone is confident that the new system is performing as expected, the old system is completely phased out. Pilot start-up involves running the new system for one group of users rather than all users. Parallel start-up involves running both the old and new systems for a period of time. The output of the new system is compared closely with the output of the old system, and any differences are reconciled. When users are comfortable that the new system is working correctly, the old system is eliminated. Many IS vendors ask the user to sign a formal user acceptance document that releases the IS vendor from liability for problems that occur after the document is signed.

Maintenance and review add to the useful life of a system but can consume large amounts of resources. These activities can benefit from the same rigorous methods and project management techniques applied to systems development. Systems operation is the use of a new or modified system. Systems maintenance involves checking, changing and enhancing the system to make it more useful in obtaining user and organizational goals. Maintenance is critical for the continued smooth operation of the system. The costs of performing maintenance can well exceed the original cost of acquiring the system. Some major causes of maintenance are new requests from stakeholders and managers, enhancement requests from users, bugs or errors, technical or hardware problems, newly added equipment, changes in organizational structure, and government regulations.

Maintenance can be as simple as a program patch to correct a small problem to the more complex upgrading of software with a new release from a vendor. For older programs, the total cost of maintenance can be greater than the total cost of development. Increased emphasis on design can often reduce maintenance costs. Requests for maintenance should be documented with a request for maintenance form, a document that formally authorizes modification of programs. The development team or a specialized maintenance team can then make approved changes. Maintenance can be greatly simplified with the object-oriented approach.

Systems review is the process of analyzing and monitoring systems to make sure that they are operating as intended. The two types of review procedures are the event-driven review and the time-driven review. An event-driven review is triggered by a problem or opportunity. A time-driven review is started after a specified amount of time.

Systems review involves measuring how well the system is supporting the mission and goals of the organization. System performance measurement monitors the system for number of errors, amount of memory and processing time required and so on.

Self-Assessment Test

1. Determining the needed hardware and software for a new system is an example of __________.
   a. logical design
   b. physical design
   c. interactive design
   d. object-oriented design
2. Disaster planning is an important part of designing security and control systems. True or false?
3. The __________ often results in a formal bid that is used to determine who gets a contract for designing new or modifying existing systems. It specifies in detail the required resources such as hardware and software.
4. Near the end of the design stage, an organization prohibits further changes in the design of the system. This is called __________.

5 Software can be purchased from external developers or developed in-house. This decision is often called the __________ decision.

6 What type of documentation is used by computer operators to execute a program, and by analysts and programmers?

a. unit documentation

b. integrated documentation

c. technical documentation

d. user documentation

7 __________ testing involves testing the entire system of programs.

8 The phase-in approach to conversion involves running both the old system and the new system for three months or longer. True or false?

9 A(n) __________ is a minor change to correct a problem or make a small enhancement to a program or system.

10 Corporate mergers and acquisitions can be a reason for systems maintenance. True or false?

Review Questions

1 What is the purpose of systems design?

2 What is interactive processing? What design factors should be taken into account for this type of processing?

3 What is the difference between logical and physical design?

4 What is a hot site? Who would need one?

5 Identify specific controls that are used to maintain input integrity and security.

6 What is an RFP? What is typically included in one? How is it used?

7 What are the major steps of systems implementation?

8 What are some tools and techniques for software development?

9 Describe how you back-up the files you use on your PC.

10 What are the steps involved in testing the information system?

Discussion Questions

1 Outline a potential disaster recovery procedure.

2 How would you advise a business owner who is thinking of developing proprietary software for their company?

Web Exercises

1 Search for tools to help you build a website. Create a website about a hobby of yours.

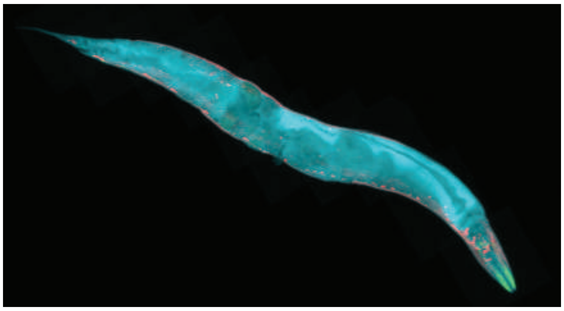
2 Search for information about current programming languages. Try out a few of the sample programs.

Case One

Open-Source Project Aims to Create Artificial Life

C. elegans is a tiny worm, about 1mm in length, which lives in the soil in many parts of the world. It is a non-hazardous, non-infectious, non-pathogenic, non-parasitic organism and only has about 1,000 cells and exactly 302 neurons (Figure 12.9). Despite its small size (or perhaps because of it), it is also one of the most studied creatures in nature. In fact, thousands of scientists are working full time to try to understand it. Between October 1994 and January 1995, 73 scientific articles about C. elegans appeared in international science journals. Three different Nobel prizes have been awarded for work on the worm, and it was the first multicellular organism to have its whole genome sequenced and the wiring between its neurons (its 'connectome') completely mapped out. Right now, an international consortium of laboratories is collaborating on a project to sequence the entire 100,000,000 bases of its DNA. As the worm is so well understood and described in the scientific literature, it was a good candidate for a project seeking to build a computer model of a real organism.

Figure 12.9 A C. elegans worm



In 2007, two software engineers, Giovanni Idili and Matteo Cantarelli, started to discuss how they might simulate C. elegans, but they were unable to progress their idea as they lacked any knowledge about neuroscience. This changed in 2010 when they came in contact with biology PhD student Stephen Larson, who joined them to found OpenWorm, an open-science, open-source software project. Their goal is to build the world's first virtual organism for the purpose of understanding the events and mechanisms of living cells. What the team is doing is implementing each of the worm's 1,000 cells and 302 neurons as software elements and having them interact with each other as they do in the real worm, to study the behaviour that emerges. For example, if the worm needs to find food, the appropriate neurons send signals to the appropriate muscle cells to get it to move. The team recreates this and they know which of their artificial neurons are the correct ones to fire from the existing scientific literature. The team has even built a robot using the Lego Mindstorms kit (see Case Two next) to illustrate this movement outside of a computer.

The goal of creating a virtual living organism is no easy task and the team still has some way to go (and they are always on the lookout for more contributors). However, they have achieved several major milestones. They have finished a software engine (see the Information Systems @ Work case in this chapter for more about engines) called Geppetto. Written in Java, Geppetto is an open-source modular platform which enables interactive simulation of biological systems. It incorporates algorithms which describe how neuron/cell signals behave and features a visualizer that can be run through a normal web browser. Again, these algorithms come from the existing scientific literature. For example, the algorithm that decides whether a neuron 'fires' (sends a signal to a cell) comes from work done in the 1950s.

The team is open for anyone to join, and they have roles available for all levels of experience and technical expertise. These include roles in programming (particularly in Java and C++ if you want to give it a go), neuroscience, technical writing and web development, and they are even looking for artists to create visuals that will 'inspire people'. The team uses social media to share information and each month has a virtual meeting using Google Hangouts.

Questions

1. What could a virtual worm be used for?
2. What other software could an open-science team use to co-ordinate their work?
3. How could 'visuals' inspire people to get involved in OpenWorm?
4. Why would a neuroscientist get involved in an open-source software project?

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Case Two

Build Your Own Robot

Lego Mindstorms is a Lego kit that contains many of the usual Lego parts plus a programmable brick, a series of sensors and some motors. The sensors include buttons, microphones and ultrasonic sensors that can detect objects at a distance. The kit can be used to create a wide variety of robots including a Rubik's Cube solver, a miniature car factory and a robotic puppy. It is also an excellent way to learn computer programming.

Programming involves taking a problem and breaking it up into tiny steps, then assembling those steps into code that will solve the problem. The steps can be made to run one after another, or a set of them can be made to repeat over and over again. At certain points a choice can be made to do one of an unlimited set of steps according to a condition. This gives us the following three ways to assemble the steps: (1) a sequence of steps, (2) loops of steps and (3) selection of different steps.

Let's see how we can break down getting a robot to navigate a maze into a series of steps. Let's say we've built the robot already. It's got wheels and a motor to move about and can make turns. To make things easier, let's say it can turn exactly 90 degrees in either direction and that the maze is made up of walls that can be detected by an ultrasonic sensor attached to the robot. The maze walls are made out of units of the same length and only contain 90 degree corners.

How could we break up navigating a maze? In fact, the only steps we need are: move forward one unit, look ahead, turn left and turn right. Imagine the steps involved in making just one move. The robot looks ahead. If the route is clear it moves forward. If there is a wall ahead it turns left and looks ahead in the new direction. When it looks ahead, if the route is clear it moves forward. If there is a wall ahead it turns right twice (once to return to its original position, and once to turn to face right). If the route is clear, it moves forward. If the route is not clear, it turns right again (so it's now facing backwards from its original position). If the route is clear, it moves forward. That's basically one move. All the robot has to do is repeat all of that until it finds the centre of the maze or the way out. Here's what it looks like written out as computer instructions:

```
Repeat
   If route ahead clear
         Move forward
   Else
         Turn left
         if route ahead clear
                  Move forward
         Else
                  Turn right
                  Turn right
                  If route ahead clear
                           Move forward
                  Else
                           Turn right
                           If route ahead clear
                                    Move forward
                           Else
                                    End
```

12

There's a lot of statements that say 'if route ahead clear then move forward' in this code and one of the questions below asks if you can re-write it to remove some or even all but one of them. Also, 'route ahead clear' is not precise enough and needs to be rewritten in terms of the ultrasonic sensor, something like: 'if ultrasonic(10 cm) = FALSE', which says 'if the ultrasonic sensor doesn't detect an object at 10 centimetres'. Also the code should really start with something like: 'Repeat until out of maze'.

If you don't want to invest in a Mindstorms kit in order to learn computer programming, perhaps you can try the Hour of Code instead. You can access it from: www.code.org/learn.

Questions

1 Rewrite the code to remove some or all but one of the statements that say: 'If route ahead clear, Move forward'.

2 Mindstorms and the Hour of Code are aimed at secondary school children (but don't let that put you off giving them a go). Do you think it is important for children to learn to computer program?

3 Write some code like that shown in the case to sort a list of words into alphabetical order.

4 Can you think of a robot project that would inspire undergraduate students studying information systems?

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Case Three

GitHub

GitHub is an online software hosting service that serves a massive worldwide community of software developers and end users. It is a great way to request projects, write code and share software. One of its main contributions is in managing versions of software. Even if only a handful of people are working on a project together, it's very easy to lose track of what's going on without tools to help. Even if you have never worked on software development, you may have experienced something similar when you've written a group report for a module assessment: you make a change and email around your version at the same time someone else does. Whose version is the latest one? Even if you use a word processor feature like track changes, managing this can be a hassle.

GitHub handles this by creating 'branches' of code. Let's say Version 1.0 of the software is up and running on systems all over the world. These systems could be running on desktop computers or in devices such as elevators, power stations or tractors – GitHub hosts all sorts of projects. Anyway, a developer makes a branch of Version 1.0. The branch is a copy that he or she can work on safely without affecting all the users. The branch can be shared with other developers so that many developers can work on it together, with the changes they make being seen by each other immediately. When the team is happy, they incorporate their changes into the version that everyone is using, calling it Version 1.1.

While this was going on someone else might make another branch of Version 1.0. Their changes might end up as a different software product, or be incorporated to make Version 1.2.

A change can start when a user of Version 1.0, who may well not be a software developer themselves – it could be a farmer who uses the tractor that the system is a part of for instance – posts a comment on GitHub with a suggestion for a new feature. Or it could come from a member of the original development team. You could go onto

GitHub today and suggest new features for an existing project or maybe initiate a new project, even if your coding skills are not strong.

Many major corporations use GitHub, including Google and NASA. Google launched a new mobile operating system on GitHub, effectively announcing it to the world and requesting developers for it at the same time. Another example is DERT, the Desktop Exploration of Remote Terrain project. It is available to explore, use and extend on GitHub. Funded by the Mars Reconnaissance Orbiter mission, it is a software tool to view and explore NASA's Digital Terrain Models in 3D, which were created from data collected during NASA missions. The software aids in understanding topography and spatial relationships of terrain features, as well as performing simple analysis tasks relevant to the planetary science community.

As with most online services, there are some very useful tutorials available to help you get started using GitHub.

Questions

1. What software on your personal computer could you request new features for? You might need to search GitHub for the answer.
2. Can you think of any useful new features to request?
3. Why does NASA use GitHub?
4. How could disputes between developers over which features they should include in Version 1.1 be solved?

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World Views Case

Systems Development at Damelin, South Africa

By Mathias Imbayarwo and Paul Abanda
Damelin, South Africa

Damelin is owned by Educor (the Education Investment Corporation Limited group). It was founded by Benjamin Damelin in 1943. Damelin has about 1,500 employees nationally. It is a private college, with 17 state of the art campuses ideally positioned in every major hub countrywide in South Africa. There are three campuses in KwaZulu-Natal, nine in Gauteng, two in the Eastern Cape, two in the Western Cape and one in the Free State.

Private higher education has been characterized by cut-throat competition reducing the market share of all the players in this industry. For Damelin, some of the main concerns that students voiced through discussions and surveys are that the campuses' advertisements were old fashioned. Concerns were also raised that students have to use their own Internet to access important study material on campus.

According to Damelin's management, to stay competitive and innovative they recently developed new systems, examples being new electronic billboards to take away the traditional method of advertising on all campuses. Internet has also been installed and wi-fi is freely available to all students on all campuses. The new billboards have been installed with provision for seasonal messages to prospective and enrolled students. The billboards that were installed are state of the art. These boards are connected to the Internet and can be updated daily from the campus server rooms. The billboards were also designed with LED displays, which means reduced energy consumption, and also messages are displayed clearly. Considerations were made to strike a balance on cost, quality and after sales support.

The installation of Internet infrastructure on the campuses was a radical innovation to systems development projects. Internet infrastructure did not need upgrading because there were no previous installations, and new Internet lines, servers and exchanges were installed. The requirement for this infrastructure was led by a team consisting of the IT department's head of telemetric and communication, a telecoms advisor on networks and infrastructure, and an external consulting company. State of the art networks were installed and government subsidized the project capital cost in the form of tax relief. The networks combined the latest fibre optics and exchanges that were just released in the USA, making Damelin campuses the first to enjoy this technology. Originally, the project was scheduled for completion in 5 months, but was completed in 6 months and the system was fully utilized 20 days after completion creating a project overrun of 20 per cent. Factors contributing to this overrun were labour unrest and weather conditions that hampered the installations of exchanges and wi-fi hotspots.

Accordingly, the institution (Damelin) has also implemented new or significantly improved production and delivery methods, including the changes in technology, equipment and software. This helped the organization to remain competitive and meet customer demands by applying process innovation. Process innovation generates value to internal customers, including employees of the actual organization. Damelin recently introduced a virtual learning system where students in the 17 different sites attend 1 class accessed in the digital classrooms. The technology enables students to receive uniform content delivery, unlike old cases where different sites had different lectures and yet they sat for the same exam. The new technology created value for external customers, including business partners, end users and customers. Standards stemming from process innovation include reducing the time it takes to produce or perform a service, increasing the number of products produced or services provided within a time frame, and reducing the costs per product produced or service provided.

The radical innovation provided a degree of novelty and newness and a difference in the environment. The organization has also brought changes in terms of looks and colours. However, Damelin has been a well-known brand name in the industry it represents based on its approaches to both internal and external customers. Although not the best, it still has a high reputation in the service and products it offers. Damelin continues to change its technological infrastructure from simple unshielded twisted pair cable to fibre-optic cables. Pentiums and laptops with CORE i5 processors are offered to each middle management employee, who are considered as internal customers. This is to create satisfaction and increase productivity in the systems development life cycles.

Lessons learnt from the system development are on technological change and transfer, and intra- and inter-organizational networks. The institution has recently adopted and embraced technological change in its design structure to accommodate both internal and external users of their systems, that is, employees and students of the organization. Damelin also invested in social capital.

Questions

1. Will the new electronic billboards as a news systems development for Damelin, internet and wi-fi hotspots be flexible and radical enough to retain and attract new students?
2. How can the institution use technology and innovation on systems development to resolve challenges and improve on its competitiveness?
3. Which latest technology or innovation is being used by comparative institutions of higher education?
4. What are the challenges that are being experienced by the institution on systems development?

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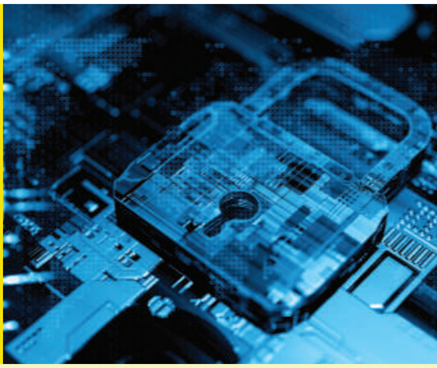
PART 5

Information Systems in Business and Society

13

Security, Privacy and Ethical Issues in Information Systems



Principles	Learning Objectives
Policies and procedures must be established to avoid computer waste and mistakes.	■ Describe some examples of waste and mistakes in an IS environment, their causes and possible solutions. ■ Identify policies and procedures useful in eliminating waste and mistakes. ■ Discuss the principles and limits of an individual's right to privacy.
Computer crime is a serious and rapidly growing area of concern requiring management attention.	■ Explain the types and effects of computer crime. ■ Identify specific measures to prevent computer crime.
Jobs, equipment and working conditions must be designed to avoid negative health effects.	■ List the important effects of computers on the work environment. ■ Identify specific actions that must be taken to ensure the health and safety of employees. ■ Outline criteria for the ethical use of information systems.

Why Learn About Security, Privacy and Ethical Issues in Information Systems?

Our last chapter will look at security, privacy and ethical issues, something that has been in the background throughout this book. A wide range of non-technical issues associated with the use of information systems provide both opportunities and threats to modern organizations. The issues span the full spectrum – from preventing computer waste and mistakes, to avoiding violations of privacy, to complying with laws on collecting data about customers, to monitoring employees. If you become a member of a human resources, information systems or legal department within an organization, you will likely be charged with leading the rest of the organization in dealing with these and other issues covered in this chapter. As a user of information systems, especially the Internet, it is in your own self-interest to become well versed on these issues. You need to know about the topics in this chapter to help avoid or recover from crime, fraud, privacy invasion or other potential problems.

13.1 Computer Waste and Mistakes

Computer-related waste and mistakes are major causes of computer problems, contributing as they do to unnecessarily high costs and lost profits. Computer waste involves the inappropriate use of computer technology and resources. It includes employees wasting computer resources and time by playing games and surfing the web, sending unnecessary email, printing documents and other material that is then not read, developing systems that are not used to their full extent, and discarding old hardware when it could be recycled or given to charity. UK-based Computers for Charities, for instance, will collect old technology, wipe clean any data stored on them and deliver them to charities where they are still useful. Junk email, also called spam, and junk faxes also cause waste. People receive hundreds of email messages and faxes advertising products and services not wanted or requested. Not only does this waste time, but it also wastes paper and computer resources. Worse still, spam messages often carry attached files with embedded viruses that can cause networks and computers to crash or allow hackers to gain unauthorized access to systems and data. Image-based spam is a new tactic spammers use to circumvent spam-filtering software that rejects email based on the content of messages and the use of keywords. The message is presented in a graphic form that can be read by people but not computers. This form of spam can be quite offensive and may contain pornographic photos and extremely graphic language.[1, 2] When waste is identified, it typically points to one common cause: the improper management of information systems and resources.

Computer-related mistakes refer to errors, failures and other computer problems that make computer output incorrect or not useful, caused mostly by human error. Despite many people's distrust, computers themselves rarely make mistakes. Even the most sophisticated hardware cannot produce meaningful output if users do not follow proper procedures. Mistakes can be caused by unclear expectations and a lack of feedback. Or a programmer might develop a program that contains errors. In other cases, a data-entry administrator might enter the wrong data. Unless errors are caught early and prevented, the speed of computers can intensify mistakes. As information technology becomes faster, more complex and more powerful, organizations and computer users face increased risks of experiencing the results of computer-related mistakes.

Preventing Computer-Related Waste and Mistakes

To remain profitable in a competitive environment, organizations must use all resources wisely. Preventing computer-related waste and mistakes like those just described should therefore be a goal. To achieve it involves (1) establishing, (2) implementing, (3) monitoring and (4) reviewing effective policies and procedures.

Establishing Policies and Procedures

The first step to prevent computer-related waste is to establish policies and procedures regarding efficient acquisition, use and disposal of systems and devices. Most companies have implemented stringent policies on the acquisition of computer systems and equipment, including requiring a formal justification statement before computer equipment is purchased, the definition of standard computing platforms (operating system, type of computer chip, minimum amount of RAM, etc.) and the use of preferred vendors for all acquisitions.

Prevention of computer-related mistakes begins by identifying the most common types of errors, of which there are surprisingly few. Types of computer-related mistakes include the following:

- Data-entry or data-capture errors.
- Errors in computer programs.
- Errors in handling files, including formatting a disc by mistake, copying an old file over a newer one and deleting a file by mistake.
- Mishandling of computer output.
- Inadequate planning for and control of equipment malfunctions.
- Inadequate planning for and control of environmental difficulties (electrical problems, humidity problems, etc.).
- Installing computing capacity inadequate for the level of activity on corporate websites.
- Failure to provide access to the most current information by not adding new and not deleting old URL links.

Training programmes for individuals, and workgroups, and manuals and documents on how computer systems are to be maintained and used, can help prevent problems. Other preventative measures include needing approval for certain systems and applications before they are implemented and used to ensure compatibility and cost-effectiveness, and a requirement that documentation and descriptions of certain applications be submitted to a central office. This should include all cell formulas for spreadsheets and a description of all data elements and relationships in a database system (which, as we saw in Chapter 5, is already recorded in the data dictionary). After companies have planned and developed policies and procedures, they must consider how best to implement them.

Sometimes, computer error combines with human procedural errors to lead to the loss of human life. In March 2003, a Patriot missile battery on the Kuwait border accidentally shot down a British Royal Air Force Tornado GR-4 aircraft that was returning from a mission over Iraq. Two British pilots were killed in the incident. Many defence industry experts think the accident was caused by problems with the Patriot's radar combined with human error.

Implementing Policies and Procedures

Implementing policies and procedures to minimize waste and mistakes varies according to the type of business. Most companies develop such policies and procedures with advice from the firm's internal auditing group or its external auditing firm. The policies often focus on the implementation of source data automation, the use of data editing to ensure data accuracy and completeness, and the assignment of responsibility for data accuracy within each information system. Some useful policies to minimize waste and mistakes include the following:

- Changes to critical tables, HTML and URLs should be tightly controlled, with all changes authorized by responsible owners, and documented.
- A user manual should be available that covers operating procedures and documents the management and control of the application.
- Each system report should indicate its general content in its title and specify the time period it covers.
- The system should have controls to prevent invalid and unreasonable data entry.
- Controls should exist to ensure that data input, HTML and URLs are valid, applicable and posted in the right time frame.
- Users should implement proper procedures to ensure correct input data.

Training is another key aspect of implementation. Many users are not properly trained in using applications, and their mistakes can be very costly. One home in the small town of Valparaiso, in the USA, fairly valued at $88,550 was incorrectly recorded in the county's computer system as being worth over $290 million. The erroneous figure was used to forecast future income from property taxes. When the error was uncovered, the local school district and government agencies were forced to slash their budgets by €1.5 million when they found they wouldn't be getting the tax money after all.[3]

Monitoring Policies and Procedures

To ensure that users throughout an organization are following established procedures, the next step is to monitor routine practices and take corrective action if necessary. By understanding what is happening in day-to-day activities, organizations can make adjustments or develop new procedures. Many organizations implement internal audits to measure actual results against established goals, such as percentage of end-user reports produced on time, percentage of data-input errors detected, number of input transactions entered per eight-hour shift and so on.

Reviewing Policies and Procedures

The final step is to review existing policies and procedures and determine whether they are adequate. During review, people should ask the following questions:

- Do current policies cover existing practices adequately? Were any problems or opportunities uncovered during monitoring?
- Is the organization planning any new activities in the future? If so, does it need new policies or procedures on who will handle them and what must be done?
- Are contingencies and disasters covered?

This review and planning allows companies to take a proactive approach to problem solving, which can enhance a company's performance, such as by increasing productivity and improving customer service. Information systems professionals and users still need to be aware of the misuse of resources throughout an organization. Preventing errors and mistakes is one way to do so. Another is implementing in-house security measures and legal protections to detect and prevent a dangerous type of misuse: computer crime.

Information Systems @ Work

Admiral to Price Car Insurance Based on Facebook Posts

To many, it's a terrifying idea. An insurance company peaks into private aspects of your life in order to help it set your premiums. In the past, a controversial example of this has been genetics. What if an insurance company had access to your genetic information, decided it was likely that you were going to get sick in the future, and refuse health cover? Maybe you might think this would be OK, but what if they predicted you would get sick in five years, covered you for four years and then refused to renew your policy? Would that be fair? Many people might see this as an 'insider-information' scenario and deem it unacceptable. Alternatively, people might agree to sharing personal data with an insurance company in the hope of getting lower premiums.

In November 2016, one of the biggest insurance companies in the UK, Admiral, announced that it was going to use data from social media to analyze the personalities of car owners and set the price of their insurance. Targeting first-time car owners, the scheme - called Firstcarquote – would have examined the Facebook posts of customers, with their permission, looking for personality traits that are correlated with safe driving. For example, conscientious and well-organized individuals might write in full sentences rather than in notes and might make arrangements with definite times and places rather than using vague notions. On the other hand, overconfident individuals might make use of exclamation marks and words like 'always' and 'never' rather than 'maybe'.

'It is incredibly transparent. If you don't want to use it in a quote then you don't have to', said Dan Mines, leader of the scheme. 'We are doing our best to build a product that allows young people to identify themselves as safe drivers. This is very much a test product for us. This is innovative, it is the first time anyone has done this. It is a test, this is early days. The data will only ever provide a discount. We will work through that and learn more.' Admiral estimated that first-time car owners, who pay on average around €2,000 for car insurance, could save up to 15 per cent via Firstcarquote.

Yossi Borenstein, the principal data scientist on Firstcarquote, told the *Guardian* newspaper that the scheme is based on algorithms developed by Admiral that will learn over time about the relationship between social media content and claims. 'Our analysis is not based on any one specific model, but rather on thousands of different combinations of likes, words and phrases and is constantly changing with new evidence that we obtain from the data', he said. 'As such our calculations reflect how drivers generally behave on social media, and how predictive that is, as opposed to fixed assumptions about what a safe driver may look like.' He also stressed that Admiral would not have access to information about what its customers look at on Facebook or what their friends do. The company would only have access to the information gathered during the quote process and would have no ongoing access.

However, hours before the scheme was set to launch, Facebook stepped on the brakes. They said that protecting the privacy of its users was of the utmost importance to it and, as a result, did not allow Firstcarquote to proceed. Facebook's terms and conditions state that its data should not be used to 'make decisions about eligibility, including whether to approve or reject an application or how much interest to charge on a loan'. Mines said, 'People share their social data with third parties every day, without any financial benefit to themselves. Firstcarquote asks users to share their data only once and offers them a clear, tangible financial benefit in return.'

Questions

1. In what ways does your personality 'shine through' in your social media posts?
2. Who should 'own' the content that you publish on social media?
3. Should insurance companies be able to use social media posts to help set premiums?
4. What protections for users should be in place from companies using their social media data?

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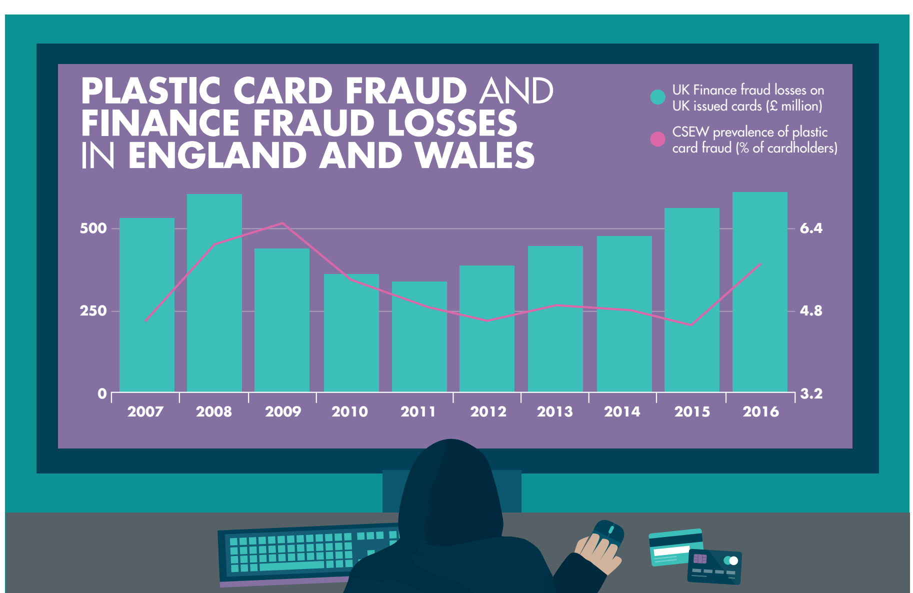
13.2 Computer Crime

According to Financial Fraud Action UK, in 2012 credit card fraudsters stole nearly €400 million in the UK alone, with €163 million of this happening through e-commerce transactions.[4] In 2013, Internet security experts Kaspersky Lab detected almost 3 billion malware attacks on user computers and 104,427 new malicious programs aimed at mobile devices.[5] The term computer crime covers a wide variety of activities, including these. Some more examples are listed next and then some types of computer crime are discussed.

- The largest consumer fraud in the USA was committed by the Gambino crime family involving two different computer-related ploys and resulted in a loss to the public of over €200 million. One of the schemes offered 'free' tours of adult Internet sites but required the victim to provide a credit card supposedly for age-verification purposes. Victims took the free tours and then their credit cards were hit for charges over and over again. The second prong to this scheme involved the use of a third-party billing provider to add charges on people's telephone bills for services not provided.[6]
- A 20-year-old man was sentenced to 57 months in prison for hijacking more than 400,000 PCs over the Internet and turning them into a 'botnet' or 'zombie network', a network of personal computers used to perform a task without the owner's knowledge. He would then rent the zombie network out to spyware distributors, hackers and spammers to use in performing their work.[7]
- Russian organized crime extorted untold thousands of dollars from firms doing business on the Internet by demanding €7,000 or more for protection from being hit by a denial-of-service attack on their website. Some firms bought the 'protection'; some of those that did not were attacked.[8]
- A British information systems expert accessed a series of computer networks used by the US Army, Navy, Air Force and Department of Defense, searching for what he called 'suppressed technology'. US authorities claimed he caused more than $700,000 of damage.[9]
- The UK government's tax credit website, which allowed qualifying citizens to claim tax benefits, was shut down in 2005 because it was being targeted by organized gangs claiming many millions of pounds from the government.[10]

Online Fraud
There is no ultimate solution to prevent computer fraud. Fraudsters and security experts are locked in an endless game of cat and mouse. Battling them involves a constantly evolving mix of technical and social measures.



Identity Theft

Identity theft is one of the fastest growing crimes. It is a crime where an imposter obtains key pieces of personal identification information, such as date of birth, address, national insurance number and mother's maiden name, and uses them to open bank accounts, get credit cards, loans, benefits and documents such as passports and driving licences in the victim's name. In other cases, the identity thief uses personal information to gain access to the person's existing accounts. Typically, the thief changes the mailing address on an account and runs up a huge bill before the person whose identity has been stolen realizes there is a problem. The Internet has made it easier for an identity thief to use the stolen information because transactions can be made without any personal interaction. The UK government has a website, nidirect.gov.uk/articles/protect-your-identity, to advise its citizens and help victims. A wide range of methods are used by the perpetrators of these crimes, which makes investigating them difficult. Frequently, a critical computer password has been talked out of a person, or guessed based on a knowledge of the person, a practice called **social engineering**. For example, many people use the name of their pet as their password. Many teenagers use the name of their favourite pop artist. Alternatively, the attackers might simply go through the person's rubbish, looking for a discarded utility bill or bank statement. In addition, over 2,000 websites offer the digital tools – for free – that will let people snoop, crash computers, hijack control of a machine or retrieve a copy of every keystroke.

social engineering Using one's social skills to get computer users to provide you with information to access an information system or its data.

Another popular method to get information is 'shoulder surfing' – the identity thief simply stands next to someone at a public office, such as the passport office or even when filling in a form to join a customer loyalty programme, and watches as the person fills out personal information on a form. The same thing can happen at a bank ATM where the attacker simply watches the person enter their PIN, or at a shop when the victim is using their credit card to make a purchase (see Figure 13.1).

Figure 13.1 **Shoulder Surfing** *Always take care when using an ATM that no one can see you enter your PIN.*

Consumers can help protect themselves by regularly checking their credit reports, following up with creditors if their bills do not arrive on time, not revealing any personal information in response to unsolicited email or phone calls, and shredding bills and other documents that contain sensitive information.[11]

Cyberterrorism

Government officials and IS security specialists have documented a significant increase in Internet probes and server scans since early 2001. A growing concern among authorities is that such intrusions are part of an organized effort by cyberterrorists to map potential security holes in critical systems. A **cyberterrorist** is someone who intimidates or coerces a government or organization to advance their political or social objectives by launching computer-based attacks against computers, networks and the information stored on them. Attacks would likely be aimed at critical infrastructure, which includes telecommunications, energy, banking and finance, water systems, government operations and emergency services. Successful cyberattacks against the facilities that provide these services could cause widespread and massive disruptions to the normal functioning of a society.

cyberterrorist Someone who intimidates or coerces a government or organization to advance his or her political or social objectives by launching computer-based attacks against computers, networks and the information stored on them.

A similar term, 'cyberwar', is arguably not a crime but involves a country or state attacking another, using the same techniques as a cyberterrorist.

Illegal Access and Use

Crimes involving illegal system access and use of computer services are a concern to both government and business. Since the outset of information technology, computers have been plagued by criminal crackers. A **cracker**, often called a **hacker**, although this term has a range of meanings, is a computer-savvy person who attempts to gain unauthorized or illegal access to computer systems. Often they are 'just looking' but could also be trying to corrupt files, steal data or even transfer money. In many cases, crackers are people who are looking for fun and excitement – the challenge of beating the system. **Script kiddies** admire crackers, but have little technical savvy. They are crackers who download programs called 'scripts' that automate the job of breaking into computers. **Insiders** are employees, disgruntled or otherwise, working solo or in concert with outsiders to compromise corporate systems.

cracker or **hacker** A computer-savvy person who attempts to gain unauthorized or illegal access to computer systems.

script kiddies A cracker with little technical savvy who downloads programs called scripts, which automate the job of breaking into computers.

insiders An employee, disgruntled or otherwise, working solo or in concert with outsiders to compromise corporate systems.

Catching and convicting criminal hackers remains a difficult task. The method behind these crimes is often hard to determine. Even if the method behind the crime is known, tracking down the criminals can take a lot of time.

Data and information are valuable corporate assets. The intentional use of illegal and destructive programs to alter or destroy data is as much a crime as destroying tangible goods. The most common of these programs are viruses and worms, which are software programs that when loaded into a computer system, will destroy, interrupt or cause errors in processing. Such programs are also called 'malware'.

A **virus** is a computer program file capable of attaching to discs or other files and replicating itself repeatedly, typically without the user's knowledge or permission. Some viruses attach to files, so when the infected file executes, the virus also executes. Other viruses sit in a computer's memory and infect files as the computer opens, modifies or creates the files. They are often disguised as games or images with clever or attention-grabbing titles such as 'Boss, naked'. Some viruses display symptoms, and some viruses damage files and computer systems. The m00p virus gang, for example, conspired to infect computers with a virus that would turn each infected machine into a zombie machine under their control. The zombie network could then be used to spread viruses and other malware across the Internet, without the owners of the compromised computers even being aware.[12] Hoax viruses can also be a problem. A hoax virus is a message, usually distributed by email, warning recipients to carry out a procedure on their computer to protect themselves from a 'virus threat', when the procedure itself is actually doing the damage. Typically a hoax virus encourages people to delete an important systems file. The message will encourage people to forward it on to all their contacts.

virus A computer program file capable of attaching to discs or other files and replicating itself repeatedly, typically without the user's knowledge or permission.

Worms are computer programs that replicate but, unlike viruses, do not infect other computer program files. Worms can create copies on the same computer or can send the copies to other computers via a network. Worms often spread via Internet Relay Chat (IRC). For example, the MyDoom worm, also known as Shimgapi and Novarg, started spreading in January 2004 and quickly became the most virulent email worm ever. The worm arrived as an email with an attachment with various names and extensions, including .exe, .scr, .zip and .pif. When the attachment executed, the worm sent copies of itself to other email addresses stored in the infected computer. The first version of the virus, MyDoom.A, was designed to attack The SCO Group Inc.'s website. A later variant, dubbed MyDoom.B, was designed to enable similar denial-of-service attacks against the Microsoft website. The B variant also included a particularly nasty feature in that it blocked infected computers from accessing sites belonging to vendors of antivirus products. Infected email messages carrying the MyDoom worm have been intercepted from over 142 countries and at one time accounted for 1 in every 12 email messages.

worm A parasitic computer program that can create copies of itself on the infected computer or send copies to other computers via a network.

A **Trojan horse** program is a malicious program that disguises itself as a useful application and purposefully does something the user does not expect. Trojans are not viruses because they do not replicate, but they can be just as destructive. Many people use the term to refer only to non-replicating malicious programs, thus making a distinction between Trojans and viruses. A German language email, for example, was used to spread a Trojan horse that steals passwords and logon details of customers' online bank accounts and then relays them back to a remote server. The malware tried to get users to install the Trojan horse by disguising itself as a software patch for a new flaw in Microsoft software.[13] Spyware is often spread using the Trojan horse method. Spyware is software which records all manner of personal information about users and forwards it to the spyware's owner, all without the user's consent. Name, address, credit card numbers and passwords can all be collected by spyware, as can information on web browsing behaviour, which would be valuable for marketing.

Trojan horse A malicious program that disguises itself as a useful application and purposefully does something the user does not expect.

A logic bomb is a type of Trojan horse that executes when specific conditions occur. Triggers for logic bombs can include a change in a file by a particular series of keystrokes or at a specific time or date.

A variant is a modified version of a virus that is produced by the virus's author or another person who amends the original virus code. If changes are small, most antivirus products will also detect variants. However, if the changes are significant, the variant might go undetected by antivirus software.

In some cases, a virus or a worm can completely halt the operation of a computer system or network for days or longer until the problem is found and repaired. In other cases, a virus or a worm can destroy important data and programs. If back-ups are inadequate, the data and programs might never be fully functional again. The costs include the effort required to identify and neutralize the virus or worm and to restore computer files and data, as well as the value of business lost because of unscheduled computer downtime.

As a result of the increasing threat of viruses and worms, most computer users and organizations have installed **antivirus programs** on their computers. Such software runs in the background to protect your computer from dangers lurking on the Internet and other possible sources of infected files. Some antivirus software is even capable of repairing common virus infections automatically, without interrupting your work. The latest virus definitions are downloaded automatically when you connect to the Internet, ensuring that your PC's protection is current. To safeguard your PC and prevent it from spreading viruses to your friends and coworkers, some antivirus software scans and cleans both incoming and outgoing email messages. Table 13.1 lists some of the most popular antivirus software.

antivirus program Software that runs in the background to protect your computer from dangers lurking on the Internet and other possible sources of infected files.

Table 13.1 Antivirus Software

Antivirus Software	Software Manufacturer	Website
Symantec's Norton AntiVirus	Symantec	www.broadcom.com
McAfee Virus Scan	McAfee	www.mcafee.com
Panda Antivirus Platinum	Panda Software	www.pandasoftware.com
Sophos Antivirus	Sophos	www.sophos.com
PC-cillin	Trend Micro	www.trendmicro.com

Proper use of antivirus software requires the following steps:

1. Install antivirus software. These programs should automatically check for viruses each time you boot up your computer or insert a flash drive or CD, and some even monitor all email and file transmissions and copying operations.
2. Ensure the antivirus software updates often. New viruses are created all the time, and antivirus software suppliers are constantly updating their software to detect and take action against these new viruses. The software should itself check for updates regularly, without the need for an instruction from the user.
3. Scan all removable media, including CDs, before copying or running programs from them. Hiding on flash drives or CDs, viruses often move between systems. If you carry document or program files on removable media between computers at school or work and your home system, always scan them.
4. Install software only from a sealed package or secure website of a known software company. Even software publishers can unknowingly distribute viruses on their program discs or software downloads. Most scan their own systems, but viruses might still remain.
5. Follow careful downloading practices. If you download software from the Internet or a bulletin board, check your computer for viruses immediately after completing the transmission.
6. If you detect a virus, take immediate action. Early detection often allows you to remove a virus before it does any serious damage.

Despite careful precautions, viruses can still cause problems. They can elude virus-scanning software by lurking almost anywhere in a system. Future antivirus programs might incorporate 'nature-based models' that check for unusual or unfamiliar computer code. The advantage of this type of virus program is the ability to detect new viruses that are not part of an antivirus database.

Hoax, or false, viruses are another problem. Crackers sometimes warn the public of a new and devastating virus that doesn't actually exist just to create fear. Companies sometimes spend hundreds of hours warning employees and taking preventative action against a non-existent virus. Security specialists recommend that IS personnel establish a formal paranoia policy to thwart virus panic among gullible end-users. Such policies should stress that before users forward an email alert to colleagues, they should send it to the help desk or the security team. The corporate intranet can be used to explain the difference between real viruses and fakes, and it can provide links to websites to set the record straight.

Be aware that virus writers also use known hoaxes to their advantage. For example, AOL4FREE began as a hoax virus warning. Then, a hacker distributed a destructive Trojan attached to the original hoax virus warning. Always remain vigilant and never open a suspicious attachment.

Equipment Theft

During illegal access to computer systems, data can be stolen. In addition to theft of data and software, all types of computer systems and equipment have been stolen from offices. Mobile computers such as laptops and smartphones are especially easy for thieves to take. Very often the data stored on these devices is more valuable than the device itself. An MI5 agent's laptop containing sensitive government information was stolen at Paddington train station in London, and a senior British Army official's laptop was taken at Heathrow Airport.[14] To fight computer crime, many companies use devices that disable the disc drive and/or lock the computer to the desk.

Software and Internet Software Piracy

Like books and movies – and other intellectual properties – software is protected by copyright laws. Often, people who would never think of plagiarizing another author's written work have no qualms about using and copying software programs they have not paid for. Such illegal duplicators are called 'pirates'; the act of illegally duplicating software is called **software piracy**.

software piracy The act of illegally duplicating software.

Technically, software purchasers are granted the right only to use the software under certain conditions; they don't really own the software. Licences vary from program to program and can authorize as few as one computer or one person to use the software or as many as several hundred network users to share the application across the system. Making additional copies or loading the software onto more than one machine might violate copyright law and be considered piracy.

The Business Software Alliance estimates that the software industry loses over €8 billion per year in revenue to software piracy annually. Half the loss comes from Asia, where China and Indonesia are the biggest offenders. In Western Europe, annual piracy losses range between €1.5 and €2 billion. Although the rate of software piracy is quite high in Latin America and Central Europe, those software markets are so small that the monetary losses are considerably lower. Overall, it is estimated that 35 per cent of the world's software is pirated.[15]

Internet-based software piracy occurs when software is illegally downloaded from the Internet. It is the most rapidly expanding type of software piracy and the most difficult form to combat. The same purchasing rules apply to online software purchases as for traditional purchases. Internet piracy can take several forms, including the following:

- Pirate websites that make software available for free or in exchange for uploaded programs.
- Internet auction sites that offer counterfeit software, which infringes copyrights.
- Peer-to-peer networks, which enable unauthorized transfer of copyrighted programs.

Computer-Related Scams

People have lost hundreds of thousands of euros on property, travel, stock and other business scams. Now, many of these scams are being perpetrated with computers. Using the Internet, scam artists offer get-rich-quick schemes involving bogus property deals, tout 'free' holidays with huge hidden costs, commit bank fraud, offer fake telephone lotteries, sell worthless penny stocks and promote illegal tax-avoidance schemes.

Over the past few years, credit card customers of various banks have been targeted by scam artists trying to get personal information needed to use their credit cards. The scam typically works by sending an email to many thousands of people, asking them to click on a link that seems to direct users to a bank's website to fill in essential security information. Some of the recipients will probably be customers of the bank. At the site, they are asked for their full debit and credit card numbers and expiration dates, their name, address and other personal information. The problem is that the website customers are directed to is a fake site operated by someone trying to gain access to that information. This form of scam is called 'phishing'. The website used is often extremely similar to the bank's real website and may contain links to the real site.

In the weeks following Hurricane Katrina in the USA, the FBI warned that over half the Hurricane Katrina aid sites it checked were registered to people outside the USA and likely to be fraudulent. A 20-year-old man was charged with setting up websites designed to look like those of the American Red Cross and other organizations accepting donations to help the victims. He then sold these to 'would-be scammers' for about $140 each. For his trouble, this person faced 50 years in prison and a fine of $1 million.[16]

The following is a list of tips to help you avoid becoming a scam victim:

- Don't agree to anything in a high-pressure meeting or seminar. Insist on having time to think it over and to discuss things with your spouse, your partner or even your solicitor. If a company won't give you the time you need to check it out and think things over, you don't want to do business with them. A good deal now will be a good deal tomorrow; the only reason for rushing you is if the company has something to hide.
- Don't judge a company based on appearances. Professional-looking websites can be created and published in a matter of days. After a few weeks of taking money, a site can vanish without a trace in just a few minutes. You might find that the perfect money-making opportunity offered on a website was a money-maker for the crook and a money-loser for you.
- Avoid any plan that pays commissions simply for recruiting additional distributors. Your primary source of income should be your own product sales. If the earnings are not made primarily by sales of goods or services to consumers or sales by distributors under you, you might be dealing with an illegal pyramid.
- Beware of 'shills', people paid by a company to lie about how much they've earned and how easy the plan was to operate. Check with an independent source to make sure that you aren't having the wool pulled over your eyes.
- Beware of a company's claim that it can set you up in a profitable home-based business but that you must first pay up front to attend a seminar and buy expensive materials. Frequently, seminars are high-pressure sales pitches, and the material is so general that it is worthless.
- If you are interested in starting a home-based business, get a complete description of the work involved before you send any money. You might find that what you are asked to do after you pay is far different from what was stated in the ad. You should never have to pay for a job description or for needed materials.
- Get in writing the refund, buy-back and cancellation policies of any company you deal with. Do not depend on oral promises.
- If you need advice about an online solicitation or if you want to report a possible scam, contact your country's computer crime unit. In the UK, you can find more information at www.direct.gov.uk.

13.3 Preventing Computer-Related Crime

Because of increased computer use, greater emphasis is placed on the prevention and detection of computer crime. Many countries have passed data laws governing how data can be stored, processed and transferred, and laws on computer crime. Some believe that these laws are not effective because companies do not always actively detect and pursue computer crime, security is inadequate and convicted criminals are not severely punished. However, all over the world, private users, companies, employees and public officials are making individual and group efforts to curb computer crime, and recent efforts have met with some success.

Crime Prevention by the State

In the UK, the Computer Misuse Act of 1990, which criminalizes unauthorized access to computer systems, and the Data Protection Act of 2018, which governs when and how data about individuals can be stored and processed, have been passed. Many countries have passed similar laws.

In the UK, the Home Office is charged with tackling computer crime with some police forces having a 'cyber crime' unit. The Information Commissioner's Office is in charge of the UK's independent authority set up to protect personal information (and as we shall see later in this chapter, to promote access to official information). The UK also has an organization dedicated to fighting specific types of computer crime. The Child Exploitation and Online Protection Centre (CEOP) tackles child sex abuse, especially where it has been facilitated in some way by the Internet.

Crime Prevention by Organizations

Companies are also taking crime-fighting efforts seriously. Many businesses have designed procedures and specialized hardware and software to protect their corporate data and systems. Specialized hardware and software, such as encryption devices, can be used to encode data and information to help prevent unauthorized use. Encryption is the process of converting an original electronic message into a form that can be understood only by the intended recipients. A key is a variable value that is applied using an algorithm to a string or block of unencrypted text to produce encrypted text or to decrypt encrypted text. Encryption methods rely on the limitations of computing power for their effectiveness – if breaking a code requires too much computing power, even the most determined code crackers will not be successful. The length of the key used to encode and decode messages determines the strength of the encryption algorithm.

Public-key infrastructure (PKI) enables users of an unsecured public network such as the Internet to securely and privately exchange data through the use of a public and a private cryptographic key pair that is obtained and shared through a trusted authority. PKI is the most common method on the Internet for authenticating a message sender or encrypting a message. PKI uses two keys to encode and decode messages. One key of the pair, the message receiver's public key, is readily available to the public and is used by anyone to send that individual encrypted messages. The second key, the message receiver's private key, is kept secret and is known only by the message receiver. Its owner uses the private key to decrypt messages – convert encoded messages back into the original message. Knowing a person's public key does not enable you to decrypt an encoded message to that person.

public-key infrastructure (PKI) A means to enable users of an unsecured public network such as the Internet to securely and privately exchange data through the use of a public and a private cryptographic key pair that is obtained and shared through a trusted authority.

Using **biometrics** is another way to protect important data and information systems. Biometrics involves the measurement of one of a person's traits, whether physical or behavioural. Biometric techniques compare a person's unique characteristics against a stored set to detect differences between them. Biometric systems can scan fingerprints, faces, handprints, irises and retinal images to prevent unauthorized access to important data and computer resources. Most of the interest among corporate users is in fingerprint technology, followed by face recognition. Fingerprint scans hit the middle ground between price and effectiveness (see Figure 13.2). Iris and retina scans are more accurate, but they are more expensive and involve more equipment.

biometrics The measurement of one of a person's traits, whether physical or behavioural.

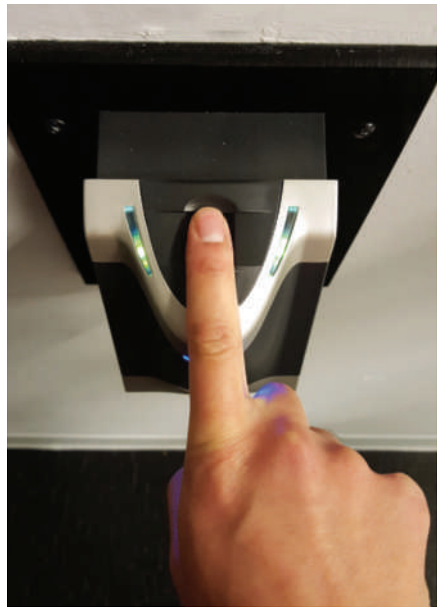


Figure 13.2 Fingerprint Authentication *Fingerprint authentication devices provide security in the PC environment by using fingerprint information instead of passwords.*

As employees move from one position to another at a company, they can build up access to multiple systems if inadequate security procedures fail to revoke access privileges. It is clearly not appropriate for people who have changed positions and responsibilities to still have access to systems they no longer use. To avoid this problem, many organizations create role-based system access lists so that only people filling a particular role (e.g. line manager) can access a specific system.

Crime-fighting procedures usually require additional controls on the information system. Before designing and implementing controls, organizations must consider the types of computer-related crime that might occur, the consequences of these crimes, and the cost and complexity of needed controls. In most cases, organizations conclude that the trade-off between crime and the additional cost and complexity weighs in favour of better system controls. Having knowledge of some of the methods used to commit crime is also helpful in preventing, detecting and developing systems resistant to computer crime (see Table 13.2). Some companies actually hire former criminals to thwart other criminals.

Although the number of potential computer crimes appears to be limitless, the actual methods used to commit crime are limited. The following list provides a set of useful guidelines to protect your computer from criminal hackers:

- Install strong user authentication and encryption capabilities on your firewall.
- Install the latest security patches, which are often available at the vendor's Internet site.
- Disable guest accounts and null user accounts that let intruders access the network without a password.
- Do not provide overfriendly logon procedures for remote users (e.g. an organization that used the word 'welcome' on their initial logon screen found they had difficulty prosecuting a criminal hacker).
- Restrict physical access to the server and configure it so that breaking into one server won't compromise the whole network.

- Give each application (email, FTP and domain name server) its own dedicated server.
- Turn audit trails on.
- Consider using caller ID.
- Install a corporate firewall between your corporate network and the Internet.
- Install antivirus software on all computers and regularly download vendor updates.
- Conduct regular IS security audits.
- Verify and exercise frequent data back-ups for critical data.

Table 13.2 Common Methods Used to Commit Computer Crimes

Methods	Examples
Add, delete or change inputs to the computer system	Delete records of absences from class in a student's school records
Modify or develop computer programs that commit the crime	Change a bank's program for calculating interest to make it deposit rounded amounts in the criminal's account
Alter or modify the data files used by the computer system	Change a student's grade from C to A
Operate the computer system in such a way as to commit computer crime	Access a restricted government computer system
Divert or misuse valid output from the computer system	Steal discarded printouts of customer records from a company trash bin
Steal computer resources, including hardware, software and time on computer equipment	Make illegal copies of a software program without paying for its use
Offer worthless products for sale over the Internet	Send email requesting money for worthless hair growth product
Blackmail executives to prevent release of harmful information	Eavesdrop on organization's wireless network to capture competitive data or scandalous information
Blackmail company to prevent loss of computer-based information	Plant logic bomb and send letter threatening to set it off unless paid considerable sum

Companies are also joining together to fight crime. The Software and Information Industry Alliance (SIIA) was the original antipiracy organization, formed and financed by many of the large software publishers. Microsoft financed the formation of a second antipiracy organization, the Business Software Alliance (BSA). The BSA, through intense publicity, has become the more prominent organization. Other software companies, including Apple, Adobe, Hewlett-Packard and IBM, now contribute to the BSA.

Crime Prevention by Individuals

A number of individuals – victims, former criminals, concerned parents – have set up websites offering support for those worried about computer crime, and advice on how to fight it.

Using Intrusion Detection Software

intrusion detection system (IDS) Software that monitors system and network resources and notifies network security personnel when it senses a possible intrusion.

An **intrusion detection system (IDS)** monitors system and network resources and notifies network security personnel when it senses a possible intrusion. Examples of suspicious activities include repeated failed logon attempts, attempts to download a program to a server and access to a system at unusual hours. Such activities generate alarms that are captured on log files. Intrusion detection systems send an alarm, often by email or pager, to network security personnel when they detect an apparent attack. Unfortunately, many IDSs frequently provide false alarms that result in wasted effort. If the attack is real, network security personnel must make a decision about what to do to resist the attack. Any delay in response increases the probability of damage from a criminal hacker attack. Use of an IDS provides another layer of protection in the event that an intruder gets past the outer security layers – passwords, security procedures and corporate firewall.

The following story is true, but the company's name has been changed to protect its identity. The ABC company employs more than 25 IDS sensors across its worldwide network, enabling it to monitor 90 per cent of the company's internal network traffic. The remaining 10 per cent comes from its engineering labs and remote sales offices, which are not monitored because of a lack of resources. The company's IDS worked very well in providing an early warning of an impending SQL Slammer attack. The Slammer worm had entered the network via a server in one of the engineering labs. The person monitoring the IDS noticed outbound traffic consistent with SQL Slammer at about 7.30 am. He contacted the network operations group by email and followed up with a phone call and a voice mail message. Unfortunately, the operations group gets so many emails that if a message is not highlighted as URGENT, the message might be missed. That is exactly what happened – the email alert wasn't read and the voice message wasn't retrieved in time to block the attack. A few hours later, the ABC company found itself dealing with a massive number of reports of network and server problems.

Using Managed Security Service Providers (MSSPs)

Keeping up with computer criminals – and with new regulations – can be daunting for organizations. Criminal hackers are constantly poking and prodding, trying to breach the security defences of companies. For most small and mid-sized organizations, the level of in-house network security expertise needed to protect their business operations can be quite costly to acquire and maintain. As a result, many are outsourcing their network security operations to managed security service providers (MSSPs) such as Counterpane, Guardent, Internet Security Services, Riptech and Symantec. MSSPs monitor, manage and maintain network security for both hardware and software. These companies provide a valuable service for IS departments drowning in reams of alerts and false alarms coming from virtual private networks (VPNs); antivirus, firewall and intrusion detection systems; and other security monitoring systems. In addition, some provide vulnerability scanning and web blocking/filtering capabilities.

Preventing Crime on the Internet

As mentioned in Chapter 6, Internet security can include firewalls and many methods to secure financial transactions. A firewall can include both hardware and software that act as a barrier between an organization's information system and the outside world. Some systems have been developed to safeguard financial transactions on the Internet.

To help prevent crime on the Internet, the following steps can be taken:

1 Develop effective Internet usage and security policies for all employees.
2 Use a stand-alone firewall (hardware and software) with network monitoring capabilities.
3 Deploy intrusion detection systems, monitor them and follow up on their alarms.
4 Monitor managers and employees to make sure that they are using the Internet for business purposes.
5 Use Internet security specialists to perform audits of all Internet and network activities.

Even with these precautions, computers and networks can never be completely protected against crime. One of the biggest threats is from employees. Although firewalls provide good perimeter control to prevent crime from the outside, procedures and protection measures are needed to protect against computer crime by employees. Passwords, identification numbers and tighter control of employees and managers also help prevent Internet-related crime.

13.4 Privacy

Privacy is a big issue for many people. When information is computerized and can be processed and transferred easily, augmented and collated, summarized and reported, privacy concerns grow. The European Union has a data-protection directive that requires firms transporting data across national boundaries to have certain privacy procedures in place. This directive affects virtually any company doing business in Europe, and it is driving much of the attention being given to privacy in the USA.

Privacy and the Government

Many people are suspicious of the government when it comes to information that is stored about them. In the UK a few years ago, the government wanted an identity card scheme which, it was claimed, would help fight international terrorism and identity theft and other fraud. The card would be linked to a database, which would hold names, addresses and biometric information on all citizens. Expected to cost many billions of euros, some people pledged never to carry them, claiming that the scheme would create a 'big brother' society. Many of these fears were unfounded, although the debate did highlight a lack of trust in the state and the scheme was not implemented.

Many governments are in fact quite open about the information that they store. Numerous countries have implemented some sort of freedom of information legislation. In South Africa, it is the Promotion of Access to Information Act. In the UK it is the Freedom of Information Act. Similar laws have been passed throughout Europe.

The UK Freedom of Information Act governs all data that is not about an individual, in any public organization including government, local councils, schools, universities and hospitals. The Act basically states that all such organizations must give out whatever information is requested of them, as long as it is not about an individual (which is protected under the Data Protection Act) or some other sensitive information. So, for example, you would be able to ask your university how many people achieved A grades in one of your modules last year (this information is probably published on the students' portal anyway). However, you couldn't request information about a professor's salary. You could, though, ask for information about lecturers' pay scales (which again is already freely available from the relevant union's website).

Privacy at Work

The right to privacy at work is an important issue. Currently, the rights of workers who want their privacy and the interests of companies that demand to know more about their employees are in conflict. Recently, companies that have been monitoring their workers have raised concerns. For example, workers might find that they are being closely monitored via computer technology. These computer-monitoring systems tie directly into workstations; specialized computer programs can track every keystroke made by a user. This type of system can determine what workers are doing while at the keyboard. The system also knows when the worker is not using the keyboard or computer system. These systems can estimate what people are doing and how many breaks they are taking. Needless to say, many workers consider this close supervision very dehumanizing.

Email Privacy

Email also raises some interesting issues about work privacy. A company has the right to look at any data stored on its servers, which includes its email servers and therefore all messages sent by or to its employees. Many companies routinely store all emails sent or received for several years and many employees have lost their jobs for forwarding inappropriate messages. Others have sent embarassing messages that have been forwarded exponentially by recipients who pass the 'joke' on to their friends. Accidentally hitting 'reply all' to an email instead of 'reply' is such a common problem it's got its own thread on Reddit.[17]

Privacy and the Internet

Some people assume that there is no privacy on the Internet and that you use it at your own risk. Others believe that companies with websites should have strict privacy procedures and be accountable for privacy invasion. Regardless of your view, the potential for privacy invasion on the Internet is huge. People wanting to invade your privacy could be anyone from criminal hackers to marketing companies to corporate bosses. Email is a prime target, as discussed previously. When you visit a website, information about you and your computer can be captured. When this information is combined with other information, companies can know what you read, what products you buy and what your interests are. According to an executive of an Internet software monitoring company, 'It's a marketing person's dream'.

Most people who buy products on the web say it's very important for a site to have a policy explaining how personal information is used, and the policy statement must make people feel comfortable and be extremely clear about what information is collected and what will and will not be done with it. However, many websites still do not prominently display their privacy policy or implement practices completely consistent with that policy. The real issue that Internet users need to be concerned with is 'What do content providers want with our personal information?' If a site requests that you provide your name and address, you have every right to know why and what will be done with it. If you buy something and provide a shipping address, will it be sold to other retailers? Will your email address be sold on a list of active Internet shoppers? And, if so, you should realize that it's no different from the lists compiled from the orders you place with catalogue retailers – you have the right to be taken off any mailing list.

These same questions can be asked of Internet chat rooms that require you to register before you can post messages. It is important for the forum moderators to know who is posting, but users should also have confidence that their information will not be misused.

A potential solution to some consumer privacy concerns is the screening technology called the **Platform for Privacy Preferences (P3P)** being proposed to shield users from sites that don't provide the level of privacy protection they desire. Instead of forcing users to find and read

Platform for Privacy Preferences (P3P) A screening technology that shields users from websites that don't provide the level of privacy protection they desire.

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through the privacy policy for each site they visit, P3P software in a computer's browser will download the privacy policy from each site, scan it and notify the user if the policy does not match his or her preferences. (Of course, unethical marketers can post a privacy policy that does not accurately reflect the manner in which the data is treated.) The World Wide Web Consortium (W3C), an international industry group whose members include Apple, Commerce One, Ericsson and Microsoft, is supporting the development of P3P.

A social network service employs the web and software to connect people for whatever purpose. There are thousands of such networks, which have become popular among teenagers. Some of the more popular social networking websites include Tumblr, QZone, QQ, Viber, LinkedIn and Snapchat. Most of these allow one to easily create a user profile that provides personal details, photos, even videos that can be viewed by other visitors to the website. Some of the websites have age restrictions or require that a parent register their pre-teen by providing a credit card to validate the parent's identity. Teens can provide information about where they live, go to school, their favourite music and interests in the hopes of meeting new friends. Unfortunately, they can also meet ill-intentioned strangers at these sites. Many documented encounters involve adults masquerading as teens attempting to meet young people for illicit purposes. Parents are advised to discuss potential dangers, check their children's profiles and monitor their activities at such websites.

Whenever someone registers a domain name such as www.mydomain.co.uk, the name and address given during registration become public information and can be seen by simply running a 'whois' query, which can be easily done on many websites. Parents should be aware of this before they let their children have their own web page.

Fairness in Information Use

Selling information to other companies can be so lucrative that many companies will continue to store and sell the data they collect on customers, employees and others. When is this information storage and use fair and reasonable to the people whose data is stored and sold? Do people have a right to know about data stored about them and to decide what data is stored and used? As shown in Table 13.3, these questions can be broken down into four issues that should be addressed: knowledge, control, notice and consent.

Table 13.3 The Right to Know and the Ability to Decide

Fairness Issues	Database Storage	Database Usage
The right to know	Knowledge	Notice
The ability to decide	Control	Consent
Knowledge: Should people know what data is stored about them? In some cases, people are informed that information about them is stored in a corporate database. In others, they do not know that their personal information is stored in corporate databases		
Control: Should people be able to correct errors in corporate database systems? This is possible with most organizations, although it can be difficult in some cases		
Notice: Should an organization that uses personal data for a purpose other than the original purpose notify individuals in advance? Many companies don't do this even though they should.		
Consent: If information on people is to be used for other purposes, should these people be asked to give their consent before data on them is used? Many companies do not give people the ability to decide if information on them will be sold or used for other purposes		

In Europe, the General Data Protection Regulation, discussed in the next section, governs the answers to these questions. The Regulation relates to data about individuals and states that:

1. Personal data shall be processed fairly and lawfully.
2. Companies must have a reason for collecting and storing the data – they cannot arbitrarily start hoarding it, and they cannot process it in any manner incompatible with that reason.
3. The data collected shall be adequate, relevant and not excessive in relation to the reason for collecting it.
4. Companies must make an effort to ensure the data is accurate and, where necessary, up to date.
5. The data will not be stored for longer than is necessary.
6. All of the above applies to processing the data, not just collecting and storing it.
7. Companies must take steps to ensure that the data is secure.
8. The data must not be transferred to somewhere that does not have a similar law on processing it.

The Regulation allows individuals to access information stored about them and, if necessary, have the data updated or deleted. Similar laws have been implemented throughout Europe.

Even though privacy laws for private organizations are not very restrictive, most organizations are very sensitive to privacy issues and fairness. They realize that invasions of privacy can hurt their business, turn away customers and dramatically reduce revenues and profits. Consider a major international credit card company. If the company sold confidential financial information on millions of customers to other companies, the results could be disastrous. In a matter of days, the firm's business and revenues could be reduced dramatically. Therefore, most organizations maintain privacy policies, even though they are not required by law. Corporate privacy policies should address a customer's knowledge, control, notice and consent over the storage and use of information. They can also cover who has access to private data and when it can be used.

Multinational companies face an extremely difficult challenge in implementing data-collection and dissemination processes and policies because of the multitude of differing country or regional statutes. A good database design practice is to assign a single unique identifier to each customer – so that each has a single record describing all relationships with the company across all its business units. That way, the organization can apply customer privacy preferences consistently throughout all databases. Failure to do so can expose the organization to legal risks – aside from upsetting customers who opted out of some collection practices.

Right to Forget

In May 2014, an EU court ruling took a step towards giving people the 'right to be forgotten' by forcing Google and other search engines to remove certain links from search results. The content itself will still be available on the web, but it will just be more difficult to find. The implications of this have not yet sunk in, and Google's response has been to produce a form that people can use to request that search results be removed. Each request they receive will be assessed and a balance sought between the 'privacy rights of the individual and the public's right to know and distribute information'. It is thought that among those most likely to use the form will be people with spent convictions, victims of domestic violence and students wishing to tidy up their online image before submitting job applications.[18]

Individual Efforts to Protect Privacy

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Many people are taking steps to increase their own privacy protection. Some of the steps that you can take to protect personal privacy include the following:

- If you are concerned about what information a company is holding on you, use the Data Protection Act (or your country's equivalent) to find out what is stored about you in existing databases.
- Be careful when you share information about yourself. Don't share information unless it is absolutely necessary.
- Be vigilant in insisting that your doctor, bank or financial institution does not share information about you with others without your written consent.
- Be proactive to protect your privacy. For instance, you could get an unlisted phone number and think twice about registering for a service if it means you must supply a postal address. Consider registering for the telephone preference and mail preference services in your country (which stops commercial calls and post). In the UK the address is www.tpsonline.org.uk.
- When purchasing anything from a website, make sure that you safeguard your credit card numbers, passwords and personal information. Do not do business with a site unless you know that it handles credit card information securely (look for https:// in the address bar). Do not provide personal information without reviewing the site's data privacy policy.

When some people give out personal information, they change it slightly somehow, maybe changing their name from John T. Smith to John R. Smith. Then, in the future, if they get contacted as John R. Smith from an unknown source, they know which company the information must have come from and can take the appropriate steps.

13.5 Relevant Laws Governing Use of Technology

Many countries have laws that regulate privacy, data use and computer misuse. In Europe, the General Data Protection Regulation (GDPR) governs how companies, charities and other organizations can collect, use and share information, regardless of whether that information is stored electronically in a computer's memory, or on paper in a filing cabinet. The regulation applies equally to video data, including video that has been collected by CCTV in a shop, or on a body camera worn by the police. Introduced in 2016, the GDPR brought together all the existing but independent laws that individual European countries had enacted. It is based around seven data principles:

- Lawfulness, fairness and transparency
- Purpose limitation
- Data minimization
- Accuracy
- Storage limitation
- Integrity and confidentiality
- Accountability[19]

Going through these in order, they mean that: data that is collected and stored must be done so for a legal and publicly known purpose; that purpose must be specific – organizations are not supposed to grab data 'just in case' they can think of a purpose for it at a later date; organizations should not collect more data than they really need for their specified purpose; organizations must take steps to ensure the data is accurate; when the data is no longer needed it should be properly deleted; the data should be held securely; and organizations must be accountable – this means that if an organization stores data about you, you are entitled to 1) know about it,

2) see a copy of the data that is held and 3) get that data corrected or deleted if there is a problem. ‘Properly deleted’ means that the data must be wiped from memory in a way that it is impossible to recover – something that simply pressing delete on your keyboard does not ensure.

Organizations of a certain size must appoint a data protection officer to ensure that these principles are adhered to. Other countries have similar legislation. South Africa has the Protection of Personal Information Act; Australia has a set of privacy acts.

Many countries also have laws that govern information held by public bodies. In the UK, the Freedom of Information Act 2000 allows anyone to see any information held by any public body. This includes government, councils, universities and hospitals, although there are exceptions to what information they have to hand over. The Act requires organizations to respond to any requests for information in a timely manner, either by supplying the information or stating why it cannot be supplied. The Act is a constant pain for many organizations who have to deal with time-wasting requests. However, many scandals of great public interest have been brought to light because of it. In the UK, one well-known example of this was the Members of Parliament expense claims (a lot of them were making frivolous claims), but the Act has also been used to investigate hospital waiting times, restaurant hygiene, council expenses and electoral fraud.[20, 21, 22]

The Computer Misuse Act is an older piece of legislation, coming into law in 1990 in the UK and essentially makes it illegal to use a computer to commit crime. It is the law that makes ‘computer hacking’ (gaining access to someone else’s computer) an offence.

There are a number of more modern laws that govern our use of technology. One controversial example is the Regulation of Investigatory Powers Act 2000, which allows authorities to issue a ‘disclosure notice’ that essentially means people can be made to hand over the passwords to their phone or computer. London-based solicitors Sanders Law say that ‘The police are able to request disclosure if the reason is to prevent or detect crime, if it’s in the interests of national security or if it is in the interests of the economic wellbeing of the UK. This definition can be applied very widely to the extent that it can cover any crime, no matter how minor. Refusal to comply with a notice served under s49 of RIPA can result in a maximum sentence of two years imprisonment, or five years in cases involving national security or child indecency’.[23]

In 2018, Stephen Nicholson was jailed under the Regulation of Investigatory Powers Act for refusing to give police his Facebook password. In 2019, Nicholson was jailed for life for murdering a teenage girl. Note that to get the murder conviction, police did not in the end use his Facebook data.[24]

13.6 The Work Environment

The use of computer-based information systems has changed the make-up of the workforce. Jobs that require IS literacy have increased, and many less-skilled positions have been eliminated. Corporate programs, such as reengineering and continuous improvement, bring with them the concern that as business processes are restructured and information systems are integrated within them, the people involved in these processes will be removed.

However, the growing field of computer technology and information systems has opened up numerous avenues to professionals and nonprofessionals of all backgrounds. Enhanced telecommunications has been the impetus for new types of business and has created global markets in industries once limited to domestic markets. Even the simplest tasks have been aided by computers, making cash registers faster, smoothing order processing and allowing people with disabilities to participate more actively in the workforce. As computers and other IS components drop in cost and become easier to use, more workers will benefit from the increased productivity and efficiency provided by computers. However, information systems can raise other concerns.

Health Concerns

Organizations can increase employee effectiveness by paying attention to the health concerns in today's work environment. For some people, working with computers can cause occupational stress. Anxieties about job insecurity, loss of control, incompetence and demotion are just a few of the fears workers might experience. In some cases, the stress can become so severe that workers might sabotage computer systems and equipment. Monitoring employee stress can alert companies to potential problems. Training and counselling can often help the employee and deter problems.

Computer use can affect physical health as well. Strains, sprains, tendonitis, tennis elbow, the inability to hold objects and sharp pain in the fingers can result. Also common is repetitive strain injury (RSI), including carpal tunnel syndrome (CTS), which is the aggravation of the pathway for nerves that travel through the wrist (the carpal tunnel). CTS involves wrist pain, a feeling of tingling and numbness, and difficulty grasping and holding objects. It can be caused by many factors, such as stress, lack of exercise and the repetitive motion of typing on a computer keyboard. Decisions on workers' compensation related to RSI have been made both for and against employees.

Other work-related health hazards involve emissions from improperly maintained and used equipment. Some studies show that poorly maintained laser printers can release ozone into the air; others dispute the claim. Numerous studies on the impact of emissions from display screens have also resulted in conflicting theories. Although some medical authorities believe that long-term exposure can cause cancer, studies are not conclusive at this time. In any case, many organizations are developing conservative and cautious policies.

Most computer manufacturers publish technical information on radiation emissions from their CRT monitors, and many companies pay close attention to this information. In addition, adjustable chairs and workstations should be supplied if employees request them.

In April 2014, French labour unions and employers in the high-tech and consulting field signed an agreement that employees must be able to disconnect communications tools. The agreement was widely reported as a ban on reading work-related emails after 6 pm although this is not the case. However, the move does show that the French recognize the negative impact that being always online can have on wellbeing.[25]

Avoiding Health and Environmental Problems

Many computer-related health problems are caused by a poorly designed work environment. The computer screen can be hard to read, with glare and poor contrast. Desks and chairs can also be uncomfortable. Keyboards and computer screens might be fixed in place or difficult to move. The hazardous activities associated with these unfavourable conditions are collectively referred to as 'work stressors'. Although these problems might not be of major concern to casual users of computer systems, continued stressors such as repetitive motion, awkward posture and eyestrain can cause more serious and long-term injuries. If nothing else, these problems can severely limit productivity and performance.

The science of designing machines, products and systems to maximize the safety, comfort and efficiency of the people who use them, called **ergonomics**, has suggested some approaches to reducing these health problems. The slope of the keyboard, the positioning and design of display screens, and the placement and design of computer tables and chairs have been carefully studied. Flexibility is a major component of ergonomics and an important feature of computer devices. People come in many sizes, have differing preferences and require different positioning of equipment for best results. Some people, for example, want to place the keyboard in their laps; others

ergonomics The science of designing machines, products and systems to maximize the safety, comfort and efficiency of the people who use them.

prefer it on a solid table. Because of these individual differences, computer designers are attempting to develop systems that provide a great deal of flexibility. In fact, the revolutionary design of Apple's iMac computer came about through concerns for users' comfort, and after using basically the same keyboard design for over a decade, Microsoft introduced a new split keyboard called the Natural Ergonomic Keyboard 4000. The keyboard provides improved ergonomic features such as improved angles that reduce motion and how much you must stretch your fingers when you type. The design of the keyboard also provides more convenient wrist and arm postures, which make typing more convenient for users.[26]

Computer users who work at their machines for more than an hour per day should consider using LCD screens, which are much easier on your eyes than CRT screens. If you stare at a CRT screen all day long, your eye muscles can get fatigued from all the screen flicker and bright backlighting of the monitor. LCD screens provide a much better viewing experience for your eyes by virtually eliminating flicker and still being bright without harsh incandescence.[27, 28]

In addition to steps taken by hardware manufacturing companies, computer users must also take action to reduce strain injury and develop a better work environment. For example, when working at a workstation, the top of the monitor should be at or just below eye level. Your wrists and hands should be in line with your forearms, with your elbows close to your body and supported. Your lower back needs to be well supported. Your feet should be flat on the floor. Take an occasional break to get away from the keyboard and screen. Stand up and stretch while at your workplace. Do not ignore pain or discomfort. Many workers ignore early signs of strain injury, and, as a result, the problem becomes much worse and more difficult to treat.

Ethical and Societal Issues

Kettle Botnet Heats Up

In October 2016, a malware program called Mirai undertook a denial-of-service attack against a number of targets, including the popular cybersecurity blog KrebsOnSecurity. A denial-of-service attack involves flooding a website with millions of requests so that the genuine requests can't get through. Often these attacks originate from a botnet. Malware infects thousands of devices, and these devices – without their owner's knowledge – are then used to send out the denial-of-service requests. What is unusual about the Mirai malware is that rather than infecting what we traditionally think of as computers, it infected everyday devices such as kettles, video recorders and cameras that were connected to the Internet of Things.

Mirai tried various hardcoded root passwords on Internet-connected devices. Kettles weren't the most common object it attacked, but it was the one that created the most surprise among the general public. Here's what happened. Someone bought an Internet-enabled smart kettle. Makers advertise these devices as being able to save time for thirsty owners as they can remote boil from anywhere in the house, gain extra time in bed as they don't have to get up to switch the kettle on, boil water from the bus so it's ready to make tea as soon as the owner arrives home and save energy with ready notifications. The password that is used to gain access to the chips inside these are 'hardcoded'; in other words they cannot be changed by the owner. Mirai searched for devices, fed them the default password and then installed a program to make it join the botnet. When the botnet's owner wanted, they could command their army of kettles and other devices to start sending out messages to deny the service of the target website. Turning the kettle off and on would remove the malware, but this didn't help the target as most smart kettle owners didn't know what was going on. In addition, there is so much constant scanning going on for vulnerable devices that they can be re-infected within minutes of a reboot. Only changing the default password can prevent this.

During the attack, connection problems began in the eastern USA before spreading to other parts of the USA and to Europe. Dozens of websites were at times unreachable including Mashable, CNN, the *New York Times*, the *Wall Street Journal*, Yelp and some businesses hosted by Amazon.

The *Atlantic* magazine then asked an interesting question: who is responsible if your kettle starts attacking Internet infrastructure? 'One idea would put more of a burden of legal responsibility on the manufacturers that produce connected devices – and hold them accountable if their products were implicated in cybercrime', said reporter Kaveh Waddell. Devices that are connected to the Internet of Things are often not designed with security in mind and this is a huge mistake. Holding manufacturers responsible may be the only way to change this. Mr Waddell acknowledges, however, that even if this started to happen tomorrow, 'the sea of poorly secured connected devices already out in the world will continue to haunt us for some time'.

KrebsOnSecurity reports that there are plenty of new, default-insecure Internet of Things devices being plugged into the Internet each day. Gartner Inc. forecasts that 20.8 billion connected things will be in use worldwide by the end of 2020.

Questions

1 What steps should manufacturers of Internet of Things devices now take to help deal with this problem?

2 Why would someone launch a denial-of-service attack?

3 Is a smart kettle a good idea?

4 What will have to happen to stop the 'sea of poorly secured connected devices' haunting us for years?

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13.7 Ethical Issues in Information Systems

As you've seen throughout the book in our Ethical and Societal Issues boxes, ethical issues deal with what is generally considered right or wrong. As we have seen, laws do not provide a complete guide to ethical behaviour. Just because an activity is defined as legal does not mean that it is ethical. As a result, practitioners in many professions subscribe to a **code of ethics** that states the principles and core values that are essential to their work and, therefore, govern their behaviour. The code can become a reference point for weighing what is legal and what is ethical. For example, doctors adhere to varying versions of the 2,000-year-old Hippocratic Oath, which medical schools offer as an affirmation to their graduating classes.

code of ethics A code that states the principles and core values that are essential to a set of people and, therefore, govern their behaviour.

Some IS professionals believe that their field offers many opportunities for unethical behaviour. They also believe that unethical behaviour can be reduced by top-level managers developing, discussing and enforcing codes of ethics. Various IS-related organizations and associations promote ethically responsible use of information systems and have developed useful codes of ethics. The British Computer Society has a code of ethics and professional conduct that can be used to help guide the actions of IS professionals. These guidelines can also be used for those who employ or hire IS professionals to monitor and guide their work and can be seen at www.bcs.org. The international professional association ISACA (the Information Systems Audit and Control Association) which focuses on IT Governance, includes recognition of ethical issues in its governance framework COBIT (Control Objectives for Information and Related Technology). COBIT governs all aspects of IT development and management and is used to meet government regulations on reporting information, such as those set out for instance in the US Sarbanes-Oxley Act and the South African King III code of corporate governance. For more information see: www.isaca.org/COBIT.

The mishandling of the social issues discussed in this chapter – including waste and mistakes, crime, privacy, health and ethics – can devastate an organization. The prevention of these problems and recovery from them are important aspects of managing information and information systems as critical corporate assets. Increasingly, organizations are recognizing that people are the most important component of a computer-based information system and that long-term competitive advantage can be found in a well-trained, motivated and knowledgeable workforce.

Summary

Policies and procedures must be established to avoid computer waste and mistakes. Computer waste is the inappropriate use of computer technology and resources in both the public and private sectors. Computer mistakes relate to errors, failures and other problems that result in output that is incorrect and without value. Waste and mistakes occur in government agencies as well as corporations. At the corporate level, computer waste and mistakes impose unnecessarily high costs for an information system and drag down profits. Waste often results from poor integration of IS components, leading to duplication of efforts and overcapacity. Inefficient procedures also waste IS resources, as do thoughtless disposal of useful resources and misuse of computer time for games and personal processing jobs. Inappropriate processing instructions, inaccurate data entry, mishandling of IS output and poor systems design all cause computer mistakes.

A less dramatic, yet still relevant, example of waste is the amount of company time and money employees can waste playing computer games, sending unimportant email or accessing the Internet. Junk email, also called spam, and junk faxes also cause waste.

Preventing waste and mistakes involves establishing, implementing, monitoring and reviewing effective policies and procedures. Careful programming practices, thorough testing, flexible network interconnections and rigorous back-up procedures can help an information system prevent and recover from many kinds of mistakes. Companies should develop manuals and training programmes to avoid waste and mistakes. Company policies should specify criteria for new resource purchases and user-developed processing tools to help guard against waste and mistakes.

Computer crime is a serious and rapidly growing area of concern requiring management attention. Some crimes use computers as tools (e.g. to manipulate records, counterfeit money and documents, commit fraud via telecommunications links and make unauthorized electronic transfers of money). Identity theft is a crime in which an imposter obtains key pieces of personal identification information to impersonate someone else. The information is then used to obtain credit, merchandise and services in the name of the victim, or to provide the thief with false credentials.

A cyberterrorist is someone who intimidates or coerces a government or organization to advance his or her political or social objectives by launching computer-based attacks against computers, networks and the information stored on them. A cracker, or criminal hacker, is a computer-savvy person who attempts to gain unauthorized access to computer systems to steal passwords, corrupt files and programs, and even transfer money. Script kiddies are crackers with little technical savvy. Insiders are employees, disgruntled or otherwise, working solo or in concert with outsiders to compromise corporate systems.

Computer crimes target computer systems and include illegal access to computer systems, alteration and destruction of data and programs by viruses (system, application and document), and simple theft of computer resources. A virus is a program that attaches itself to other programs. A worm functions as an independent program, replicating its own program files until it destroys other systems and programs or interrupts the operation of computer systems and networks. Malware is a general term for software that is harmful or destructive. A Trojan horse program is a malicious program that disguises itself as a useful application and purposefully does something the user does not expect. A logic bomb is designed to 'explode' or execute at a specified time and date.

Because of increased computer use, greater emphasis is placed on the prevention and detection of computer crime. Antivirus software is used to detect the presence of viruses, worms and logic bombs. Use of an intrusion detection system (IDS) provides another layer of protection in the event that an intruder gets past the outer security layers – passwords, security procedures and corporate firewall. It monitors system and network resources and notifies network security personnel when it senses a possible intrusion. Many SME organizations are outsourcing their network security operations to managed security service providers (MSSPs), which monitor, manage and maintain network security hardware and software.

Software and Internet piracy might represent the most common computer crime. Computer scams have cost people and companies thousands of euros. Computer crime is also an international issue.

Many organizations and people help prevent computer crime. Security measures, such as using passwords, identification numbers and data encryption, help to guard against illegal computer access, especially when supported by effective control procedures. Public-key infrastructure (PKI) enables users of an unsecured public network such as the Internet to securely and privately exchange data through the use of a public and a private cryptographic key pair that is obtained and shared through a trusted authority. The use of biometrics, involving the measurement of a person's unique characteristics, such as the iris, retina or voice pattern, is another way to protect important data and information systems. Virus-scanning software identifies and removes damaging computer programs. Although most companies use data files for legitimate, justifiable purposes, opportunities for invasion of privacy abound. Privacy issues are a concern with government agencies, email use, corporations and the Internet. A business should develop a clear and thorough policy about privacy rights for customers, including database access. That policy should also address the rights of employees, including electronic monitoring systems and email. Fairness in information use for privacy rights emphasizes knowledge, control, notice and consent for people profiled in databases. People should know about the data that is stored about them and be able to correct errors in corporate database systems. If information on people is to be used for other purposes, they should be asked to give their consent beforehand. Each person has the right to know and the ability to decide. Platform for Privacy Preferences (P3P) is a screening technology that shields users from websites that don't provide the level of privacy protection they desire.

Jobs, equipment and working conditions must be designed to avoid negative health effects. Computers have changed the make-up of the workforce and even eliminated some jobs, but they have also expanded and enriched employment opportuntities in many ways. Computers and related devices can affect employees' emotional and physical health. Some critics blame computer systems for emissions of ozone and electromagnetic radiation.

The study of designing and positioning computer equipment, called ergonomics, has suggested some approaches to reducing these health problems. Ergonomic design principles help to reduce harmful effects and increase the efficiency of an information system. The slope of the keyboard, the positioning and design of display screens, and the placement and design of computer tables and chairs are essential for good health. Good practice includes keeping good posture, not ignoring pain or problems, performing stretching and strengthening exercises, and seeking proper treatment. Although they can cause negative health consequences, information systems can also be used to provide a wealth of information on health topics through the Internet and other sources.

Ethics determine generally accepted and discouraged activities within a company and society at large. Ethical computer users define acceptable practices more strictly than just refraining from committing crimes; they also consider the effects of their IS activities, including Internet usage, on other people and organizations. Many IS professionals join computer-related associations and agree to abide by detailed ethical codes.

Self-Assessment Test

1 Fooling or convincing someone into giving you their password is called ______________.

2 Another name for a zombie network is ______________.

3 ______________ software runs in the background protecting your computer from infected files.

4 ______________ are people who illegally duplicate software.

5 A ______________ is a slang term for someone paid by a company to make them look good and make you a victim of a scam.

6 ______________ allows you to send information securely through a public network.

7 ______________ involves identifying you from your physical traits.

8 ______________ watches for people illegally using a company's network.

9 Your work email account is legally accessible only by you. True or false?

10 Under the ______________ an individual can ask for certain web pages to be removed from the results of web searches.

Review Questions

1 Identify several potential sources of computer-related waste.

2 List several examples of computer-related mistakes.

3 Give some examples of computer crime.

4 What is identity theft?

5 Who can prevent computer crime?

6 What is social engineering?

7 What is a code of ethics? Give an example.

8 How can you protect yourself from identity theft?

9 Give an example of biometrics.

10 How can you create a secure password?

Discussion Questions

1 How might you guess someone's password?

2 Why do you think people write computer viruses?

Web Exercises

1 Search for information about cyber warfare. Has there ever been a cyber war?

2 What information can you find out about the dean of your faculty? What additional information could you get through a freedom of information request?

Case One

Open-Access Pirates

The world of research publishing is a strange place. Scholars are often employed by universities to create (research) and share (teach) knowledge. Often they are paid – at least in part – by the tax payer. The knowledge that they create is published in a number of places including academic journals. Scholars write the papers which are then reviewed and edited by other scholars. None of this is paid for by the journal's publisher. The publisher then publishes the journal and sells it back to university libraries who often subscribe to many hundreds such journals. Many see the fees that they charge as being so high they are obscene. Tax payers, most of whom do not have access to university libraries and who paid for the research in the first place, have to purchase access to individual papers for over €30 if they want to read them. Scholars whose libraries don't subscribe are expected to pay this as well, although in fact most authors would just send a copy of their paper to anyone who asked. Many see this system as being unfair and exploitative. This is certainly the view of Alexandra Elbakyan.

Elbakyan is seen as a hero or a villain, depending on who you talk to. In 2011, the graduate student from Kazakhstan opened a searchable online database giving free access to 50 million journal articles. The technical details of how the system works have not been fully published, but it looks like it relies on library login details that have been donated by sympathetic university employees, and these are used to access the papers.

'There are many ways to argue that copyright infringement is not theft, but even if it is, it is justified in this case', she told the *Washington Post* from her place in hiding somewhere in Eastern Europe or Russia. 'All content should be copied without restriction. But for education and research, copyright laws are especially damaging.' It would seem that many agree with her. *Science* magazine has said that her site, Sci-Hub, has millions of users. Publishers are not impressed. They have slapped lawsuits on the site but have been unable to completely shut it down. Elsevier brought a copyright lawsuit against it in 2015 in a New York court, claiming lost revenue, but as Elbakyan does not live in the USA, is not a US citizen and has no assets in the USA, not much can really be done to stop her by that court.

Science magazine was given some data from Elbakyan on the use of Sci-Hub. These data revealed that it has become the world's de facto open-access research library. Sci-Hub users are not limited to the developing world, as some have thought. In fact, many scholars seem to be using the site for convenience rather than necessity. A full quarter of Sci-Hub downloads came from the 34 members of the Organization for Economic Cooperation and Development, the wealthiest nations with presumably the best journal access. In fact, some of the most intense use of Sci-Hub appears to be happening on the campuses of US and European universities.

Elbakyan has now enrolled in a history of science master's programme at a small private university in an undisclosed location. Appropriately enough, her thesis focuses on scientific communication. 'I perceive Sci-Hub as a practical side of my research.'

Questions

1. In what ways might Sci-Hub disrupt traditional journal publishing?
2. How can international websites be policed?
3. Why are researchers at well-resourced universities using Sci-Hub?
4. What lessons can all publishers learn from Sci-Hub?

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Case Two

The Encryption Row Is Back

In 2015, then UK prime minister David Cameron said, 'Are we going to allow a means of communication where it simply isn't possible to [read electronic communications even under a warrant from the Home Secretary] and my answer to that question is no we must not'. He was talking about encrypted communications, and as we have seen earlier in this text (see Case One in Chapter 6) with some instant messaging services that use end-to-end encryption, it isn't possible for the company running the service to hand over messages to the government or anyone else as they simply don't have access to them!

In response to calls like these from politicians, a group of computer security experts published a paper called 'Keys Under Doormats: Mandating Insecurity by Requiring Government Access to All Data and Communications' which looked at the technical problems in allowing access to two types of information: texts sent via instant messaging services and information stored on an encrypted mobile phone.

Briefly, encrypted instant messages are encrypted with a throw-away key that not even the instant message company has access to – it is only available to the two devices that are communicating with each other. In order to make messages available to governments and law enforcement agencies, the suggestion is that the throw-away key itself be encrypted with a government key and sent alongside the message. A recording of the message could then be decoded by the government – they would first decrypt the throw-away key and then use it to decrypt the message.

The implication of this is that the throw-away key would no longer be throw-away. In fact it would be forever stored in encrypted form, ready to be used when needed. It also means that all messages would be kept safe by one government-owned key. If – or rather, according to many experts, when – that key is leaked, all messages would suddenly be available.

Alternatively the government could ban the use of encryption by instant messaging companies. One problem with this is that it involves forcing a company in one country to obey the law in another country. A second problem is that encryption algorithms are simple and well known and could easily be implemented by someone with a little programming knowledge. We also should note that all Internet banking and e-commerce relies on exactly the same techniques as encrypted instant messaging – if you ban them then you would no longer be able to securely text chat with live help from your bank.

The second scenario, gaining access to data stored on encrypted mobile phones, has helped in numerous court cases, but it does involve the active help of the tech company involved (Apple or Google, for instance). The current position is that many modern encrypted phones cannot be opened, even by the tech firms.

The security experts argue that anything that weakens security for some (those involved in court cases) weakens security for all, and that this should be avoided. Very similar arguments were made in the 1990s when encryption techniques were classed by the US Army as a munition and subject to the same laws as guns, bullets and missiles. At that time, those arguing against banning encryption won their battle. It would seem that they are about to win again if for no other reason than once the techniques are out of the bag, it is impossible to put them back in. This will likely remain the case until quantum computers (which would make current encryption techniques insecure) are perfected!

Questions

1. Should instant messages be available for law enforcement to read?
2. How could a government encryption be leaked?
3. Might mobile phone owners not benefit from the tech company being able to get inside them, if for instance they forgot their passcode?
4. If you represented Google and you were refusing to provide access to a phone that may contain evidence of a crime, what would you say to the victim of that crime?

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Case Three

On Patrol With the Love Police

There are many communities within the video sharing site YouTube that specialize in sharing videos which centre around certain themes. We have already discussed 'let's play' videos where vloggers (video bloggers) share footage of themselves playing computer games. There is another, much smaller community that makes videos about what we might call 'authority baiting'. A typical scene is as follows. A camera is set up on a high street pointing into a bank or shop. Inevitably, a security guard takes an interest and approaches the vlogger. The guard then verifies that filming is taking place. Once this is confirmed, they tell the vlogger that 'You cannot film here' giving the opportunity for an argument. This can make for entertaining footage, especially if the security guard responds aggressively. Many variations can be found including filming bailiffs, traffic wardens, university campus security, shopping centre security, police and postal workers. The vlogger is usually arguing from a better informed position than the security guard with a working knowledge of relevant laws and cases, backed up with a moral argument about the number of CCTV cameras filming inside the bank and around the city centre. On at least one occasion the vlogger announces Action!' to the camera as the guard approaches!

In the late 1990s, a group of technology experts led by Steve Mann created wearable technology that could record everything that the wearer saw and did (see Chapter 10 for more about this). Back then they were already talking about smart floors, smart elevators and smart light switches that could be used for ubiquitous surveillance inside buildings. With the popularity of smartphones, tablet computers, other mobile devices and even smart TVs, the opportunity for, and the practice of, surveillance inside what were once very private spaces is now very real. The imbalance between those surveying and the inability of those under surveillance to control it has created what, towards the end of the 18th century, Jeremy Bentham imagined as a *panopticon*. The concept referred to the ability of a single watchman to observe all inmates of an institution without them being able to tell whether or not they were being watched. In response to what he saw as the emergence of the panopticon, Steve Mann and others began to confront surveillance with their technological creations, many of which were wearable cameras. These were used to 'record the recorders' and essentially asked organizations: *how do you like it?* The term they coined for this was sousveillance, and indeed the concept captures closely what the YouTube authority baiters are doing. They describe sousveillance as a performance that uses recording technology to:

a) uncover the panopticon and undercut its primacy and privilege

b) relocate the relationship of the surveillance society within a more traditional commons notion of observability.

Today, authority baiters on YouTube seek to highlight the hypocrisy of filming the public but not allowing filming by the public even though in many countries the law is clear – there can be no expectation of privacy on public land. London Metropolitan Police, for example, state on their website that 'members of the public and the media do not need a permit to film or photograph in public places and police have no power to stop them filming or photographing incidents or police personnel'.

The Love Police is a group of authority baiters. They describe themselves as an 'absurdist performance art group which concentrates on issues such as the encroaching fear and greed in our society'. The group would regularly hold up signs stating 'Everything is OK' claiming they were trying to make people realize that everything is not OK: authority figures regularly try to prevent citizens enjoying freedoms to behave in ways that they want to reserve for themselves, such as recording in public spaces and limiting free expression in public spaces. The group say they do not take themselves too seriously and that they try to see the human under the uniform. Indeed, often they offer to hug that human. They say that the best footage they have is when the 'facade of the training and the indoctrination of a police officer break[s] down and he looks at you as a fellow human being'.

Questions

1 Why do you think authority baiters film themselves and share their videos?

2 Would authority baiting exist without *video-sharing* sites like YouTube?

3 Should we object to being filmed in city centres and inside stores?

4 Can YouTube lead to social change?

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World Views Case

Facebook: A Platform for Cyberbullying and Cyber Racism or Not?

By Natasha Madhav
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Social media can be described as an innovative tool that has increased collaboration and engagement among people; however, recent trends in social media have seen its contribution to cyberstalking, cyberbullying, racism and hacking into accounts to provide potential threats to social media users. The web is progressively being used by people to attack, bully and circulate racist ideologies, as well as to communicate, organize and mobilize. Cyberbullying is bullying that happens across an online medium generally using devices such as mobile phones, personal computers and tablets as well as online communication mediums such as social media sites, SMSs, online chats and websites.

There are various forms of racist and bullying activity on the web. These include websites, social networks, computer games and online chat-rooms. Twitter and Facebook, the most popular social media sites, have seen their share of cyberstalking, racist attacks on communities as well as cyberbullying.

Cyberbullying among Aboriginal people in Australia has become a perturbing trend. In 2012, Aboriginal people called for a ban on social media including Facebook as it was perceived to fuel tension and hate speech among communities. While some communities were requesting a ban on Facebook and other sites, other members felt that Facebook could provide an educational platform for Aboriginal people. The other concern participants voiced about Facebook and suicidal behaviour was in regards to suicide clusters. Research conducted on Australian Aboriginal communities indicated that their suicide rates are among the highest in the world. Research conducted by *The Elders Report* (2014) indicates that suicide among Aboriginal people is 40 per cent higher than the general Australian population, making them among the highest in the world.

Further research funded by the Australian Research Council reveals how their engagement on social media has assisted the strategies aimed at preventing suicide. Facebook, for instance, has been able to provide a platform for the Aboriginals as they seek advice and support for issues relating to suicide. Increased use of mobile technologies has also been a significant contributor to Aboriginal youth and their engagement on Facebook.

Research conducted by Carlson (2013) describes how social media is changing the way we communicate and connect with each other globally. For Aboriginals, Facebook and other social media provide a point of connection allowing people also using these channels to share their thoughts, concerns and the cultural activities in their communities. Carlson (2013) further states that the Aboriginal people are also participating in political and cultural activities on social media, which can be the platform for notifications of deaths and extending support to the grieving. They also revealed that social media can be both a productive and problematic space for Aboriginal people. While social media provided an online space where families could assemble, it also created a space where cultural compassion, values and performances are displayed publicly, thus allowing the Aboriginal people to become subject to abuse, racism and hate speech. Australia's Race Discrimination Commissioner has also raised the issue of cyber racism, stating that there has been an increase in complaints about online racism to the extent where Georgatos (2014) argued that racism had contributed to some suicides in Aboriginal communities.

On a brighter side, the Aboriginal People describe Facebook as a site that helped them to engage with family and friends and identify people at risk and who needed help. This also enabled quicker responses to get help by calling emergency or other services. Another important aspect was their ability to share their thoughts and concerns about their communities. So it seems that even though Facebook and Twitter encourage bullying, racism and suicidal talk, they also have the ability to reduce suicidal tendencies, create an online community and serve as a platform for prevention interventions.

Questions

1. What do you understand by the term cyber racism? Could you provide any recent examples in your communities?
2. Do you think that social media such as Facebook provides a space of support and care for the Aboriginal people?
3. What potential barriers might the Aboriginal people have experienced using these tools?
4. Do you think Facebook has the potential to help people from various communities to overcome barriers, such as personal, social and cultural, or is it likely to facilitate racial abuse and social segregation?

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Answers to Self-Assessment Tests

Chapter 1

1. Processed
2. System performance standard
3. Feedback
4. Cloud computing
5. People
6. Executive information system
7. Transaction
8. Mobile device
9. Systems development
10. Computer literate

Chapter 2

1. Flat
2. Empowerment
3. On-demand computing
4. Reengineering
5. Key operational systems
6. Output divided by Input
7. Competitive advantage
8. Market share
9. Strategic alliance
10. Chief information officer

Chapter 3

1. Arithmetic/logic unit
2. Register
3. MIPS
4. 40
5. Secondary storage
6. Thin client
7. Free e-books
8. Scalability
9. Sea water
10. Green computing

Chapter 4

1 Operating and Application
2 Linus Torvalds
3 Chrome
4 Embedded
5 Proprietary software
6 Software as a service
7 Presentation
8 Compiler
9 Open-source software
10 Database software

Chapter 5

1 Primary key
2 Tables
3 Entity
4 Data redundancy
5 Definition and manipulation
6 SELECT
7 Database administrator
8 Warehouse
9 Rattle (or Weka)
10 Replicated

Chapter 6

1 Channel bandwidth
2 Beam of light
3 Broadband over power lines
4 Near field communication
5 Switch
6 Network operating system and network-management software
7 <b>
8 Web services
9 File Transfer Protocol
10 Cloud computing

Chapter 7

1 Enterprise resource planning
2 Transaction processing systems
3 Online transaction processing
4 Collect or input
5 Data manipulation
6 M-commerce
7 E-government
8 Customer relationship management
9 B2B commerce
10 C2C

Chapter 8

1 Intelligence
2 Rule
3 Satisficing
4 TPS
5 Scheduled
6 Marketing
7 Geographic information system
8 What-if analysis
9 Group
10 Brainstorming

Chapter 9

1 Intelligence
2 Expert systems, robotics, vision systems, natural language processing systems, learning systems or neural networks
3 Mircorobotics
4 Natural language processing
5 Knowledge base
6 Credit granting, picking stocks, identifying cheats and designing factories
7 Head mounted display
8 Genetic algorithm
9 Neural network
10 Perceptive

Chapter 10

1 An area where wireless Internet access is available
2 Wearable technology
3 E-money
4 Mobile phone
5 Virtual pet
6 Computer supported cooperative work
7 Interactive whiteboard
8 Blog
9 M-commerce
10 Market segmentation

Chapter 11

1 Systems development
2 c
3 a
4 a
5 False
6 Prototyping
7 True
8 a
9 Entity-relationship (ER) diagrams, data-flow diagrams
10 True

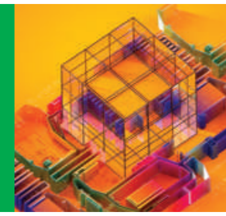
Chapter 12

1 b
2 True
3 Request for proposal (RFP)
4 Freezing design specifications
5 Make-or-buy
6 c
7 System
8 False
9 Patch
10 True

Chapter 13

1 Social engineering
2 Botnet
3 Antivirus
4 Software pirates
5 Shill
6 Public key infrastructure
7 Biometrics
8 Intrusion detection system
9 False
10 Right to be forgotten

Glossary



A

acceptance testing Conducting any tests required by the user.

accounting systems Systems that include budget, accounts receivable and payable, payroll, asset management and general ledger.

ad hoc DSS A DSS concerned with situations or decisions that come up only a few times during the life of the organization.

alignment When the output from an information system is exactly what is needed to help a company achieve its strategic goals, the two are said to be in alignment.

alpha testing Testing an incomplete or early version of the system.

analogue signal A variable signal continuous in both time and amplitude so that any small fluctuations in the signal are meaningful.

antivirus program Software that runs in the background to protect your computer from dangers lurking on the Internet and other possible sources of infected files.

applet A small program embedded in web pages.

application program interface (API) Tools software developers use to build application software without needing to understand the inner workings of the OS and hardware.

application service provider (ASP) A company that provides the software, support and computer hardware on which to run the software from the user's facilities over a network.

applications portfolio A scheme for classifying information systems according to the contribution they make to the organization.

arithmetic/logic unit (ALU) The part of the CPU that performs mathematical calculations and makes logical comparisons.

ARPANET A project started by the US Department of Defense (DoD) in 1969 as both an experiment in reliable networking and a means to link DoD and military research contractors, including many universities doing military-funded research.

artificial intelligence (AI) The ability of computer systems to mimic or duplicate the functions or characteristics of the human brain or intelligence.

artificial intelligence systems People, procedures, hardware, software, data and knowledge needed to develop computer systems and machines that demonstrate characteristics of intelligence.

auditing Analyzing the financial condition of an organization and determining whether financial statements and reports produced by the financial MIS are accurate.

B

B2Me A form of e-commerce where the business treats each customer as a separate market segment. Typical B2Me features include customizing a website for each customer, perhaps based on their previous purchases and personalized (electronic) marketing literature.

backbone One of the Internet's high-speed, long-distance communications links.

backward chaining The process of starting with conclusions and working backwards to the supporting facts.

batch processing system A form of data processing where business transactions are accumulated over a period of time and prepared for processing as a single unit or batch.

benchmark test An examination that compares computer systems operating under the same conditions.

beta testing Testing a complete and stable system by end-users.

biometrics The measurement of one of a person's traits, whether physical or behavioural.

blade server A server that houses many individual computer motherboards that include one or more processors, computer memory, computer storage and computer network connections.

blog An online diary, a combination of the words 'web' and 'log'.

Bluetooth A wireless communications specification that describes how smartphones, computers, printers and other electronic devices can be interconnected over distances of a few metres at a rate or about 2 Mbps.

brainstorming A decision-making approach that often consists of members offering ideas 'off the top of their heads'.

bridge A telecommunications device that connects one LAN to another LAN that uses the same telecommunications protocol.

broadband communications A telecommunications system in which a very high rate of data exchange is possible.'

bus A bus is a connection between components within a computer, or devices connected to a computer.

business intelligence 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.

business-to-business (B2B) e-commerce A subset of e-commerce where all the participants are organizations.

business-to-consumer (B2C) e-commerce A form of e-commerce in which customers deal directly with an organization and avoid intermediaries.

byte (B) Eight bits that together represent a single character of data.

C

cache memory A type of high-speed memory that a processor can access more rapidly than main memory.

cardinality In a relationship, cardinality is the number of one entity that can be related to another entity.

central processing unit (CPU) The part of the computer that consists of three associated elements: the arithmetic/logic unit, the control unit and the register areas.

centralized processing Processing alternative in which all processing occurs at a single location or facility.

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

channel bandwidth The rate at which data is exchanged over a communications channel, usually measured in bits per second (bps).

chief knowledge officer (CKO) A top-level executive who helps the organization use a KMS to create, store and use knowledge to achieve organizational goals.

chief programmer team A group of skilled IS professionals who design and implement a set of programs.

chip-and-PIN card A type of card that employs a computer chip that communicates with a card reader using radio frequencies; it does not need to be swiped at a terminal.

choice stage The third stage of decision making which requires selecting a course of action.

client/server An architecture in which multiple computer platforms are dedicated to special functions such as database management, printing, communications and program execution.

clock speed A series of electronic pulses produced at a predetermined rate that affects machine cycle time.

cloud computing A computing environment where software and storage are provided as an Internet service and are accessed via a web browser.

code of ethics A code that states the principles and core values that are essential to a set of people and, therefore, govern their behaviour.

cold site A computer environment that includes rooms, electrical service, telecommunications links, data storage devices and the like; also called a shell.

command-based user interface A user interface that requires you to give text commands to the computer to perform basic activities.

command line interface An interface where the user types text commands to the computer.

compact disc read-only memory (CD-ROM) A common form of optical disc on which data cannot be modified once it has been recorded.

competitive advantage The ability of a firm to outperform its industry; that is, to earn a higher rate of profit than the industry norm.

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

compiler A special software program that converts the programmer's source code into the machine-language instructions, which consist of binary digits.

computer-aided manufacturing (CAM) A system that directly controls manufacturing equipment.

computer-aided software engineering (CASE) Tools that automate many of the tasks required in a systems development effort and encourage adherence to the SDLC.

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

computer-integrated manufacturing (CIM) Using computers to link the components of the production process into an effective system.

computer literacy Knowledge of computer systems and equipment and the ways they function; it stresses equipment and devices (hardware), programs and instructions (software), databases and telecommunications.

computer network The communications media, devices and software needed to connect two or more computer systems and/or devices.

computer programs Sequences of instructions for the computer.

computer supported cooperative work A term that refers to technologies which allow groups to work together to achieve goals.

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

consumer-to-consumer (C2C) e-commerce A subset of e-commerce that involves consumers selling directly to other consumers.

contactless card A card with an embedded chip that only needs to be held close to a terminal to transfer its data; no PIN needs to be entered.

continuous improvement Constantly seeking ways to improve business processes to add value to products and services.

control unit The part of the CPU that sequentially accesses program instructions, decodes them and coordinates the flow of data in and out of the ALU, the registers, the primary storage and even secondary storage and various output devices.

coprocessor The part of the computer that speeds processing by executing specific types of instructions while the CPU works on another processing activity.

cost–benefit analysis An approach that lists the costs and benefits of each proposed system. After they are expressed in monetary terms, all the costs are compared with all the benefits.

counterintelligence The steps an organization takes to protect information sought by 'hostile' intelligence gatherers.
cracker A computer-savvy person who attempts to gain unauthorized or illegal access to computer systems.
creative analysis The investigation of new approaches to existing problems.
critical analysis The unbiased and careful questioning of whether system elements are related in the most effective ways.
cross-platform development A development technique that allows programmers to develop programs that can run on computer systems having different hardware and operating systems or platforms.
customer relationship management (CRM) system A system that helps a company manage all aspects of customer encounters, including marketing and advertising, sales, customer service after the sale and programmes to retain loyal customers.
cyberterrorist Someone who intimidates or coerces a government or organization to advance his or her political or social objectives by launching computer-based attacks against computers, networks and the information stored on them.

D

data administrator A non-technical position responsible for defining and implementing consistent principles for a variety of data issues.
data analysis The manipulation of collected data so that the development team members who are participating in systems analysis can use the data.
data collection Capturing and gathering all data necessary to complete the processing of transactions.
data correction The process of re-entering data that was not typed or scanned properly.
data definition language (DDL) A collection of instructions and commands used to define and describe data and relationships in a specific database.
data dictionary A detailed description of all the data used in the database.
data editing The process of checking data for validity and completeness.
data entry Converting human-readable data into a machine-readable form.
data input Transferring machine-readable data into the system.
data manipulation language (DML) The commands that are used to manipulate the data in a database.
data manipulation The process of performing calculations and other data transformations related to business transactions.
data mining The process of analyzing data to try to discover patterns and relationships within the data.
data preparation (data conversion) Ensuring all files and databases are ready to be used with new computer software and systems.
data warehouse A database or collection of databases that collects business information from many sources in the enterprise, covering all aspects of the company's processes, products and customers.
database An organized collection of information.
database administrator (DBA) The role of the database administrator is to plan, design, create, operate, secure, monitor and maintain databases.
data-flow diagram (DFD) A model of objects, associations and activities that describes how data can flow between and around various objects.
decentralized processing Processing alternative in which processing devices are placed at various remote locations.
decision-making phase The first part of problem solving, including three stages: intelligence, design and choice.
decision support system (DSS) An organized collection of people, procedures, software, databases and devices used to support problem-specific decision making.
degree The number of entities involved in a relationship.
demand report A report developed to give certain information at someone's request.
design report The primary result of systems design, reflecting the decisions made and preparing the way for systems implementation.
design stage The second stage of decision making in which alternative solutions to the problem are developed.
desktop computer A nonportable computer that fits on a desktop and provides sufficient computing power, memory and storage for most business computing tasks.
dialogue manager A user interface that allows decision makers to easily access and manipulate the DSS and to use common business terms and phrases.
digital audio player A device that can store, organize and play digital music files.
digital camera An input device used with a PC to record and store images and video in digital form.
digital signal A signal that represents bits.
digital video disc (DVD) A storage medium used to store software, video games and movies.
direct access A retrieval method in which data can be retrieved without the need to read and discard other data.
direct access storage device (DASD) A device used for direct access of secondary storage data.
direct conversion Stopping the old system and starting the new system on a given date.
direct observation Watching the existing system in action by one or more members of the analysis team.
disaster planning The process of anticipating and providing for disasters.
disaster recovery The implementation of the disaster plan.
disc mirroring A process of storing data that provides an exact copy that protects users fully in the event of data loss.
distributed database A database in which the data is spread across several smaller databases connected via telecommunications devices.
documentation Text that describes a program's functions to help the user operate the computer system.
document production The process of generating output records and reports.

domain The area of knowledge addressed by the expert system.
domain expert The individual or group who has the expertise or knowledge one is trying to capture in the expert system.
downsizing Reducing the number of employees to cut costs.
drill-down report A report providing increasingly detailed data about a situation.

E
e-commerce Any business transaction executed electronically between companies (business-to-business), companies and consumers (business-to-consumer), consumers and other consumers (consumer-to-consumer), business and the public sector, and consumers and the public sector.
economic feasibility The determination of whether the project makes financial sense and whether predicted benefits offset the cost and time needed to obtain them.
economic order quantity (EOQ) The quantity that should be reordered to minimize total inventory costs.
effectiveness A measure of the extent to which a system achieves its goals; it can be computed by dividing the goals actually achieved by the total of the stated goals.
efficiency A measure of what is produced divided by what is consumed.
e-government The use of information and communications technology to simplify the sharing of information, speed up formerly paper-based processes and improve the relationship between citizen and government.
electronic bill presentment A method of billing whereby a vendor posts an image of your statement on the Internet and alerts you by email that your bill has arrived.
electronic business (e-business) Using information systems and the Internet to perform all business-related tasks and functions.
electronic commerce (e-commerce) Conducting business transactions (e.g. distribution, buying, selling and servicing) electronically over computer networks such as the Internet, extranets and corporate networks.
electronic exchange An electronic forum where manufacturers, suppliers and competitors buy and sell goods, trade market information and run back-office operations.
electronic retailing (e-tailing) The direct sale from business to consumer through electronic storefronts, typically designed around an electronic catalogue and shopping cart model.
e-money The transfer of funds electronically rather than by handing over physical coins and notes.
empowerment Giving employees and their managers more responsibility and the authority to make decisions, take certain actions and have more control over their jobs.
encryption The process of converting an original message into a form that can be understood only by the intended receiver.
encryption key A variable value that is applied (using an algorithm) to a set of unencrypted text to produce encrypted text or to decrypt encrypted text.
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.
enterprise rules The rules governing relationships between entities.
enterprise sphere of influence The sphere of influence that serves the needs of the firm in its interaction with its environment.
entity A person, place or thing about whom or about which an organization wants to store data.
ergonomics The science of designing machines, products and systems to maximize the safety, comfort and efficiency of the people who use them.
event-driven review A review triggered by a problem or opportunity such as an error, a corporate merger or a new market for products.
exception report A report automatically produced when a situation is unusual or requires management action.
execution time (e-time) The time it takes to execute an instruction and store the results.
executive support system (ESS) Specialized DSS that includes all hardware, software, data, procedures and people used to assist senior-level executives within the organization.
expert system A system that gives a computer the ability to make suggestions and act like an expert in a particular field (or) hardware and software that stores knowledge and makes inferences, similar to a human expert.
explanation facility Component of an expert system that allows a user or decision maker to understand how the expert system arrived at certain conclusions or results.
Extensible Markup Language (XML) The markup language for web documents containing structured information, including words, pictures and other elements.
extranet A network based on web technologies that allows selected outsiders, such as business partners, suppliers or customers, to access authorized resources of a company's intranet.

F
feasibility analysis Assessment of the technical, economic, legal, operational and schedule feasibility of a project.
feedback Output that is used to make changes to input or processing activities.
field A characteristic or attribute of an entity that is stored in the database.
File Transfer Protocol (FTP) A protocol that describes a file transfer process between a host and a remote computer and allows users to copy files from one computer to another.
final evaluation A detailed investigation of the proposals offered by the vendors remaining after the preliminary evaluation.
financial MIS A management information system that provides financial information not only for executives but also for a broader set of people who need to make better decisions on a daily basis.

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.

flat organizational structure An organizational structure with a reduced number of management layers.

flexible manufacturing system (FMS) An approach that allows manufacturing facilities to rapidly and efficiently change from making one product to making another.

forecasting Predicting future events.

foreign key When a primary key is posted into another table to create a relationship between the two, it is known as a foreign key.

forward chaining The process of starting with the facts and working forwards to the conclusions.

front-end processor A special-purpose computer that manages communications to and from a computer system serving hundreds or even thousands of users.

future strategic application Future strategic applications are ideas for systems which, if fully developed and deployed, might one day become strategic applications.

G

Gantt chart A graphical tool used for planning, monitoring and coordinating projects.

gateway A telecommunications device that serves as an entrance to another network.

genetic algorithm An approach to solving large, complex problems in which a number of related operations or models change and evolve until the best one emerges.

genetic programming An approach to creating computer code based on natural selection. Initially random code evolves through numerous iterations to become a program that solves a set problem.

geographic information system (GIS) A computer system capable of assembling, storing, manipulating and displaying geographic information; that is, data identified according to its location.

gigahertz (GHz) Billions of cycles per second, a measure of clock speed.

global positioning system (GPS) A navigation system that enables a receiver to determine its precise location.

goal-seeking analysis The process of determining the problem data required for a given result.

graphical user interface (GUI) An interface that displays pictures (icons) and menus that people use to send commands to the computer system.

graphics processing unit (GPU) A specialized circuit that is very efficient at manipulating computer graphics and is much faster than the typical CPU chip at performing floating point operations and executing algorithms for which the processing of large blocks of data is done in parallel.

green computing A program concerned with the efficient and environmentally responsible design, manufacture, operation and disposal of IS-related products.

grid computing The use of a collection of computers, often owned by multiple individuals or organizations, to work in a coordinated manner to solve a common problem.

group consensus Decision making by a group that is appointed and given the responsibility of making the final evaluation and selection.

group consensus approach A decision-making approach that forces members in the group to reach a unanimous decision.

group support system (GSS) Software application that consists of most elements in a DSS, plus software to provide effective support in group decision making; also called a group decision support system.

H

hacker A computer-savvy person who attempts to gain unauthorized or illegal access to computer systems.

handheld computer A single-user computer that provides ease of portability because of its small size.

hardware Any machinery (most of which uses digital circuits) that assists in the input, processing, storage and output activities of an information system.

heuristics Commonly accepted guidelines or procedures that usually find a good solution.

highly structured problems Problems that are straightforward and require known facts and relationships.

home page A cover page for a website that has graphics, titles and text.

hot site A duplicate, operational hardware system or immediate access to one through a specialized vendor.

hotspot An area where wi-fi wireless Internet access is available.

HTML tags Codes that let the web browser know how to format text – as a heading, as a list, or as body text – and whether images, sound or other elements should be inserted.

human resource MIS (HRMIS) An information system that is concerned with activities related to employees and potential employees of an organization, also called a personnel MIS.

hypermedia An extension of hypertext where the data, including text, images, video and other media, on web pages is connected allowing users to access information in whatever order they wish.

hypertext Text used to connect web pages, allowing users to access information in whatever order they wish.

Hypertext Markup Language (HTML) The standard page description language for web pages.

I

IF-THEN statements Rules that suggest certain conclusions.

implementation stage A stage of problem solving in which a solution is put into effect.

incremental back-up Making a back-up copy of all files changed during the last few days or the last week.

inference engine Part of the expert system that seeks information and relationships from the knowledge base and provides answers, predictions and suggestions the way a human expert would.

information system (IS) A set of interrelated components that collect, manipulate, store and disseminate information and provide a feedback mechanism to meet an objective.

information systems literacy Knowledge of how data and information are used by individuals, groups and organizations.

input The activity of gathering and capturing data.

insider An employee, disgruntled or otherwise, working solo or in concert with outsiders to compromise corporate systems.

installation The process of physically placing the computer equipment on the site and making it operational.

institutional DSS A DSS that handles situations or decisions that occur more than once, usually several times per year or more. An institutional DSS is used repeatedly and refined over the years.

instruction time (i-time) The time it takes to perform the fetch instruction and decode instruction steps of the instruction phase.

integrated development environments (IDEs) A development approach that combines the tools needed for programming with a programming language in one integrated package.

integration testing Testing all related systems together.

intelligence stage The first stage of decision making in which potential problems or opportunities are identified and defined.

intelligent agent Programs and a knowledge base used to perform a specific task for a person, a process or another program; also called intelligent robot or bot.

intelligent behaviour The ability to learn from experiences and apply knowledge acquired from experience, handle complex situations, solve problems when important information is missing, determine what is important, react quickly and correctly to a new situation, understand visual images, process and manipulate symbols, be creative and imaginative, and use heuristics.

interactive whiteboard This term can be used to mean slightly different technologies, but essentially it is a combination of a whiteboard and a desktop computer.

international network A network that links users and systems in more than one country.

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

Internet Protocol (IP) A communication standard that enables traffic to be routed from one network to another as needed.

Internet service provider (ISP) Any company that provides people or organizations with access to the Internet.

intranet An internal company network built using Internet and World Wide Web standards and products that allows people within an organization to exchange information and work on projects.

intrusion detection system (IDS) Software that monitors system and network resources and notifies network security personnel when it senses a possible intrusion.

J

Java An object-oriented programming language from Sun Microsystems based on C++ that allows small programs (applets) to be embedded within an HTML document.

just-in-time (JIT) inventory A philosophy of inventory management in which inventory and materials are delivered just before they are used in manufacturing a product.

K

kernel The heart of the operating system, which controls its most critical processes.

key-indicator report A summary of the previous day's critical activities; typically available at the beginning of each workday.

key operational application Key operational applications are essential. Without them the organization could not conduct business.

knowledge acquisition facility Part of the expert system that provides convenient and efficient means of capturing and storing all the components of the knowledge base.

knowledge base A component of an expert system that stores all relevant information, data, rules, cases and relationships used by the expert system.

knowledge engineer A person who has training or experience in the design, development, implementation and maintenance of an expert system.

knowledge user The person or group that uses and benefits from the expert system.

L

laptop computer A personal computer designed for use by mobile users, being small and light enough to sit comfortably on a user's lap.

LCD display Flat display that uses liquid crystals – organic, oil-like material placed between two polarizers – to form characters and graphic images on a backlit screen.

learning systems A combination of software and hardware that allows the computer to change how it functions or reacts to situations based on feedback it receives.

legal feasibility The determination of whether laws or regulations may prevent or limit a systems development project.

local area network (LAN) A computer network that connects computer systems and devices within a small area, such as an office, home or several floors in a building.

logical design A description of the functional requirements of a system.

M

machine cycle The instruction phase followed by the execution phase.

magnetic disc A direct access storage device with bits represented by magnetized areas.

magnetic strip card A type of card that stores a limited amount of data by modifying the magnetism of tiny iron-based particles contained in a band on the card.

magnetic tape A type of sequential secondary storage medium, now used primarily for storing backups of critical organizational data in the event of a disaster.
mainframe computer A large, powerful computer often shared by hundreds of concurrent users connected to the machine over a network.
maintenance team A special IS team responsible for modifying, fixing and updating existing software.
make-or-buy decision The decision whether to obtain the necessary software from internal or external sources.
management information system (MIS) An organized collection of people, procedures, software, databases and devices that provides routine information to managers and decision makers.
market segmentation The identification of specific markets to target them with advertising messages.
marketing MIS An information system that supports managerial activities in product development, distribution, pricing decisions and promotional effectiveness.
massively parallel processing systems A form of multiprocessing that speeds processing by linking hundreds or thousands of processors to operate at the same time, or in parallel, with each processor having its own bus, memory, discs, copy of the operating system and applications.
material requirements planning (MRP) A set of inventory-control techniques that help coordinate thousands of inventory items when the demand for one item is dependent on the demand for another.
megahertz (MHz) Millions of cycles per second, a measure of clock speed.
menu-driven system A system in which users simply pick what they want to do from a list of alternatives.
mesh networking A way to route communications between network nodes (computers or other devices) by allowing for continuous connections and reconfiguration around blocked paths by ‘hopping’ from node to node until a connection can be established.
metropolitan area network (MAN) A telecommunications network that connects users and their devices in a geographical area that spans a campus or city.
middleware Software that allows various systems to communicate and exchange data.
MIPS Millions of instructions per second, a measure of machine cycle time.
mobile commerce (m-commerce) Conducting business transactions electronically using mobile devices such as smartphones.
model base Part of a DSS that provides decision makers with access to a variety of models and assists them in decision making.
model management software Software that coordinates the use of models in a DSS.
modem A telecommunications hardware device that converts (modulates and demodulates) communications signals so they can be transmitted over the communication media.
monitoring stage The final stage of the problem-solving process in which decision makers evaluate the implementation.
Moore’s Law A hypothesis stating that transistor densities on a single chip will double every two years.
MP3 A standard format for compressing a sound sequence into a small file.
multicore microprocessor A microprocessor that combines two or more independent processors into a single computer so that they share the workload and improve processing capacity.
multiplexer A device that encodes data from two or more data sources onto a single communications channel, thus reducing the number of communications channels needed and therefore lowering telecommunications costs.
multiprocessing The simultaneous execution of two or more instructions at the same time.

N

narrowband communications A telecommunications system that supports a much lower rate of data exchange than broadband.
natural language processing Processing that allows the computer to understand and react to statements and commands made in a ‘natural’ language, such as English.
near field communication (NFC) A very short-range wireless connectivity technology designed for consumer electronics, smartphones and credit cards.
netbook computer A small, light, inexpensive member of the laptop computer family.
net present value The preferred approach for ranking competing projects and determining economic feasibility.
nettop computer An inexpensive desktop computer designed to be smaller, lighter and consume much less power than a traditional desktop computer.
network Computers and equipment that are connected in a building, around the country or around the world to enable electronic communications.
network-attached storage (NAS) Hard disc storage that is set up with its own network address rather than being attached to a computer.
network-management software Software that enables a manager on a networked desktop to monitor the use of individual computers and shared hardware (such as printers), scan for viruses and ensure compliance with software licences.
network operating system (NOS) Systems software that controls the computer systems and devices on a network and allows them to communicate with each other.
neural network A computer system that attempts to simulate the functioning of a human brain.
nominal group technique A decision-making approach that encourages feedback from individual group members, and the final decision is made by voting, similar to the way public officials are elected.
non-programmed decision A decision that deals with unusual or exceptional situations that can be difficult to quantify.
notebook computer Smaller than a laptop computer, an extremely lightweight computer that weighs less than 2 kilogrammes and can easily fit in a briefcase.

O

off-the-shelf software Software mass-produced by software vendors to address needs that are common across businesses, organizations or individuals.

on-demand computing Contracting for computer resources to rapidly respond to an organization's varying workflow. Also called on-demand business and utility computing.

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

online transaction processing (OLTP) A form of data processing where each transaction is processed immediately, without the delay of accumulating transactions into a batch.

open-source software Software that is distributed, typically for free, with the source code also available so that it can be studied, changed and improved by its users.

operating system (OS) A set of computer programs that controls the computer hardware and acts as an interface with applications.

operational feasibility The measure of whether the project can be put into action or operation.

optical storage device A form of data storage that uses lasers to read and write data.

optionality If a binary relationship is optional for an entity, that entity doesn't have to be related to the other.

organic light-emitting diode (OLED) display Flat display that uses a layer of organic material sandwiched between two conductors, which in turn are sandwiched between a glass top plate and a glass bottom plate so that when electric current is applied to the two conductors, a bright, electroluminescent light is produced directly from the organic material.

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

organizational change The responses that are necessary so that for-profit and non-profit organizations can plan for, implement and handle change.

organizational learning The adaptations to new conditions or alterations of organizational practices over time.

organizational structure Organizational subunits and the way they relate to the overall organization.

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

outsourcing Contracting with outside professional services to meet specific business needs.

P

parallel computing The simultaneous execution of the same task on multiple processors to obtain results faster.

parallel running Running both the old and the new systems for a period of time.

patch A minor change to correct a problem or make a small enhancement. It is usually an addition to an existing program.

perceptive system A system that approximates the way a person sees hears and feels objects.

personal area network (PAN) A network that supports the interconnection of information technology within a range of ten metres or so.

personal productivity software The software that enables users to improve their personal effectiveness, increasing the amount of work and quality of work they can do.

personal robotics A term which refers to robotic companions that people socialize with.

personal sphere of influence The sphere of influence that serves the needs of an individual user.

pervasive computing A term meaning the move of the computer away from the desktop and towards something that is all around us, all the time.

phase-in approach Slowly replacing components of the old system with those of the new one. This process is repeated for each application until the new system is running every application and performing as expected; also called a piecemeal approach.

phicon Phicon stands for 'physical icon' and is a physical representation of digital data, in the same way that an icon on a computer screen represents a file.

physical design The specification of the characteristics of the system components necessary to put the logical design into action.

pilot running Introducing the new system by direct conversion for one group of users rather than all users.

pipelining A form of CPU operation in which multiple execution phases are performed in a single machine cycle.

pixel A dot of colour on a photo image or a point of light on a display screen.

plasma display A type of display using thousands of smart cells (pixels) consisting of electrodes and neon and xenon gases that are electrically turned into plasma (electrically charged atoms and negatively charged particles) to emit light.

Platform for Privacy Preferences (P3P) A screening technology that shields users from websites that don't provide the level of privacy protection they desire.

podcast An audio broadcast over the Internet.

point evaluation system An evaluation process in which each evaluation factor is assigned a weight, in percentage points, based on importance. Then each proposed system is evaluated in terms of this factor and given a score ranging from 0 to 100. The scores are totalled and the system with the greatest total score is selected.

point-of-sale (POS) device A terminal used to enter data into the computer system.

policy-based storage management Automation of storage using previously defined policies.

portable computer A computer small enough to carry easily.

preliminary evaluation An initial assessment whose purpose is to dismiss the unwanted proposals; begins after all proposals have been submitted.

primary key A field in a table that is unique – each record in that table has a different value in the primary key field. The primary key is used to uniquely identify each record and to create relationships between tables.

primary storage (main memory; memory) The part of the computer that holds program instructions and data.

private branch exchange (PBX) A telephone switching exchange that serves a single organization.

problem solving A process that goes beyond decision making to include the implementation and monitoring stages.

procedures The strategies, policies, methods and rules for using a CBIS.
processing Converting or transforming input into useful outputs.
productivity A measure of the output achieved divided by the input required. Productivity = (Output / Input) × 100%.
program evaluation and review technique (PERT) A formalized approach for developing a project schedule.
programmed decision A decision made using a rule, procedure or quantitative method.
programming languages Sets of keywords, commands, symbols and rules for constructing statements by which humans can communicate instructions to a computer.
project organizational structure A structure centred on major products or services.
proprietary software One-of-a-kind software designed for a specific application and owned by the company, organization or person that uses it.
public-key infrastructure (PKI) A means to enable users of an unsecured public network such as the Internet to securely and privately exchange data through the use of a public and a private cryptographic key pair that is obtained and shared through a trusted authority.

Q

quality control A process that ensures that the finished product meets the customer's needs.
questionnaires A method of gathering data when the data sources are spread over a wide geographic area.

R

radio frequency identification (RFID) A technology that employs a microchip with an antenna to broadcast its unique identifier and location to receivers.
random access memory (RAM) A form of memory in which instructions or data can be temporarily stored.
rapid application development (RAD) A systems development approach that employs tools, techniques and methodologies designed to speed application development.
read-only memory (ROM) A nonvolatile form of memory.
record A row in a table; all the data pertaining to one instance of an entity.
redundant array of independent/ inexpensive discs (RAID) A method of storing data that generates extra bits of data from existing data, allowing the system to create a 'reconstruction map' so that, if a hard drive fails, the system can rebuild lost data.
reengineering Also known as 'process redesign' and 'business process reengineering' (BPR). The radical redesign of business processes, organizational structures, information systems and values of the organization to achieve a breakthrough in business results.
register A high-speed storage area in the CPU used to temporarily hold small units of program instructions and data immediately before, during and after execution by the CPU.
relational database A series of related tables, stored together with a minimum of duplication to achieve consistent and controlled pool of data.
release A significant program change that often requires changes in the documentation of the software.
reorder point (ROP) A critical inventory quantity level.
replicated database A database that holds a duplicate set of frequently used data.
request for maintenance form A form authorizing modification of programs.
request for proposal (RFP) A document that specifies in detail required resources such as hardware and software.
requirements engineering Also known as 'requirements analysis' and 'requirements capture'. Identifying what an information system is needed (required) to do. Once the requirements have been identified, a solution can then be designed.
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.
robotics Mechanical or computer devices that perform tasks requiring a high degree of precision or that are tedious or hazardous for humans.
router A telecommunications device that forwards data packets across two or more distinct networks towards their destinations, through a process known as routing.

S

satisficing model A model that will find a good – but not necessarily the best – problem solution.
scalability The ability to increase the processing capability of a computer system so that it can handle more users, more data or more transactions in a given period.
schedule feasibility The determination of whether the project can be completed in a reasonable amount of time.
scheduled report A report produced periodically, or on a schedule, such as daily, weekly or monthly.
script kiddie A cracker with little technical savvy who downloads programs called scripts, which automate the job of breaking into computers.
search engine A web search tool.
secondary storage Devices that store large amounts of data, instructions and information more permanently than allowed with main memory.
semi-structured or unstructured problems More complex problems in which the relationships between the pieces of data are not always clear, the data might be in a variety of formats, and the data is often difficult to manipulate or obtain.
sequential access A retrieval method in which data must be accessed in the order in which it was stored.
sequential access storage device (SASD) A device used to sequentially access secondary storage data.
server A computer employed by many users to perform a specific task, such as running network or Internet applications.

service-oriented architecture (SOA) A modular method of developing software and systems that allows users to interact with systems and systems to interact with each other.

simulation The ability of the DSS to duplicate the features of a real system.

single-user licence A software licence that permits you to install the software on one or more computers, used by one person.

site preparation Preparation of the location of a new system.

slipstream upgrade A minor upgrade – typically a code adjustment or minor bug fix – not worth announcing. It usually requires recompiling all the code and, in so doing, it can create entirely new bugs.

smartphone A handheld computer that combines the functionality of a mobile phone, camera, web browser, email tool, MP3 player and other devices into a single device.

social engineering Using one's social skills to get computer users to provide you with information to access an information system or its data.

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

software as a service (SaaS) A service that allows businesses to subscribe to web-delivered application software.

software piracy The act of illegally duplicating software.

software suite A collection of single programs packaged together in a bundle.

source data automation Capturing and editing data where it is initially created and in a form that can be directly entered into a computer, thus ensuring accuracy and timeliness.

speech-recognition technology Input devices that recognize human speech.

start-up The process of making the final tested information system fully operational.

statistical sampling Selecting a random sample of data and applying the characteristics of the sample to the whole group.

steering committee An advisory group consisting of senior management and users from the IS department and other functional areas.

storage area network (SAN) A special-purpose, high-speed network that provides high-speed connections between data storage devices and computers over a network.

storage as a service A data storage model where a data storage service provider rents space to individuals and organizations.

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

strategic application A strategic application gives a firm a competitive advantage.

strategic planning Determining long-term objectives by analyzing the strengths and weaknesses of the organization, predicting future trends and projecting the development of new product lines.

structured interview An interview where the questions are prepared in advance.

structured walkthrough A planned and pre-announced review of the progress of a program module.

supercomputers The most powerful computer systems with the fastest processing speeds.

support application Support applications make work more convenient but are not essential.

switch A telecommunications device that uses the physical device address in each incoming message on the network to determine to which output port it should forward the message to reach another device on the same network.

syntax A set of rules associated with a programming language.

system A set of elements or components that interact to accomplish goals.

system performance measurement Monitoring the system – the number of errors encountered, the amount of memory required, the amount of processing or CPU time needed and other problems.

system performance products Software that measures all components of the computer-based information system, including hardware, software, database, telecommunications and network systems.

system performance standard A specific objective of the system.

system testing Testing the entire system of programs.

systems controls Rules and procedures to maintain data security.

systems design A stage of systems development where a solution to the problem is planned out and documented.

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

systems implementation A stage of systems development that includes hardware acquisition, software acquisition or development, user preparation, hiring and training of personnel, site and data preparation, installation, testing, start-up and user acceptance.

systems investigation report A summary of the results of the systems investigation and the process of feasibility analysis and recommendation of a course of action.

systems maintenance and review The systems development phase that ensures the system operates as intended and modifies the system so that it continues to meet changing business needs.

systems operation Use of a new or modified system.

systems review The final step of systems development, involving the analysis of systems to make sure that they are operating as intended.

T

tablet computer A portable, lightweight computer with no keyboard that allows you to roam the office, home or factory floor, carrying the device like a clipboard.

team organizational structure A structure centred on work teams or groups.

technical documentation Written details used by computer operators to execute the program, and by analysts and programmers to solve problems or modify the program.

technical feasibility Assessment of whether the hardware, software and other system components can be acquired or developed to solve the problem.

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

technology-enabled relationship management Occurs when a firm obtains detailed information about a customer's behaviour, preferences, needs and buying patterns, and uses that information to set prices, negotiate terms, tailor promotions, add product features and otherwise customize its entire relationship with that customer.

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

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

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

Telnet A terminal emulation protocol that enables users to log on to other computers on the Internet to gain access to public files.

thin client A low-cost, centrally managed computer with essential but limited capabilities and no extra drives (such as CD or DVD drives) or expansion slots.

time-driven review Review performed after a specified amount of time.

total cost of ownership (TCO) The measurement of the total cost of owning computer equipment, including desktop computers, networks and large computers.

traditional organizational structure An organizational structure similar to a managerial pyramid, where the hierarchy of decision making and authority flows from strategic management at the top down to operational management and non-management employees. Also called a hierarchical structure.

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

transaction processing cycle The process of data collection, data editing, data correction, data manipulation, data storage and document production.

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

Transmission Control Protocol (TCP) The widely used transport-layer protocol that most Internet applications use with IP.

Trojan horse A malicious program that disguises itself as a useful application and purposefully does something the user does not expect.

U

ultra wideband (UWB) a form of short-range communication that employs extremely short electromagnetic pulses lasting 50 to 1000 picoseconds that are transmitted across a broad range of radio frequencies or several gigahertz.

uniform resource locator (URL) An assigned address on the Internet for each computer.

unit testing Testing of individual programs.

unstructured interview An interview where the questions are not prepared in advance.

user acceptance document A formal agreement signed by the user that states that a phase of the installation or the complete system is approved.

user interface The element of the operating system that allows people to access and interact with the computer system.

user preparation The process of readying managers, decision makers, employees, other users and stakeholders for new systems.

utility program Program that helps to perform maintenance or correct problems with a computer system.

V

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.

version A major program change, typically encompassing many new features.

videoconference A simultaneous communication between two or more parties where they both see and hear each other.

virtual organizational structure A structure that employs individuals, groups or complete business units in geographically dispersed areas that can last for a few weeks or years, often requiring telecommunications or the Internet.

virtual pet An artificial companion. Could be screen based, i.e. the pet is animated on a computer monitor, or a robot.

virtual private network (VPN) A private network that uses a public network (usually the Internet) to connect multiple remote locations.

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

virtual tape A storage device for less frequently needed data so that it appears to be stored entirely on tape cartridges, although some parts of it might actually be located on faster hard discs.

virtual world A computer-based environment where users' avatars can interact.

virus A computer program file capable of attaching to discs or other files and replicating itself repeatedly, typically without the user's knowledge or permission.

vision systems The hardware and software that permit computers to capture, store and manipulate visual images.

volume testing Testing the application with a large amount of data.

W

wearable computing A term that refers to computers and computing technology that are worn on the body.

web browser Software that creates a unique, hypermedia-based menu on a computer screen, providing a graphical interface to the web.

web services Standards and tools that streamline and simplify communication among websites for business and personal purposes.

what-if analysis The process of making hypothetical changes to problem data and observing the impact on the results.

wide area network (WAN) A telecommunications network that ties together large geographic regions.

wi-fi A medium-range wireless telecommunications technology brand owned by the Wi-Fi Alliance.

wiki A web page that can be edited by anyone with the proper authority.

workgroup Two or more people who work together to achieve a common goal.

workgroup application software Software that supports teamwork, whether team members are in the same location or dispersed around the world.

workgroup sphere of influence The sphere of influence that helps workgroup members attain their common goals.

workstation A more powerful personal computer used for mathematical computing, computer-assisted design and other high-end processing, but still small enough to fit on a desktop.

World Wide Web (WWW or W3) A collection of tens of thousands of independently owned computers that work together as one in an Internet service.

worm A parasitic computer program that can create copies of itself on the infected computer or send copies to other computers via a network.

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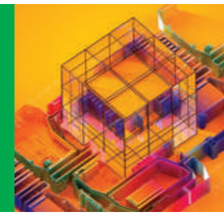

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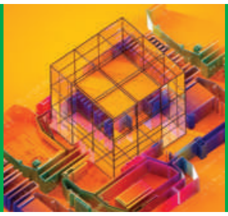

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