

# CHAPTER • 4 •

## Software: Systems and Application Software

### PRINCIPLES

- Systems and application software are critical in helping individuals and organizations achieve their goals.
- Organizations should not develop proprietary application software unless doing so will meet a compelling business need that can provide a competitive advantage.
- Organizations should choose a programming language whose functional characteristics are appropriate for the task at hand, considering the skills and experience of the programming staff.
- 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.

### LEARNING OBJECTIVES

- 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.
- 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.
- Outline the overall evolution and importance of programming languages and clearly differentiate among the generations of programming languages.
- Identify several key software issues and trends that have an impact on organizations and individuals.

## Information Systems in the Global Economy

### General Motors, United States

#### GM Changes Focus from Gears and Mechanics to Software and Electronic Systems

The automotive industry is experiencing perhaps the most significant evolutionary transition since Henry Ford designed the first production line. Faced with formidable pressures that include international competition, environmental concerns, increasing traffic, and driving-related fatalities, automotive companies are rethinking the way they design and build cars. For General Motors (GM), this means changing its focus from gears and pistons to electronic systems and software.

Addressing an audience of technology innovators, GM researcher Robert Baillargeon explained that GM is embracing what it calls “a new automotive DNA.” Although the automotive industry historically focused on mechanical innovation, GM is now turning its attention to electronic propulsion, steering systems, and the software that controls them. Baillargeon suggested that an increasing number of GM researchers will have backgrounds in software engineering. Overseas competitors such as Toyota have relied on technology to streamline production processes and offer lower prices to consumers. Now GM is countering with its own technological innovations.

The new automotive DNA that Baillargeon described uses dozens of software systems to control some vehicle operations and work together by communicating over a network. Not only will various systems within a car communicate with each other, but each car on the road will communicate with other cars. For example, cars a mile ahead of your car could warn you of icy conditions, a pothole, or heavy traffic, allowing you to prepare by slowing down or choosing an alternate route. Software in the car will also provide information about the cost of travel routes based on fuel consumption and tolls. Software will empower cars with new levels of intelligence, creating smart cars that provide the driver with helpful travel information. Eventually, cars will be able to drive themselves using vehicle-to-vehicle communications, GPS, 360-degree sensing, and swarm intelligence (the ability to solve traffic problems as a group) to deliver passengers to their destination safely, quickly, and with minimum impact on the environment.

Companies such as GM are taking the first steps to realize this automotive vision. GM engineers are selecting software platforms on which to base these systems and determining how to distribute the software systems throughout the car’s components. They are relying on state-of-the-art software development techniques such as object-oriented design and programming to define how software systems interact within the car, and using the Unified Modeling Language (UML) to map the entire automotive system. The new electronics paradigm of the automotive industry will dramatically change the way we think of cars and transportation.

**As you read this chapter, consider the following:**

- What types of activities can we entrust to software? In systems where life is at stake, how can we ensure safety when software fails?
- What should companies consider when designing software systems that need to interact with similar systems designed by competitors?

## Why Learn About Software?

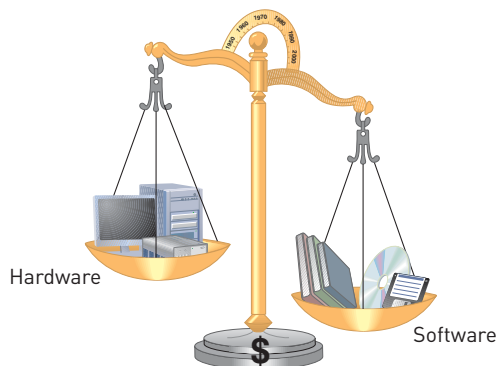
Software is indispensable for any computer system and the people using it. In this chapter, you will learn about systems and application software. Without systems software, computers would not be able to input data from a keyboard, make calculations, or print results. Application software is the key to helping you achieve your career goals. Sales representatives use software 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 dollars. Scientists use software to analyze the threat of global warming. Regardless of your job, you most likely will use software to help you advance in your career and earn higher wages. Today, most organizations could not function without accounting software to print payroll checks, enter sales orders, and send out bills. You can also use software to help you prepare your personal income taxes, keep a budget, and play entertaining games. 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 and spend more on software than on computer hardware.

Figure 4.1

### The Importance of Software in Business

Since the 1950s, businesses have greatly increased their expenditures on software compared with hardware.



## AN OVERVIEW OF SOFTWARE

### computer programs

Sequences of instructions for the computer.

### documentation

The text that describes the program 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. The program displays some documentation on screen, while other forms appear in external resources, such as printed manuals. People using commercially available software are usually asked to read and agree to End-User License Agreements (EULAs). After reading the EULA, you normally have to click an “I agree” button before you can use the software, which can be one of two basic types: systems software and application software.

### 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.

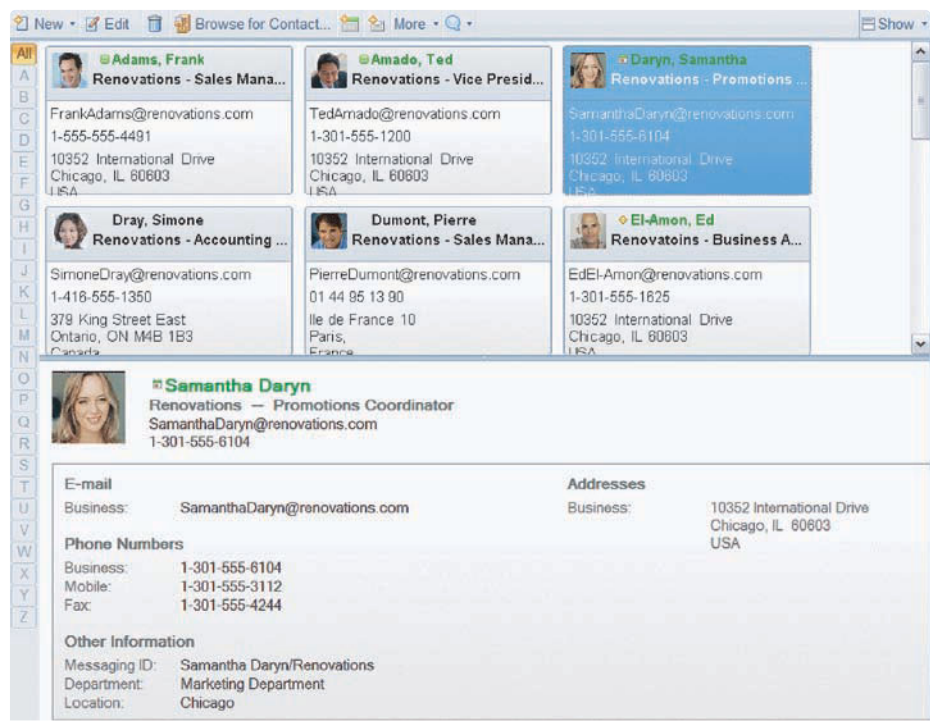


Application software has the greatest potential to affect processes that add value to a business because it is designed for specific organizational activities and functions.

(Source: © Jim West / Alamy.)

### Application Software

Application software consists of programs that help users solve particular computing problems. In most cases, application software resides on the computer’s hard disk before it is brought into the computer’s memory and run. Application software can also be stored on CDs, DVDs, and even flash or keychain storage devices that plug into a USB port. Before a person, group, or enterprise decides on the best approach for acquiring application software, they should analyze their goals and needs carefully.



Lotus Notes is an application that enables a workgroup to schedule meetings and coordinate activities.

(Source: Courtesy of IBM Corporation.)

### Supporting Individual, Group, and Organizational Goals

Every organization relies on the contributions of people, groups, and the entire enterprise to achieve its business objectives. Conversely, the organization also supports people, groups, and the enterprise with application software and information systems. One useful way of

**Table 4.1**  
**Software Supporting Individuals, Workgroups, and Enterprises**

Software	Personal	Workgroup	Enterprise
Systems software	Personal computer and workstation operating systems	Network operating systems	Midrange computer and main-frame operating systems
Application software	Word processing, spreadsheet, database, graphics	Electronic mail, group scheduling, shared work, collaboration	General ledger, order entry, payroll, human resources

**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 they can perform and enhancing its quality.

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

**workgroup sphere of influence**  
The sphere of influence that serves the needs of a workgroup.

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

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

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 software can support these three spheres.

Information systems that operate within the **personal sphere of influence** serve the needs of an individual user. These information systems help users improve their personal effectiveness, increasing the amount and quality of work they can do. Such software is often called **personal productivity software**. 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 a workgroup attain its common goals. Users of such applications must be able to communicate, interact, and collaborate to be successful.

Information systems that operate within the **enterprise sphere of influence** support the firm in its interaction with its environment. The surrounding environment 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.

## 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.

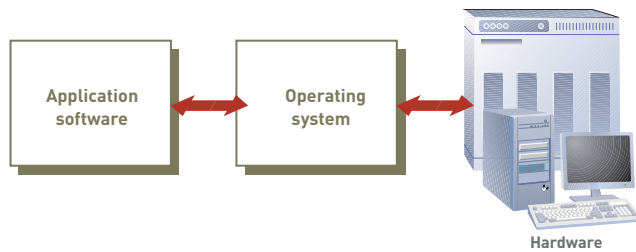
### Operating Systems

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 or a handheld computer that allows one user at a time.
- **Single computer with multiple users.** This system is typical of larger, mainframe computers that can accommodate hundreds or thousands of people, all using the computer at the same time.
- **Multiple computers.** This 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 around the world.



- **Special-purpose computers.** This system is typical of a number of computers with specialized functions, such as those that control sophisticated military aircraft, the space shuttle, and some home appliances.

**Figure 4.2****The Role of Operating Systems**

The role of the operating system is to act as an interface or buffer between application software and hardware.

The OS, which plays a central role in the functioning of the complete computer system, is usually stored on disk. After you start, or “boot up,” a computer system, portions of the OS are transferred to memory as they are needed. You can also boot a computer from a CD, DVD, or even a thumb drive that plugs into a USB port. A storage device that contains some or all of the OS is often called a “rescue disk” because you can use it to start the computer if you have problems with the primary hard disk.

Some OSs for handheld computers and notebooks that use solid-state hard drives have an “Instant On” feature that significantly reduces the time needed to boot a computer. The set of programs that make up the OS performs a variety of activities, including the following:

- Performing common computer hardware functions
- Providing a user interface and input/output management
- Providing a degree of hardware independence
- Managing system memory
- Managing processing tasks
- Providing networking capability
- Controlling access to system resources
- Managing files

The **kernel**, as its name suggests, is the heart of the OS and controls the most critical processes. The kernel ties all of the OS components together and regulates other programs.

**kernel**

The heart of the operating system, which controls the 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 disks
- Store data on disks
- 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 typical OS performs hundreds of such tasks, translating each task into one or more instructions for the hardware. The OS notifies the user if input or output devices need attention, if an error has occurred, and if anything abnormal happens in the system.

**User Interface and Input/Output Management**

One of the most important functions of any OS is providing a **user interface**. A user interface allows people to access and command 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 (see Figure 4.3). For example, the command ERASE 00TAXRTN would cause the computer to erase a file called 00TAXRTN. RENAME and COPY are other examples of commands used to rename files and copy files from one location to another. Many operating systems that use a graphical user interface, discussed next, also have powerful command-based features.

**user interface**

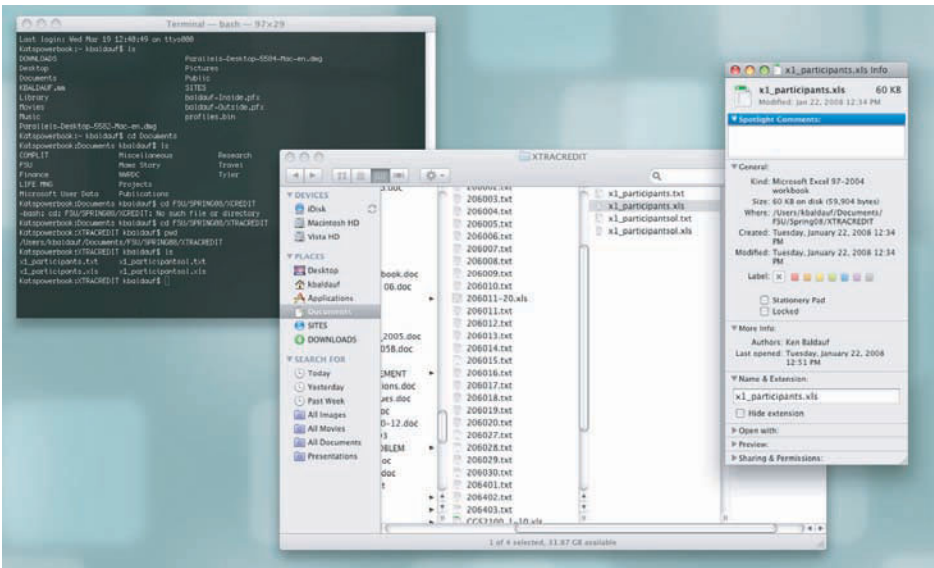
The element of the operating system that allows you to access and command the computer system.

**command-based user interface**

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

**Figure 4.3**  
Command-Based and Graphical User Interfaces

While a command-based user interface provides only a prompt for text commands, a GUI provides icons, menus, and dialog boxes to support many forms of input.



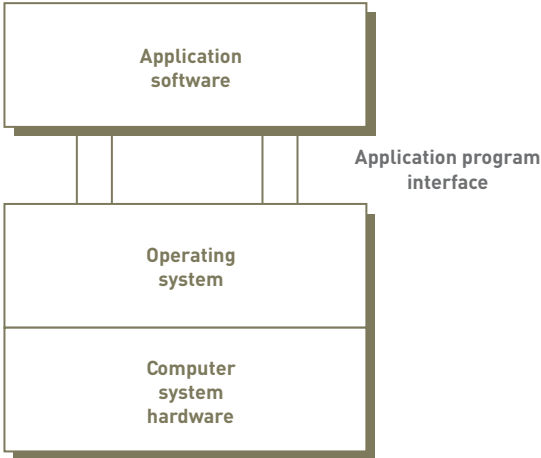
**graphical user interface (GUI)**  
An interface that uses icons and menus displayed on screen to send commands to the computer system.

**application program interface (API)**  
An interface that allows applications to make use of the operating system.

**Figure 4.4**  
Application Program Interface Links Application Software to the Operating System

Figure 4.3 also shows a **graphical user interface (GUI)**, which uses pictures (called icons) and menus displayed on screen to send commands to the computer system. Many people find that GUIs are easier to use because they intuitively grasp the functions. Today, the most widely used graphical user interface is Microsoft Windows. Alan Kay and others at Xerox PARC (Palo Alto Research Center, located in California) were pioneers in investigating the use of overlapping windows and icons as an interface. 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. GUIs have contributed greatly to the increased use of computers because users no longer need to know command-line syntax to accomplish tasks.

**Hardware Independence**  
To run, applications request services from the OS through a defined **application program interface (API)**, as shown in Figure 4.4. Programmers can use APIs to create application software without having to understand the inner workings of the OS.



Suppose that a computer manufacturer designs new hardware that can operate much faster than before. If the same OS for which an application was developed can run on the new hardware, the application will require minimal (or no) changes to enable it to run on the new hardware. If APIs did not exist, the application developers might have to completely rewrite the application to take advantage of the new, faster hardware.

## Memory Management

The OS also controls how memory is accessed and maximizes available memory and storage. Newer OSs typically manage memory better than older OSs. 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 disk 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 disk devices—a concept called paging. This 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 can permit one user to run several programs or tasks at the same time (multitasking) and allow 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. Without having to exit a program, you can work in one application, easily pop into another, and then jump back to the first program, picking up where you left off. Better still, while you're working in the *foreground* in one program, one or more other applications can be churning away, unseen, in the *background*, 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 be entering sales data into a computer system for a mail-order company at the same time. In another case, thousands of people might be simultaneously using an online computer service to get stock quotes and valuable business news.

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 number of users, such as a mainframe computer or a Web server. Because personal computer OSs usually are oriented toward single users, they do not need to manage multiple-user tasks often.

## 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. PCs running Mac, Windows, or Linux operating systems allow users to easily set up home or business networks for sharing Internet connections, printers, storage, and data. 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. If the identification code is invalid or if the password does not match the identification code, the user cannot gain access to the computer. Some OSs require that user passwords change frequently—such as every 20 to 40 days. If the 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 disks or tape drives. The OS keeps track of where each file is stored and who can access it. The OS must determine what to do if more than one user requests access to the same file at the same time. Even on stand-alone personal computers with only one user, file management is needed to track where files are located, what size they are, when they were created, and who created them.

**Current Operating Systems**

Early OSs were very basic. Recently, however, more advanced OSs have been developed, incorporating sophisticated features and impressive graphics effects. Table 4.2 classifies a few current OSs by sphere of influence.

**Table 4.2**  
Popular Operating Systems  
Cross All Three Spheres of  
Influence

Personal	Workgroup	Enterprise
Microsoft Windows Vista, Windows XP, Windows Mobile, Windows Automotive, and Windows Embedded	Microsoft Windows Server 2003 and Server 2008	Microsoft Windows Server 2003 and Server 2008
Mac OS X	Mac OS X Server	
UNIX	UNIX	UNIX
Solaris	Solaris	Solaris
Linux	Linux	Linux
Red Hat Linux	Red Hat Linux	Red Hat Linux
Palm OS	Netware	
	IBM i5/OS and z/OS	IBM i5/OS and z/OS
	HP-UX 11i	HP-UX 11i

**Microsoft PC Operating Systems**

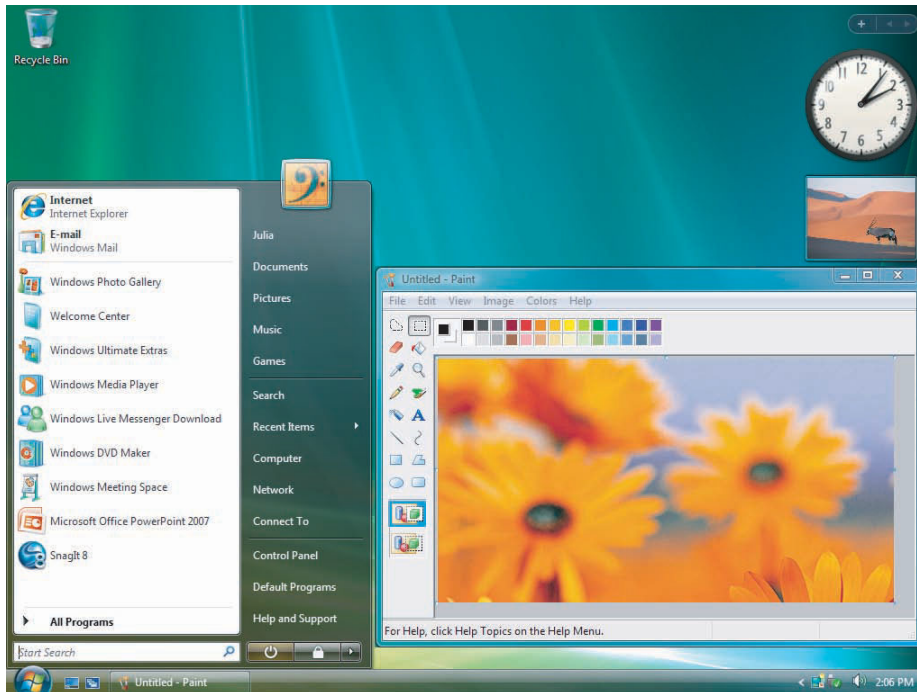
Since a small company called Microsoft developed PC-DOS and MS-DOS to support the IBM personal computer introduced in the 1980s, personal computer OSs have steadily evolved. *PC-DOS* and *MS-DOS* had command-driven interfaces that were difficult to learn and use. Each new version of OS has improved the ease of use, processing capability, reliability, and ability to support new computer hardware devices.

*Windows XP* (XP reportedly stands for the positive experience that you will have with your personal computer) was released in fall 2001. Previous consumer versions of Windows were notably unstable and crashed frequently, requiring frustrating and time-consuming reboots. With XP, Microsoft sought to bring reliability to the consumer.

In 2007, Microsoft released Windows Vista to the public, introducing it as the most secure version of Windows ever. Windows Vista includes design improvements that make it attractive and easy to use. The most advanced editions of Windows Vista include a 3-D graphics interface called Aero. However, the system requirements for Windows Vista with Aero require many users to purchase new, more powerful PCs. Windows Vista also suffered some negative press when early adopters found that some software and hardware designed for Windows XP did not run on Vista.

Windows Vista is available in five editions. Windows Vista Home Basic provides improved security, but otherwise has features similar to those included in Windows XP. Windows Vista Home Premium includes enhanced security, the Aero interface, and other improvements such as home media, but lacks business features. Windows Vista Business includes all of the above except the home media features plus business features such as a backup and restore tool, a scan and fax tool, and easy access to business networks from home.

Windows Vista Ultimate includes all of these features (see Figure 4.5). A fifth version of Windows Vista, Vista Enterprise, is designed for use on business networks. It includes encryption technology to keep stored data secure, and the ability to deliver a Windows desktop environment from an enterprise server. Today, Microsoft has over 90 percent of the PC OS market. Apple holds 7.3 percent of the market, and Linux publishers and other companies account for the rest of the PC OS market.<sup>1</sup>

**Figure 4.5**

Microsoft Windows Vista

The National Aquarium in Baltimore decided to upgrade to Microsoft Vista Home Premium to improve data security and staff productivity.<sup>2</sup> The staff that manages the 16,000 aquatic specimens has little time for computer work. Staff members share PC workstations placed strategically around the 250,000 square foot facility. Before upgrading to Windows Vista, various versions of operating systems were installed around the aquarium, and staff members found the logon time a test of their patience. It was not uncommon for users to forget to log out and leave secure data open to others. The aquarium chose Windows Vista for two important features: Fast User Switching, which automatically logs users out after a period of inactivity, but allows them to return to their work in seconds, and Windows built-in desktop search, which saves time when looking for data. The staff estimates that it has doubled its computing productivity since switching to Windows Vista.

### Apple Computer Operating Systems

Although IBM system platforms traditionally use one of the Windows OSs and Intel microprocessors (often called *Wintel* for this reason), Apple computers have used non-Intel microprocessors designed by Apple, IBM, and Motorola which run a proprietary Apple OS—the Mac OS. Newer Apple computers, however, use Intel chips. Although Wintel computers hold the largest share of the business PC market, Apple computers are also popular, especially in the fields of publishing, education, graphic arts, music, movies, and media. Software developed for the Macintosh often provides cutting-edge options for creative people. GarageBand, for example, is Macintosh software that allows you to create your own music the way a professional does, and it can sound like a small orchestra. Pro Tools is another software program used to edit digital music.

The Apple OSs have also evolved over a number of years and often provide features not available from Microsoft. Starting in July 2001, the Mac OS X was installed on all new Macs. It includes an entirely new user interface, which provides a new visual appearance for

users—including luminous and semitransparent elements, such as buttons, scroll bars, windows, and fluid animation to enhance the user's experience.

Since its first release, Apple has upgraded OS X several times. Leopard is the most recent version of OS X, released in 2007 to compete with Windows Vista (see Figure 4.6). OS X Leopard includes an attractive 3-D graphical user interface that Apple claims is more intuitive than Windows. Leopard includes Time Machine, a powerful backup tool that allows users to view their system as it looked in the past and resurrect deleted files. Leopard also includes multiple desktops, a video chat program that allows users to pose in front of imaginary landscapes, a powerful system search utility, and other updated software. Because Mac OS X runs on Intel processors, Mac users can set up their PC to run both Windows Vista and Mac OS X and select which platform they want to work with when they boot their PC. Macs are also considered very secure, with no widespread virus or spyware infections to date.

**Figure 4.6**

### Mac OS X Leopard

[Source: Courtesy of Apple Computer, Inc.]



When attorney Renee Mancino decided to leave her Las Vegas law firm and start her own home-based practice, she chose an Apple MacBook Pro with the Mac OS as her mobile office.<sup>3</sup> She appreciates the Mac's organizational features that help her to manage and sift through the thousands of documents associated with her cases.

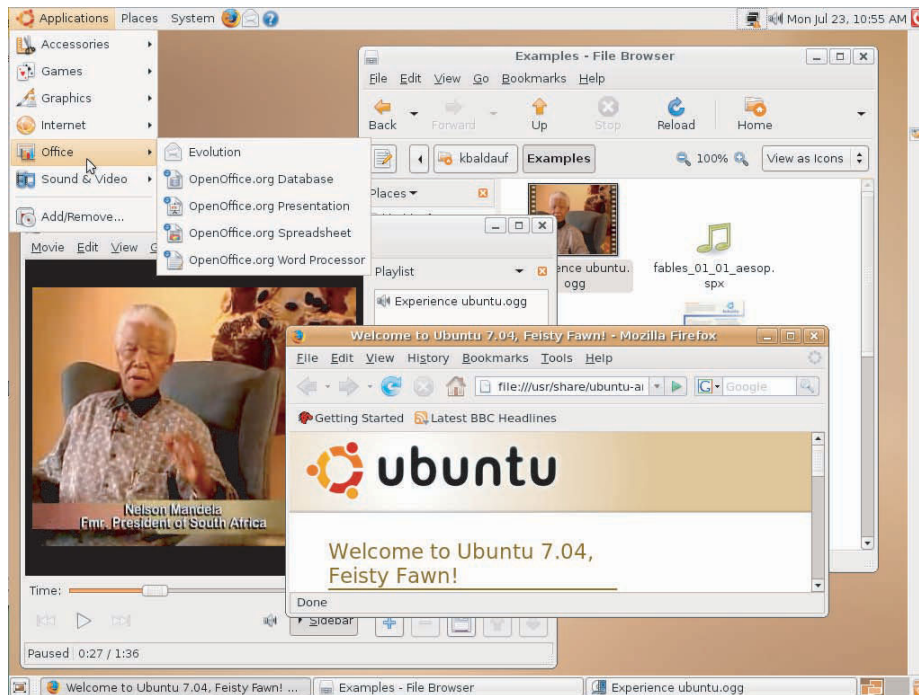
### Linux

*Linux* is an OS developed by Linus Torvalds in 1991 as a student in Finland. The OS is distributed under the GNU General Public License, and its source code is freely available to everyone. It is, therefore, called an open-source operating system. This doesn't mean, however, that Linux and its assorted distributions are necessarily free—companies and developers can charge money for a distribution as long as the source code remains available. Linux is actually only the kernel of an OS, the part that controls hardware, manages files, separates processes, and so forth. Several combinations of Linux are available, with various sets of capabilities and applications to form a complete OS. Each of these combinations is called a *distribution* of Linux. Many distributions are available as free downloads.

Linux is available on the Internet and from other sources, including Red Hat Linux and Caldera OpenLinux. Many people and organizations use Linux.

In addition, several large computer vendors, including IBM, Hewlett-Packard, and Intel, support the Linux operating system. For example, IBM has more than 500 programmers working with Linux, primarily because of its security features. Many CIOs are considering switching to Linux and open-source software because of security concerns with Microsoft software.

Linux is making inroads to the consumer PC market with their GUI distributions. Both Dell and Lenovo sell notebook computers running Ubuntu and SuSE Linux.<sup>4</sup> Ubuntu is a user-friendly Linux distribution that is free to download and includes dozens of free software packages (see Figure 4.7). Wal-Mart and Sears are selling Linux PCs for \$200, making them a popular alternative to other types of computers.<sup>5</sup> (Wal-Mart is selling the PCs only online.) New ultra-compact notebooks such as the ASUS Eee PC are preinstalled with Linux to make the most of their limited system resources.

**Figure 4.7**

Ubuntu Linux Operating System  
(Source: Courtesy of Ubuntu.)

Radio station KRUU, “the Voice of Fairfield” in Iowa, is a nonprofit, community-based radio station. It broadcasts locally every day, 24 hours a day, and online to 30 countries ([www.kruufm.com](http://www.kruufm.com)). The station supports about 100 hosts and 75 programs, broadcasting programs ranging from bedtime stories to death-metal music. When shopping for an operating system to use in the studio, KRUU selected Linux Ubuntu.<sup>6</sup> “Our requirements were quite complex and our decision to go with Ubuntu was based on three factors and Ubuntu won hands down,” stated Sundar Raman, a presenter at the station. The three factors were: (1) Ubuntu looks good and is simple for both Windows and Mac users to use, (2) Ubuntu is reliable and easy to manage both locally and remotely, and (3) Ubuntu software supports professional audio editing and mixing software and hardware. One benefit of using Linux Ubuntu is the user community support. KRUU found all the answers it needed regarding running a professional studio on Linux from the “Ubuntu-Studio” community. Communicating with other Linux professionals helped the station use Linux computers for all of their computing tasks, including recording and mixing consoles.

## 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. This rapid increase in communications and data-processing capabilities pushes the boundaries of computer science and physics. Powerful and sophisticated OSs are needed to run the servers that meet these business needs for workgroups. Small businesses, for example, often use workgroup OSs to run networks and perform critical business tasks.



### Windows Server

Microsoft designed *Windows Server* to perform a host of tasks that are vital for Web sites and corporate Web applications. For example, Microsoft Windows Server can be used to coordinate large data centers. The OS also works with other Microsoft products. It can be used to prevent unauthorized disclosure of information by blocking text and e-mails from being copied, printed, or forwarded to other people. Microsoft *Windows Server 2008* is the most recent version of Windows Server and 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.

### UNIX

*UNIX* is a powerful OS originally developed by AT&T for minicomputers. UNIX can be used on many computer system types and platforms, from personal computers to mainframe systems. UNIX also makes it much easier to move programs and data among computers or to connect mainframes and personal computers to share resources. There are many variants of UNIX—including HP/UX from Hewlett-Packard, AIX from IBM, UNIX SystemV from UNIX Systems Lab, Solaris from Sun Microsystems, and SCO from Santa Cruz Operations. Sun Microsystems hopes that its open-source Solaris will attract developers to make the software even better.

The online marketplace eBay uses Sun Microsystems servers, software, storage, and services to run its operations.<sup>7</sup> Sun's Solaris operating system manages eBay's systems, including database servers, Web servers, tape libraries, and identity management systems. The online auction company found that when they switched to Sun and Solaris, system performance increased by 20 percent. The Idaho National Laboratory also uses Solaris to conduct research in their work to design more efficient and safe nuclear reactors.<sup>8</sup>

### NetWare

*NetWare* is a network OS sold by Novell that can support users on Windows, Macintosh, and UNIX platforms. NetWare provides directory software to track computers, programs, and people on a network, helping large companies to manage complex networks. NetWare users can log on from any computer on the network and use their own familiar desktop with all their applications, data, and preferences.

### Red Hat Linux

Red Hat Software offers a Linux network OS that taps into the talents of tens of thousands of volunteer programmers who generate a steady stream of improvements for the Linux OS. The *Red Hat Linux* network OS is very efficient at serving Web pages and can manage a cluster of up to eight servers. Linux environments typically have fewer virus and security problems than other OSs. Distributions such as SuSE and Red Hat have proven Linux to be a very stable and efficient OS.

### Mac OS X Server

The *Mac OS X Server* is the first modern server OS from Apple Computer and is based on the UNIX OS. The most recent version is OS X Server 10.5 Leopard. It includes features that allow the easy management of network and Internet services such as e-mail, Web site hosting, calendar management and sharing, wikis, and podcasting.

## Enterprise Operating Systems

New mainframe computers provide the computing and storage capacity to meet massive data-processing requirements and offer many users high performance and excellent system availability, strong security, and scalability. In addition, 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. As a result, mainframe computers remain the computing platform of choice for mission-critical business applications for many companies. Examples of mainframe OSs include z/OS from IBM, HP-UX from Hewlett-Packard, and Linux.



## z/OS

The *z/OS* is IBM's first 64-bit enterprise OS. It supports IBM's z900 and z800 lines of mainframes that can come with up to sixteen 64-bit processors. (The z stands for zero down-time.) The OS provides several new capabilities to make it easier and less expensive for users to run large mainframe computers. The OS has improved workload management and advanced e-commerce security. The IBM zSeries mainframe, like previous generations of IBM mainframes, lets users subdivide a single computer into multiple smaller servers, each of which can run a different application. In recognition of the widespread popularity of a competing OS, *z/OS* allows partitions to run a version of the Linux OS. This means that a company can upgrade to a mainframe that runs the Linux OS.

## HP-UX and Linux

The *HP-UX* is a robust UNIX-based OS from Hewlett-Packard designed to handle a variety of business tasks, including online transaction processing and Web applications. It supports Internet, database, and business applications on server and mainframe enterprise systems. It can work with Java programs and Linux applications. The OS comes in five versions: foundation, enterprise, mission critical, minimal technical, and technical. HP-UX supports Hewlett-Packard's computers and those designed to run Intel's Itanium processors. *Red Hat Enterprise Linux* for IBM mainframe computers is another example of an enterprise operating system.

## Operating Systems for Small Computers, Embedded Computers, and Special-Purpose Devices

New OSs and other software are changing the way we interact with personal digital assistants (PDAs), smartphones, cell phones, digital cameras, TVs, and other appliances. These OSs are also called *embedded operating systems* because they are typically embedded within a device, such as an automobile or TV recorder. Embedded software is a multibillion dollar industry. Some of these OSs allow you to synchronize handheld devices with PCs using cradles, cables, and wireless connections. Cell phones also use embedded OSs (see Figure 4.8). In addition, some OSs have been developed for special-purpose devices, such as TV set-top boxes, computers on the space shuttle, computers in military weapons, and computers in some home appliances. Some of the more popular OSs for devices are described in the following section.



**Figure 4.8**

### Mobile Phones Have Embedded Operating Systems

Many cell phones and smartphones, such as this BlackBerry, have an embedded OS that can support access to communications, media, and information.

(Source: Courtesy of PRNewsFoto/Verizon Wireless.)

An IT group within the United States Department of Agriculture recently deployed BlackBerries to their IT staff.<sup>9</sup> The high-speed network connection between BlackBerry and the organization's private network allowed system support staff to troubleshoot problems on Linux, UNIX, and Microsoft servers located in the home office from any location.

### Palm OS

*ACCESS Systems* makes the Palm operating system, which is used in over 30 million handheld computers and smartphones manufactured by Palm, Inc. and other companies. Palm also develops and supports applications, including business, multimedia, games, productivity, reference and education, hobbies and entertainment, travel, sports, utilities, and wireless applications. Today, the smartphone market is overtaking the PDA market, as mobile users prefer to combine phone and information services in one device. OSs for this market are also provided by Research in Motion, Microsoft, Symbian, Apple (for the iPhone), and others.

### Windows Embedded

*Windows Embedded* is a family of Microsoft OSs included with or embedded into small computer devices. Windows Embedded 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. Microsoft Auto provides a computing platform for automotive software such as Ford Sync. The Ford Sync system uses an in-dashboard display and wireless networking technologies to link automotive systems with cell phones and portable media players (see Figure 4.9).

**Figure 4.9**

#### Microsoft Auto and Ford Sync

The Ford Sync system, developed on the Microsoft Auto operating system, allows drivers to wirelessly connect cell phones and media devices to automotive systems.

[Source: Courtesy of Microsoft Corporation and Ford Motor Company.]



### Windows Mobile

*Windows Mobile* is an operating system designed for smartphones and PDAs. Different versions of Windows Mobile support either a touch screen interface or a menu-driven interface. In addition to supporting typical cellular services, Windows Mobile provides handwriting recognition, instant messaging technology, support for more secure Internet connections, and the ability to beam information to other devices. The OS also has advanced telecommunications capabilities, discussed in more detail in Chapter 6. Dozens of phones provided by all of the major carriers run Windows Mobile.

## Utility Programs

**Utility programs** help to perform maintenance or correct problems with a computer system. 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. Some utility programs can help computer systems run better and longer without problems.

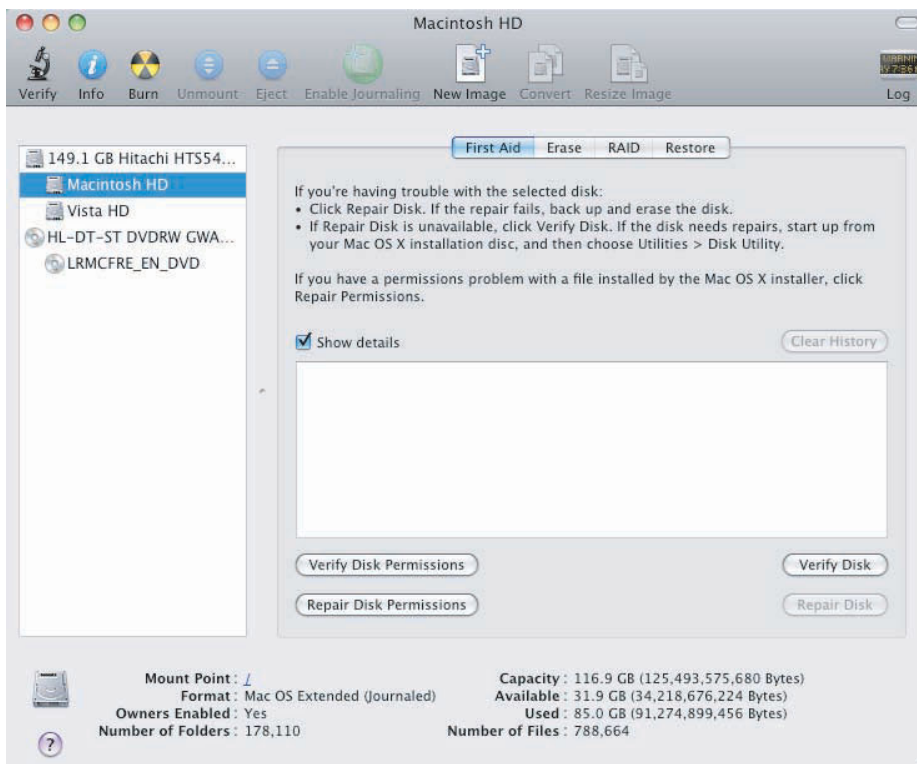
Another type of utility program allows people and organizations to take advantage of unused computer power over a network. Often called *grid computing*, the approach can be very efficient and less expensive than purchasing additional hardware or computer equipment. Financial services firm Wachovia Corporation uses grid computing to combine the power of 10,000 CPUs located on computers around the world for processing transactions.<sup>10</sup> In the future, grid computing could become a common feature of OSs and provide inexpensive, on-demand access to computer power and resources.

Utility programs can also help to secure and safeguard data. For example, the recording and motion picture industry uses digital rights management (DRM) technologies to prevent copyright-protected movies and music from being unlawfully copied. Music and media files are encoded so that software running on players recognizes and plays only legally obtained copies. DRM has been criticized for infringing on the freedom and rights of customers. Record companies are experimenting with DRM-free music to see if it increases sales.

Although many PC utility programs come installed on computers (see Figure 4.10), you can also purchase utility programs separately. The following sections examine some common types of utilities.

### utility programs

Programs that help to perform maintenance or correct problems with a computer system.



**Figure 4.10**

### Mac Disk Utility

The Apple Mac Disk Utility is packaged with OS X and provides tools for repairing disks, backing up disks, creating disk images, and burning CDs and DVDs.

## 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 disks, memory, modems, speakers, and printers. Disk utilities check the hard disk's boot sector, file allocation tables, and directories, and analyze them to ensure that the hard disk is not damaged. Disk utilities can also optimize the placement of files on a crowded disk.

### 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, often times it can be removed. This software runs continuously in the background to keep new viruses and spyware from entering the system. To keep current and make sure that the software checks for the latest threats, it can be easily updated over the Internet. It is also a good idea to protect computer systems with firewall software. Firewall software filters incoming and outgoing packets making sure that hackers or their tools are not attacking the system. Some software assists in keeping private data from being accessed from a computer system, in order to protect you from scams and fraud. Symantec, McAfee, and Microsoft are the most popular providers of security software.

### File-Compression Utilities

File-compression programs can reduce the amount of disk space required to store a file or reduce the time it takes to transfer a file over the Internet. A popular program on Windows PCs is WinZip ([www.winzip.com](http://www.winzip.com)), which generates zip files, which are collections of one or more compressed files. A zip file has a .zip extension, and its contents can be easily unzipped to their original size. Windows Vista includes utilities for compressing and uncompressing files. 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. MP3 can compress files ten times smaller than the original file with near-CD-quality sound. Software, such as iTunes from Apple, can be used to store, organize, and play MP3 music files.

### Spam and Pop-Up Blocker Utilities

Getting unwanted e-mail (spam) and having annoying and unwanted ads pop up on your screen while you are on the Web can be a frustrating waste of time. You can install a number of utility programs to help block unwanted e-mail spam and pop-up ads. Most Internet service providers and Web-based e-mail systems provide a spam-blocking service, and Web browsers such as Internet Explorer and Firefox include pop-up blocking utilities.

### 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 Web server is crashing or a network problem occurs. Although these general management features are helpful, what is needed is a way to pinpoint the cause of the problem. Topaz from Mercury Interactive is an example of software called an *advanced Web-performance monitoring utility*. It is designed to sound an alarm when it detects problems and let network administrators isolate the most likely causes of the problems. Its Auto RCA (root-cause analysis) module uses statistical analysis with built-in rules to measure system and Web performance. Actual performance data is compared with the rules, and the results can help pinpoint where trouble originated—in the application software, database, server, network, or the security features.

### Server and Mainframe Utilities

Some utilities enhance the performance of servers and mainframe computers. IBM has created systems-management software that allows a support person to monitor the growing number of desktop computers in a business attached to a server or mainframe computer. With this software, the support people can sit at their personal computers and check or diagnose problems, such as a hard disk failure on a network computer. The support people can even repair individual systems anywhere on the organization's network, often without having to leave their desks. The direct benefit is to the system manager, but the business also gains from having a smoothly functioning information system. Utility programs can meet the needs of a single user, workgroup, or enterprise, as listed in Table 4.3. These programs perform useful tasks—from tracking jobs to monitoring system integrity.

Personal	Workgroup	Enterprise
Software to compress data so that it takes less hard disk space	Software to provide detailed reports of workgroup computer activity and status of user accounts	Software to archive contents of a database by copying data from disk to tape
Screen saver	Software that manages an uninterruptible power supply to do a controlled shutdown of the workgroup computer in the event of a loss of power	Software that compares the content of one file with another and identifies any differences
Antivirus and antispyware software	Software that reports unsuccessful user logon attempts	Software that reports the status of a particular computer job

Table 4.3

Examples of Utility Programs

*Virtualization software* can make computers simulate other computers. The result is often called a *virtual machine*. Using virtualization software, servers and mainframe computers can run software applications written for different operating systems. For example, you can use a server or mainframe to test and run a number of PC applications simultaneously, such as spreadsheets, word processors, and databases. Virtualization software such as VMWare is being used by businesses to safeguard private data. For example, Kindred Healthcare uses VMWare on its server to run hundreds of virtual Windows PC desktops that are accessed by mobile computers throughout the organization.<sup>11</sup> Because the patient data and the software tools used to access that data are running on the server, security measures are easy to implement.

Other Utilities

Utility programs are available for almost every conceivable task or function. For example, you can use Microsoft Windows Rights Management Services with Microsoft Office programs to manage and protect important corporate documents. ValueIT is a utility that can help a company verify the value of investments in information systems and technology. Widgit Software has developed an important software utility that helps people with visual disabilities use the Internet. The software converts icons and symbols into plain text that can be easily seen. Another software utility allows a manager to see every keystroke a worker makes on a computer system. Monitoring software can catalog the Internet sites that employees visit and the time that employees are working at their computer.

In addition, you can use many search tools to find important files and documents. Most of these desktop search tools are free and available from a number of popular Internet sites. Yahoo! Desktop Search, Google Desktop, Mac Spotlight, and Windows Search are examples (see Figure 4.11).

Middleware

**Middleware** is software that allows different systems to communicate and exchange data. Middleware can also be used as an interface between the Internet and older legacy systems. (Legacy software is a previous, major version that continues to be used.) For example, middleware can be used to transfer a request for information from a corporate customer on the corporate Web site to a traditional database on a mainframe computer and return the results to the customer on the Internet.

The use of middleware to connect disparate systems has evolved into an approach for developing software and systems called SOA. A **service-oriented architecture**, or 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, which reduces development time. Because SOA modules are designed using programming standards so they can interact with other modules, rigid custom-designed middleware software is not needed to connect systems. However, Southside Electric Cooperative, Inc. in Virginia found SOA to be the perfect solution to eliminating time-consuming paperwork, reducing response time to customer needs, and doubling the rate that it is able to collect delinquent payments.<sup>12</sup> The system uses Qualcomm OmniTRACS wireless communications and IBM’s SOA-based WebSphere software.

**middleware**  
Software that allows different systems to communicate and exchange data.

**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.



**Figure 4.11**

**Desktop Search Tool**

With a desktop search tool, you can search through files on your computer to instantly find files of all types that have something to do with the specified keyword.



# 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. When you need the computer to do something, you use one or more application programs. The application programs interact with systems software, and the systems software then directs the computer hardware to perform the necessary tasks. Applications help you perform common tasks, such as creating and formatting text documents, performing calculations, or managing information, though some applications are more specialized. A pharmaceutical company, for example, has developed application software to detect the early signs of Parkinson’s disease. The new software detects slight trembling in speech patterns not detectable by the human ear that predicts the disease. Application software is used throughout the medical profession to save and prolong lives. For example, Oregon Health & Science University uses iRecruitment software from Oracle to match employees to job openings.<sup>13</sup>

The functions performed by application software are diverse, and range from personal productivity to business analysis. For example, application software can help sales managers track sales of a new item in a test market. Software from IntelliVid monitors video feeds from store security cameras and notifies security when a shopper is behaving suspiciously.<sup>14</sup> Most of the computerized business jobs and activities discussed in this book involve application software. We begin by investigating the types and functions of application software.

### Software Helps Target Radiation Treatment for Cancer

Doctors have been using radiation therapy as a treatment for cancer since the 1940s. The treatment has saved countless lives, yet has been somewhat imprecise until recently. The original method of treating a tumor with radiation used a linear accelerator that delivered radiation in rectangular beams. Doctors used lead blocks to prevent the beams from harming healthy tissue. The process was cumbersome and only partially effective. Surrounding tissue was often destroyed along with the tumor.

In the 1980s, a machine called an MLC, for multileaf collimator, was invented. The MLC had motorized leaves to disrupt the beam of radiation and focus it more closely on where it was needed. Still, the treatment was imprecise, lacking real-time control of the radiation intensity and direction.

Until the mid-1990s, most of the development of radiation treatment technologies focused on hardware. Varian Medical Systems decided that devising a more effective system would require a heavy investment in software development. Computing processors and hardware were advanced enough to precisely control beams of radiation, but the software to empower the hardware had yet to be developed. Varian transformed itself from a hardware company to a software company to get the job done.

Varian hired experts in programming embedded controls, user interfaces, treatment planning, and databases. It proceeded incrementally over many years to develop a trustworthy and powerful system called the SmartBeam IMRT (for Intensity Modulated Radiation Therapy), which is now in use at thousands of medical facilities around the world.

The SmartBeam IMRT combines an x-ray and radiation technology into one device that rotates around the patient delivering radiation at precise intensities from any angle. The machine is the first that allows physicians to examine and treat a tumor at the same time. The on-board imager produces "high-resolution images of tumors and tracks changes in a tumor's shape, size, and position... that when coupled with SmartBeam IMRT, allows clinicians to be even more precise when targeting tumors," according to *Computerworld*. The magazine awarded Varian the top prize for information systems in manufacturing in its 2007 Computer-world Honors Program.

### Discussion Questions

1. What role does software play in the SmartBeam IMRT medical system?
2. Why couldn't Varian produce the SmartBeam IMRT before it did?

### Critical Thinking Questions

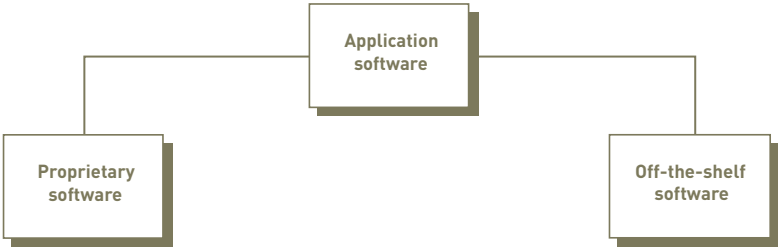
1. What additional safeguards must be programmed into the software that runs the SmartBeam IMRT that aren't necessary in typical PC software?
2. How do you think the development of the SmartBeam IMRT launched Varian to the top of the market in cancer treatment systems?

**SOURCES:** Pratt, Mary K., "Software Helps Target Radiation Treatment for Cancer," *Computerworld*, December 3, 2007, [www.computerworld.com/action/article.do?command=viewArticleBasic&articleId=304865&pageNumber=1](http://www.computerworld.com/action/article.do?command=viewArticleBasic&articleId=304865&pageNumber=1). Varian Medical Systems Web site, [www.varian.com](http://www.varian.com), accessed February 3, 2007.

### Overview of Application Software

Proprietary software and off-the-shelf software are important types of application software (see Figure 4.12). A company can develop a one-of-a-kind program for a specific application (called **proprietary software**). Proprietary software is not in the public domain. A company can also purchase or acquire an existing software program (sometimes called **off-the-shelf software** because it can literally be purchased or acquired “off the shelf” in a store). The relative advantages and disadvantages of proprietary software and off-the-shelf software are summarized in Table 4.4.

**Figure 4.12**  
**Types of Application Software**  
Some off-the-shelf software can be customized to suit user needs.



Proprietary Software		Off-the-Shelf Software	
Advantages	Disadvantages	Advantages	Disadvantages
You can get exactly what you need in terms of features, reports, and so on.	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 system development staff may become 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 can be very expensive because users must adopt 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. A merger with or acquisition of another firm also requires software changes to meet new business needs.	The features and performance of software that has yet to be developed presents 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.

**Table 4.4**  
**A Comparison of Proprietary and Off-the-Shelf Software**

Many companies use off-the-shelf software to support business processes. For example, the lawyers at Ferwick & West LLP use a combination of several off-the-shelf software packages to help “cull data” from millions of legal documents.<sup>15</sup> One case required sorting through over 100 million legal files. The system they developed is called FIND, for File Identification Narrowed by Definition, and it combines the power of 75 software tools, most of them off-the-shelf applications. Key questions for selecting off-the-shelf software include the following: (1) Will the software run on the OS and hardware you have selected? (2) Does the software meet the essential business requirements that have been defined? (3) Is the software manufacturer financially solvent and reliable? and (4) Does the total cost of purchasing, installing, and maintaining the software compare favorably 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, police officers and dispatchers in Dover, N.H., use a

customized off-the-shelf software package that provides a map view of the jurisdiction. Dispatchers can easily identify the location of patrol cars and crime scenes on the map, and quickly route the nearest car to the desired location.<sup>16</sup> In another example of the blended approach, Blue Cross and Blue Shield worked with Sun Microsystems to customize a claims management system for its customers to access over the Web.<sup>17</sup>

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*. An ASP can also simplify a complex corporate software package so that it is easier for the users to set up and manage. ASPs provide contract customization of off-the-shelf software, and they speed deployment of new applications while helping IS managers avoid implementation headaches, reducing the need for many skilled IS staff members and decreasing project start-up expenses. Such an approach allows companies to devote more time and resources to more important tasks. For example, Avanax, a Silicon Valley company that develops intelligent photonic solutions for optical networks, uses a Product Lifecycle Management system provided by SAP. The system runs on SAP servers, which has helped Avanax reduce costs and provide much higher levels of service.<sup>18</sup>

Using an ASP makes the most sense for relatively small, fast-growing companies with limited IS resources. It is also a good strategy for companies that want to deploy a single, functionally focused application quickly, such as setting up an e-commerce Web site or supporting expense reporting. Contracting with an ASP might make less sense, however, for larger companies that have major systems and their technical infrastructure already in place.

Using an ASP involves some risks—sensitive information could be compromised in a number of ways, including unauthorized access by employees or computer hackers; the ASP might not be able to keep its computers and network up and running as consistently as necessary; or a disaster could disable the ASP's data center, temporarily putting an organization out of business. These are legitimate concerns that an ASP must address.

The high overhead of an ASP designing, running, managing, and supporting many customized applications for many businesses has led to a new form of software distribution known as software as a service. **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. 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. SaaS can reduce expenses by sharing its running applications among many businesses. For example, Sears, JCPenney, and Wal-Mart might use customer relationship management software provided by a common SaaS provider. Providing one high-quality SaaS application to thousands of businesses is much more cost-effective than custom designing software for each business.

Customer relationship management (CRM) and other general business systems are good candidates for SaaS. For example, The Improv, "America's Original Comedy Showcase," turned to a SaaS CRM system from salesforce.com to manage marketing and sales of event space to businesses wanting to use its theaters.<sup>19</sup> SaaS is becoming popular for information security as well, as described in the Ethical and Societal Issues sidebar.

#### **application service provider (ASP)**

A company that provides software, support, and the 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 business application software by paying a monthly service charge or a per-use fee.



## ETHICAL AND SOCIETAL ISSUES

### Imperial Chemical Turns to SaaS Security Tools

Imperial Chemical Industries is a very large paint and chemicals manufacturer based in London. The company was recently purchased by Akzo Nobel for \$16 billion. With a research budget of around \$60 million annually, and research data spread geographically over many computer systems at a variety of locations, Imperial Chemical works hard to keep its valuable data protected and secure.

Securing data over large distributed systems can be a costly, time-consuming affair. It becomes more complex when one company's systems are merged with another company's systems over a network. In today's global information economy, it is not unusual for a corporation to join its network with several partners and suppliers. To secure such networks would require a large suite of security software continuously running on all computers and a team of security experts working around the clock.

Rather than incur these costs, Imperial Chemical decided to outsource much of its information security to online companies offering security SaaS. SaaS makes sense for many security applications because the scanning of systems can take place from any network-connected system.

Imperial uses three SaaS security providers:

- Qualys provides a vulnerability management service that includes network discovery and mapping, asset prioritization, vulnerability assessment reporting, and remediation tracking according to business risk.
- Veracode provides a service that scans all binary executable files on the system, looking for bugs and viruses.
- Message Labs protects Imperial's e-mail systems from spam and viruses. It can also be used to filter out unauthorized and inappropriate content.

As securing corporate and customer data becomes increasingly regulated, many companies are turning to security SaaS vendors to make sure that they are in compliance with the law. For example, the three companies above insure that their customers are in compliance with the PCI DSS, the Payment Card Industry Data Security Standard. This standard is required by certain companies and banks that wish to insure their customers' privacy.

SaaS security systems are ideal for large organizations that have thousands of computers to secure. However, it is also easy to imagine how such services could provide a security solution for individual personal computers as well. Currently hundreds or thousands of home PCs are infected by spyware and serving as bots being controlled by hackers to send spam and attack other systems. Internet service providers do what they can to keep their users safe, but they can't stop a user from running an infected file or wandering to an infected Web site. Incorporating SaaS security systems through Internet service providers to personal PCs would clear up most of the infections that plague the Internet. As with most security practices, there would probably be some tradeoff in convenience and privacy.

### Discussion Questions

1. Why does it make sense for a large corporation to outsource information security to a SaaS provider?
2. What are the dangers of trusting corporate information systems to an outside security firm?

### Critical Thinking Questions

1. Would you be willing to allow a security company to guard your PC remotely while you are connected to the Internet? Why or why not?
2. Currently, PC users must run about four different security applications to keep their computers safe: a firewall, virus protection, spyware protection, and Windows Update. The user is responsible for making sure these systems are operational and up to date. Whose responsibility should it be to secure a PC? How might this system be simplified for users?

**SOURCES:** Hines, Matt, "Security SaaS offerings growing up fast," *Computerworld*, August 23, 2007, [www.computerworld.com/action/article.do?command=viewArticleBasic&taxonomyName=saas&articleId=9032321&taxonomyId=170&intsrc=kc\\_feat](http://www.computerworld.com/action/article.do?command=viewArticleBasic&taxonomyName=saas&articleId=9032321&taxonomyId=170&intsrc=kc_feat). Qualys Web site, [www.qualys.com](http://www.qualys.com), accessed February 2, 2008. MessageLabs Web site, [www.messagelabs.com](http://www.messagelabs.com), accessed February 2, 2008. PCI (Payment Card Industry) Security Standards Council Web site, <https://www.pcisecuritystandards.org>, accessed February 2, 2008.



## 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 3-D views of where they are, along with directions and 3-D maps to where they would like to go. The features of personal application software are summarized in Table 4.5. In addition to these general-purpose programs, thousands of other personal computer applications perform specialized tasks: to 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.

**Table 4.5**

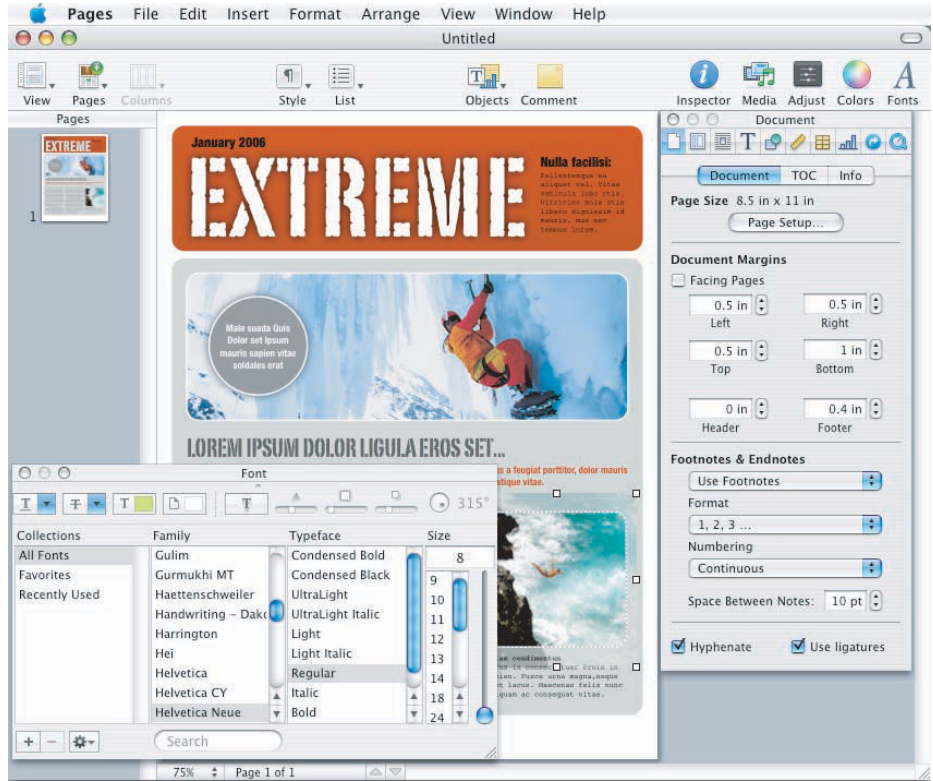
Examples of Personal Productivity Software

Type of Software	Explanation	Example	Vendor
Word processing	Create, edit, and print text documents	Word WordPerfect Google Docs Pages Writer	Microsoft Corel Google Apple Sun
Spreadsheet	Provide a wide range of built-in functions for statistical, financial, logical, database, graphics, and date and time calculations	Excel Lotus 1-2-3 Spreadsheet Numbers Calc	Microsoft Lotus/IBM Google Apple Sun
Database	Store, manipulate, and retrieve data	Access Approach dBASE Base	Microsoft Lotus/IBM Borland Sun
Graphics	Develop graphs, illustrations, and drawings	Illustrator FreeHand	Adobe Macromedia
Project management	Plan, schedule, allocate, and control people and resources (money, time, and technology) needed to complete a project according to schedule	Project for Windows On Target Project Schedule Time Line	Microsoft Symantec Scitor Symantec
Financial management	Provide income and expense tracking and reporting to monitor and plan budgets (some programs have investment portfolio management features)	Quicken Money	Intuit Microsoft
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 Publisher PageMaker Ventura Publisher Pages	Quark Microsoft Adobe Corel Apple
Creativity	Generate innovative and creative ideas and problem solutions. The software does not propose solutions, but provides a framework conducive to creative thought. The software takes users through a routine, first naming a problem, then organizing ideas and "wishes," and offering new information to suggest different ideas or solutions	Organizer Notes	Macromedia Lotus

**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 (see Figure 4.13). This book (and most like it) was entered into a word processing application using a personal computer.

**Figure 4.13**  
**Word Processing Program**  
Word processing applications can be used to write letters, professional documents, work reports, and term papers.



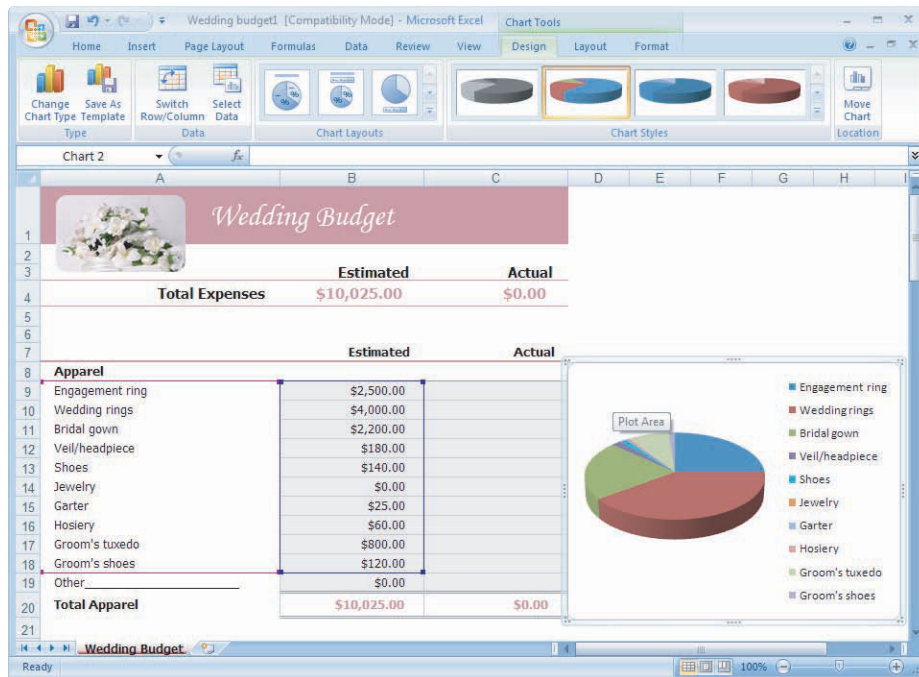
A team of people can use a word processing program to collaborate on a project. The authors and editors who developed this book, for example, used the Track Changes and Reviewing features of Microsoft Word to track and make changes to chapter files. You can add comments or make revisions to a document that a coworker can review and either accept or reject.

Professional chef JoAnna Minneci runs her own catering and in-home cooking services in Los Angeles, California. She believes in treating all of her customers as though they were celebrities. Minneci uses Word for Mac to design colorful and artistic menus and gift certificates.<sup>20</sup> The cross-platform compatibility of Microsoft Office for Mac allows her to deliver materials such as menus, contracts, and budgets to clients working on Macintosh or Windows-based PCs.

**Spreadsheet Analysis**

Spreadsheets are powerful tools for individuals and organizations. Features of spreadsheets include graphics, limited database capabilities, statistical analysis, built-in business functions, and much more (see Figure 4.14). The business functions include calculation of depreciation, present value, internal rate of return, and the monthly payment on a loan, to name 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 lumber, 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 labor and material constraints to maximize profits.



**Figure 4.14**

### Spreadsheet Program

Spreadsheet programs should be considered when calculations are required.

### Database Applications

Database applications are ideal for storing, manipulating, 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, then export the stored results to other applications, such as a spreadsheet or tax-preparation application (see Figure 4.15).

### Graphics Program

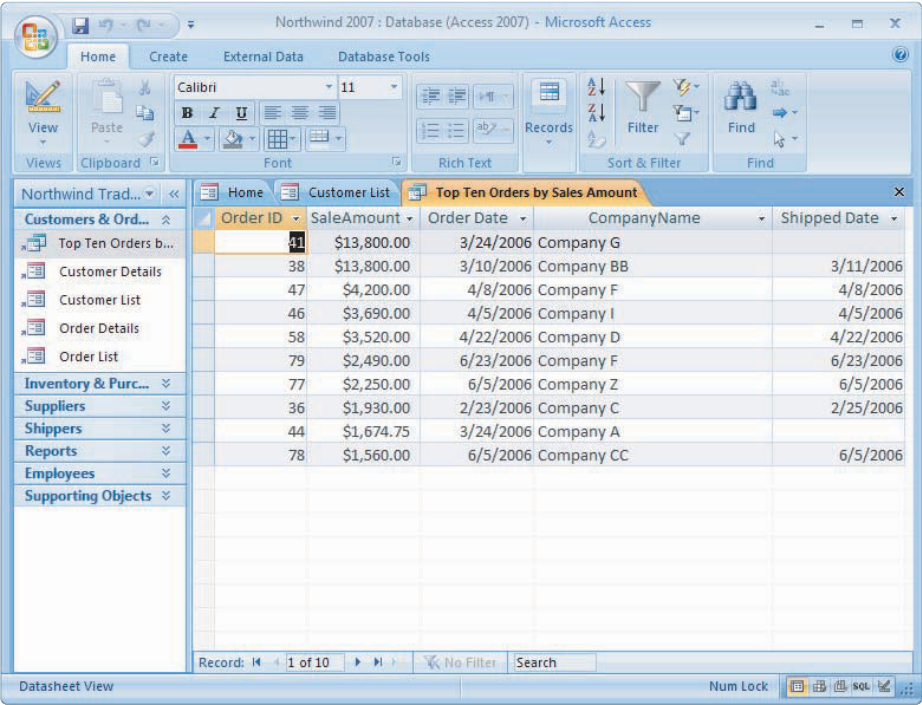
It is often said that a picture is worth a thousand words. With today's graphics programs, it is easy to develop attractive graphs, illustrations, and drawings (see Figure 4.16). Graphics programs can be used to develop advertising brochures, announcements, and full-color presentations, and to organize 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, such as Microsoft Office 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.

**Figure 4.15**

**Database Program**

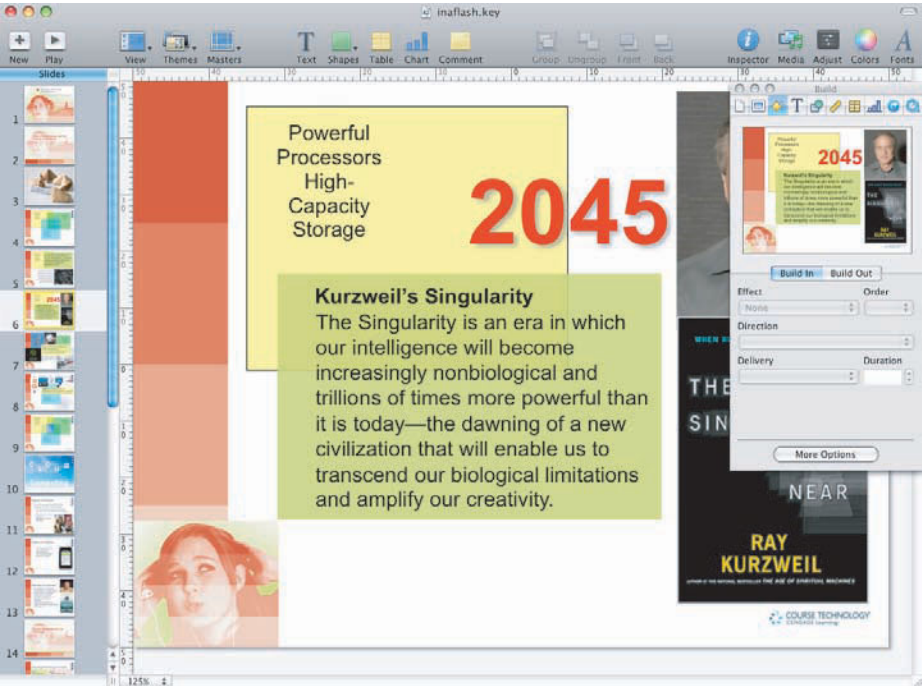
After being entered into a database application, information can be manipulated and used to produce reports and documents.



**Figure 4.16**

**Presentation Graphics Program**

Graphics programs can help you make a presentation at school or work.



The presentation graphics program takes you through the presentation step by step, including applying color 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 managers (PIMs)* help people, groups, and organizations store useful information, such as a list of tasks to complete or a set of names and addresses. PIMs usually provide an appointment calendar 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. Google provides PIM software to integrate e-mail, appointment, and address book tasks.



**Figure 4.17**

### Personal Information Manager

PIM software assists individuals, groups, and organizations with organizing appointments, schedules, contacts, and to-do lists.

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 e-mails sent and received over the Internet.

Consider Greenfield Online as an example of one collaborative PIM system. Greenfield Online is a Web survey solution provider that has about 500 employees in 12 countries and 30 cities. Employees were having a difficult time scheduling and preparing for meetings. Using Microsoft Live Meeting and Outlook, the company reduced meeting time by 60 percent.<sup>21</sup> Now employees schedule Web conferences directly using Microsoft Office Outlook. Documents are distributed to meeting participants who receive meeting requests through Outlook to attend the Web conferences. When it is time for a meeting, all participants click a URL in the meeting request and the link takes them to the Web-conferencing area.

### Software Suites and Integrated Software Packages

A **software suite** is a collection of single application programs packaged in a bundle. Software suites can include word processors, spreadsheets, database management systems, graphics programs, communications tools, organizers, and more. Some suites support the development of Web pages, note taking, and speech recognition, where 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 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's WordPerfect Office, Lotus SmartSuite, and Sun Microsystems's StarOffice are examples of popular general-purpose software suites for personal computer users. Microsoft Office has the largest market share. The Free Software Foundation offers software similar to Sun Microsystems's StarOffice that includes word processing, spreadsheet, database, presentation graphics, and e-mail applications for the Linux OS. OpenOffice is another Office suite for Linux. Wine, software designed for Linux and Unix, can run any Windows application, including those in Microsoft Office, on Linux, although some features might not work as well as a Microsoft OS. Each of these software suites includes a spreadsheet program, word processor, database program, and graphics package with the ability to move documents, data, and diagrams among them (see Table 4.6). Thus, a user can create a spreadsheet and then cut and paste that spreadsheet into a document created using the word processing application.

### software suite

A collection of single application programs packaged in a bundle.



**Table 4.6****Major Components of Leading Software Suites**

Personal Productivity Function	Microsoft Office	Lotus Symphony	Corel WordPerfect Office	Sun StarOffice	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	Keynote	Presentation
Database	Access		Paradox	Base		

More than a hundred million people worldwide use the Microsoft Office software suite, with Office 2007 representing the latest version of the productivity software. Office 2007 uses new file formats that are more compatible with Web standards. It also provides a revolutionary new interface, moving from menus and toolbars to a Ribbon with tabs. Office 2007 is available in seven editions: Professional, Standard, Home and Student, Small Business, Ultimate, Professional Plus, and Enterprise. Each edition includes a subset of 15 applications.

In addition to suites, some companies produce *integrated application packages* that contain several programs. For example, *Microsoft Works* is one program that contains basic word processing, 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. Some integrated packages cost about \$100.

Some companies are offering Web-based productivity software suites that require no installation, only a Web browser. Zoho, Google, and Thinkfree offer free online word processing, spreadsheet, presentation, and other software that require no installation on the PC. Documents created with the software can be stored on the Web server. Currently these online applications are not as powerful and robust as installed software such as Microsoft Office. However, it is likely that as the technology becomes more powerful, and network connection speeds increase, users will need to install less software on their own PCs and turn instead to using software online.

Microsoft has observed the trend towards Web-based software and is migrating its software towards the Web as well. Microsoft Windows Live provides several Web-based services such as a Live Search for searching the Web, Windows Live Messenger for instant messaging, Windows Live Hotmail for e-mail, and Windows Live OneCare for PC security. Windows Live Spaces provides Windows users with online storage for sharing files with others on the Web. Microsoft Office Live provides tools for sharing Office documents on the Web. The difference between Office Live and Google's applications is that Microsoft requires users to have its software installed on their PCs. Microsoft also provides Xbox Live for online multiplayer gaming.

### 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. Other exciting software packages have been developed for training and distance learning. University professors often believe that colleges and universities must invest in distance learning for their students. Using this type of software, some universities offer complete degree programs over the Internet. 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.

## Workgroup Application Software

**Workgroup application software** is designed to support teamwork, whether people are in the same location or dispersed around the world. 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 e-mail features. Also called *collaborative software*, the approach allows a team of managers to work on the same production problem, letting them share their ideas and work via connected computer systems. The “Three Cs” rule for successful implementation of groupware is summarized in Table 4.7.

Quality	Description
Convenient	If it's too hard to use, it's not used; it should be as easy to use as the telephone.
Content	It must provide a constant stream of rich, relevant, and personalized content.
Coverage	If it isn't easy to access, it might never be used.

**Table 4.7**

Ernst & Young's “Three Cs” Rule for Groupware

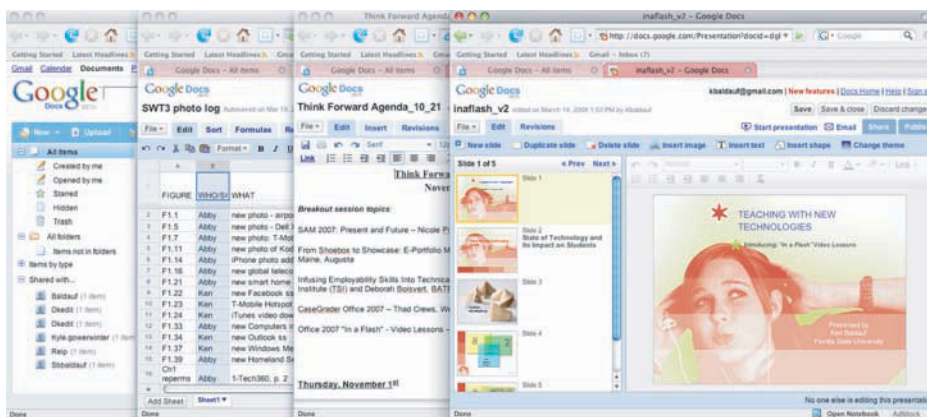
Examples of workgroup software include group scheduling software, electronic mail, and other software that enables people to share ideas. Lotus Notes from IBM, for example, lets companies use one software package and one user interface to integrate many business processes. Lotus Notes can allow a global team to work together from a common set of documents, have electronic discussions using threads of discussion, and schedule team meetings. As the program matured, Lotus added services to it and renamed it Domino (Lotus Notes is now the name of the e-mail package), and now an entire third-party market has emerged to build collaborative software based on Domino.

The Web-based software described in the previous section 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 (see Figure 4.18). This makes it convenient for several people to contribute to a document without concern for software compatibility or storage.

**Figure 4.18**

### Google's Online Applications

Google applications are designed to share documents, presentations, spreadsheets, calendars, and notes with specific users or everyone on the Web.



An increasing number of software applications are moving online to support group document and information sharing. Google applications let users share notes, calendars, documents, spreadsheets, and presentations. At *tadalists.com*, users can share to-do lists with others in a group. Microsoft offers Office Live Workspace for sharing documents, spreadsheets, and other Office files with Office users online. If you have digital information you wish to share, it is likely that some online service has been set up to allow you to put it online and control who can access it.

## Enterprise Application Software

Software that benefits an entire organization can also be developed or purchased. Some software vendors, such as SAP, specialize in developing software for enterprises. A fast-food chain, for example, might develop a materials ordering and distribution program to make sure that each of its franchises gets the necessary raw materials and supplies during the week. This program can be developed internally using staff and resources in the IS department or purchased from an external software company. Boeing and DaimlerChrysler use enterprise software to design new airplanes and automotive products. The software simulates the effectiveness and safety of designs, allowing the companies to save time and money compared to developing physical prototypes of airplanes and vehicles. Dunkin' Donuts, Baskin-Robbins, and Togo's, uses enterprise software to help it locate new stores. iSite from geoVue ([www.geovue.com](http://www.geovue.com)) is site-selection software that lets companies analyze factors to help determine the location of new stores.

One of the first enterprise applications was a payroll program for Lyons Bakeries in England, developed in 1954 on the Leo 1 computer. Table 4.8 lists some applications that can be addressed with enterprise software. Many organizations are moving to integrated enterprise software that supports supply chain management (movement of raw materials from suppliers through shipment of finished goods to customers), as shown in Figure 4.19.

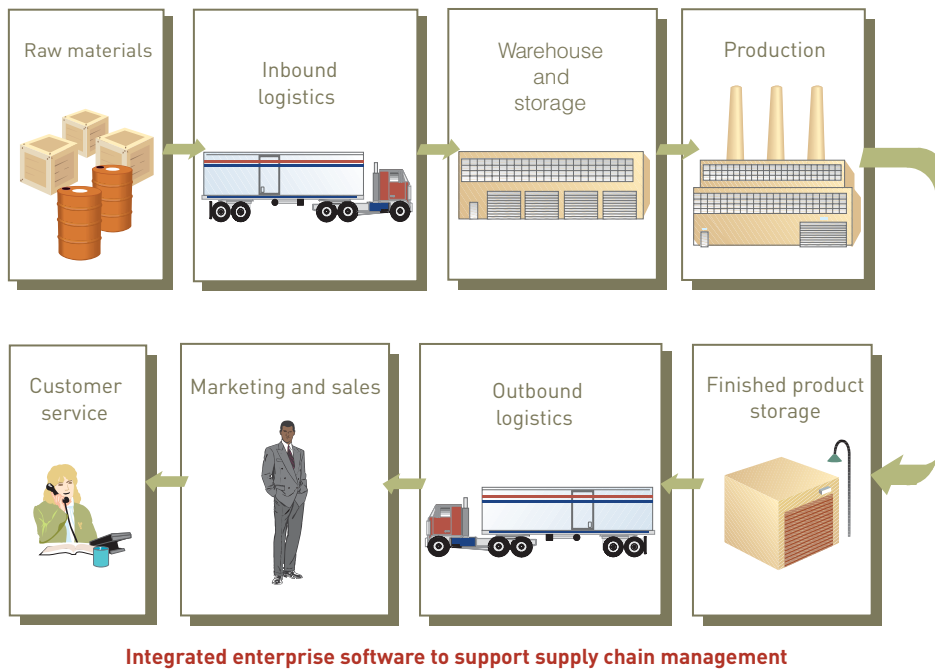
**Table 4.8**  
Examples of Enterprise  
Application Software

Type of Software	Description
Accounts receivable	Sales ordering
Accounts payable	Order entry
Airline industry operations	Payroll
Automatic teller systems	Human resource management
Cash-flow analysis	Check processing
Credit and charge card administration	Tax planning and preparation
Manufacturing control	Receiving
Distribution control	Restaurant management
General ledger	Retail operations
Stock and bond management	Invoicing
Savings and time deposits	Shipping
Inventory control	Fixed asset accounting

### Enterprise Resource Planning (ERP) Software

A set of integrated programs that manage a company's vital business operations for an entire multisite, global organization.

Organizations can no longer respond to market changes using nonintegrated information systems based on overnight processing of yesterday's business transactions, conflicting data models, and obsolete technology. Wal-Mart and many other companies have sophisticated information systems to speed processing and coordinate communications between stores and their main offices. Many corporations are turning to **enterprise resource planning (ERP)** software, a set of integrated programs that manage a company's vital business operations for an entire multisite, global organization. Thus, an ERP system must be able to support many legal entities, languages, and currencies. Although the scope can vary from vendor to vendor, most ERP systems provide integrated software to support manufacturing and finance. In addition to these core business processes, some ERP systems might support business functions such as human resources, sales, and distribution. The primary benefits of implementing ERP include eliminating inefficient systems, easing adoption of improved work processes, improving access to data for operational decision making, standardizing technology vendors

**Figure 4.19**

Use of Integrated Supply Chain Management Software

and equipment, and enabling supply chain management. Even small businesses can benefit from enterprise application software. Intuit's QuickBooks and Microsoft's Office Small Business Accounting are accounting and recording-keeping programs for small businesses and organizations.

## Application Software for Information, Decision Support, and Specialized Purposes

Specialized application software for information, decision support, and other purposes is available in every industry. Genetic researchers, for example, are using software to visualize and analyze the human genome. Music executives use decision support software to help pick the next hit song. Sophisticated decision support software is also being used to increase the cure rate for cancer by analyzing about 100 scans of a cancerous tumor to create a 3-D view of the tumor. Software can then consider thousands of angles and doses of radiation to determine the best program of radiation therapy. The software analysis takes only minutes, but the results can save years or decades of life for the patient. As you will see in future chapters, information, decision support, and specialized systems are used in businesses of all sizes and types to increase profits or reduce costs. But how are all these systems actually developed or built? The answer is through the use of programming languages, discussed next.

## PROGRAMMING LANGUAGES

Both OSs 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. IS professionals work with **programming languages**, which are sets of keywords, symbols, and rules for constructing statements by which people can communicate instructions to be executed by 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

### programming languages

Sets of keywords, symbols, and a system of rules for constructing statements by which humans can communicate instructions to be executed by a computer.

**syntax**  
A set of rules associated with a programming language.

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 that have special meaning. Each language also has its own set of rules, called the **syntax** of the language. The language syntax dictates how the symbols should be combined into statements capable of conveying meaningful instructions to the CPU. A rule that “Variable names must start with a letter” is an example. A variable is a quantity that can take on different values. Program variable names such as SALES, PAYRATE, and TOTAL follow the rule because they start with a letter, whereas variables such as %INTEREST, \$TOTAL, and #POUNDS do not.

The Evolution of Programming Languages

The desire to use the power of information processing efficiently in problem solving has pushed the development of newer programming languages. The evolution of programming languages is typically discussed in terms of generations of languages (see Table 4.9).

**Table 4.9**  
The 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
Beyond Fourth	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

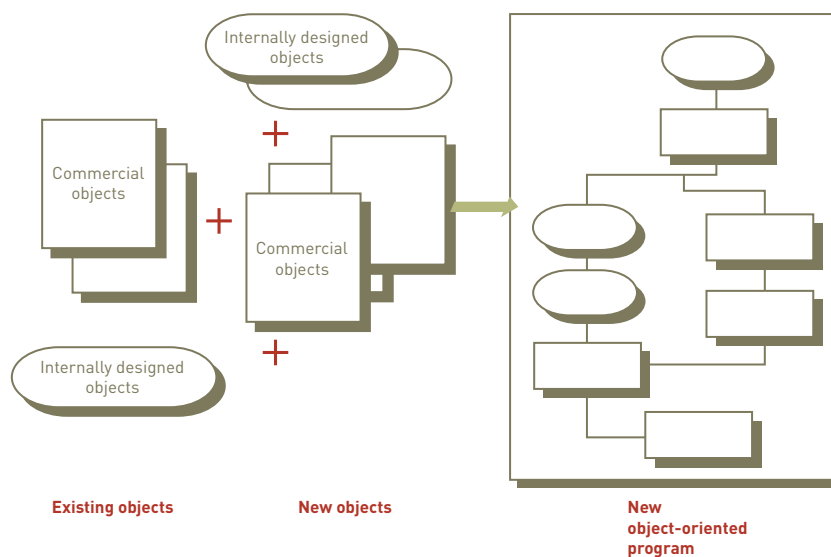
Today, programmers often use visual and object-oriented languages. In the future, they will likely be using artificial intelligence languages to a greater extent. In general, these languages are easier for nonprogrammers to use compared with older generation languages.

*Visual languages* use a graphical or visual interface for program development. Unlike earlier languages that depended on writing detailed programming statements, visual languages allow programmers to “drag and drop” programming elements and icons onto the computer screen. Many of these languages are used to develop Web applications. *Visual Basic* was one of the first visual programming languages. Microsoft Visual Studio is a set of object-oriented programming languages and tools to develop Windows and Web-based applications. You can develop applications that can range from a simple Web-based program for displaying your résumé to complex business applications that process customer orders, control inventory, and send out bills—using languages such as Visual Basic .NET, Visual C++ .NET, Visual C#, and Visual J#. C++ is a powerful and flexible programming language used mostly by computer systems professionals to develop applications. *Java* is an object-oriented programming language developed by Sun Microsystems that can run on any OS and on the Internet. Java can be used to develop complete applications or smaller applications, called *Java applets*. Many of these languages are also examples of object-oriented languages, which are discussed next.

The preceding 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*.



Building programs and applications 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 (see Figure 4.20). By combining existing program objects with new ones, programmers can easily and efficiently develop new object-oriented programs to accomplish organizational goals.


**Figure 4.20**

### Reusable Code in Object-Oriented Programming

By combining existing program objects with new ones, programmers can easily and efficiently develop new object-oriented programs to accomplish organizational goals. Note that these objects can be either commercially available or designed internally.

Programmers often start writing object-oriented programs by developing one or more user interfaces, usually in a Windows or Web environment. You can create programs to run in a Windows or Web environment by using forms to design and develop the type of interface you want. You can select and drag text boxes to add descriptions, buttons that can be clicked and executed, a list box that contains several choices that can be selected, and other input/output features. After creating the Windows interface, you can write programming code to convert tasks a user selects in the interface into actions the computer performs.

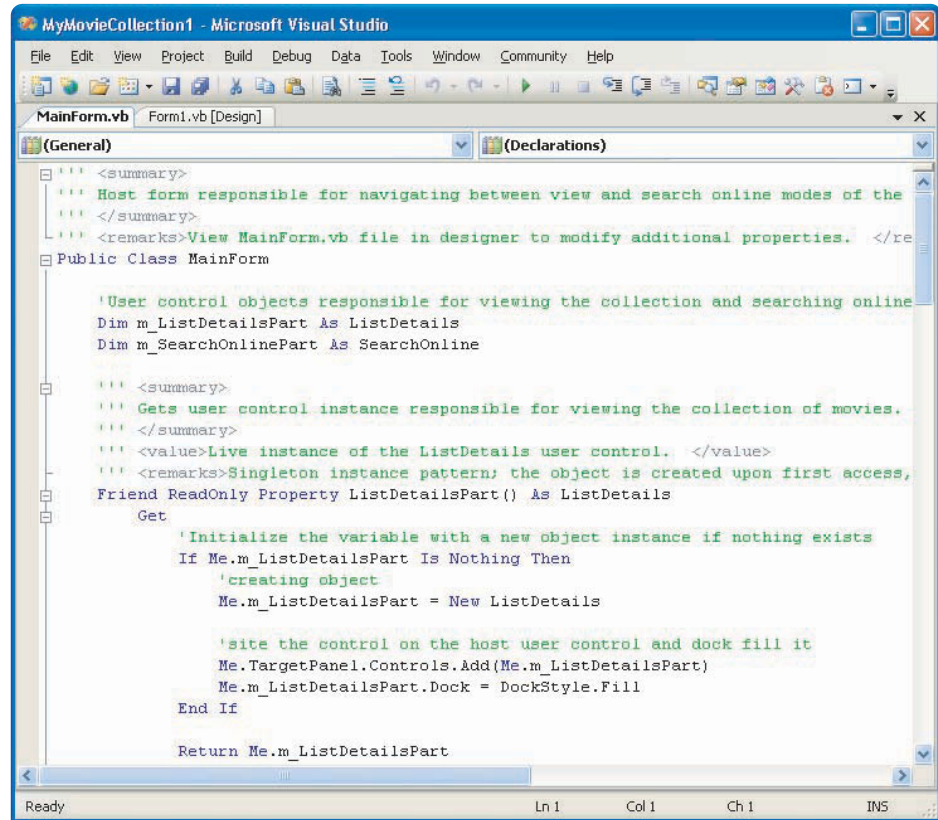
Some of the most popular object-oriented programming languages include Smalltalk, Visual Basic .NET, C++, and Java (see Figure 4.21). Some old languages, such as COBOL, have been modified to support the object-oriented approach. As mentioned earlier, Java is an Internet programming language from Sun Microsystems that can run on a variety of computers and OSs, including UNIX, Windows, and Macintosh OSs.

Object-oriented programs often use *methods*, which are instructions to perform a specific task in the program. The following instructions in C++ use a method named `ComputeArea` to compute the area of a rectangle, given the width and length.

```
// Method to Compute the Area of a Rectangle Given the Width and
// Length
double Rectangle::ComputeArea()
{
    return width * length;
}
// End of the ComputeArea Method
```

**Figure 4.21**

Microsoft Visual Basic



After they are developed as part of a C++ program, the instructions or method can be used in other programs to compute the area of a picture frame, a living room, a front lawn, or any other application that requires the area of a rectangle. Following are a few instructions in another C++ program that show how to use the ComputeArea method to compute the area of a picture frame.

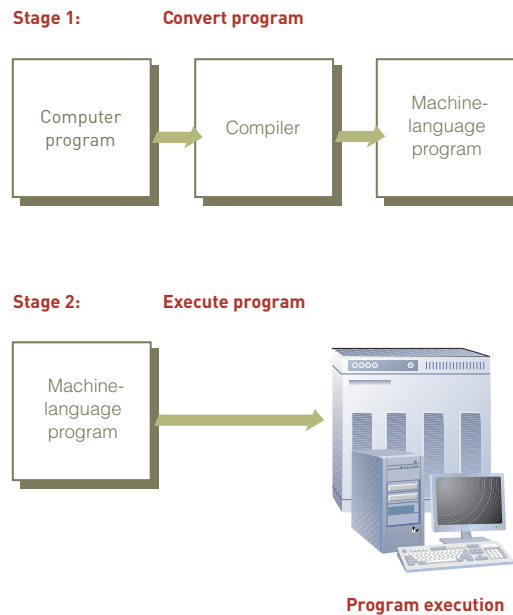
```
//Assign Data and Compute Area
frameObject -> SetDimensions (frameWidth, frameLength);
frameArea = frameObject -> ComputeArea();
```

Programming languages used to create artificial intelligence or expert systems applications are often called *fifth-generation languages (5GLs)*. FLEXPERT, for example, is an expert system used to perform plant layout and helps companies determine the best placement for equipment and manufacturing facilities. 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 consisting of binary digits, as shown in Figure 4.22. 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 consisting of binary digits.

**Figure 4.22****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 ISSUES AND TRENDS

Because software is such an important part of today's computer systems, issues such as software bugs, licensing, upgrades, and global software support have received increased attention. We highlight several major software issues and trends in this section: software bugs, copyright, software licensing, open-source software, shareware and public domain software, multiorganizational software development, software upgrades, and global software support.

### Software Bugs

A software bug is a defect in a computer program that keeps it from performing as it is designed to perform. Some software bugs are obvious and cause the program to terminate unexpectedly. Other bugs are subtler and allow errors to creep into your work. For example, a bug discovered in Microsoft Office Excel 2007 caused the equation  $850 \times 77.1$  to display 100,000 rather than the correct result of 65,535.<sup>22</sup> Computer and software vendors say that as long as people design and program hardware and software, bugs are inevitable. In fact, according to the Pentagon and the Software Engineering Institute at Carnegie Mellon University, there are typically 5 to 15 bugs in every 1,000 lines of code. 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 Web site for patches.
- Install the latest software updates.
- Before reporting a bug, make sure that you can re-create the circumstances under which it occurs.
- After you can re-create the bug, call the manufacturer's tech support line.
- Avoid buying the latest release of software for several months or a year until the software bugs have been discovered and removed.

### Copyrights and Licenses

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 is typical with many applications developed for personal computers.

**single-user license**

A software license that permits only one person to use the software, typically on only one computer.

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 without restrictions. Some software now requires that you *register* or *activate* it before it can be fully used. Registration and activation sometimes put software on your hard disk that monitors activities and changes your computer system.

When people purchase software, they don’t actually own the software, but rather are licensed to use the software on a computer. This is called a single-user license. A **single-user license** permits you to install the software on one computer, or sometimes two computers, used by one person. A single-user license does not allow you to copy and share the software with others. Table 4.10 describes different types of software licenses. Licenses that accommodate multiple users are usually provided at a discounted price.

**Table 4.10**  
Software Licenses

License	Description
Single-user license	Permits you to install the software on one computer, or sometimes two computers, used by one person.
Multuser license	Specifies the number of users allowed to use the software, and can be installed on each user’s computer. For example, a 20-user license can be installed on 20 computers for 20 users.
Concurrent-user license	Designed for network-distributed software, this license allows any number of users to use the software, but only a specific number of users to use it at the same time.
Site license	Permits the software to be used anywhere on a particular site, such as a college campus, by everyone on the site.

**open-source software**

Software that is freely available to anyone in a form that can be easily modified.

**Open-Source Software**

**Open-source software** is freely available to anyone in a form that can be easily modified. The Open Source Initiative (OSI) is a nonprofit corporation dedicated to the development and promotion of open-source software (see the OSI Web site at [www.opensource.org](http://www.opensource.org) for more information on the group’s efforts). Users can download the source code and build the software themselves, or the software developers can make executable versions available along with the source. Open-source software development is a collaborative process—developers around the world use the Internet to keep in close contact via e-mail and to download and submit new software. Major software changes can occur in days rather than weeks or months. Many open-source software packages are widely used, including the Linux OS; Free BSD, another OS; Apache, a popular Web server; Sendmail, a program that delivers e-mail for most systems on the Internet; and Perl, a programming language used to develop Internet application software. See Table 4.11 for some examples of open-source software.

Why would an organization run its business using software that’s free? Can something that’s given away over the Internet be stable or 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, by making a program’s source code readily available, users can fix any problems they discover. A fix is often available within hours of the problem’s discovery. Second, with the source code for a program 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. Of course, open-source software is usually much less expensive than traditional software that is purchased from a software vendor. The auditor of one state estimated that the cost savings using open-source software could be as high as \$10 million compared to developing software internally, when legal and project delays are included. Some companies are also starting to reveal their source code, including IBM, Microsoft, and others.

Software Type	Example
Operating system	Linux
Application software	Open Office
Database software	MySQL
Internet browser	Firefox
Photo editing	Gimp
Project management	OpenProj
Personal accounting	Grisbi
E-mail	Thunderbird

Table 4.11

Examples of Open-Source Software

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 that 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 toll-free support number or access its Web site. 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, C2Net for Apache, and Sendmail, Inc., for Sendmail. These companies offer high-quality, for-pay technical assistance.

## Shareware, Freeware, and Public Domain Software

Many software users are doing what they can to minimize software costs. Some are turning to **shareware** and **freeware**—software that is very inexpensive or free, usually for use in personal computers, but whose source code cannot be modified. Freeware can be used to perform a variety of tasks. StarOffice is a freeware office suite that contains word processor, spreadsheet, database, drawing, and presentation programs. PhotoPlus 6 is a photo-editing program, and Picasa is a photo-editing and management program. The Web site [www.SourceForge.net](http://www.SourceForge.net) is a resource for programmers to freely exchange programs and program code. It allows programmers to create, collaborate on, and evaluate program code. Over 80,000 programs are at various stages of completion.

Shareware might not be as powerful as commercial software, but it provides what some people need at a good price. In some cases, you can try the software before sending a nominal fee to the software developer. Some shareware and freeware is in the public domain, often called *public domain software*. This software is not protected by copyright laws and can be freely copied and used. Although shareware and freeware can be free or inexpensive to acquire, it can be more expensive to use and maintain over time compared with software that is purchased. If the software is hard to use and doesn't perform all the required functions, the cost of wasted time and lost productivity can be far greater than the cost of purchasing better software. Shareware, freeware, and public domain software is often not open source—that is, the source code is not available and cannot be modified.

### shareware and freeware

Software that is very inexpensive or free, but whose source code cannot be modified.



## Software Upgrades

Software companies revise their programs and sell new versions periodically. In some cases, the revised software offers new and valuable enhancements. In other cases, the software uses complex program code that offers little in terms of additional capabilities. In addition, revised software can contain bugs or errors. When software companies stop supporting older software versions or releases, some customers feel forced to upgrade to the newer software. Deciding whether to purchase the newest software can be a problem 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. Instead, they might upgrade to newer software only when it offers vital new features. Software upgrades usually cost much less than the original purchase price.

## Global Software Support

Large global companies have little trouble persuading vendors to sell them software licenses 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, company-wide 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 provide support for 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 license with the software vendor directly, but it then hands the global support contract to a third-party supplier. The supplier acts as a middleman between software vendor and user, often providing distribution, support, and invoicing. American Home Products Corporation handles global support for both Novell NetWare and Microsoft Office applications this way throughout the 145 countries in which it operates. American Home Products, a pharmaceutical and agricultural products company, negotiated the agreements directly with the vendors for both purchasing and maintenance, but fulfillment of the agreement is handled exclusively by Philadelphia-based Softsmart, an international supplier of software and services.

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 wiser consumers, and they can make better decisions.

## SUMMARY

### Principle

**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.

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, several popular OSs have been developed. These include several proprietary OSs used primarily on mainframes. MS-DOS is an early OS for IBM-compatibles. Older Windows OSs are GUIs used with DOS. Newer versions, such as Windows Vista and XP, are fully functional OSs that do not need DOS. Apple computers use proprietary OSs such as the Mac OS and Mac OS X. UNIX is a powerful OS that can be used on many computer system types and platforms, from personal computers to mainframe systems. UNIX makes it easy to move programs and data among computers or to

connect mainframes and personal computers to share resources. Linux is the kernel of an OS whose source code is freely available to everyone. Several variations of Linux are available, with sets of capabilities and applications to form a complete OS, for example, Red Hat Linux. z/OS and HP-UX are OSs for mainframe computers. Some OSs, such as Palm OS, Windows Mobile, Windows Embedded, Pocket PC, and variations of Linux, have been developed to support mobile communications and consumer appliances.

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, and monitor hardware and network performance. Middleware is software that allows different systems to communicate and transfer data back and forth. A service-oriented architecture (SOA) uses modular application services to allow users to interact with systems, and systems to interact with each other.

### Principle

**Organizations should not develop proprietary application software unless doing so will meet a compelling business need that can 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, and includes group scheduling software, electronic mail, and other software that enables people to share ideas. Enterprise software that benefits the entire organization can also be developed or purchased. Many organizations are turning to enterprise resource planning software, a set of integrated programs that manage a company's vital business operations for an entire multisite, global organization.

Three approaches to developing 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 will get software that more closely matches

its needs; by being involved with the development, the organization has further control over the results; and the organization has more flexibility in making changes. The disadvantages include the following: It is likely to take longer and cost more to develop, the in-house staff will be hard pressed to provide ongoing support and maintenance, and there is a greater risk that the software features will not work as expected or that other performance problems will occur.

Purchasing off-the-shelf software has many advantages. The initial cost is lower, there is a lower risk that the software will fail to work as expected, and the software is likely to be of higher quality than proprietary software. Some disadvantages are that the organization might pay for features it does not need, the software might lack important features requiring expensive customization, and the system might require process reengineering.

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 can provide 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. Use of ASPs reduces the need for many skilled IS staff members and also lowers 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.

Although hundreds of computer applications can help people at school, home, and work, the primary applications are word processing, spreadsheet analysis, database, graphics, and online services. A software suite, such as SmartSuite, WordPerfect, StarOffice, or Office, offers a collection of powerful programs.

## Principle

**Organizations should choose a programming language whose functional characteristics are appropriate for the task at hand, considering 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 languages.

Programming languages have changed since their initial development in the early 1950s. In the first generation,

computers were programmed in machine language, and the second generation of languages used assembly languages. The third generation consists of many high-level programming languages that use English-like statements and commands. They also must be converted to machine language by special software called a compiler, and include BASIC, COBOL, FORTRAN, and others. 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. Visual and object-oriented programming languages—such as Smalltalk, C++, and Java—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.

## Principle

**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.

Open-source software is software that is freely available to anyone in a form that can be easily modified. Open-source software development and maintenance is a collaborative process, with developers around the world using the Internet to keep in close contact via e-mail and to download and submit new software. Shareware and freeware can reduce the cost of software, but sometimes they might not be as powerful as commercial software. Also, their source code usually cannot be modified.

Multiorganizational software development is the process of extending software development beyond a single organization by finding others who share the same business problem and involving them in a common development effort.

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, company-wide systems. A common solution is outsourcing global support to one or more third-party software distributors.