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Кафедра иностранных языков №2

Readings in Computer Science
Teaching Aid for Computer Students

Методическая разработка
по развитию навыков технического чтения
на английском языке
для студентов 2-го курса ФКСиС и ФИТиУ

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Методическая разработка по развитию навыков
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Методическая разработка предназначена для студентов 1-2-го этапов обучения. Содержит оригинальные тексты по вычислительной технике. Цель разработки — развить навыки чтения, понимания и реферирования текстов, увеличить лексический словарь, а также развить навыки профессионально-ориентированной устной речи.

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СОДЕРЖАНИЕ

UNIT 1
Computer Literacy and Concepts

Key Terms

application software
assembler
assembly language
character
computer literacy
cyberphobia
database
desktop publishing
electronic spreadsheet
embedded computer
end user
general-purpose program
graphics software
hardware
high-level language
input
input device
IPOS cycle
mainframe computer
notebook computer
output
procedure
processing
prompt
saving
software
software package
special-purpose program
storage
system software
word processing

1. Read the text and explain the need for computer literacy in tomorrow's computer society.

The Need for Computer Literacy

A major technological revolution has both positive and negative effects. Because the computer revolution is so new, many effects are still to be discovered. But there's one effect you can count on—the effect on you and your future. Because computers have moved into society so rapidly and so completely, you need basic computer skills just to pursue your career goals and function effectively in society. In short, you need **computer literacy,** sufficient computer knowledge to prepare you for working and living in a computerized society.

For many people, computer literacy means simply knowing which key to press. That knowledge is important, but it isn't enough. You need to under-stand some fundamental concepts about how computer systems are set up and how they work. To see this point, think about cars. Assume that you have learned to drive and you can get from point A to point B. If you want to maintain your car and drive with maximum

safety, however, you must learn more. For example, does your car have an antilock braking system (ABS)? If so, in a sudden stop, the brake pedal normally vibrates. But some people do not know this fact. They think that something is wrong, and they release the brake pedal—resulting in crashes that could have been prevented. In the same way, lack of knowledge causes people to make mistakes using computers.

Lack of knowledge also causes some people to fear computers. We have even coined a term to describe this irrational fear: **cyberphobia.**

With knowledge, you will be able to learn more rapidly how to use computers effectively – tomorrow's computers as well as today's. You will quickly recognize tasks that can benefit from computer applications. You will know how to make wise choices when you select computer equipment. You will know how to gauge the gravity of the computer's potentially negative effects, such as its threat to jobs and individual privacy. And most of all, you will be prepared for full citizenship in a society that requires computer literacy for the best jobs and careers.

2. Read the text and say what a computer. What are the five elements of the computing process.

The Computer Defined

To many people, the word *computer* suggests "computation," and that word means "math," which scares some people. But this connection is misleading. Computers are not calculators, although you can turn a computer in to a calculator. In the simplest definition, a computer is an electronic device—a flexible machine that can manipulate data. Many of these manipulations have nothing to do with math. Computers are used by writers, television producers, musicians, poets, graphics illustrators, and scholars of medieval history!

Why are computers so flexible that physicists and poets feel equally at home using them? A computer is programmable; that is, what the computer does depends on the program the computer is using. (A program is a instructions telling the computer what to do.) A computer's **hardware** – the machine and its components—is designed to be as flexible as possible. By using computer programs, called **software,** you transform this flexible hardware into a tool for a specific purpose.

No matter which program a computer is using, the machine itself performs only four basic operations. The most widely accepted definition of the computer includes the following operations:

- **Input.** A computer accepts data that is provided by means of an **input device,** such as a keyboard.

- **Processing.** A computer performs operations on the data to transform it in some way.
- **Output.** A computer produces output on a device, such as a printer or monitor, that shows the results of processing operations.
- **Storage.** A computer stores the results of processing operations for future use.

This definition is often referred to as the **IPOS cycle.** The four steps of the IPOS cycle—input, processing, output, storage—don't have to occur in a rigid I-P-O-S sequence. Under the direction of a program, a computer uses the steps of this process when needed and as often as needed.

The use **of a personal computer,** a computer designed to meet an individual's computing needs, illustrates these four basic computer operations. You use the keyboard to input data. The computer's internal circuitry processes the data. You see the results (output) on the computer's **monitor**, and you can print these results on the printer. You can also store the results on the computer's internal disk or on a removable disk.

3. Read the text and disscuss the characteristics of computers that explain why they are so widely used.

The Computer: Its Uses

The purpose of the computer is to transform data into information. In this context, **data** means some kind of unorganized material that can be entered into the computer—a rough sketch that needs work, a first draft of an essay that needs revision or polishing, figures from a company's books, a list of names and addresses. What results from processing operations is **information,** data that has been made meaningful and useful.

This capability to process data can be used in a variety of ways. People have come up with some very interesting uses:

- Today's dairy farmers are using computers to optimize feeding times, resulting in gains of up to 30 percent in milk output. Dairy farmers produce as much milk today as they did 30 years ago, but with fewer cows, lower costs, and less pollution.
- *The Federalist Papers* are some of America's most important historical documents, but some of the articles weren't signed. Who wrote them? Using computers to analyze the writing styles of James Madison, Patrick Henry, and other known authors of the *Papers,* scholars have been able to identify the authors of the unsigned texts.
- A psychologist keeps a computer in the counseling room. At the touch of a key, the psychologist can search through references on a

computer disk for information relating to topics that come up during counseling sessions.

The Five Elements of the Computing

Process

Computers consist of hardware, the physical parts of the computer, and software, the programs that tell the computer what to do. Processing data into information (the computing process) involves more elements than just hardware and software, though. And all these elements must be organized so that each works smoothly and efficiently with the others. During the **computing process,** computers integrate the use of five key elements:

- Hardware
- Software
- Data
- People
- Procedures

The computing process, in short, includes everything and everyone necessary for the computer to perform a useful task.

4. Read the text and explain why computers are called digital devices and how they represent data.

Hardware

The term *hardware* refers to the physical parts of the computer. Computer hardware is versatile – what it does depends on the computer program you use.

The key to the computer's versatility is **memory.** You can think of memory as a temporary workspace. The computer's processor uses this workspace is a scratch pad during processing.

Many people confuse memory with storage. Memory is temporary. When you turn off the computer, everything in memory is lost. Storage is usually permanent. On most computers, storage also has far greater capacity than memory.

Understanding the distinction between memory and storage is essential. Some programs keep their output in memory. You must transfer the information to a storage device, such as a disk drive, if you want to keep the information permanently. If you switch off the computer without **saving this** information (transferring it to storage),

the information is lost. More than a few students have stayed up all night to finish a paper, only to lose all their work because they didn't understand this distinction.

The key to the computer's precision is the fact that it represents data digitally. Computers use binary digits, which are numbers using a base 2 number system rather than a decimal (or base 10) number system. A binary digit, commonly called a bit, has a value of either 0 (zero) or 1 (one). Eight bits are grouped together to represent a **character**—a letter, number, or special character. This group is called a **byte.** Many people use the terms *character* and *byte* to mean the same thing.

People talk about bytes when they talk about the capacity of computer memories and storage devices. Because one byte equals only one character, these devices must be capable of storing thousands, millions, or even billions of bytes. To describe these large capacities, the terms **kilobyte** (K), **megabyte** (M), and **gigabyte** (G) are used.

5. Read the text and explain the difference between hardware and software. Why do we need both? Describe the major types of general – purpose application programms.

Software

Software is the set of instructions (also called a program) that guides the hardware through its job.

Programming Languages

Software programs must be written in **programming languages**.

Programmers—people trained in the use of a programming language – write programs.

Before 1952, the only available programming language was **machine language**, now called a **low-level language**. A machine language is recognized by a given brand or design of computer processor. Machine language consists of nothing but the Os and Is with which the computer works. Machine language is difficult to learn, and early programs were few and short.

In 1952, a new low-level programming language called **assembly language** was introduced. In assembly language, programmers use short letter codes (such as RTJ) that stand for specific machine operations. A program called an **assembler** translates these codes into machine language so that the computer can carry out the instructions. Assembly language is easier than machine language, but by contemporary standards, assembly language is difficult to use. The programmer in assembly language must pay careful attention to how the machine works.

In the 1960s, high-level programming languages emerged. With a **high level language**, the programmer uses simple English words and familiar mathematical expressions. The programmer is free to

concentrate on the desired result—what the program is supposed to accomplish—rather than worry about the details of how the computer operates.

System and Application Software Packages

Today's complex computer programs, such as Microsoft Word (a word processing program), consist of many separate programs that are designed to run together. In recognition of this fact, people sometimes speak of **software packages**. When you buy Microsoft Word, you are actually buying a software package rather than a single program.

Based on the function of the package, software packages are divided into two categories: system software and application software. Computer literacy involves learning how to use both system software and one or more application programs.

Computers need **system software** to function. System software integrates the computer's hardware components and provides tools for day-to-day maintenance tasks, such as displaying a list of the files contained on a disk. MS-DOS, UNIX, Microsoft Windows 95, 98 and System 7 are well-known examples of system software.

Application software turns the computer into a tool for a specific task, such as writing. Not all application programs will prove useful to you. Some application programs are **special-purpose programs,** which perform a specific task for a single profession.

Other application programs are called **general-purpose programs.**

Millions of people use these programs for a variety of tasks. Commonly used general-purpose programs include the following:

- **Word processing.** More than 85 percent of the personal computers now in existence are equipped with a word processing program, which transforms the computer into a tool for creating, editing, proofing, printing, and storing text. Many of today's books originated in text typed into computers—including this one!
- **Desktop publishing.** In the past, newsletters and magazines were created through an expensive, tedious process called layout, in which someone cut and pasted photographs, borders, and text to create a pleasing design. With desktop publishing software and your computer, you can produce attractive results with a little special training. Community organizations everywhere are doing a better job of keeping in touch with their members, thanks to desktop publishing tools.
- **Electronic spreadsheet.** Businesses previously worked out budgets and made forecasts using accountant's paper and a calculator. Electronic spreadsheet programs enable you to type the headings and numbers into a computerized version of accountant's paper, but with a twist. You can hide formulas within the on-screen "paper." These formulas perform

computations with the data. The payoff is that you can change any number and immediately see the effect of the change. People use electronic spreadsheets for many purposes, not just business-related ones. In California, for example, a forest ranger uses an electronic spreadsheet to analyze data concerning endangered animal populations.

- **Database.** A database program creates an electronic version of a card file—and the program gives you the tools you need to organize this file (for example, by alphabetizing it) and to retrieve information. An eighth-grade English teacher, for instance, could create a database of interesting uses of language—and retrieve examples for use in class discussions.
- **Telecommunications software.** Do you want access to computer resources available elsewhere? Telecommunications software transforms a computer into a terminal, which can connect to a multiuser computer system by means of the telephone. Commercial multiuser systems enable you to join discussion groups, exchange mail with other users, make plane and hotel reservations, and obtain free software for your computer.
- **Graphics software.** Is there a public presentation in your future? If so, you need to learn how to use presentation graphics programs to create attractive charts and graphs that you can share with your audience.
- **Resource discovery software.** Currently, the latest wrinkle in application software is a set of tools for exploring the riches of the Internet, a global network of linked computer networks. Such tools as Archie, Gopher, and the World Wide Web help you find computer resources available on millions of publicly accessible computers throughout the globe.

6. Read the text and explain the difference between data and information. Why is information important?

Data

Computers transform data into information. What's the difference between these two terms? *Data* is the raw material; *information* is processed data. Data is the input to the processing; information is the output.

A useful model to describe the relationship between data and information is called the **systems model.** It shows that data goes into a process and information is then output.

Several characteristics distinguish useful information from data. The purpose of information is to help people make well-informed decisions, but what makes information useful? Information must be

relevant, timely, accurate, concise, and complete in order to be useful. Data must be accurate but doesn't need to be relevant, timely, or concise. Table 1 describes these characteristics.

Table 1 Characteristics of Useful Information

Relevant	Information applies to the current situation.
Timely	Information is up-to-date and available when it is needed.
Accurate	Data given to the computer and the output are correct in every detail.
Concise	Information is condensed into a usable length.
Complete	All important items are included.

7. Read the text and explain the relationship between computer professionals and other computer users.

People and Procedures

You may be surprised to learn that people are part of the computing process. Some computers, such as the computer chip that controls an automobile engine, function without human intervention. But even these computers were designed by people and occasionally require maintenance by people. Most computers require people, who are called **users** (or sometimes **end users).**

Some users progress beyond the basics of computer literacy. They learn the advanced features of application programs. With this knowledge, these users can customize an application program for a specific task. These knowledgeable people are called **power users.**

Computer professionals have taken intermediate and advanced courses about computers. These people apply their professional training to improve the performance, ease of use, and efficiency of computer systems. One kind of computer professional is the programmer, who creates new computer programs. Excellent career opportunities exist for students interested in becoming computer professionals

Procedures are the steps that you must follow to accomplish a specific computer-related task. Part of a user's computer literacy is knowing common procedures.

Chances are, you already know several computer procedures. For example, you have probably used an automated teller machine (ATM). Inside the ATM is a computer. In response to on-screen messages called **prompts,** you insert your card, enter your personal identification number

(PIN), and tell the machine how much money you want. You also follow computer procedures when you program your VCR or set the coffee pot to brew your coffee at 7:00 A.M. In this course, you will become familiar with many more computer procedures.

8. Read the text and make a list of the computer's advantages.

The Computer: Its Advantages

No matter where computers are found or how they are applied, they're used for input, processing, output, and storage. But computers wouldn't be worth the trouble without the following characteristics:

- They are *fast.* Many of today's computers can perform hundreds of millions of processing operations in one second.
- They are *reliable.* Today's computers may run day in and day but for years without failure.
- They are *accurate.* The computer's physical processing circuits rarely make errors. Computers make errors, of course, but they are almost always due to faulty programs or incorrect data input.
- They can *store massive amounts of information.* Today's personal computers can be equipped with disks capable of storing more than one billion characters (letters or numbers). That capacity is enough to store the complete works of William Shakespeare, an unabridged English dictionary, a 32-volume encyclopedia, a world atlas and almanac, dozens of computer programs, and all your written work from the third grade through graduate school—with room for more.
- They can *move information* very quickly from one place to another. Using an experimental connection that may soon play a role in the Information Superhighway, one computer can send the entire text of the *Encyclopedia Britannica* to another linked computer in less than one second.

People like to think of the computer as a useful tool. A computer-literate person knows that the computer is a tool for creating useful information that can be printed, communicated to others, and stored for future use.

Computers come in many sizes. **Supercomputers** are highly sophisticated computers that perform complex calculations very quickly; supercomputers are most often used for scientific research. **Mainframe computers** are large, expensive computers designed to meet a large organization's computing needs. **Minicomputers** are smaller than mainframes but still large enough to meet the computing needs of a medium-sized or small organization. Personal computers, or **microcomputers,** meet the computing needs of individuals. **Notebook computers** provide a personal computer's capabilities in a small,

lightweight, portable package. All around us are **embedded computers,** special-purpose computers that perform control functions in such devices as microwave ovens, fuel-injection systems, and wristwatches.

9. Read the text and discuss the computer's positive and negative effects on society.

Positive and Negative Effects

Computer literacy means learning fundamental computer concepts and application programs. Computer literacy means also recognizing both the positive and the negative consequences of computers in our society.

The positives are all around us. For example, a rescue squad has reduced its emergency response time by nearly 20 percent by using a custom-designed computer system that optimizes its operations. For some accident victims, the difference is literally a matter of life or death. Computers also ease your daily activities by brewing your coffee, printing your newspaper, and helping you write your letters and pay your bills.

But there are negatives too:

- Computers may pose a threat to personal privacy, because firms can so easily accumulate a detailed picture of an individual's buying habits.
- Computer manufacturing processes require the use of hazardous chemicals, which could endanger workers and pollute water supplies.
- Discarded computers are taking up too much room in our nation's landfills.
- Too much work at the computer can result in painful nerve injuries, such as carpal tunnel syndrome.
- Computer failures do occur—and if they occur in a critical system, such as the air traffic control system, lives may be endangered.
- Computers may displace workers by automating tasks that people used to perform or by enabling fewer workers to perform tasks more efficiently. Displaced workers may find jobs that pay substantially less—if they can find jobs at all.

Lesson Summary

- Computers have changed the way we view our lives. Understanding

the fundamental concepts of how computer systems are set up and how they work, as well as how to apply the computer to various tasks, contributes to computer literacy.

- Some people who are not computer literate have cyberphobia—a fear of computers.
- A computer is a tool that can manipulate data. You can use software (lists of instructions) to instruct computer hardware (the machine and its components) to do a variety of tasks that involve processing data.
- The cycle that the computer hardware and software follows is known as the IPOS cycle. Input is the data that goes into a process, supported by storage, where the input is converted into output.
- The computing process can be described in terms of five elements: hardware, software, data, people, and procedures.
- Hardware is the equipment—it includes storage and memory. Memory is temporary whereas storage is permanent.
- Hardware works with digital units. The digits are kept in binary form, with each binary digit (called a bit) being placed in either memory or storage.
- The characteristics of computers that give them their power are speed, reliability, accuracy, storage capacity, and the capability to move data quickly from one place to another.
- Hardware comes in various sizes, but the most common types are supercomputers, mainframes, minicomputers, microcomputers, and embedded microprocessors.
- Software, or programs, gives computers their flexibility. When a task is needed, the instructions for it are loaded into memory. When the task is completed, a different program can be loaded to do a different task.
- The basic language of the computer is machine language, but it is in binary form and extremely difficult to work with. Assembly languages were developed to simplify working with machine languages. High-level languages were developed to make programming available to most people.
- Software packages are of two types: system software, which works directly with the hardware to maintain the computer system; and application software, which accomplishes either a specific or a general task.
- General-purpose application software includes word processing, electronic spreadsheets, graphics, communications, and database programs.
- Data is input to the computer so that it can be transformed into information. To be useful, information must be relevant, timely, concise, accurate, and complete.

- People who use computers can be users (or end users), power users, or computer professionals. Whatever their role, people provide the direction for the hardware and software to process the data.
- Procedures are the steps that you take to have the computer do the necessary processing.
- Using computers has both positive and negative effects on our lives. Your goal is to take advantage of the positives and either reduce the negatives or deal with their results in the best way for you.

Lesson Review

Matching

In the blank next to each of the following terms or phrases, write the letter of the corresponding term or phrase.

1. Usually represents a character	a. cyberphobia
2. Permanent	b. hardware
3. Also called programs	c. software
4. Desktop publishing	d. microcomputer
5. Fear of computers	e. byte
6. Temporary storage	f. memory
7. MS-DOS	g. storage
8. Processed data	h. system software
9. A computer and its components	i. general-purpose software
10. Another name for a personal computer	j. information

Multiple Choice

Circle the letter of the correct choice for each of the following.

1. In the long run, what is the purpose of using computers?
   a. to produce reports
   b. to be able to get on the Internet
   c. to process data into information
   d. to be computer literate
2. What is computer literacy?
   a. the ability to understand the basic concepts of computers
   b. the ability to evaluate the positive and negative effects of computers
   c. the ability to use the computer as a tool to do appropriate tasks
   d. all of the above
3. Which of the following are the two parts of the computer system that must be present?

a. hardware and software
b. input and output
c. keyboard and printer
d. none of the above

4. Which cycle describes the computer's processing of data?
a. processing cycle
b. cyberphobia cycle
c. hardware cycle
d. IPOS cycle

5. The purpose of the computer is to process data into what?
a. useful data
b. information
c. reports
d. formulas

6. What are the five elements of computer processing?
a. hardware, software, information, word processing, and spreadsheets
b. hardware, programs, information, communications, and people
c. hardware, software, data, people, and procedures
d. input, processing, output, storage, and people

7. The difference between memory and storage is that ___ is temporary and ___ is permanent.
a. storage, memory
b. memory, storage
c. disk, storage
d. RAM, memory

8. Which of the following is not a characteristic of computers that makes them useful?
a. They are fast.
b. They can store massive amounts of data.
c. They are concise.
d. They are accurate.

9. How are software packages categorized?
a. special purpose and word processing
b. system software and application software
c. hardware and software
d. none of the above

10. What is the purpose of information?
a. to process into data
b. to be timely
c. to help people make decisions
d. all of the above

Completion

In the blank provided, write the correct answer for each of the followin

1. The irrational fear of computers is called ___.
2. A program is a list of ___ telling the hardware what to do.
3. The machine and its components are called ___.
4. Using memory to hold a program improves the ___ of the use of the computer.
5. A binary digit, commonly called a(n) ___ has a value of either zero or one.
6. When you discuss a computer's memory, a megabyte means a capacity of approximately one ___ bytes.

7. Computers designed to meet the computing needs of individuals are called ___.
8. A group of programs designed to work together to perform a task is called a software ___ .
9. Application programs that can be used to do many related tasks are called ___ programs.
10. When information is a usable length, it is said to be ___ .

Critical Thinking

Answer the following questions.

1. Describe the process of registering for a class in terms of the IPOS cycle.
2. Can cyberphobia affect you even if you don't suffer from it personally? If so, how? If not, why not?
3. What does becoming computer literate mean to you? How do you envision using the knowledge gained in this course?
4. Describe a negative consequence that computers could have on society. Suggest a way to correct this negative situation.
5. List three general-purpose application software packages and describe how you will be likely to use them in the next few years.

UNIT 2
The Historical Perspective

Key Terms

analytical engine
artificial intelligence
bug
debug
difference engine
graphical user interface (GUI)
IBM compatible
integrated circuit
local area network (LAN)
multiprogramming
parallel processing
punched card
stored-program concept
time-sharing
Turing machine
Turing test
very large scale integration (VLSI)
wide area network (WAN)

1. Read the text and identify key people and their contribution to the development of computers.

The First Computers

The idea of computing is as old as civilization itself—and maybe older. The first computing device could have been as simple as a set of stones used to represent bushels of wheat or herds of animals. The abacus illustrates how these ancient computers worked. Another counting device, "Napier's bones," was invented at the beginning of the 1600s by John Napier, a Scottish mathematician. When the bones were arranged properly, the user could read the numbers in adjacent columns to find the answer to a multiplication operation.

The first known automatic calculating machine was invented in France in 1642 by Blaise Pascal. Pascal's machine was the Pascaline, a mechanical calculator. To add and subtract, the Pascaline rotated wheels to register values and used a lever to perform the carrying operation from one wheel to another. In recognition of Pascal's contribution to the computing field, a computer programming language has been named for him. This language, **Pascal**, is often used to teach programming to beginning computer science majors.

The next significant improvement in calculating devices was made in 1673 by Gottfried Wilhelm von Leibniz. Leibniz invented a calculator that could add, subtract, multiply, and divide accurately. The calculator also performed a square root function, although not always accurately.

The first calculator with commercial prospects was known as the "arithmometer." It was developed by the Frenchman Charles Xavier Thomas (known as Charles of Colmar) and won a gold medal at the International Exhibition in London in 1862. The machine could add, subtract, multiply, divide, and calculate square roots with precision.

In the early nineteenth century, a French weaver named Joseph Marie Jacquard developed a loom that could be programmed. The loom used large cards with holes punched in them to control automatically the pattern that was woven into the material. The result was a thick, rich cloth with repetitive floral or geometric patterns. Jacquard patterns are still produced to this day.

The **punched cards** used in Jacquard's loom were adapted by others to serve as the primary form of computer input. Punched cards were used to enter both data and programs, until about twenty years ago.

Charles Babbage and the First Modern Computer Design

Charles Babbage created the first modern computer design. While Babbage was working on his doctorate, he had to solve many complex formulas, and he could not solve these problems manually in a reasonable

length of time. To solve the equations, Babbage began developing a steam-powered machine, which he called the **difference engine**.

Later, Babbage turned to planning a more ambitious device, the **analytical engine**. The machine was designed to use a farm of punched card similar to Jacquard's punched cards for data input. This device would have been a modern computer with a recognizable IPOS cycle (input, processing, output, and storage). Unfortunately, the technology of Babbage's time could not produce the parts required to complete the analytical engine.

Babbage worked on his plans for years with Augusta Ada Byron, the daughter of the famed poet Lord Byron. Augusta Ada, a brilliant mathematician, contributed greatly to Babbage's plans and can be considered the world's first female computer scientist and the first computer programmer. A programming language called Ada is named in her honor. And Charles Babbage has been recognized as "the father of the computer."

Hollerith and the Automated Census Bureau

The next major figure in the history of computing was Dr. Herman Hollerith, a statistician. Dr. Hollerith devised a plan to encode the answers to the census questions on punched cards. He also developed a punching device; an electronic, manually fed reader that could process fifty cards in a minute; and a sorting device. When the census was completed, Hollerith decided to perfect his punched-card equipment and market it. He founded the Tabulating Machine Company in 1896 to continue his work. In 1911, the Tabulating Machine Company merged with two other companies to form the Computing-Tabulating-Recording Company. The company was extremely successful. In 1924, management decided that a new name would better indicate the progressive nature of the firm, so the Computing-Tabulating-Recording Company became International Business Machines Corporation (IBM).

2. Read the text and speak on how computer technology has evolved and explain the main differences among generations of computers.

Toward Modern Computing

The first electronic computers were complex machines. The computer industry might never have developed without government support and funding. World War II provided a stimulus for governments to invest enough money in research to create powerful computers. The earliest computers, created during the war, were the exclusive possessions

of government and military organizations. Only in the 1950s it became business to produce and consume computers. And only in the 1960s it became obvious that a huge market existed for these machines.

Before the First Generation: Early Electronic Computers

In the late 1930s, the English mathematician Alan Turing wrote a paper describing all the capabilities and limitations of a hypothetical general computing machine that became known as the **Turing machine.**

In 1950, Turing published a paper entitled "Computing Machinery and Intelligence," in which he proposed the **Turing test** of artificial intelligence. Scientists still use this test as a standard.

In 1939 Professor John Atanasoff of Iowa State University and a graduate student named Clifford Berry built an electronic calculating machine that could solve systems of equations. Known as the ABC (Atanasoff Berry Computer), it was the first special purpose, electronic digital computer.

Soon after this, Dr. Howard Aiken of Harvard approached IBM. Aiken completed the Mark I computer in 1944. The Mark I was partly electronic and partly mechanical. It was huge and slow, taking 3 to 5 seconds to perform a single multiplication operation.

During World War II the military asked Dr. John Mauchly to develop a machine for military purpose. Mauchly worked with a graduate student, J. Presper Eckert, to build the device. Eckert and Mauchly met with Atanasoff and Berry and used their work as a reference. ENIAC (Electronic Numeric Integrator and Calculator) could do five multiplication operations in a second, which was much faster than the Mark I. However, ENIAC was difficult to use because every time it was used to solve a new problem, the staff had to rewire it completely to enter the new instructions. At a chance meeting, Eckert discussed these problems with John von Neumann. The result was von Neumann's solution to the problems Eckert described: the stored-program concept.

With the **stored-program concept,** the computer's program is stored in internal memory with the data. One key advantage of this technique is that the computer can easily go back to a previous instruction and repeat it. Most of the interesting tasks that today's computers perform stem from repeating certain actions over and over. Since then, all computers that have been sold commercially (beginning with UNIVAC) have used the stored-program concept.

The First Generation (1951 to 1959)

Until 1951, electronic computers were the exclusive possessions of scientists, engineers, and the military. Then ENIAC's creators, Mauchly and Eckert, formed a company to market a commercial version of their latest machine. Known as UNIVAC, this computer used IBM punched

cards for input. Mauchly and Eckert's company became the UNIVAC division of Sperry-Rand Corporation (later known as UNISYS).

The first generation of computers—usually dated from 1951 to 1959—used vacuum tubes. First generation computers were large and slow, and they produced lots of heat. The vacuum tubes failed frequently, so first-generation computers were "down" (not working) much of the time. But they caught the public's imagination. In newspapers and magazines, journalists wrote of "electronic brains" that would change the world.

Noting that a market existed for business computers, IBM announced its first commercial computer, the IBM 701, in 1953. IBM made a total of 19 of these computers. Large, slow, and expensive, these first computers requires special facilities and highly trained personnel.

First-generation computers were given instructions in machine language, which is composed of the numbers 0 and 1. All data and instructions came into the first-generation computers from punched cards. Computer secondary storage consisted of magnetic drums. It wasn't until 1957 that magnetic tape was introduced as a faster and more convenient secondary storage medium. A single tape could hold the contents of approximately 1,100 punched cards (about 21 pages of information).

The Second Generation (1959 to 1963)

A 1948 invention, the transistor, was to change the way computers were built, leading to the second generation of modern computer technology. Unlike vacuum tubes, transistors are small, require very little power, and run cool. And they're much more reliable. Because second-generation computers were created with transistors instead of vacuum tubes, these computers were faster, smaller, and more reliable than first-generation computers.

In the second generation, memory was composed of small magnetic cores strung on wire within the computer. For secondary storage, magnetic disks were developed, although magnetic tape was still commonly used.

Second-generation computers were easier to program than first-generation computers. The reason was the development of high-level languages, which are much easier for people to understand and work with than assembly languages. Also a high-level language makes it possible to use the same program on computers produced by different manufacturers.

Second-generation computers could communicate with each other over telephone lines, transmitting data from one location to another.

These second-generation computers had some problems. The input and output devices were extremely slow. Two different but equally important solutions solved this problem. Dr. Daniel Slotnick developed the

first solution. His computer, known as ILLIAC IV, was completed in 1964. ILLIAC IV was unique in that it had four control units; thus, ILLIAC IV could perform input, output, and math operations at the same time. ILLIAC IV was acknowledged as the first supercomputer, and Slotnick was granted a patent for **parallel processing.** More commonly known as multiprocessing (because there are multiple central processing units), parallel processing has been used on all supercomputers and numerous mainframe since ILLIAC IV.

A group of professors and students at Massachusetts Institute of Technology developed the second solution. They created a **multiprogramming** system that could concurrently process programs being run by different users.

The Third Generation (1963 to 1975)

In 1958, Jack St. Clair Kilby and Robert Noyce invented the first integrated circuit. **Integrated circuits** incorporate many transistors and electronic circuits on a single wafer or chip of silicon.The result was a computer that cost no more than first-generation computers but offered more memory and faster processing.

The first commercially available **minicomputer** was introduced in 1965. The computer could be accessed by users from different location in the same building (the implementation of **time-sharing).**

During this time, IBM released its 360 family of computers. The 360s were different sizes of mainframes based on the same machine language.

Another significant development of this generation was the launching of the first telecommunications satellite. Communications stations on the earth could transmit and receive data to and from the satellites, enabling worldwide communications between computer systems.

The Fourth Generation (1975 to Today)

In the early 1970s, an Intel Corporation engineer, Dr. Ted Hoff decided that he could create a tiny computer on a chip. The result was the Intel 4004, the world's first **microprocessor.** A microprocessor chip holds *on a single chip* the entire control unit and arithmetic-logic unit of a computer.

The creation of the microprocessor has changed the world. The techniques, called **very large scale integration** (**VLSI**), used to build microprocessors, enable chip companies to mass produce computer chips that contain hundreds of thousands, or even millions, of transistors.

Two young entrepreneurs, Steve Jobs and Steve Wozniak, dreamed of creating an "appliance computer." They wanted a microcomputer so simple that you could take it out of the box, plug it in, and use it. Jobs and Wozniak set up shop in a garage after selling a Volkswagen for $1,300 to raise the needed capital. They founded Apple Computer, Inc., in

April 1977. Its first product was the Apple I. And the Apple II was a huge success. With a key-board, monitor, floppy disk drive, and operating system, the Apple II was a complete microcomputer system. Apple Computer, Inc., became one of the leading forces in the microcomputer market. The introduction of the first electronic spreadsheet software, VisiCalc, in 1979 helped convince the world that these little microcomputers were more than toys.

In 1980, IBM decided that the microcomputer market was too promising to ignore and contracted with Microsoft Corporation to write an operating system for a new microcomputer. The IBM Personal Computer (PC), with a microprocessor chip made by Intel Corporation and a Microsoft operating system, was released in 1981. Because Microsoft and Intel were independent contractors, they were free to place their products on the open market. As a result, many different manufacturers produced microcomputers that are now known as **IBM compatibles.**

Fourth-generation technology is still going strong. Efforts to pack even more transistors on one chip have led to such developments as Intel's Pentium Pro microprocessor. It contains 5.5 million transistors—a far cry from the 2,250 transistors found in the first Intel chip.

Very high-level languages appeared during the fourth generation. A very high-level language is really a way of writing instructions for a complex application program. Most new languages are based on a concept known as object-oriented programming (OOP), which encourages programmers to reuse code by maintaining libraries of code segments.

Another fourth-generation development is the spread of high-speed computer networking, which enables computers to communicate and share data. Within organizations, **local area networks** (**LANs**) connect several dozen or even several hundred computers within a limited geographic area (one building or several buildings near each other). **Wide area networks** (**WANs**) provide global connections for today's computers.

2. Read the text and speak on the trends in the development of computers

Computer Technology Today

Today's microcomputer is smaller, faster, cheaper, and more powerful than ENIAC. Microcomputers are available in desktop, laptop, notebook, and palmtop models. The Christmas season of 1994 was notable for the computer industry because for the first time, the sales of microcomputers exceeded the sales of television sets. It has been estimated that by 2010, microcomputers will be as common as television sets.

Because of microcomputers, individuals who are not computer professionals are now the majority of users. To make computers more **user friendly**(easier to work with), companies developed graphical user interfaces. A **graphical user interface** (**GUI**) provides icons (pictures) and menus (lists of command choices) that users can select with a mouse. The first commercially marketed GUI, known as Finder, was introduced by Apple for the Macintosh in 1984. Microsoft has developed a similar GUI, known as Windows, that is popular on IBM-compatible microcomputers.

The microcomputer industry has been split between the Apple and IBM families of microcomputers since 1981. Historically, these two families could not use the same programs. This changed in 1991 when Apple, IBM, and Motorola entered into an agreement that has resulted in the development of microcomputers that can switch between a Macintosh mode and an IBM mode. Since 1992, all Apple Macintosh computers come equipped with the capability of reading IBM formatted floppy disks and executing programs written for IBM microcomputers. In late 1995, IBM released computers capable of reading Apple formatted floppy disks and running programs written for Apple computers. In 1996, IBM purchased license rights to the Apple Macintosh operating system. It is a matter of time before the two families become one.

A Fifth Generation?

Major changes are occurring in software as well as in hardware. According to experts, the trademark of the next generation will be artificial intelligence (AI). Computers that use artificial intelligence will have some attributes associated with human intelligence, such as the capabilities to decode and respond to natural language (a human language such as English), to reason and draw inferences, and to recognize patterns in sensory input.

The human drive to learn required innovations in equipment. Past inventions made future innovations possible. Innovations, from graphics capabilities to parallel processing, have filtered down from the supercomputers to the mainframes. Minicomputers and microcomputers capable of parallel processing are being perfected even as you read this. You can foresee the future of small computers by watching the developments in the larger machines.

Lesson Summary

- The history of calculating devices is important to understanding the development of computers. Charles Babbage designed the first computer. He is known as the "father of the computer."

- Herman Hollerith used punched cards to automate the U.S. Census Bureau. He later became one of the founders of IBM.
- ENIAC was invented by Eckert and Mauchly for the U.S. Department of Defense during World War II.
- First-generation computers were large, slow, and based on vacuum tube technology. They were programmed using machine language and assembly language.
- Second-generation computers were based on transistors and used a magnetic core for primary storage, with magnetic tape and disk as secondary storage. These computers were programmed using high-level languages.
- Multiprogramming is the capability of a computer to switch between programs requested by different users and to execute the programs concurrently.
- Multiprocessing is possible on a computer system that has more than one central processing unit. Each processor can execute a program, enabling simultaneous processing of programs.
- The invention of the integrated circuit enabled smaller computers to be invented. The minicomputers that were developed in the late 1960s can fit in a corner of a room.
- Fourth-generation computers are very small, from microcomputers to notebook computers to palmtop computers.

Lesson Review

Matching

In the blank next to each of the following terms or phrases, write the letter of the corresponding term or phrase.

1. Developed during the second generation of computers to make programs portable and easier to write
2. Founded IBM Corporation
3. Made computing affordable for small- and medium-sized businesses
4. Known as "the father of the computer"
5. Used as input to first- and second generation computers
6. Programs for the first-generation computers were written in this
7. Founded Apple Corporation
8. A single chip containing the control and arithmetic-logic units of a

computer

9. The main hardware component of first-generation computers

10. A chip that contains many transistors and electronic circuits

a. microprocessor
b. minicomputer
c. high-level language
d. machine language
e. Charles Babbage
f. vacuum tubes
g. punched cards
h. Jobs and Wozniak
i. Hollerith and Watson
j. integrated circuit

Multiple Choice

Which answer is correct for the following.

1. Which calculating device was used in ancient times?
   a. arithmometer
   b. computer
   c. stepped reckoner
   d. abacus
2. What characterizes first-generation computers?
   a. vacuum tubes and magnetic drum
   b. magnetic tape and transistors
   c. minicomputers
   d. none of the above
3. Which of the following is *not* true of computers as we progress from one generation to the next?
   a. Computer size decreased.
   b. Computer cost decreased.
   c. Speed of processing increased.
   d. Memory/storage capacities decreased.
4. What are Steve Jobs and Steve Wozniak known for?
   a. the first IBM-compatible computer
   b. the first communications satellite
   c. the first Apple computer
   d. the stored-program concept
5. Which of the following is true about GUIs?
   a. They make computers easier to use for nonprofessionals.
   b. They use icons and menus that users can select with a mouse.
   c. They were first introduced for the Macintosh by Apple Computer, Inc.
   d. all of the above
6. What is John von Neumann credited with?
   a. designing the first electronic computer
   b. automating the U.S. Census Bureau
   c. the stored-program concept
   d. inventing the microprocessor
7. What invention enabled developers to create microcomputers?
   a. integrated circuit
   b. transistor
   c. vacuum tube
   d. magnetic disk

8. What type of system concurrently processes programs submitted by different users?

a. multiprocessing
b. microcomputer
c. GUI
d. multiprogramming

9. Multiprogramming was developed by students and professors at which school?

a. Harvard
b. MIT
c. Cambridge
d. University of Pennsylvania

Completion

In the blank provided, write the correct answer for each of the following.

1. Joseph Jacquard used ___ to give instructions to an automated loom.
2. High-level language was introduced during the ___ computer generation.
3. ___ was the first computer programmer.
4. ___ and ___ built the first special-purpose electronic digital computer.
5. Sending data from one computer to another using telephone lines started during the ___ generation.
6. The "Silicon Valley" is located in ___.
7. The software industry started when computer manufacturers ___ their systems and started selling language translators separately.
8. The ___ was the first commercially available microcomputer.
9. Computer programs that are easy to learn to work with are called ___.
10. A(n) ___ holds the control unit and arithmetic-logic unit of a computer.

Review

Answer the following questions.

1. What major innovation of the nineteenth century used ideas similar to the programmable loom to aid in the census taking? Explain in what way the innovation was similar.
2. What major hardware technology characterized each of the four generations of computers?
3. What have you observed regarding the size, cost, and processing speed of computers throughout the four generations?
4. What is a GUI? Why is it valuable? Name two companies responsible for developing the first GUIs.
5. Who was Lady Augusta Byron?
6. What is Herman Hollerith remembered for?
7. What is the Turing test?
8. Explain the stored-program concept.
9. What are two major families of microcomputers?
10. Why were Apple microcomputers on the market for so long before any

compatibles appeared, even though IBM compatibles appeared almost immediately?

Critical Thinking

Answer the following questions.

1. Do you believe that the fifth generation of computers has a already started? If not, why? If so, what innovation do you believe marked the beginning?
2. In what way were computers that used the stored-program concept different from earlier computers that did not?
3. What might have been the immediate and long-range consequences if Babbage's difference engine and analytical engine had been successfully produced?
4. Provide two examples of how artificial intelligence might be used in the future to improve the quality of living for people.

UNIT 3
Processing and Memory

Key Terms

adapter
address/data bus
ASCII
bus width
cache/virtual memory
central processing unit (CPU)
compatible
CISC
even/odd parity
expansion card
numeric coprocessor
parallel/serial port
peripheral device
random – access memory (RAM)
read – only memory (ROM)
ROM BIOS chip
software emulator
superscalar architecture
volatile

1. Read the text and explain why more than one coding method (ASCII and EBCDIC) used on computer.

Processing - Data Representation

Computers represent data in digital form; computers treat everything, even text, numerically. Computers can operate in only two states: on and off. The on state is represented by 1; the off state, by 0. Computers work with data that has been encoded using nothing but the

binary digits 0 and 1. These are the only digits in the binary, or base 2, number system used by computers.

Binary digits, also called **bits,** can be grouped to form letters, numbers, or special symbols. To represent the numbers 0 through 9 and the letters *a* through z and *A* through Z, computer designers have created coding systems consisting of several hundred standard codes. In one code, for instance, the binary number 01000001 stands for the letter *A*.

There are two competing coding standards. Most supercomputers and mainframe computers use a code called Extended Binary Coded Decimal Interchange Code **(EBCDIC).** Almost all smaller computers, including minicomputers and personal computers, use the American Standard Code for Information Interchange (ASCII). ANSI, a superset of ASCII, is the basis of the code used in Microsoft Windows. Some application programs attach special meanings to certain ASCII codes. These codes are used for designated purposes, such as formatting (for example, boldface or italic). As a result, one program often cannot read data created in another program unless the receiving program has the capability to translate the other program's codes.

Originally, ASCII used a seven-bit system and EBCDIC used a six-bit system, but those systems didn't allow computers to represent enough characters. Today, both ASCII and EBCDIC use an eight-bit coding system. This eight-bit group is known as a **byte,** or a character. Most computers are designed to add a ninth bit to each character's code. This extra bit, a **parity bit,** provides a way to check for memory or data communication errors. These errors can occur if a computer transfers a character incorrectly. For example, a speck of dust or smoke on a disk can cause the computer to interpret a 0 as a 1, or vice versa.

Computers use odd parity or even parity. The computer counts the number of 1s in each byte and records a 1 or a 0 as the parity bit, whichever is necessary to equal an odd or an even number of 1s. (The word *parity* means "equality.") In **odd parity,** the computer sets a 1 bit if the sum of the other 1 bits is an even number. In **even parity,** the computer sets a 0 bit if the sum of the other 1 bits is an even number. The parity bit is extremely important when two computers exchange information. To interpret the incoming information properly, each computer needs to know whether the other computer is using even parity or odd parity.

2. Read through the text and describe two parts of the CPU. Make a list of the key points of any processor.

The Central Processing Unit

No other single element of a computer determines its overall performance as much as the **central processing unit** (CPU). The CPU is composed of two parts: control unit and arithmetic-logic unit.

The control unit coordinates and controls all the other parts of the computer system. The control unit even oversees the operations of the input and output devices. The **arithmetic-logic unit** does the actual processing by performing mathematical operations and logical operations, such as making comparisons. In a **microprocessor,** the control unit and the arithmetic-logic unit are mounted on a single silicon chip.

Large computer systems, as well as newer workstations and network servers, frequently contain more than one central processing unit. Multiple CPUs enable the computer to execute more than one instruction, or process more than one program, at the same time. This capability is known as **multiprocessing.**

Here are some key points you should know about processors:

- Software must be written in accordance with particular CPU's requirements. For this reason, programs written for one processor may not be compatible with a processor that is designed differently.
- Some CPUs process data much more quickly than others. You should learn how to evaluate a given processor's speed. To do this, you need to understand how the data bus width and system clock speed affect performance.
- The width of a CPU's address bus determines the maximum amount of memory it can use.
- The performance of most CPUs can be improved through the use of a coprocessor, a second processing chip that handles numeric or graphics computations.

3. Read the text and explain why microprocessor manufacturers must carefully consider compatibility?

Compatibility

Every processor has its own unique instruction set. An **instruction set** is a list of the specific instructions that tell the CPU what to do. The machine language designed for a specific CPU must be designed to work with the CPU's instruction set.

Because each processor has a unique instruction set, programs devised for one computer will not run on another (with two exceptions, discussed shortly). Programs must be written using instructions recognized by that CPU. For example, a program written for the Apple Macintosh will not run on an IBM PC. A program that can run on a given

computer is **compatible** with that computer's processor. Or you can say that a program is a **native application** for a given CPU design.

One exception to the rule that a program written for one brand of processor will not run on another involves a program called a **software emulator,** which can make one CPU "pretend" to be another. For example, the Apple Macintosh can emulate an IBM PC and run IBM PC programs. This emulation, though, brings a severe performance penalty. IBM PC programs run very slowly on a Macintosh. The second exception is to have programs written for a particular operating system and then have the operating system tailored to fit the CPU. One example of this approach is Windows NT.

Microprocessor manufacturers must carefully consider compatibility when introducing new models. In particular, manufacturers must decide whether to make the new chip downwardly compatible with previous models. A **downwardly compatible** chip can run the programs designed to run with the earlier chip(s). To introduce a microprocessor that is not downwardly compatible with previous models is very risky. People may not buy a computer that cannot run the programs they already own. Manufacturers learned this lesson with early mainframe computers.

For this reason, the microprocessors used in today's personal computers are descendants of older microprocessor designs. Two brands predominate: Intel and Motorola (although Digital Equipment Corporation is also producing some impressive microprocessors). Intel microprocessors, including the Pentium chip, are downwardly compatible with chips dating all the way back to Ted Hoff's 4004, the world's first microprocessor. The Motorola 68040 series microprocessor is downwardly compatible with the 68000 (dating from the early 1980s), the 68020, and the 68030.

CPU performance is evaluated by the number of operations that the processor can carry out in one second. Today's fastest processors can carry out many millions of operations per second! A microprocessor's speed is determined by two major factors: bus width and clock speed.

4. Read the text and describe the relation between word size and the bus width on a computer. Explain the difference between open and closed bus systems?

Data Bus

The first element that determines a CPU's speed is its data bus width, measured in bits (8, 16, 32, or 64). **Bus width** is what people are talking about when they say, "That's a 16-bit computer" or "That's a 32-bit computer." The number of bits in the bus determines the number of

bits that the computer can work with at a time; this number is the computer's **word** size. A 16-bit computer works with a 16-bit word, while a 32-bit computer works with a 32-bit word.

What does bus width mean? The control unit and arithmetic-logic unit — as well as all the components of the computer — are connected by a bus, which is a "highway" of parallel wires. The bus is a pathway for the electronic impulses that form bytes. **A data bus** connects the CPU and memory and provides a pathway to the computer's peripherals. A microprocessor has both an internal data bus and an external data bus. Sometimes the internal data bus is wider than the external data bus. The internal data bus operates only within the microprocessor itself; the external bus regulates communication with the rest of the computer. For example, the CPU used in the original IBM PC had a 16-bit internal data bus and an 8-bit external data bus. The use of a narrower external bus enables designers to use inexpensive, existing peripherals, such as disk drives and memory chips. However, this design is a compromise that results in a substantial performance penalty.

There are two types of bus systems: open and closed. An **open bus system**

has expansion slots on the motherboard. To add a new peripheral, a board must be plugged into an expansion slot, and the system must be instructed to accept the new device. A **closed bus system** comes with established ports into which cables attached to peripheral devices can be plugged.

5. Read the text and briefly discuss one of the factors that determine the speed of a computer.

System Clock

Bus width is not the only design factor that affects a computer's speed. The **system clock** regulates the CPU's processing functions by emitting a pulse at regular intervals. The **clock speed** is the number of times that the system clock pulses in one second. Clock speed is usually measured in millions of pulses, or cycles. One million cycles is a **megahertz.**

Clock speed alone is not an adequate gauge of a microprocessor's performance. A 32-bit chip can process data much more rapidly than a chip hobbled by a 16-bit external data bus, even if the clock speed is the same. The number of operations per clock tick, or cycle, also affects performance. Most computers perform one operation per cycle. The Pentium and Pentium Pro chips, however, use a superscalar architecture that permits more than one instruction to be executed each clock tick.

6. Read the text and describe how the address bus works.

Address Bus

Like a post office box at the post office, every storage location in the computer's memory has a unique address. The address for the location does not change, but the data stored there can change. (Again using the mailing address analogy, the street address for a house doesn't change even though different people may move in and out of the house.) The width of the CPU's **address bus** — a set of wires running from the CPU to the memory — determines the maximum number of storage locations.

7. Read the text and compare advantages and disadvantages of both types (CISC and RISC).

CISC and RISC

Another aspect of microprocessor design that you should be aware of is the distinction between CISC and RISC. Each has advantages and disadvantages. CISC stands for **complex instruction set computer.** A CISC chip, such as the Motorola 68040 or the Intel Pentium, provides programmers with many instructions, and the processing circuitry includes many special-purpose circuits that carry out these instructions at high speed. Because the chip provides so many processing tools, CISC designs make the programmer's job easier. CISC chips, however, are complex and expensive to produce, and they run hot because they consume so much current.

RISC stands for **reduced instruction set computer.** A RISC chip offers a "bare bones" instruction set. For this reason, RISC chips are less complex, less expensive to produce, and more efficient in power usage. The drawback of the RISC design is that the computer must combine or repeat operations to complete many processing operations. (For example, you can eliminate multiplication circuitry by repeated addition.) RISC chips also place extra demands on programmers, who must consider how to get complex results by combining simple instructions. But careful tests show that this design results in faster processing than the CISC chips. An example of a RISC chip (with certain CISC compromises) is the PowerPC processor, which was developed jointly by Apple, IBM, and Motorola.

Computer designers argue about which design is best. CISC chips are still in production because so many people use CISC software. (RISC chips can run CISC programs only under software emulation, which slows performance.) RISC chips, such as the PowerPC, may become popular if

enough native applications become available. Even so, the distinction between CISC and RISC may become meaningless. CISC manufacturers are employing many RISC design features that enable the chips to carry out more than one instruction at a time. These features include **superscalar architecture** (a design that enables the computer to process more than one instruction at a time), **pipelining** (a design that provides two or more processing pathways that can be used simultaneously), and **branch prediction** (a module that tries to predict the most effective way to route an instruction through the microprocessor). In the meantime, RISC manufacturers are finding that they must include some CISC design components to ensure compatibility.

8. Read the text and explain the purpose of a numeric coprocessor.

Numeric Coprocessor

For applications requiring intensive computation, such as spreadsheets, system performance can be enhanced by including a **numeric coprocessor.** Numeric coprocessors enable computers to perform mathematical operations faster. Until recently, numeric coprocessors were separate chips that could be added to a computer system as an option. Increasingly, numeric coprocessing circuitry is included in the microprocessor design.

All this information should help you understand some of the specifications of microprocessors. The distinctions among the Intel 486, Pentium, and Pentium Pro chips are much clearer when you understand the terminology. The 486DX chip operates at a maximum clock speed of 100 megahertz (the 486DX4 - 100) and has a 32-bit architecture (internal data bus, external data bus, and address bus.) The Pentium chip has a 32-bit internal data bus and address bus but also has a 64-bit external data bus. The Pentium Pro has clock speeds up to 200MHz.

9. Read the information about 3 main types of chips and list similarities and differences between them. What are the most frequently used chips in our country?

New Processor Chips

More than anything else, the microprocessor determines the computer's overall performance. Microprocessor chips produced by Intel, Motorola, and Digital Equipment Corporation (DEC) are primary movers

in today's computer industry. And the industry has been moving quickly. The newest chip on the market today will probably be outdated next year!

Intel Chips

Most IBM and IBM-compatible microcomputers use microprocessor chips made by Intel. The 486 chips that were considered standard entry-level systems in the early and mid-1990s are now rarely seen. Today, the minimum configuration of most Intel machines includes some form of the Pentium chip.

The original Pentium chip, the hot new item of 1993-94 (maximum speed 200MHz) is in the twilight of its career. At a minimum, new computers will implement the Intel Pentium MMX with extensions to improve graphics and audio in multimedia applications written for it. This chip is available at 166, 200, and 233MHz. As newer, faster chips are released, on-line trade journals are becoming the best and most efficient way to keep up with changing industry standards.

The Pentium Pro (or 80686) Intel chip was originally announced at Comdex in November 1995. The Pentium Pro was the first of the Intel chips designed to be used in a multiprocessor system. Several years ago at the top of the line was the Pentium II, which essentially combines Pentium Pro architecture with MMX extensions. The Pentium II crams 7.5 million transistors onto the chip, compared to 5.5 million for the Pentium Pro and 4.5 million on the Pentium MMX. It was initially released, in May 1997, at 233, 266, and 300MHz. The beginning of 1998 brought a 333MHz version. This Pentium II was a substantial improvement over the first crop because it reduced the size of the circuitry from 0.33 microns to 0.25 microns. (By comparison, a human hair averages 75 microns.) The smaller size reduced the distance electrical signals needed to travel. It also required less power and, therefore, produced less heat.

Amazingly, still newer and faster chips are being designed. New chips is being developed by Intel in cooperation with Hewlett-Packard at a research facility in Sweden. The IntelP7/HPPA9000 is a 64-bit RISC chip. (The *PA* in the code stands for precision architecture.) Its 0.18 micron technology allows it to carry at least 10 million transistors and run at speeds upward of 500MHz.

Motorola Chips

The Macintosh computer by Apple uses Motorola 68000 series microprocessors. The Motorola 68040 performs in a similar way to the Intel 486 chips. Introduced in 1989, this chip runs at 25MHz and uses a 32-bit word. The 68040V is a comparable chip that includes some energy-

saving features and was designed specifically for the PowerBook laptop computer. The newer Motorola 68060, introduced in 1994, is quicker than the 68040, operating at 66MHz.

Power Macintoshes use PowerPC chips jointly designed by Motorola, IBM, and Apple Computer. In Power Macintoshes, the PowerPC runs software designed for 68000 series microprocessors by using emulation. The more powerful Power Macintoshes, such as the 7101 and 8101 models, can run Microsoft Windows software by using a different emulation program. However, there is a performance penalty when emulation is used.

The most widely used PowerPC chip is the 603e, which was designed specifically for use on laptops but works equally well on a desktop computer. The 603e is reasonably priced and is available in either 100MHz or 120MHz speed with a 32-bit word. The PowerPC 604, introduced in 1994, executes four instructions per cycle. With a speed of 133MHz, this is a fast, 32-bit processor. The PowerPC 620 appeared in 1995. This is the most ambitious PowerPC chip, offering full 64-bit processing capabilities and performing twice as fast as earlier PowerPC models. The 620 is designed primarily for technical and scientific workstations or for network servers.

Digital Equipment Corporation Chips

The Digital Equipment Corporation (DEC) Alpha microprocessor is a versatile RISC chip that has been used in super-minicomputers, mainframes, and supercomputers. The Alpha family of chips are all 64-bit processors that do not support 8- or 16-bit operations.

The new family of computers, based on the Alpha 21164 processor, is designed primarily for use in a client/server environment. The Digital AlphaServer 1000 with four 266MHz Alpha 21164 processors, for example, is priced beginning at $16,000 and can go as high as $250,000, depending on primary memory size and potential peripheral configuration. The Alpha 21164 has been acknowledged as the world's fastest — and first — billion instructions per second (BIPS) processor.

10. Read the information about three main types of computer memory. Compare ROM and RAM with respect to their purpose and accessibility. How does cache memory help programs execute faster? What are the differences in ROM, PROM, EPROM and EEPROM?

Memory

Computers use memory as a "scratch pad" to hold the programs and data in use by the CPU. Most computers have several types of memory:

RAM, virtual memory, cache memory, and ROM. The following sections explain these terms.

RAM (Random-Access Memory)

No processor could function without high-speed memory, where the processor can store the programs and data it is using. Memory has many different names. It is called **random-access memory** — or just RAM — as well as **primary memory.** And sometimes, just to confuse things further, memory is called primary storage. This storage is in contrast to storage devices that are referred to as secondary storage, such as disks.

Generally speaking, the more memory, the better. For today's Microsoft Windows and Macintosh applications, 8M of RAM is the absolute minimum, and 16M is much better. Many programs run much more quickly with 16M, which is large enough to enable most of the program's instructions to be kept in memory. With 8M, the program must access instructions from secondary storage, which is much slower.

With most personal computers, the computer's motherboard is designed so that you can easily add more memory — you just add **memory chips.** Most memory chips are now mounted on boards, and all you need to do is to plug the board into a slot on the motherboard. Adding more memory chips may be necessary to run large or graphics-intensive applications.

Larger computers have greater memory requirements because they usually run more than one program at a time. (The Cray-4 supercomputer comes standard with 256M of RAM; the DEC AXP/150 minicomputer has 128M of RAM standard.) This capability to run many programs submitted by different users is known as multiprogramming. In **multiprogramming,** memory is divided and then allocated to the programs being processed concurrently.

Some CPUs are designed to use **virtual memory** to run very large programs or two or more smaller programs, without running out of memory. Virtual memory systems divide large programs into smaller pieces and enable the computer to use free hard disk space as an extension of RAM. The computer will "swap" portions of the program between the hard drive and RAM as they are needed. Virtual memory can enable a computer with 4M of RAM to run a program that requires 6M.

Random-access memory is fast, but it has one drawback; it is **volatile** — which is a fancy way of saying that all the data disappears if the power fails. Nonvolatile media, such as disks, tapes, and CD-ROMs, are needed to store programs and data when the power is switched off.

Cache Memory

When designing a computer, an engineer can include some options

that make the machine run much faster. One of these options is cache memory. Storing instructions and data in cache memory can minimize the number of times that the computer needs to access secondary storage. **Cache memory** (pronounced "cash" memory) is a specialized chip used with the computer's memory. Cache chips are faster and more expensive than regular RAM chips. The computer stores the most frequently used instructions and data in cache. Cache has a relatively small storage capacity but can significantly increase the system's speed.

ROM (Read-Only Memory)

If everything in RAM is erased when the power is turned off, how does the computer start again? The answer is **read-only memory (ROM).** The instructions to start the computer are stored in read-only memory chips, which are not volatile. Read-only memory chips are manufactured with instructions stored permanently on them. The instructions to start the computer are on a special chip known as a **ROM BIOS (Basic Input/Output System) chip.** Some ROM chips are manufactured with instructions that are appropriate for a specific end user. For example, NASA has different needs than a school has. These specially programmed ROM chips are **PROM(Programmable Read-Only Memory) chips.** Once the chip is programmed, the contents cannot be altered. Newer chips, **EPROM (Erasable PROM) chips,** can be removed from the computer, erased using a special device, and reprogrammed. The newest type of ROM chips, **EEPROM (Electrically Erasable PROM) chips,** can be altered electrically using special programs, without being removed from the computer.

11. Read the text and explain the purpose of a port in a computer system.

The Motherboard

In a microcomputer, all the components are located on the **motherboard,** which is a large circuit board. (Some people prefer to use the term *mainboard.)* In addition to housing the CPU, memory, and coprocessor chips, the motherboard also has expansion slots designed for expansion cards. An **expansion card,** also called an **adapter,** is a circuit board that provides additional capabilities for the computer. Expansion cards are available for many different purposes. One type of expansion card controls a monitor, another expansion card controls a mouse, and still another provides an internal fax modem.

Also found on the motherboard are one or more **ports,** which enable the computer to communicate with **peripheral devices,** such as printers, modems, and scanners. Most personal computers have **parallel**

ports (commonly used for printers) and **serial ports** (commonly used for modems). A **modem** is an accessory that enables your computer to communicate with another computer through a telephone.

New motherboards developed by Intel for network servers have chip sets with built-in management features to help guard against system failure. These chip sets include sensors to detect errors and correct RAM, bus, and I/O failures. These new boards will increase system reliability without significantly increasing cost.

Lesson Summary

Computers represent all data and instructions using the binary number system, which consists of 0s and 1s.

Large computers use a data coding system called EBCDIC; smaller computers use the ASCII coding system.

Eight bits, known as a byte, are used to represent any given letter or number.

The computer adds a parity bit to each byte to help protect against errors.

The central processing unit (CPU) is composed of a control unit and an arithmetic-logic unit. A microprocessor is a CPU on a single silicon chip.

Computer programs are written to run on a specific processor. Most new processors are designed to be compatible with older processors so that existing programs can run on the new processor.

A computer's performance, or speed, is determined by the size of the data bus and the address bus and by the speed of the system clock.

Two types of microprocessor chips are in use today: CISC chips and RISC chips.

Primary memory is composed of RAM, ROM, and cache chips. RAM and cache are volatile.

Matching

Match the explanations or definitions from the first column with the appropriate terms.

1. A processor that works with a limited instruction set	a. cache memory
2. A 0 (zero) or a 1 (one)	b. random-access memory
3. A volatile form of memory	c. ROM BIOS
4. A technique to supplement RAM	d. virtual memory

5. A chip that holds many of the instructions needed to start the computer	e. read-only memory
1. A collection of Os and 1s that represents a letter, number, or special symbol	f. byte
7. A form of memory that is manufactured with instructions permanently stored on it	g. megahertz
8. A form of memory that holds frequently used data and instructions	h. RISC
9. A processor that uses a large, complex set of instructions	i. CISC
10. A unit of measurement for the number of clicks of the system clock in a second	j. bit

Multiple Choice

Circle the letter of the correct choice for each of the following.

1. Which of the following represents a computer code?

a) WORM, b) FAT, c) EBCDIC, d) EEPROM

2. What holds ROM, RAM, the CPU and expansion cards?

a) computer, b) motherboard, c) hard disk, d) cache memory.

3. Which of the following is *not a* determining factor of computer speed?

a) number of disk drives, b) internal data bus width,
c) clock speed, d) external data bus width.

4. Where are the instructions for starting the computer housed?

a) read-only memory chips, b) random-access memory,
c) hard disk, d) CD-ROM.

5. Which of the following is an example of volatile memory?

a) ROM, b) PROM, c) EPROM, d) RAM.

6. Which of the following statements about a data bus is true?

a) It is a form of secondary storage.
b) It performs mathematical operations.
c) It connects the CPU and memory.
d) It can carry one byte of data.

7. Which of the following is *not* kept in primary memory?

a) program instructions, b) data,
c) the bus, d) parts of the operating system.

8. Software that can make one CPU pretend to be another is a(n) ____.

a) virtual memory program, b) emulator,
c) simulator, d) word.

9. The most popular coding systems use a(n) ____-bit byte.

a) five, b) six,
c) seven, d) eight.

10. When someone talks about the "memory" of a computer, that person is usually referring to ____.

a) virtual memory, b) cache memory,
c) random-access memory, d) read-only memory.

Completion

In the blank provided, write the correct answer for each of the following.

1. Data and instructions are stored in _____ during processing.
2. A(n) _____ is used to speed up mathematical operations in a computer.
3. It is important that new processors be _____ with older processors.
4. A(n) _____ represents a number, letter, or special symbol.
5. _____ is the data representation code used on most microcomputers.
6. The width of a computer's _____ determines how much memory can be accessed.
7. The _____ holds the instructions needed to start the computer.

8. The _____ is where all the mathematical and comparison operations are executed.
9. The _____ holds the memory, carries the bus lines, and contains expansion slots.
10. _____ is a technique that uses hard disk space to supplement memory.

Critical Thinking

Answer the following questions.

- Imagine the computer system of the year 2005. From the devices described in this lesson, select the type of memory the system will have.
- Compare the way the components of a computer system function with the general way our brain accepts, processes, and outputs data.
- Commonly, the ASCII code and the EBCDIC code use eight positions to represent different combinations of Is and Os. Each different grouping is associated with a unique character. Show how many characters could be represented if you used one, two, three, and four positions. Do you see a pattern?
- Can you think of any advantages or disadvantages to having a computer system with only ROM, RAM, and a hard drive but no tape drive and no removable hard disks?
- List some reasons why users might be reluctant to purchase a computer based on a new, fast processor that is not downwardly compatible.

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