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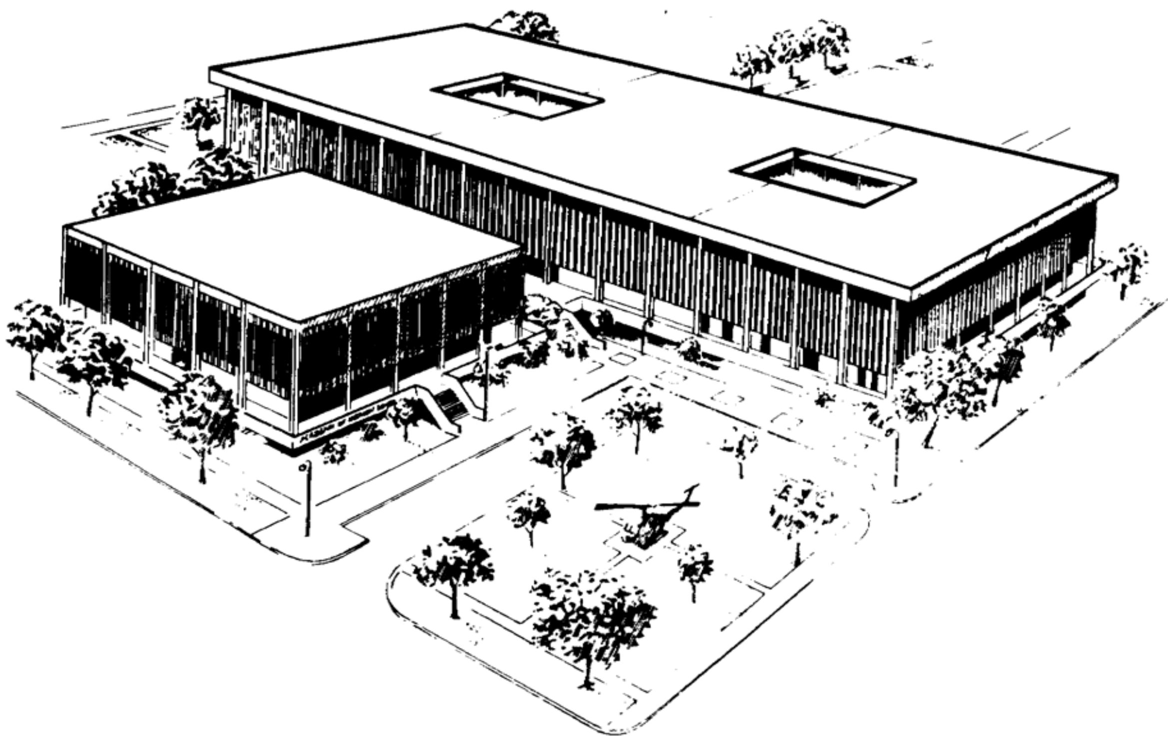

AMEDD COMPUTER LITERACY II

SUBCOURSE MD0058 EDITION 200

DEVELOPMENT

This subcourse is approved for resident and correspondence course instruction. It reflects the current thought of the Academy of Health Sciences and conforms to printed Department of the Army doctrine as closely as currently possible. Development and progress render such doctrine continuously subject to change.

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CLARIFICATION OF TRAINING LITERATURE TERMINOLOGY

When used in this publication, words such as "he," "him," "his," and "men" are intended to include both the masculine and feminine genders, unless specifically stated otherwise or when obvious in context.

.

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CORRESPONDENCE COURSE OF
THE ACADEMY OF HEALTH SCIENCES, UNITED STATES ARMY

SUBCOURSE ME0058

AMEDD COMPUTER LITERACY II

INTRODUCTION

Computers have become such a pervasive and indispensable feature of the work setting, that it is hard to imagine functioning efficiently without them. While some have embraced computerization whole-heartedly, others have remained aloof, even hostile, to the changes computers have brought about.

The AMEDD Computer Literacy subcourses will not teach you how to use and operate a computer. (Those skills are best learned on the job, in circumstances that permit constant and repeated practice.) But they will help you to become computer-literate. In AMEDD Computer Literacy I, you gained a working knowledge of how computers evolved, what the components do, and how computer systems work. In this subcourse, you will learn how the computer translates digital messages into the binary code, how a program is designed, how computers are used in business, in health care, and in the x-ray department, and finally future trends, safety, personal comfort, and other issues. With this foundation, you should be able to use the computer more intelligently and master the actual operations more quickly.

Do your best to achieve the objectives of this subcourse. Make sure to read the captions of the illustrations and the definitions of new terms that appear throughout the text. New terms are presented in the body of text, and again in a glossary at end of the subcourse. These are devices designed to help you retain the subject matter more easily. Good luck and good reading.

Subcourse Components:

The subcourse instructional material consists of the following:

Lesson 1, Computer Operations.
Lesson 2, Introduction to Programming.
Lesson 3, Computer Applications in Business and in Health Care.
Lesson 4, Future Trends.
Glossary.

Study Suggestions:

Here are some suggestions that may be helpful to you in completing this subcourse:

--Read and study each lesson carefully.

--Complete the subcourse lesson by lesson. After completing each lesson, work the exercises at the end of the lesson, marking your answers in this booklet.

--After completing each set of lesson exercises, compare your answers with those on the solution sheet that follows the exercises. If you have answered an exercise incorrectly, check the reference cited after the answer on the solution sheet to determine why your response was not the correct one.

Credit Awarded:

To receive credit hours, you must be officially enrolled and complete an examination furnished by the Nonresident Instruction Branch at Fort Sam Houston, Texas. Upon successful completion of the examination for this subcourse, you will be awarded 10 credit hours.

You can enroll by going to the web site http://www.train.army.mil and enrolling under "Self Development" (School Code 555).

A listing of correspondence courses and subcourses available through the Nonresident Instruction Section is found in Chapter 4 of DA Pamphlet 350-59, Army Correspondence Course Program Catalog. The DA PAM is available at the following website: http://www.usapa.army.mil/pdffiles/p350-59.pdf.

LESSON ASSIGNMENT

LESSON 1 Computer Operations.

LESSON ASSIGNMENT Paragraphs 1-1 through 1-7.

LESSON OBJECTIVES After completing this lesson, you should be able to:

1-1. Identify key developments in the formulation of the binary numbers concept.

1-2. Identify differences between the binary and decimal number systems.

1-3. Identify place values in the binary, decimal, and other systems.

1-4. Identify the symbols used in various number systems.

1-5. Identify characteristics of ASCII (American code for information interchange), the electronic language of computers.

1-6. Identify the significance and use of bytes and bits in computers.

1-7. Calculate place values for the decimal and binary number systems.

1-8. Calculate decimal and binary equivalents (conversions).

SUGGESTION After completing the assignment, complete the exercises of this lesson. These exercises will help you to achieve the lesson objectives.

LESSON 1

COMPUTER OPERATIONS

Section I. THE DEVELOPMENT OF BINARY AND OTHER NUMBERING SYSTEMS

1-1. INTRODUCTION

As stated in the previous subcourse, a modern computer's chief capability is its capacity to react with lightning speed to binary coded bursts of voltage expressed as zeros and ones. This lesson looks more closely at that capability: the computer's use of the binary code, the manipulation of characters, symbols, and numbers through the presence (1) or absence (0) of an electrical signal. (See figure 1-2, for a visual model of the binary code.) It covers the development of the binary code, its roots in philosophy and logic, and its eventual application to the computer. In order to provide a fuller appreciation of how a computer encodes (converts) information into the binary code, a section on converting decimal numbers into the binary system and vice versa is included. The concept of the byte and its significance to users, and a description of American standard code for information interchange (ASCII), the shared electronic language of computers are covered.

binary code: a system for representing things by combinations of two symbols, such as 1 and 0, TRUE and FALSE, or the presence or absence of voltage.

1-2. THE BINARY CODE

a. **What It Is.** Basically all digital computers, regardless of size or purpose, are a traffic system for information expressed in zeros and ones. Although some of the early computers, such as ENIAC (1945), used an internal language based on the decimal number system, nearly every computer since 1950 has used the binary number system. ENIAC was huge, cumbersome, and unreliable, in part, because it processed numbers in decimal form, and thus required over 17,000 vacuum tubes to handle all its circuitry. The binary system, with only two symbols, is a much more efficient means of encoding information. It requires much less circuitry. The microscopic electronic switches in a modern CPU have to deal with only two states, on or off represented by zero and one, rather than the 10 needed for a decimal circuit.

b. **Digitizing Input.** Computers process information that often does not seem to have anything to do with numbers or logic. A computer can reproduce sounds coming through a microphone onto a special disk, monitor temperature in laboratories, or manipulate images on television. To process this kind of input, the computer must first "digitize" the information, that is, turn it into binary digits. To digitize music, the computer takes periodic measurements of the sound waves and records each measurement as a binary number.

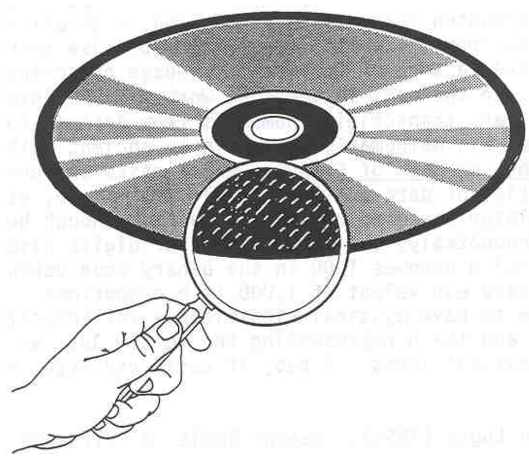


Figure 1-1. Digitizing information: the laser beam in a digital record player reads pits on the record as zeros, and spaces as ones. These digits are eventually reconverted into music by the electronic circuitry.

1-3. NUMBER SYSTEMS

a. **Two-Symbol Code.** The two-symbol method of encoding information has been in use for a long time. African bush tribes sent messages using combinations of low and high pitches, Australian aborigines counted by twos, as did other hunter-gatherers from New Guinea to South America. More recently, the Morse code used groups of dots and dashes to represent the letters of the alphabet. In a philosophical vein, the Chinese viewed the world as a place of dualities: male and female, good and evil, new and old.

b. **Other Codes**. There are many other systems besides the decimal and binary codes. Babylonians used a number system based on 60. English- speaking people used a 12-based system, whose influence can still be seen in the units of measurement we use today (the 12 months of the year, the 12 inches in a foot, the two 12-hour periods in a day). In the West, the decimal system came to predominate, probably because of the ease of counting by the fingers on a pair of hands.

1-4. DEVELOPMENT OF THE BINARY CODE

Since the l600s, Western thinkers, logicians, philosophers, mathematicians, and engineers have studied the two-state simplicity of the binary system with great interest.

a. **Gottfrled Wilhelm Lelbnlz (1666).** The German mathematical genius, Leibniz, proposed that rational thinking, with all its ambiguities, could be transposed from the verbal realm, into precise mathematical terms. He further suggested “a sort of universal language or script”..(which he never developed). In the next 10 years, he worked on refining the binary system, spending years transcribing numerals from decimal to binary. He found validation of his mathematical work in an ancient philosophical text, the Chinese I Ching, or Book of Changes, which casts the universe in terms of contrasting dualities of dark and light, male and female, and so forth. Leibniz never developed a calculator based on the binary system, though he did give some thought to it. Undoubtedly, the long strings of digits discouraged him. For example, the decimal 8 becomes 1000 in the binary code because only one and zero are used. The binary equivalent of 1,000 is a cumbersome 1111101000. The binary system came to have mystical significance for Leibniz: the one representing God, and the zero representing the void. Just as one and zero could express all mathematical ideas, so too, it could represent everything in the universe.

b. **Boolean Logic (1854).** George Boole, a self-made mathematician, continued with the search for a universal language. In 1854, he devised a system for stripping logical argument of all words by expressing it in mathematical terms. Using Boolean algebra any statement could be expressed symbolically and could be manipulated like ordinary numbers. Using three basic operations (logic gates), AND, OR, and NOT, he could add, subtract, multiply, divide, and compare symbols or numbers. The logic gates are binary since they involve either truth or falsity, yes or no, closed or open, one or zero. He believed that by stripping logic of words, it would be easier to arrive at sound conclusions.

c. **Charles Pierce Brings Boolean Logic to the United States.** In 1867, Charles Sanders Pierce, an American logician, introduced Boolean logic in a paper delivered to the American Academy of Arts and Sciences. He realized that Boole's two-state logic lent itself to the description of electrical circuits, because currents were either "one or "off," just as propositions were either true or false. He designed, but never built, a logic circuit using electricity. His real contribution was in introducing Boolean logic into American university courses in logic and philosophy, so that it eventually worked its way into the innovations of key thinkers.

d. **Claude Shannon (1936).** Claude Shannon was just such a key thinker. A brilliant mathematician, he had the insight to translate Boolean algebra into practical terms. Working at the Massachusetts Institute of Technology, with a cumbersome mechanical calculating device, called the differential analyzer, he recognized that the machine's bulk was dictated by the need to compute with all 10 digits of the decimal numbering system. Recalling Boolean algebra, he saw its similarity to an electric circuit, and recognized in that similarity the potential for streamlining computer design. Electric circuits could be laid out according to Boolean principles, and they could express logic, test the truth of propositions and carry out complex calculations. Using electric circuits instead of shafts and gears would streamline design. Shannon's master's thesis (1938), which outlined his thoughts about Boolean algebra and binary numbers, had an immediate impact on the design of telephone systems. A subsequent paper, "A Mathematical Theory of Communication" described what later came to be known as information theory. This was a method of defining and measuring information in mathematical terms, as yes-no choices represented by binary digits, that became the basis of modern telecommunications.

information theory: the application of mathematics to language, concepts, processes, and problems in the field of communications.

e. **John Atanasoff's Binary Computer (1939).** A physics professor at Iowa State College, Atanasoff built a rough model of a binary-based computer in 1939. He decided that the ease of representing two symbols instead of 10 in a computer's circuitry, outweighed the adjustment needed for users in transitioning to the unfamiliar binary system. The machines, at any rate, could make the conversions without difficulty.

f. **George Stibitz's Binary Adder (1939)**. A research mathematician at Bell Telephone Laboratories, he realized that Boolean logic was a natural language for the circuitry of electromechanical telephone relays. He built a binary adder circuit, an electromechanical circuit that could perform binary addition, using the logic of Boolean gates to control current flow. This device is still a basic feature of digital computers today.

g. **Stibitz and Williams' Complex Number Calculator.** In 1940, Stibitz and Williams developed a device that could subtract, multiply, and divide as well as add complex numbers. The calculator was hooked up to four teletype machines. A nearby teletype machine transmitted signals to the calculator and received answers from it within seconds. Two more teletypes in other parts of the building and a fourth 250 miles away permitted shared access remote control electromechanical computation.

h. **Konrad Zuse's Binary Computer.** Zuse worked independently in Germany, with no knowledge of Boolean algebra or Charles Babbage's attempts to build a general purpose computer. He built a binary-based computer that operated on Boolean-like principles.

i. **John Von Neuman (1945), World War II.** The race for new weapons speeded up the development of computer theory and design and facilitated progress in building binary-based computers. John Von Neuman's famous "First Draft of a Report on evacuation (EDVAC)" (1945) played a key role in spreading the word in the scientific and scholarly community about the advantages of circuitry designed to handle two digits (bits) rather than 10.

1-5. ADVANTAGES OF BINARY-BASED CIRCUITRY

a. **Simplified Design.** The design of a computer that handled two digits instead of 10 was infinitely more simplified. Cost was reduced, and reliability improved. Use of the binary system helped to alleviate modern computers of the "elephantiasis" that had afflicted the earlier models. The heat, space, and reliability problems that had plagued the decimal-based EDVAC, for example, were eliminated with the switch to the binary system.

b. **Form Follows Function.** Electronic components, by their very nature, operate in binary mode. Switches are either open (0 state) or closed (1 state). Transistors are either not conducting (zero) or conducting (one). As Von Neuman indicated in his paper on evacuation, equipment design lent itself to the binary model. Shown below are other computer elements that operate in one of two states ("on" or "off," present or absent, and so forth).

binary number system: a number system that uses two as its base and expresses numbers as strings of zeros and ones.

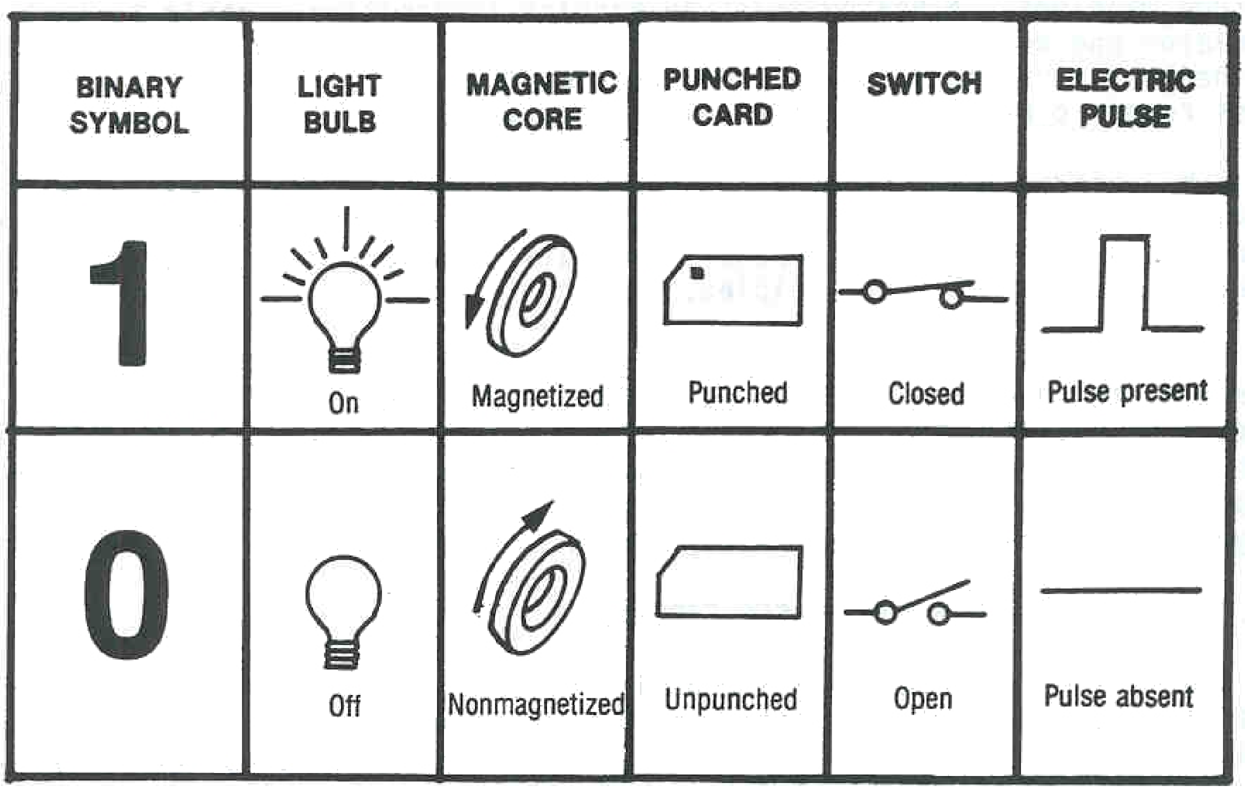


Figure 1-2. Computer design lends itself to the two-state binary mode. Shown are two-state elements of a computer.

Section II. WORKING IN THE BINARY AND DECIMAL SYSTEM

1-6. CONVERSION FROM DECIMAL TO BINARY AND BACK

a. **Powers.** The computer is constantly converting your input into decimal and then binary terms and back. To understand conversion, you must know how to determine powers. If you are familiar with this, skip down to paragraph 1-6b. If you need a quick review, look at the examples and explanation provided here.

$$10^4 = 10 \times 10 \times 10 \times 10 = 10{,}000$$
$$10^3 = 10 \times 10 \times 10 = 1{,}000$$
$$10^2 = 10 \times 10 = 100$$
$$10^1 = 10 = 10$$
$$10^0 = 1$$

Figure 1-3. The exponent indicates the number of times the number is multiplied by itself.

(1) The small raised number, or exponent, indicates how many times the number should be multiplied by itself. The first example, shown above, is ten to the fourth power. Ten multiplied by itself four times is l0xl0xl0xl0 or 10,000. The next example, ten to the third power, is l0xl0xl0 or 1000. Ten to the second power (ten squared) is l0xl0 or 100. Ten to the first power is 10. Note, that any number to the first power is the number itself.

$$90^1 = 90$$
$$25^1 = 25$$
$$12^1 = 12$$
$$2^1 = 2$$

Figure 1-4. Any number to the first power is the number itself.

(2) And any number to the zero power is, by definition, one.

$$90^0 = 1$$
$$25^0 = 1$$
$$12^0 = 1$$
$$2^0 = 1$$

Figure 1-5. Any number to the 0 power is 1.

(3) Now, calculate powers of 2 for yourself in figure 1-6, following the example provided at figure 1-3. (The answers are provided at figure 1-8.)

2^4	$2 \times 2 \times 2 \times 2 =$	16
2^3		
2^2		
2^1		
2^0		

Figure 1-6. - Powers of 2 exercise.

b. **Place.**

(1) General. In any number system, be it binary or decimal, the value of a digit is determined by its place, that is, where it stands in relation to the other digits in the number. Place value is the backbone of arithmetic. The first thing you do before adding or subtracting is make sure that the digits line up properly according to their place value.

(2) Decimal system. In the decimal system, each position to the left of the decimal point indicates an increased power of 10. The first place to the left of the decimal is 10^0 or 1. (This is the units place.) The second place to the left of the decimal is 10^1 or 10 (the tens place). The third place to the left is 10^2 or 100 (the hundreds place). And the fourth place to the left is 10^3 or 1000 (the thousands place).

Place (thousands) ($10^3 = 1{,}000$)	Place (hundreds) ($10^2 = 100$)	Place (tens) ($10^1 = 10$)	Place (units) ($10^0 = 1$)
			1
		1	0
	1	0	0
1	0	0	0

Figure 1-7. Each position to the left of the decimal indicates an increased power of 10.

(a) What would the fourth place to left of the decimal be? You were right if you said 10^4 or 10x10x10x10, which is 10,000.

2^4	2 x 2 x 2 x 2 =	16
2^3	2 x 2 x 2 =	8
2^2	2 x 2 =	4
2^1	2 =	2
2^0	=	1

Figure 1-8. Solution to powers of two, exercise--previous page.

(b) Thus, an one by itself is worth one because the one occupies the place whose value is 10^o or 1. Putting the one to the left of zero (a placeholder) makes the one worth 10, as it now occupies the second place to the left, valued at 10^1 or 10. Putting the one to the left of two zeros, makes it worth 100, as it occupies the third place to the left, valued at 10^2 or 100. We don't go through this process consciously when working in the decimal system, because it is familiar to us. What we are doing is adding up the value of the places marked by any digit except 0 (and multiplying each place value by the digit). In the example below, the digits are all is (1, 10, 100, 1000).

10^3 Place	10^2 Place	10^1 Place	10^0 Place	
			1	= 1 (10^0)
		1	0	= 1 (10^1)
	1	0	0	= 1 (10^2)
1	0	0	0	= 1 (10^3)

Figure 1-9. Place value, something we take for granted in the familiar decimal system, determines the value of the number.

(c) Let's do a decimal number in which-the digits aren't 1s, the number 23. The 2 occupies the place valued at 10^1. The digit 2 x the place value, is $2 \times 10^1 = 2 \times 10 = 20$. The three occupies the place valued at 100. The digit 3 x the place value, is $3 \times 10^o = 3 \times 1 = 3$.

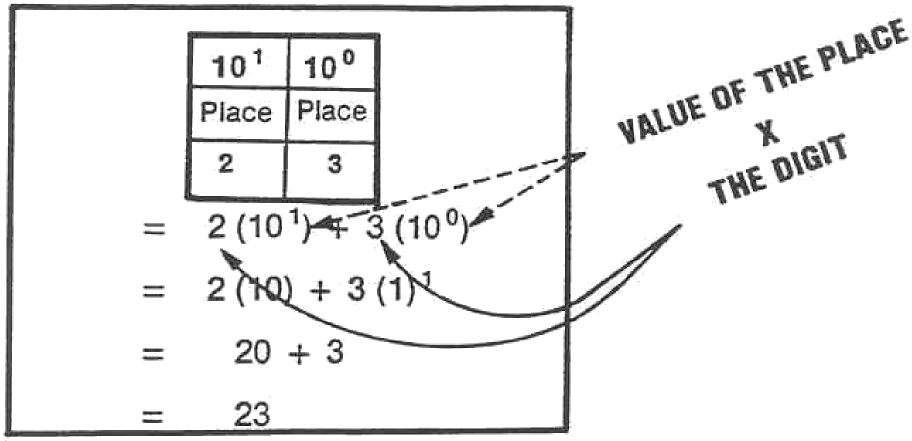


Figure 1-10. Determining value. Multiply each digit (except 0) by the value of its place. Then add the subtotals.

(d) Can you "explain" the number 506? Remember, multiply each digit by the value of the place it occupies, then add. Use the explanation of the number 23 in the previous paragraph as your model.

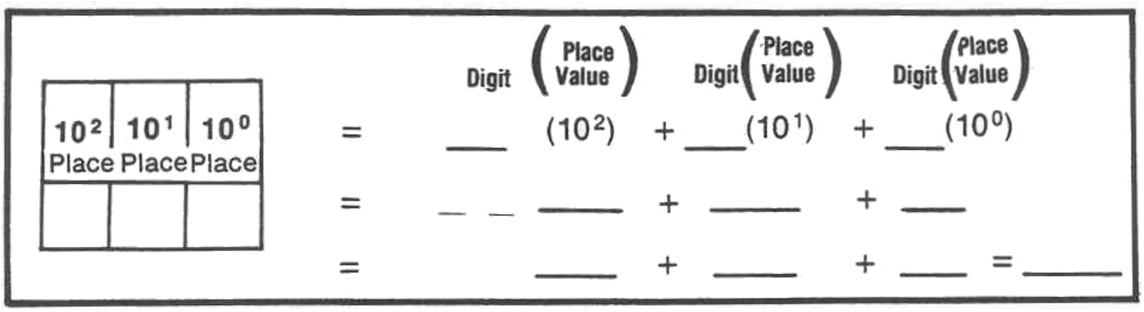


Figure 1-11. Explain a decimal number exercise.

c. **Converting Binary to Decimal.**

(1) Symbols in a number system. The decimal or base ten system consists of ten symbols: One through nine, plus zero. The binary or base two system consists of two symbols: One and zero. The highest symbol in a number system will always be one less than the base. For example, in base eight, which has eight symbols (1-7), the highest is seven. What would the highest symbol in base nine be? You were right if you said eight (0-8).

(2) Place value.

(a) Earlier, we said that in the decimal system each position to the left of the decimal represented an increased power of ten. Similarly, in the binary system, each position to the left of the decimal represents an increased power of two. In the base three system, each position to the left of the decimal represents an increased power of what number? You were right if you said: an increased power of three.

10^2	10^1	10^0
Place	Place	Place
5	0	6

$$= 5(10^2) + 0(10^1) + 6(10^0)$$
$$= 5(100) + 0(10) + 6(1)$$
$$= 500 + 0 + 6 = 506$$

Figure 1-12. Explain a decimal number solution.

(b) Thus, in the binary system, the first place to the left of the decimal is 2^o or 1. The second place to the left is 2^1 or 2. The third place to the left is 2^2 or 4. The fourth place to the left is 2^3 or 2x2x2, which is 8. What would the fifth place to the left of the decimal be? You were right if you said 2^4 or 2x2x2x2, which is 16.

Binary

Place	Place	Place	Place
2^3	2^2	2^1	2^0
8	**4**	**2**	**1**
			0
			1
		1	0
		1	1
	1	0	0
	1	0	1
	1	1	1

Figure 1-13. In the binary system, each position to the left of the decimal indicates an increased power of two.

(3) Physical appearance of binary numbers. For a moment, forget about place value (the entries at the top of each column) and consider the binary numbers themselves: 0, 1, 10, 11, 100, 101, 11, 1000, and so forth. In appearance, they look like strings of zeros and ones. This is because there are only two symbols to work with. As soon as you've used the zero and the one in the first place to the left of the decimal, you must move out to the next place to the left. Thus, binary numbers quickly become multidigit strings of zeros and ones. What are the next three binary numbers after 111? The first one is 1000. The next is 1001. The one after that is 1011. Enter these in figure 1-14. We now have a list of 10 binary numbers occupying up to four places. If we were in the decimal system, the first 10 numbers (0 through 9) would occupy only one place each. This is what we mean when we say that binary numbers quickly turn into multidigit figures.

Place	Place	Place	Place
2^3	2^2	2^1	2^0
8	**4**	**2**	**1**
			0
			1
		1	0
		1	1
	1	0	0
	1	0	1
	1	1	1

Figure 1-14. Binary digits quickly turn into multidigit figures because there are only two symbols.

(4) Binary to decimal conversion. Binary to decimal conversion is really quite easy. To determine the decimal equivalent, simply add up the values of the places marked by binary one.

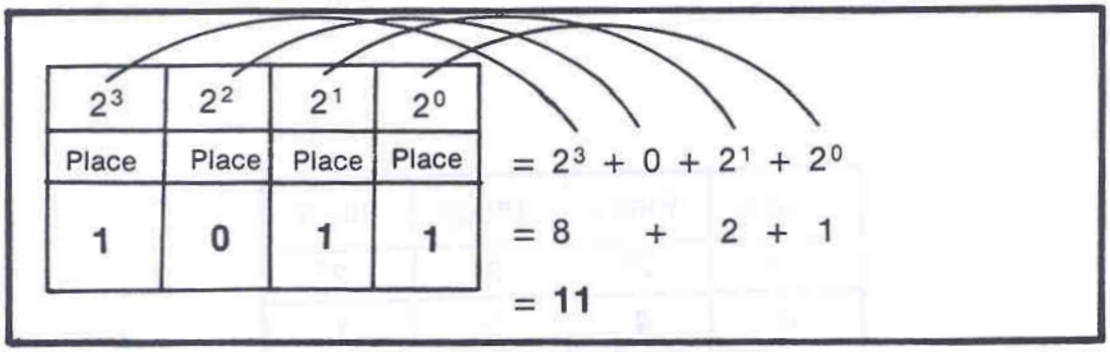


Figure 1-15. Adding up the values of the places marked by binary one will give you the decimal equivalent.

(a) Note that since the third place to the left is occupied by a zero, we did NOT add in the value of that place **(**2^2 x 0 = 0). Only places marked by binary 1 are added in. Let's try another example: binary 1001. This time you do the calculations. Follow the same steps as in the preceding example. Enter your computations below.

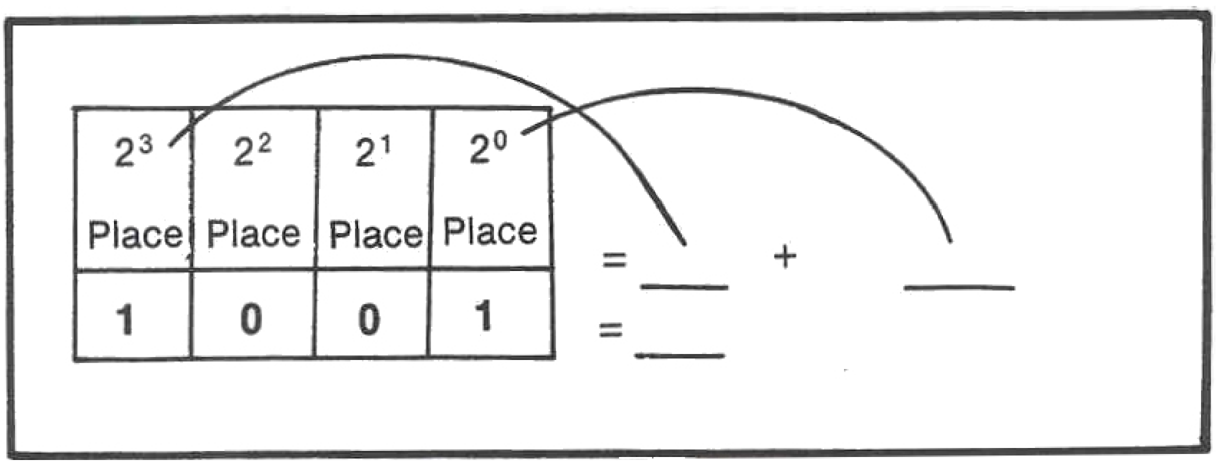


Figure 1-16. Binary conversion exercise.

BINARY				DECIMAL	
Place 8	Place 4	Place 2	Place 1	Place 10	Place 1
			0		0
			1		1
		1	0		2
		1	1		3
	1	0	0		4
	1	0	1		5
	1	1	0		6
	1	1	1		7
1	0	0	0		8
1	0	0	1		9
1	0	1	0	1	0

Figure 1-17. Binary and decimal equivalents.

(b) You were right if you did as follows: 1001 = $2^3 + 2^o$ = (2x2x2) (1) = 8 + 1 = 9. Again, we did not add in the values of the middle places, because they are occupied by zeros.(Correct your calculations if they were wrong and then proceed.) Up to now, we have been providing you with the place values, at the top of the box. You will be expected to have these in your head for the exam. Can you calculate them yourself? It's simply a matter of entering increasing powers of 2: 2^o, 2^1, 2^2, 2^3, and so forth, for the binary system (or increasing powers of 10 for the decimal). Enter the binary place values in figure 1-18 above the word "place." (Try not to refer back to the previous figures.)

Place	Place	Place	Place	Place	Place

Figure 1-18. Enter binary place value at the top.

(c) You were right if you entered 2^0 or 1 as the first place value, as shown below. Take a moment to memorize the top line of figure 1-19 before you go on: 1, 2, 4, 8, 16, 32.

32 (2^5) Place	16 (2^4) Place	8 (2^3) Place	4 (2^2) Place	2 (2^1) Place	1 (2^0) Place

Figure 1-19. Know your place values to facilitate conversion.

(d) So far, we have done conversions using the helpful place value information provided. Have that in your head as you convert binary ill.

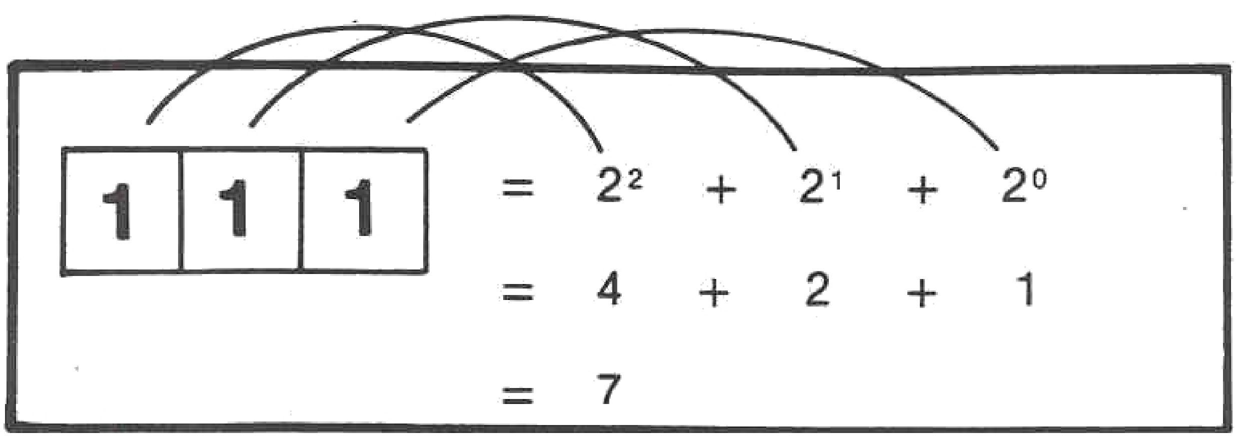


Figure 1-20. Converting binary 111 to its decimal equivalent.

(c) What is the decimal equivalent of binary 110? Enter your calculations below.

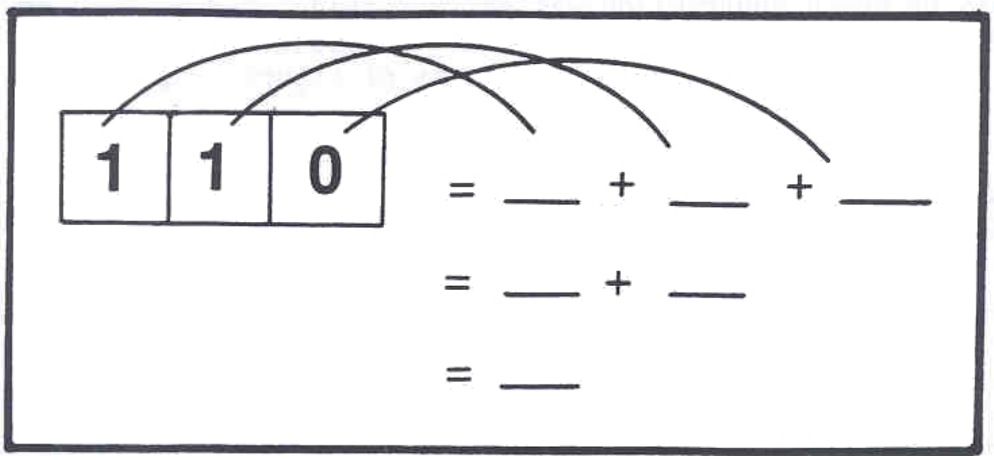


Figure 1-21. Conversion exercise: binary 110.

(f) You were right if you wrote: $2^2 + 2^1 = 4 + 2 = 6$. Remember that we don't add in the value of places occupied by zero. (Correct your entries, if necessary, then proceed.)

(5) Decimal to binary conversion. Essentially, to convert decimal numbers to their binary equivalent you subtract place values. Let's convert decimal 28 to see exactly how this is done. First, subtract the largest binary place value (power of two) that is less than the decimal number. In this case, 2^4 or 16 is the largest binary place value less than 28. Subtracting 16 from 28 leaves a remainder of 12. Keep subtracting the next largest power of 2 from each succeeding remainder.

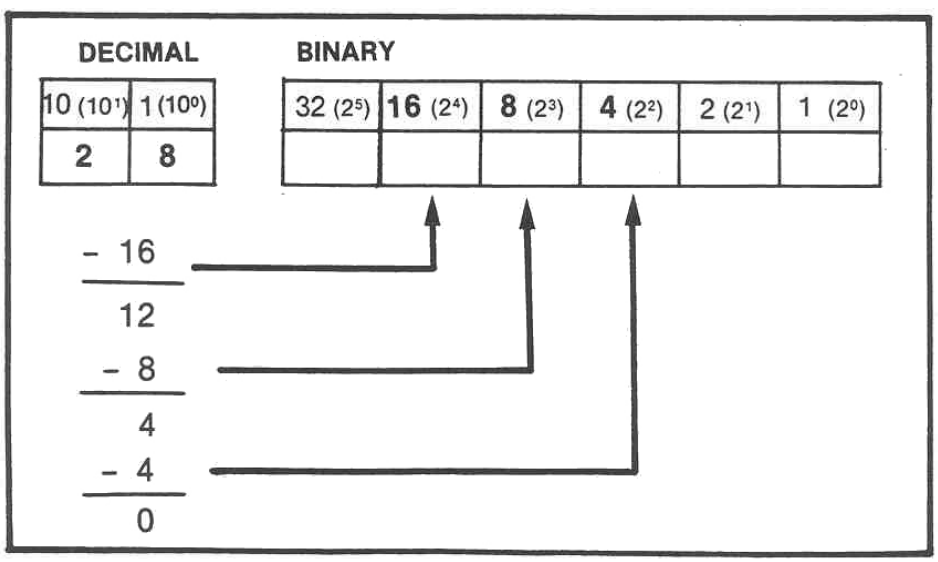


Figure 1-22. To convert from decimal to binary, subtract the largest power of 2, and keep subtracting the next largest power from each succeeding remainder.

(a) Mark is in each column where subtraction was possible. (See arrows, preceding figure.) Mark zeros where subtraction was not possible. For decimal 28, then, there was one 16, one 8, one 4, no 2, and no 1, resulting in binary 11100. Enter these numbers in the appropriate columns of figure 1-22.

DECIMAL			BINARY					
10	1		32	16	8	4	2	1
2	**8**	=		**1**	**1**	**1**	**0**	**0**

Figure 1-23. Decimal 28 is equivalent to binary 11100.

(b) Now, convert decimal 35. The subtraction of powers of two (binary place values) has been done for you. Enter the arrows, pointing to the corresponding place, and enter the zeros and ones. Note that this time, we did not provide the place values. If you want, enter them above the boxes yourself, before you begin.

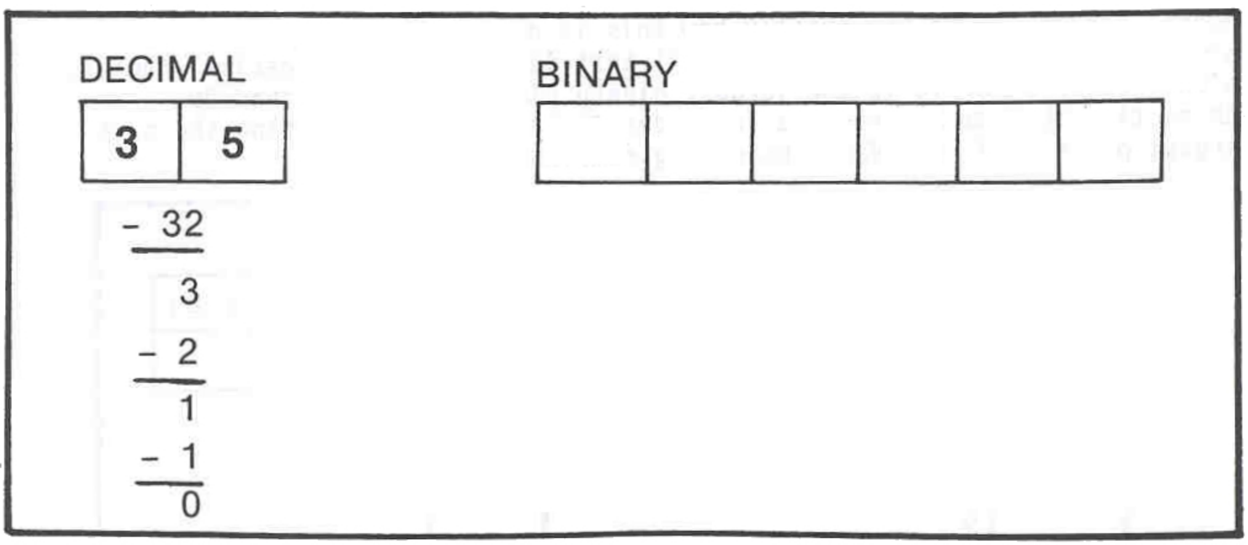


Figure 1-24. Enter the arrows and the ones in the places for which subtraction is possible.

(c) You were right if you said that decimal 35 converts to binary 100011. Subtraction was possible for the place that is farthest from the decimal, the place valued at 32. It was also possible for the two places nearest the decimal, valued at two and one.

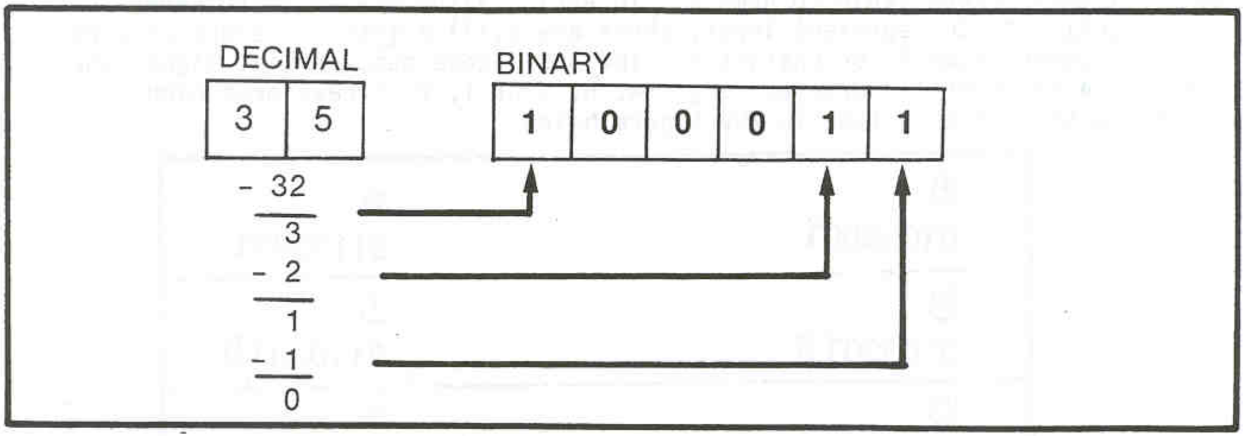


Figure 1-25. Decimal 35 is equivalent to binary 100011.

1-7. AMERICAN STANDARD CODE FOR INFORMATION INTERCHANGE

a. **The Language of Computers.** Earlier, we said that the computer can accept input in many forms because it can digitize input. All computers in the United States use a shared electronic language to translate input into decimal and binary terms, and back. This shared language is American standard code for information interchange, (ASCII) (which rhymes with passkey). Other countries use a slightly different international version.

b. **How the American Standard Code For Information Interchange Works.** When you strike the letter A" on a computer keyboard, the computer uses ASCII to electronically encode (convert into code) the letter, or any other character or control function. The ASCII assigns a string of seven zeros and ones (binary digits or bits) to every upper- and lowercase letter of the alphabet, to the numerals of the decimal system, and to an assortment of punctuation marks, control symbols and special characters.

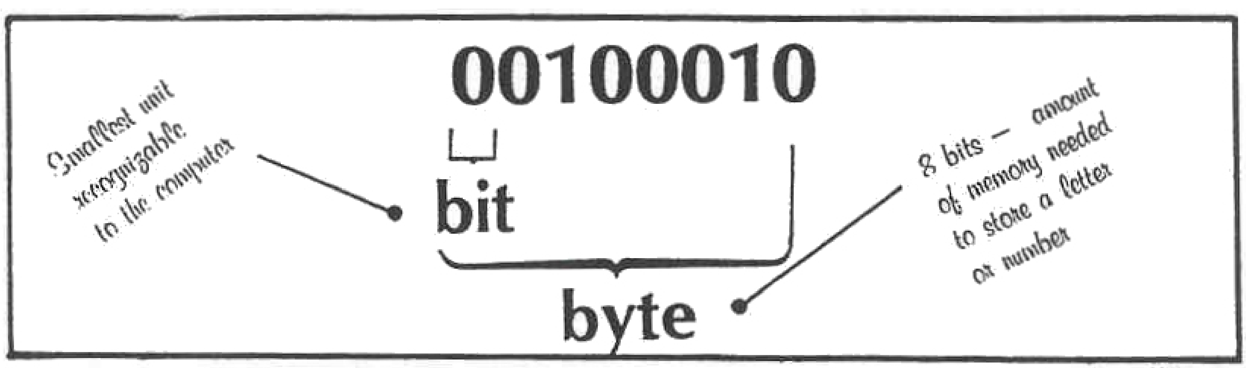


Figure 1-26. Bit vs. byte.

c. **The 256 Bits in American Standard Code For Information Interchange I.** The seven significant bits that ASCII assigns, provide 2^7 (2 x 2 x 2 x 2 x 2 x 2 x 2) or 128 possible combinations of 0s and 1s. An eighth bit is either ignored or used to check accuracy. So, there are 2^8 or 256 possible combinations of zeros and ones.

d. **Eight Bits or One Byte to Represent Letters, Numbers, Symbols, or Characters.** You will recall that eight bits equal one byte, a byte being the smallest unit recognizable to humans. In ASCII, although there are seven significant bits to represent input, there are still a total of eight bits per letter, number, symbol, or character. The ASCII code numbers that signal the specific alphanumeric character, that is, A, B, C or 1, 2, 3 have been highlighted with boldfaced type in the figure below.

A 0100000**1**	a 0110000**1**
B 010000**10**	b 011000**10**
C 010000**11**	c 011000**11**
D 01000**100**	d 01100**100**
E 01000**101**	e 01100**101**
F 01000**110**	f 01100**110**
G 01000**111**	g 01100**111**
H 0100**1000**	h 0110**1000**
I 0100**1001**	i 0110**1001**
J 0100**1010**	j 0110**1010**
K 0100**1011**	k 0110**1011**

Figure 1-27. The boldfaced binary bits represent the letters of the alphabet in ASCII.

e. **Deciphering American Standard Code For Information Interchange I Representation.** The ASCII is constructed so that certain bits signal one piece of information, that is, capital letter or numeral. The remaining bits identify the letter or numeral itself. The ASCII code for the capital letter “A,” for example, is decimal 65, or binary 01000001. Lowercase “a” is 97, or binary 01100001. The difference is in the three left most bits, which are bracketed (see above). The last three bits, then, distinguish between upper- and lowercase letter. All uppercase letters will start with the binary digits 010, all lowercase letters with the digits 011.

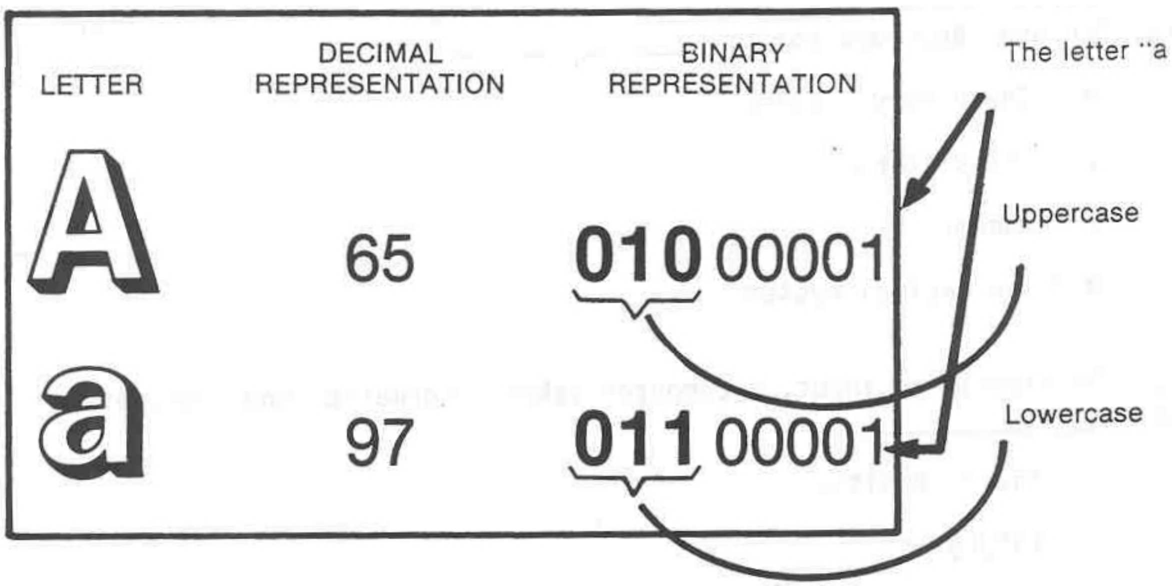


Figure 1-28. The three left most bits in ASCII, signal upper- or lowercase.

Continue with Exercises

EXERCISES, LESSON 1

INSTRUCTIONS. The following exercises are to be answered by marking the lettered response that best answers the question or best completes the incomplete statement or by writing the answer in the space provided.

After you have completed all the exercises, turn to, "Solutions to Exercises" at the end of the lesson and check your answers.

1 Early computers, such as ENIAC, were cumbersome and unreliable, in part, because they made use of:

a. The binary system.

b. Transistors.

c. Modems.

d. The decimal system.

2. By digitizing input, a computer takes information and translates it into:

a. Binary digits.

b. Kilobytes.

c. Periodic measurements.

d. Sound waves.

3. Gottfried Wilhelm Leibniz sought to transpose rational thinking into precise __________________________ terms.

a. Lyrical.

b. Computerized.

c. Mathematical.

d. Individual.

4. George Boole's two-state ________________ lent itself to the description of electrical circuits.

   a. Logic.

   b. Computer theory

   c. Language.

   d. Gadgetry.

5. By applying Boolean algebra to computer design, Claude Shannon was able to replace computer shafts and gears with:

   a. Microprocessors.

   b. Vacuum tubes.

   c. Transistors.

   d. Electrical circuits.

6. Compared to decimal-based computers, binary-based computers are:

   a. Cheaper, smaller, and more reliable.

   b. Costlier but more streamlined.

   c. Only slightly larger.

   d. More costly and less reliable.

7. The value of a digit is determined by its _______________________, that is, where it stands in relation to the other digits.

   a. Exponential value.

   b. Place value.

   c. Inherent value.

   d. Base value.

8. In the decimal system, the first place to the left of the decimal is valued at 1 because it is:

   a. 2^0

   b. 10^0

   c. 10^1

   d. 2^3

9. The second place to the left of the decimal is __________in the decimal system.

   a. 10^3

   b. 10^2

   c. 10^1

   d. 10^0

10. The third place to the left of the decimal is valued at _____in the decimal system.

    a. 10^3

    b. 10^2

    c. 10^1

    d. 10^0

11. The first place to the left of the decimal is valued at in the binary system.

    a. 2^0

    b. 10^1

    c. 2^1

    d. 10^0

12. The second place to the left of the decimal is valued at ____in the binary system.

    a. 2^0

    b. 2^1

    c. 2^2

    d. 2^3

13. The third place to the left of the decimal is valued at ______ in the binary system.

    a. 2^0

    b. 2^1

    c. 2^2

    d. 2^3

14. In the base 9 system, each decimal place to the left would represent:

    a. Increasing powers of 10.

    b. Decreasing multiples of 8.

    c. Increasing multiples of 9.

    d. Increasing powers of 9.

15. Any number to the 0 power (2^0, 10^0, 56^0, and so forth) is:

    a. 0

    b. 1

    c. 2

    d. 10

16. Binary numbers quickly turn into multidigit strings because there are only _________ symbols to work with in the binary or base 2 system.

    a. 2^0.

    b. 1^1.

    c. 2.

    d. 3.

17. In the base _______ system, the symbols are 0, 1, 2, and 3.

    a. 5

    b. 4

    c. 3

    d. 2

18. The shared electronic language that US computers use to translate input into decimal and binary terms and then back is called

    a. The language of bits and bytes.

    b. Digital language.

    c. Boolean logic.

    d. ASCII.

19. The language used by the computer consists of 28 bits or ________ possible combinations of zeros and ones.

    a. 100

    b. 128

    c. 200

    d. 256

20. How many bits are there in the binary number 00100010?

    a. 8

    b. 4

    c. 2

    d. 1

21. How many bytes are there in the binary number 00100010?

    a. 8

    b. 4

    c 2

    d. 1

22. In the language used by computers, a string of eight (8) zeros and ones is used to represent letters of the alphabet, numerals of _______________ system, punctuation marks, control symbols and special characters.

    a. The decimal.

    b The binary.

    c The base 3.

    d Any number.

CALCULATIONS. For exercises 23 through 26, do the necessary calculations to compute the numerical answer.

23. Calculate the place values of the first four places to the left of the decimal in the decimal system. Enter values on the top line, and powers on the second line of the chart.

Place	Place	Place	Place

24. Calculate the place values of the first four places to the left of the decimal in the binary system. Enter values on the top line, and powers on the second line of the chart.

Place	Place	Place	Place

25. Convert binary 1011 to its decimal equivalent.

26. Convert decimal 31 to its binary equivalent.

Check Your Answers on Next Page

SOLUTIONS TO EXERCISES, LESSON 1

1. d (para 1-2a)
2. a (para 1-2b)
3. c (para 1-4a)
4. a (para 1-4b)
5. d (para 1-4d)
6. a (para 1-5a)
7. b (para 1l-6b)
8. b (para 1-6b(2))
9. c (para 1-6b(2))
10. b (para 1-bb(2))
11. a (para 1-bc(2))
12. b (para 1-6c(2))
13. c (par-a 1-6c(2))
14. d (para 1-6c(2))
15. b (para 1-ba)
16. c (para 1-bc(3))
17. b (para 1-6c(1))
18. d (para 1-7a)
19. d (para 1-1c)
20. a (para 1-1d)
21. d (para 1-1d)
22. a (para 1-7b)

23. Figure 1-9 and para 1-6(2)

1000	100	10	1
(10^3)	(10^2)	(10^1)	(10^0)
Place	Place	Place	Place

24. Figure 1-13 and para 1-6c(2)

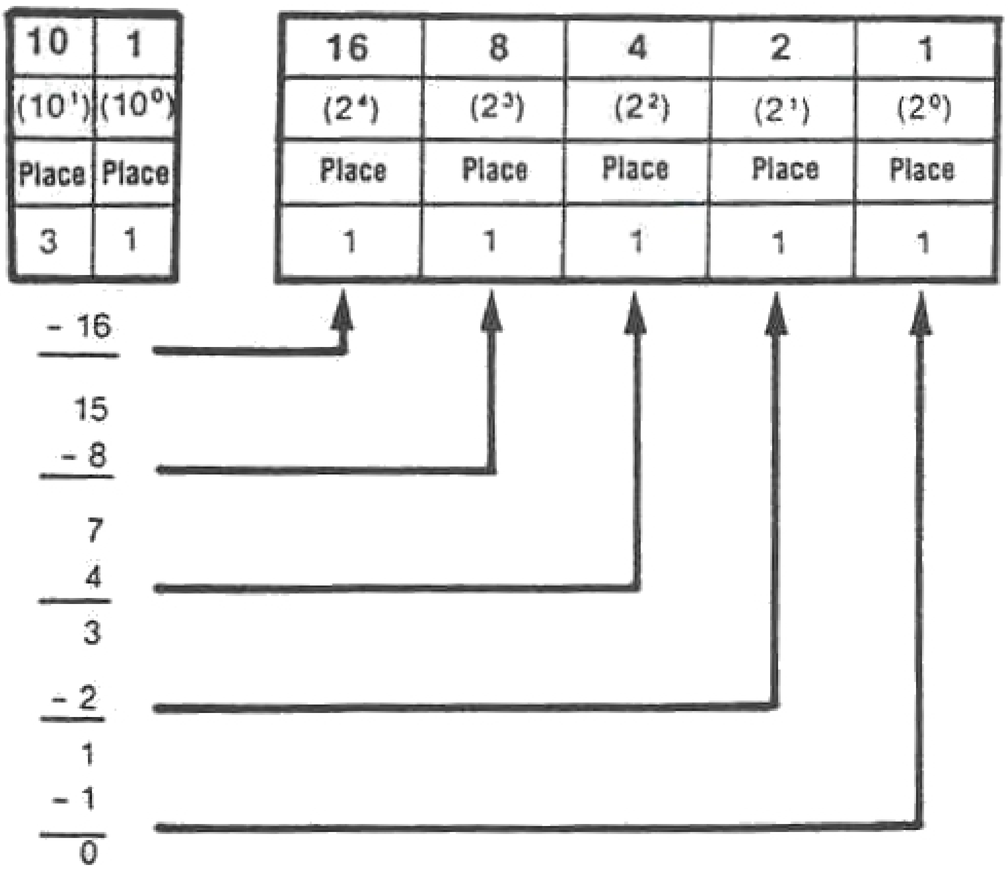
8	4	2	1
(2^3)	(2^2)	(2^1)	(2^0)
Place	Place	Place	Place

25. para 1-6c(4)

$= 1\ (2^3) + 0 + (2^1) + 1(2^0)$
$= 8 + 2 + 1$
$= 11$

8	4	2	1
(2^3)	(2^2)	(2^1)	(2^0)
Place	Place	Place	Place

26. para 1-6c(5)



End of Lesson 1

LESSON ASSIGNMENT

LESSON 2 Introduction to Programming.

LESSON ASSIGNMENT Paragraphs 2-1 through 2-11.

LESSON OBJECTIVES After completing this lesson, you should be able to:

2-1. Identify procedures for developing a computer program.

2-2. Identify tools of program design (flowchart, logic patterns, pseudocode) and their uses.

2-3. Identify types of programming languages.

2-4. Identify differences between high- and low-level languages.

SUGGESTION After completing the assignment, complete the exercises of this lesson. These exercises will help you to achieve the lesson objectives.

Section I. DEVELOPING A PROGRAM

2-1. INTRODUCTION

a. No matter how sophisticated the hardware, a computer can do very little without a good program (also known as software). This lesson looks more closely at programs, the set of instructions that the computer uses not only to solve a specific problem but to direct its own operations. A program consists of a plan of action (algorithm) for accomplishing some goal, plus data structures, objects in memory that make possible the plan of action.

program: A set of instructions used by the computer to solve a specific problem and direct the computer's operations; a plan of action + data structures.

b. The plan of action or algorithm refers to the actual steps taken to accomplish a goal. This involves operations like adding two numbers, testing one number against another, and moving values in memory. Data structures are the objects in memory that make the plan of action possible. It is the data structures that make it legal to add two numbers (2 + 3 = 5) and illegal to add Sunday + apples. Needless to say, good data structures are the necessary foundation for the development of a good plan of action (algorithm). Therefore, it can be said that a program equals a plan of action (algorithm) + data structures. This lesson considers the four steps in writing a program, the use of a program flowchart and other design tools and types of programming languages.

2-2. COMPUTER PROBLEM-SOLVING

Unlike humans, who solve problems through reason, intelligence, and intuition, computers solve problems according to detailed step-by-step instructions provided by the programmer. A computer cannot take a general instruction like "schedule clinic patient load" and turn it into statements it needs to perform the task. It has to be told each step. The programmer must think out each task logically and fully, so that any condition that might be encountered is anticipated in advance. If a possible condition is overlooked, the program will be executed incorrectly, or not at all.

2-3. IMPORTANCE OF THE PROGRAM

Any "intelligence" the computer seems to possess is provided by the programmer. The hardware only provides the electronic capability to execute the program. That is why it is critical to select programs exactly suited to the kinds of things you want to do. Many people make the mistake of buying the hardware first, without considering whether or not that system can run the software they need.

2-4. DEVELOPING THE PROGRAM (SOLVING THE PROBLEM

a. A structured approach to problem-solving and program development is essential, especially with the variety of programming languages, processing techniques, storage devices, and printing media available today. Programmers often approach the program development/problem-solving task by using the four-step process, shown in figure 2-1.

1. Define the problem.
2. Design a solution.
3. Write the program.
4. Compile, debug, and test the program.

Figure 2-1. Steps in developing a program.

b. The first step is to define the problem, that is, to determine the exact nature and extent of the problem to be solved. The next step, designing the solution, entails combining the four basic patterns of program logic to produce the required output. The third step, writing the program, means selecting the appropriate computer language and coding program statements in computer-acceptable form. The final step, compiling, involves encoding, that is, translating program statements into a form the computer can understand. Debugging involves correcting poorly written statements and eliminating logic errors. Testing means trying the program out to see if it processes data the way it was intended.

encode: convert the information into computer language.

2-5. DEFINING THE PROBLEM

a. **What Is the Desired Output?** When a programmer/analyst receives a request from management or other users, he begins by looking at the desired output. In defining the output required, the programmer prepares mock-ups to show his prospective users. In this way, the programmer can verify the output requirements, determine format, and avoid omissions or invalid assumptions about the purpose of the program.

b. **Input.** By reviewing the available data, the programmer can determine what new data is needed to provide the required information, and what format the input should be in.

c. **Processing.** With a clear statement of the desired output developed (in cooperation with the users and management) and the required input identified, the programmer can begin to outline processing requirements.

2-6. DESIGNING A SOLUTION

a. **Basic Logic Patterns.** In the design phase, the programmer takes each of the processing segments uncovered during problem definition (previous step), and works out a tentative program flow of what needs to be done first, second, and so on. To develop this tentative flow, the programmer uses the four basic logic patterns of a computer. There are four basic patterns that a computer can understand and execute: simple sequence, selection, loop, and branch patterns.

(1) Simple sequence. The simple sequence is the most simple and often-used pattern. In simple sequence, the computer executes one statement after another in the order given by the programmer. The computer will assume that all statements are to be executed in this way, unless told otherwise.

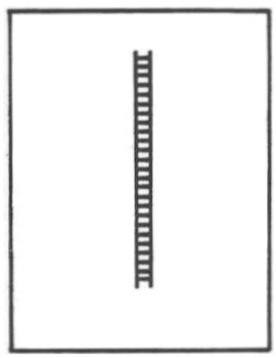


Figure 2-2. Simple sequence pattern: statements executed in order given.

(2) Selection. In selection, the computer must make a choice, based on whether one item is equal to, less than, or greater than another. (These are the only comparisons a computer can make. Complex selections are made by using a sequence of these comparisons.)

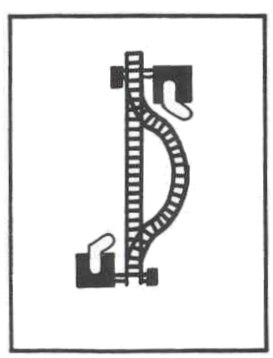


Figure 2-3. Selection pattern: computer chooses based on one item being greater or lesser.

(3) Loop pattern. The loop pattern enables the programmer to instruct the computer to alter the normal (consecutive) sequence and loop back to a previous statement in the program. In a payroll program, in which the same sequence of statements is executed for each employee; this eliminates duplication for each employee.

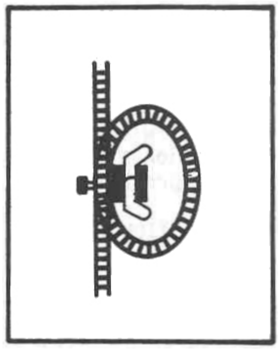


Figure 2-4. Looping pattern: computer loops back to earlier statement.

(4) Branching pattern. The branching pattern allows the programmer to skip past statements in a program. When all the employee payroll statements have been processed, for example, the computer can branch to the next set of statements in the program. Branching is somewhat controversial. When used a lot, it causes the computer to jump frequently from one part of the program to another, and makes it hard for other programmers to understand the program.

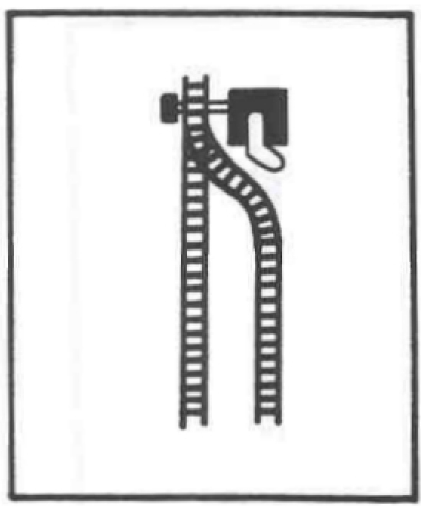


Figure 2-5. Branching pattern: computer skips past statements.

b. **Pseudocode.** The pseudocode is a narrative description of the processing steps used by the programmer in the design phase, to ensure that steps are not left out or are in error. The pseudocode allows the programmer to zero in on a step without concern for how it should be phrased in computer language.

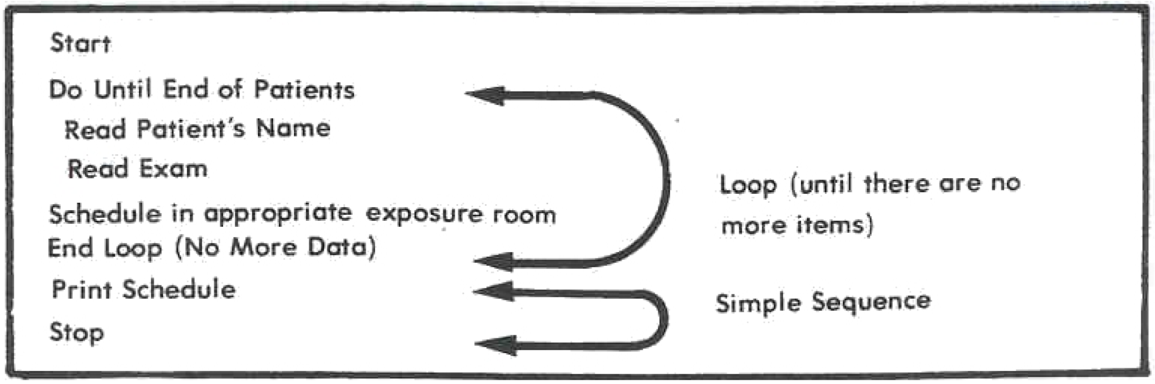


Figure 2-6. This pseudocode provides a narrative description of the processing steps for patient scheduling.

c. **Flowchart.**

(1) <u>Defined</u>. The flowchart is another device used to avoid design errors or omissions. Also known as a block or logic diagram, a flowchart represents the processing steps in visual form. It uses the English-like statements of the pseudocode and easily recognizable symbols in the same sequence in which they will occur in the program.

flowchart: a graphic representation of the processing that is performed in a program.

(2) <u>Uses</u>. A flowchart can be a useful working document for tracking the evolution of a program and for updating. To enhance readability, standard ANSI (American National Standards Institute) flowchart symbols are used. The start or stop of a program is represented by the symbol ⬭. A process step (addition, subtraction, and so forth) is shown by the symbol ▭. This symbol will occur frequently in a flowchart because most data manipulation involves some kind of process. The ◇ symbolizes a comparison or decision, a program statement that directs the computer to compare values. At a decision step, the computer may take one of two paths (represented by two exit lines leaving the decision block). If the result of the comparison is true, one path is executed. (See figure 2-9.) If the result is false, the other is taken. Finally, the symbol ▱ indicates that the program requires either input or output of data. A list of ANSI flowchart symbols is shown in figure 2-8.

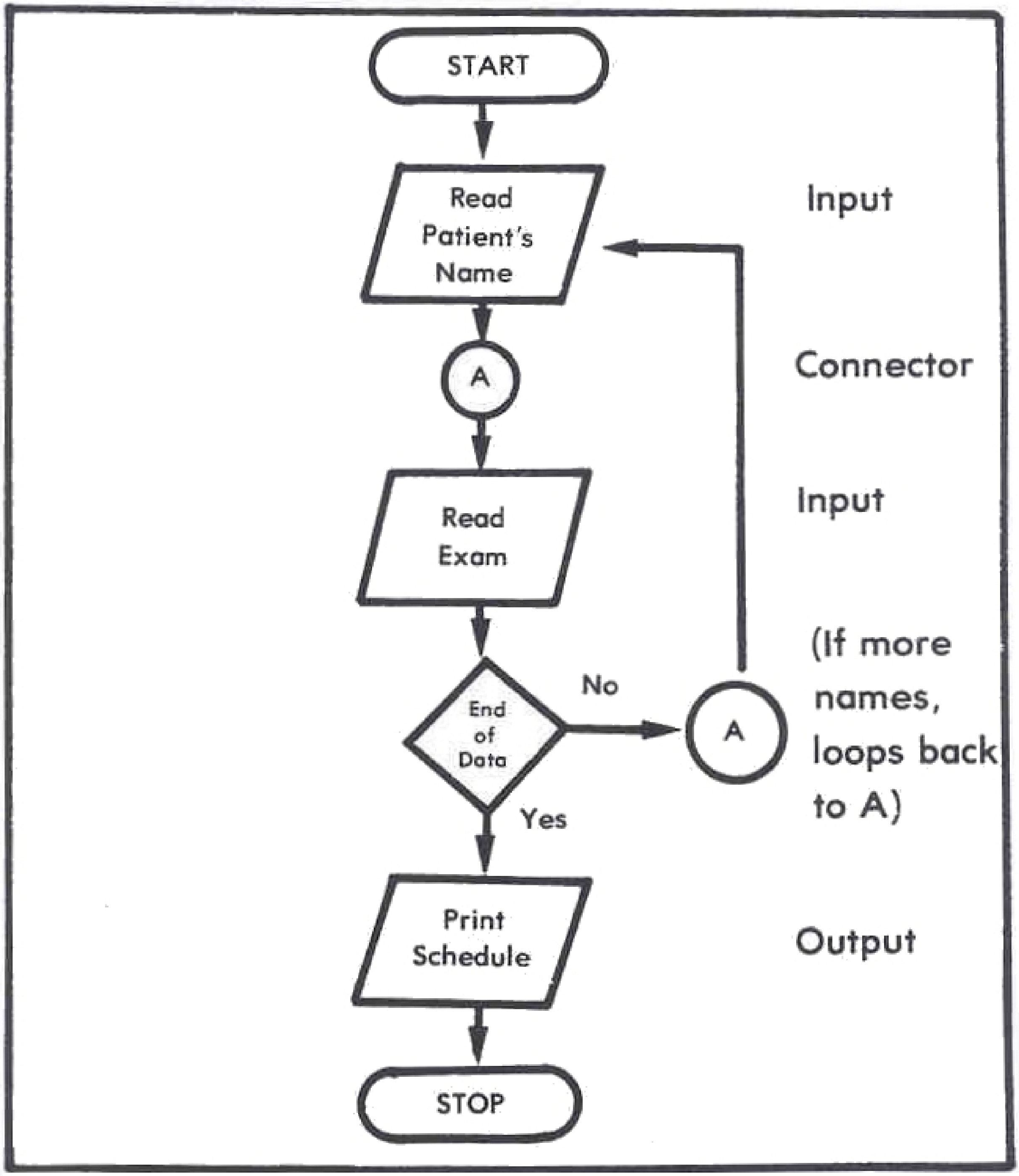


Figure 2-7. This flowchart provides a graphic representation of the processing steps for patient scheduling.

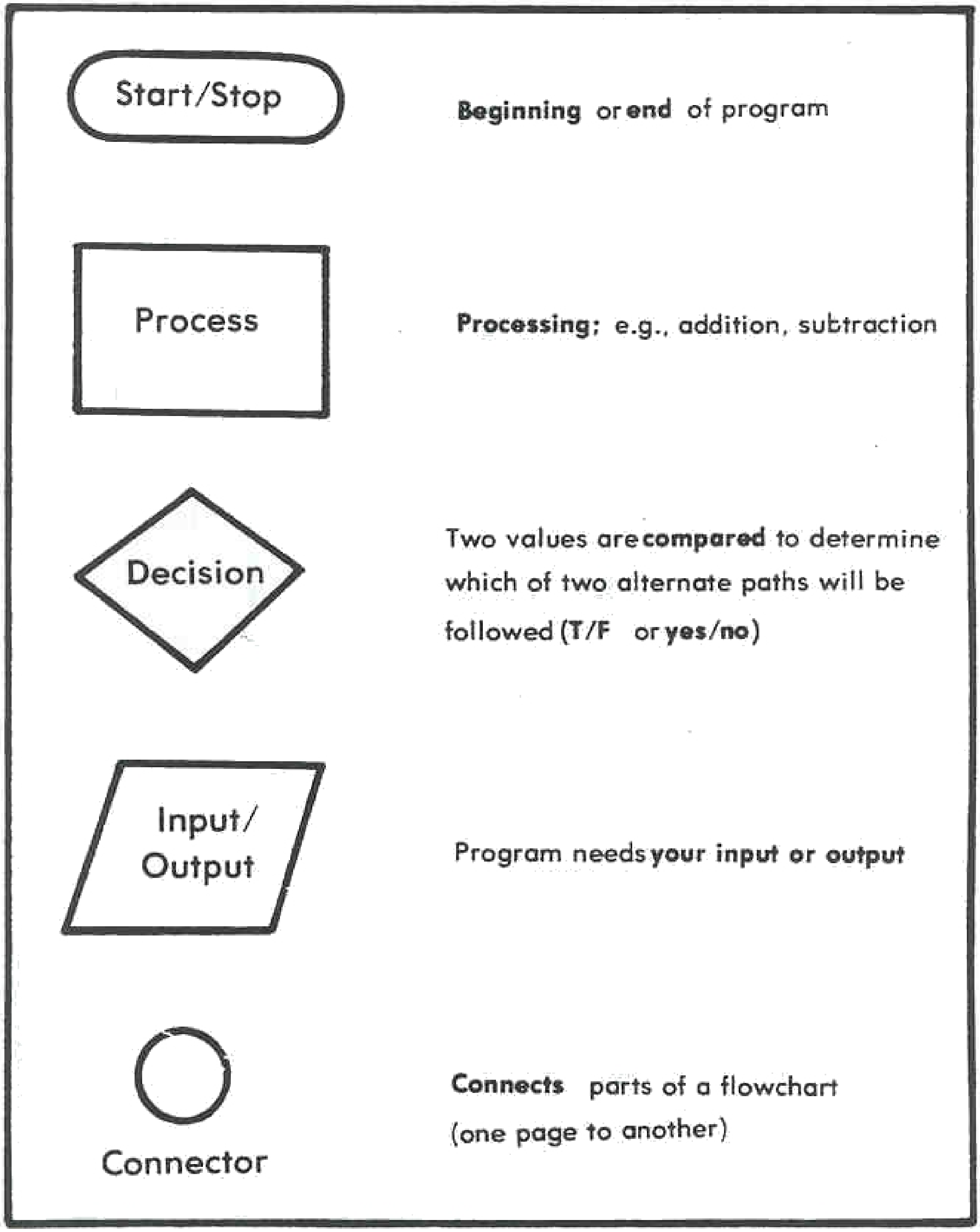


Figure 2-8. ANSI flowchart symbols.

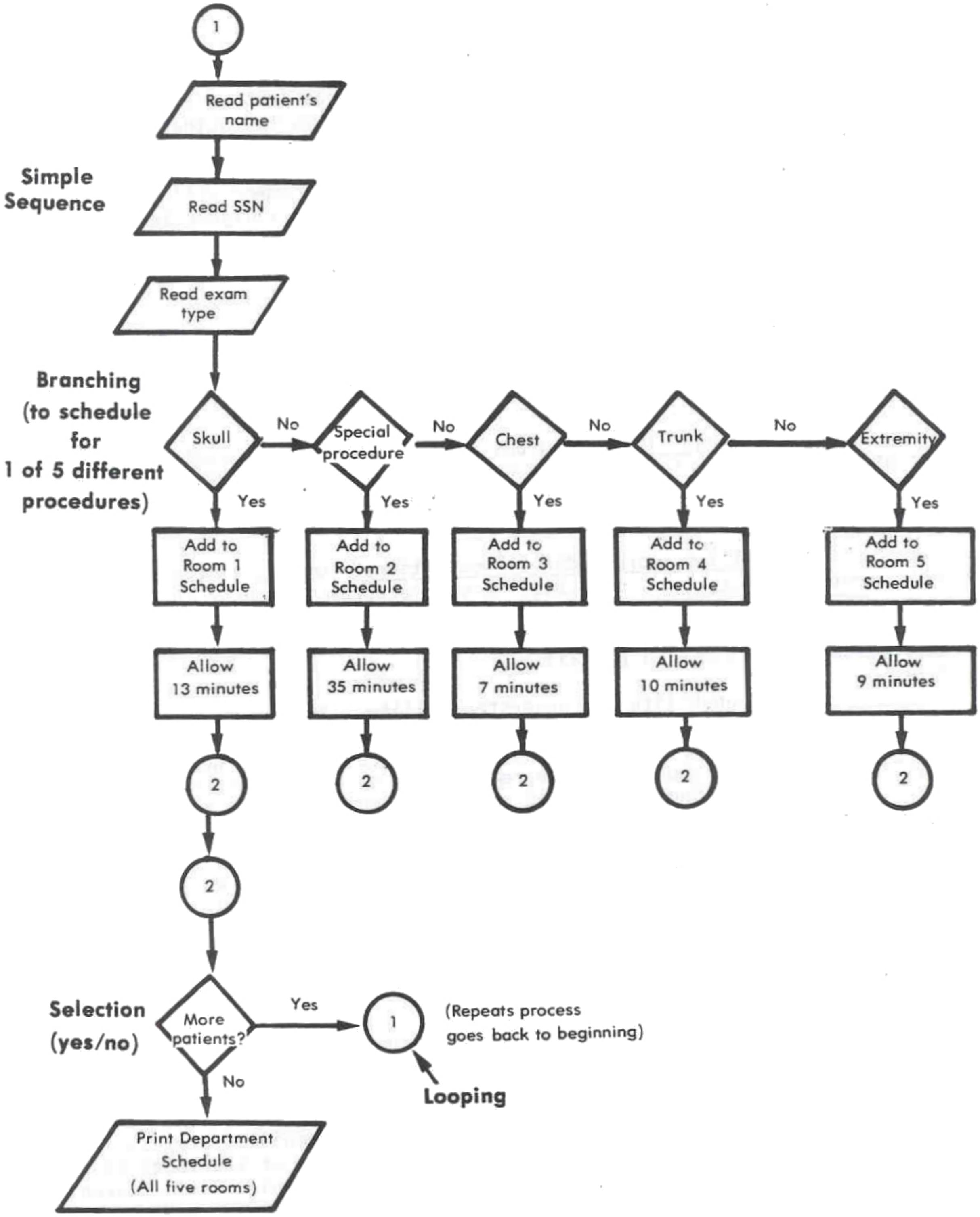


Figure 2-9. The four logic patterns represented in flowchart form.

2-7. WRITING THE PROGRAM

a. **Choosing a Programming Language.** With the problem defined, and the solution designed, the programmer can proceed with the actual writing of the program. First, the programming language best suited to the specific application must be chosen. For example, COBOL is normally used for business applications, FORTRAN for science. Sometimes, a programmer will not have a choice of languages, the selection having been made at a higher level. COBOL, for example, is often required for business because of its readability. (Programming languages will be discussed more fully later in the lesson, in Section II.)

b. **Desirable Program Qualities.** There is always more than one way to code a program to provide the correct solution. The programmer should, therefore, keep in mind not only solving the problem, but making the program reliable and user friendly.

(1) <u>Reliability</u>. Programs should consistently produce the correct output. Logic tests, formulas, and computations should be accurate to ensure reliability. For example, all checks and deposits on a bank statement should be accurately reflected with 0 mistakes.

(2) <u>Will it work under all conditions</u>? What will the program do if a person's age is input as 4,892? A good program that uses the age of a person as input should have a test, or error trap, for incorrect ages built onto it. Otherwise, despite the internal logic of the program, “a garbage in, garbage out” syndrome will prevail.

(3) <u>Readability and understandability</u>. The programmer should do everything possible to ensure that the user can read and understand the program easily. For example, data names should be descriptive, not short and cryptic. The format should enhance readability of statements, not cloud meaning. A variable holding a name need not be called "x$" when it could be called "names $." (The dollar sign is used to represent text rather than numbers.)

(4) <u>Maintainability</u>. Programs should be written so that updating and revision are easily accomplished. By writing a program in independent segments, for example, a change in one section will not automatically necessitate a change in others.

2-8. COMPILING, DEBUGGING, AND TESTING THE PROGRAM

a. **Compiling.** Most programs are written in hi h-level or assembly language. Once written, they must be compiled or translated into a form that computer will understand. A language translator program does the job of encoding (converting) the program into machine executable form. As an aid to he programmer, a list of errors detected during the compiling process is generated. The list includes syntax errors: violations of the rules associated with the particular programming language (for example, data entered in the wrong column), misspellings of language keywords (such as WRITE or COMPUTE), grammatical and punctuation errors.

b. **Debugging.** Other, more subtle types of errors will be detected in the debugging phase. These are logic errors that result when the programmer hasn’t fully understood the problem or when he has not fully accounted for problems that might arise during processing. In fact, one-third to one-half of the programmer s time is spent debugging the program. For example, a logic error would result if the programmer told the computer to go to a program line that didn’t exist. In an "a-b-c-d" multiple choice test item, the programmer might have omitted alternative "d."

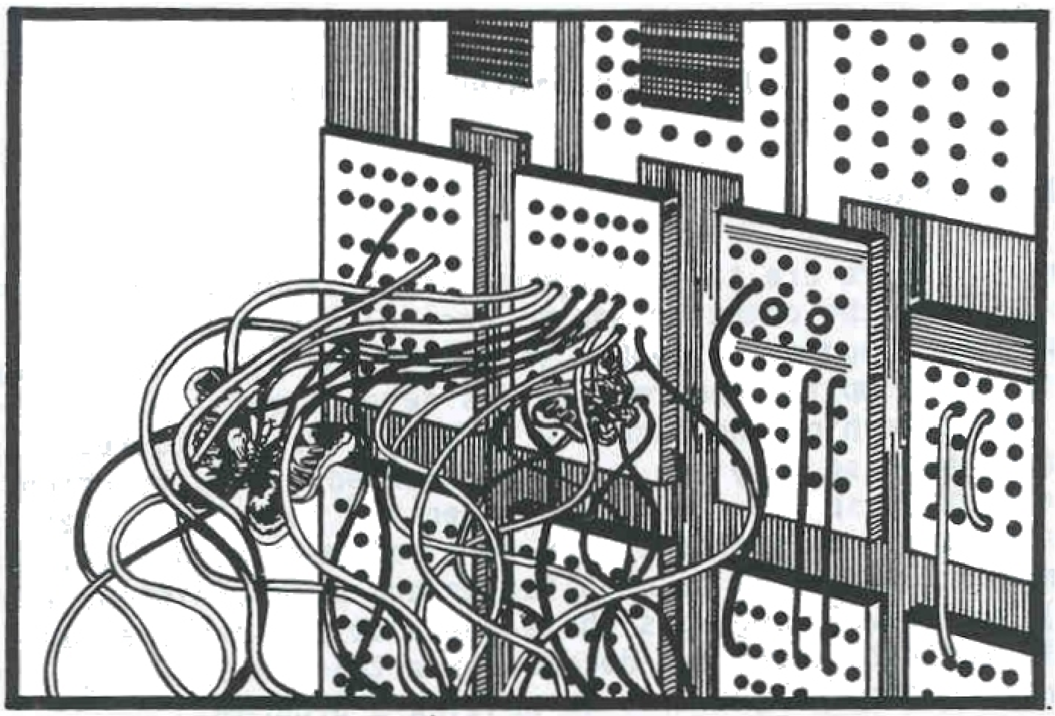


Figure 2-10. Origin of the term “debugging.

debugging: locating, isolating, and eliminating errors found in the program.

c. **Testing.** In the testing phase, the programmer actually executes or tries out the program, using sample or facsimile input data whose results he knows and understands. In this way, it will become clear if the program produces the desired results. The programmer might also enter invalid data to ensure that they are detected and/or bypassed. A complex program is written and tested in separate units so that errors can be isolated to one specific section. Error traps should be written to detect invalid data that repeatedly result in improper execution of the program. The programmer will strengthen error traps, that is, write program lines that will detect inappropriate user responses. Questions will be re-asked if the user enters numbers where text should have been entered, or if zero is the answer to a question where a higher number should have been entered. Programmers often swap partially debugged program with colleagues, so that a fresh perspective is gained on the clarity and error-freeness of the program.

2-9. PROGRAM DOCUMENTATION

It is important that the programmer provide written documentation to support the program. It is important to the client in understanding the program, and is useful if updating or further debugging is required. Documentation includes the flowchart, the pseudocode or narrative description of the program steps, sample input and output data, an explanation of any techniques use by the programmer, andspecific guidance needed by the user.

Section II. PROGRAMMING LANGUAGES

2-10. LEVELS OF LANGUAGE

a. **General.** There are three language levels that programmers may use to communicate with the computer and to control program execution. These three levels, machine language, assembly language, and high-level language, have evolved with the computer and reflect its development toward increasing sophistication. Both machine and assembly language are considered low-level languages because they are machine-oriented. They function at extremely fast operating speeds. Even the lowest computer can work much faster than humans. (Therefore, even if a “slower” high-level language is used, the computer will still be much faster and more efficient than a human could be.) Low-level languages share one distinct disadvantage: they are extremely difficult to learn and decode. For this reason, high-level languages are preferred by programmers in writing a program.

decode: translate from computer to human language.

b. **Machine Language.** The oldest language, this is the only one the computer can execute directly. It is the language of zeros and ones that designates the electrical states in the computer. Machine language is rarely used to write programs because it is complex and time-consuming. Each instruction must specify both the operation to be done and the storage location of data items. It is nontransferable, that is, each type of computer has its own machine language.

c. **Assembly Language.** As with machine language, the programmer must designate both the operation and the storage location of the data. But instead of 0s and 1s, convenient symbols and abbreviations, more easily understood by humans, are used. “STO”, for example, may stand for STORE: TRA” for TRANSFER. Though one step removed from machine language, it is still difficult to program in assembly language and, therefore, it is not commonly used for this purpose.

d. **High-Level Programming Languages.** These languages are more frequently used to write programs because they permit the programmer to concentrate on the problem rather than the details of computer operation. They are easier to learn and use, because they employ English-like terms and mathematical symbols. One high-level language statement will accomplish the same result as a half-dozen or more machine language instructions, mainly because the storage locations of data are handled automatically rather than specified. High-level languages require less time to write, provide better documentation, and are easier to maintain. They are somewhat slower than low-level languages, and need to be translated by the computer into machine language. Their advantages far outweigh the disadvantages as a program development tool.

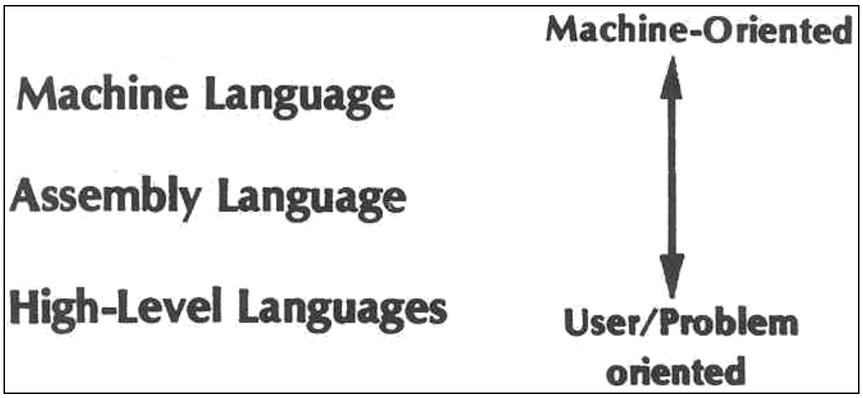


Figure 2-11. Machine vs. user orientation of programming languages.

2-11. HIGH-LEVEL LANGUAGES

a. **FORTRAN (FORmula TRANslation).** As stated earlier, high-level languages are written for people, understood by people, and suited for specific applications. FORTRAN was developed in 1954, specifically to solve scientific and mathematical problems.

b. **COMMON BUSINESS ORIENTED LANGUAGE.** Common Business Oriented Language was designed in 1960, with business data processing applications in mind. Common Business Oriented Language is well- suited to the retrieval of data from files. It can process files in an individualized manner, and look up indexed files efficiently, for example, files indexed by client zip codes.

c. **PROGRAM LANGUAGE, FIRST EDITION.** Promoted in the mid-1960s by IBM as a universal language, Program Language, First Edition (PL/I) combines the scientific mathematical capabilities of FORTRAN with the business orientation of COBOL. Program Language, First Edition is a very powerful language with many features. Less wordy than COBOL, it is designed for use by both beginners and experienced users. Because it is such a powerful language, a large amount of storage is required for its compiler. This means it can't be used on smaller computers. But as mini- and microcomputers become more powerful, subsets of PL/1 may be successfully applied.

d. **Beginner's All-purpose Symbolic Instruction Code.** Beginner's All-purpose Symbolic Instruction Code (BASIC) was developed in 1963 at Dartmouth University, for use with time-sharing systems. The growth of time-sharing systems has been accompanied by a growth in the use of BASIC. BASIC is simple to learn, flexible, and applicable to both science and business. It is the most widely use of the high-level languages and comes packaged with most microcomputers. The increasing popularity of microcomputers in home as contributed to the growth of BASIC, since it is the language most often supported by these microcomputers.

e. **Algorithmic Language.** Algorithmic Languag**e** (ALGOL) was developed in 1957 by an international group of mathematicians for mathematical applications, it is used extensively in Europe.

f. **PASCAL.** PASCAL is the only language mentioned here whose name is not an acronym. Named after the French philosopher and mathematician, Blaise Pascal, it was developed by Niklaus Wirth, a computer scientist from Switzerland, in the early 1910s. PASCAL is a very structured language, suited to both scientific and business applications. It is relatively easy to learn like BASIC, powerful like PL/1, and (unlike PL/1) suited for use on microcomputers. It is a good alternative to BASIC for small computers.

g. **A Programing Language.** A programing language (APL) developed by Kenneth Iverson in 1962, and made available through IBM in 1968 is used primarily for time-sharing on large mainframe computers. Several businesses use APL as their programming language. A programing language is well-suited to formula-type problems because APL codes can be combined to perform some very complex operations with a minimum of coding. A programing language is oriented to formula-type problems and competes with FORTRAN in this area.

h. **Massachusetts General Hospital Utility Medical Programming System.** Massachusetts General Hospital Utility Medical Programming System (MUMPS) was developed by Massachusetts General Hospital for the management of general hospitals, with some segments designed specifically for radiology departments. Massachusetts General Hospital Utility Medical Programming System is used in laboratory test reporting, automated patient histories, patient summary reports, critical patient care planning, medical education, medical examinations, automated medication systems, physician-generated narrative notes, and for statistical information.

```
10 REM *** multiplication drill program
20 REM
30 REM **variable definitions
35 REM N$ = student name
40 REM a = first factor
50 REM b = second factor
60 REM c =correct response
70 REM s = student response
80 REM cr = number of correct responses
90 REM ir = number of incorrect response
100 REM sc = score
110 REM
120 CR = 0:IR = 0
125 CLS:  REM clear screen
130 PRINT “MULTIPLICATION DRILL”
135 PRINT
140 INPUT “what is your name”; N$
145 PRINT
150 PRINT “Pay attention.  “;N$”.  This is a test of your”
160 PRINT “knowledge of the multiplication tables.  You will be”
165 PRINT “asked to multiply twenty pairs of numbers.  Consider”
170 PRINT “your answers carefully.  Your whole future could hang”
175 PRINT “in the balance.”
178 PRINT “
180 PRINT “A score of 85 is considered passing.  Good luck!”
190 PRINT
200 REM *** loop through sequence of questions
210 FOR J = 1 to 20
212 RANDOMIZE TIMER
215 PRINT
220 LET A = INT (RND (10) * 10)
230 LET B = INT (RND (10) * 10)
240 REM * compute correct answer
250 C = A * B
260 REM * obtain student response
270 PRINT “Sorry, the correct answer was “C”.  Tisk, tisk”
310 IR = IR + 1
320 GO TO 400
350 PRINT “Congratulations.  This is a correct answer!"
360 CR = CR + 1
400 NEXT J
450 REM *** compute final score
460 SC = (C/(CR + IR))* 100
470 IF SC <85 THEN 500
475 PRINT:PRINT
480 PRINT “Good work, “N$”.  Your score was “SC”.  85 was considered passing.
490 STOP
500 REM * failing score routine
505 PRINT:PRINT
510 PRINT “Too bad, “N$”.  You failed with a score of “SC”.  85 was passing.”
520 PRINT “Too bad, “N$”.  You failed with a score of “SC”.  85 was passing.”
530 STOP   “Keep practicing.  You CAN improve!"
```

Figure 2-12. Example of a computer program written in BASIC.

Continue with Exercises

EXERCISES, LESSON 2

INSTRUCTIONS. The following exercises are to be answered by marking the lettered response that best answers the question or best completes the incomplete statement or by following the special instructions.

After you have completed all the exercises, turn to, "Solutions to Exercises" at the end of the lesson and check your answers.

SPECIAL INSTRUCTIONS: MATCHING. For exercises 1 through 5, match each programming language to the appropriate description. Enter the letter you have selected in the space provided. (There is one extra lettered statement that will not be used.)

1. FORTRAN _____
2. PASCAL _____
3. BASIC _____
4. COBOL _____
5. ALGOL _____

a. Used extensively in Europe.

b. Packaged with most microcomputers, for science and business; easy to learn.

c. Developed for scientific and mathematical applications.

d. Business data processing applications; retrieves data from files easily.

e. Used for microcomputers; scientific and mathematical applications; very structured; named after a philosopher.

f. Developed for use in hospitals.

SPECIAL INSTRUCTIONS: MATCHING. For exercises 6 through 11, match each term to the appropriate description. Enter the letter you have selected in the space provided. (One lettered statement will not be used.)

6. PL/I _____
7. MUMPS _____
8. Machine language _____
9. High-level languages _____
10. Assembly language _____
11. APL _____

a. Oriented to both the machine and the user.

b. Language of 0s and 1s; rarely used to write programs.

c. Uses convenient symbols and abbreviations, instead of 0s and 1s; but still difficult to program in this language.

d. Used in hospital applications.

e. Powerful language, requiring substantial storage for its compiler; not suited to small computers. Combines science, math, and business applications.

f. Easier to write programs in; storage locations of data handled automatically. Written for and understood by people.

g. Suited to formula-type problems; handles complex problems with minimum of coding; used for time-sharing on mainframes.

SPECIAL INSTRUCTIONS: MATCHING. For exercises 12 through 15, match the logic patterns represented in the sketches, to their designated title (a, b, c, or d). Enter the letter in the space provided.

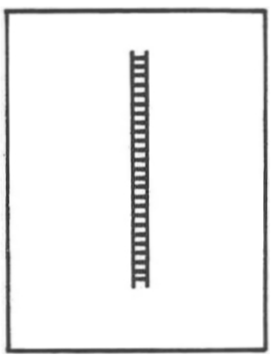
a. Selection

b. Branching

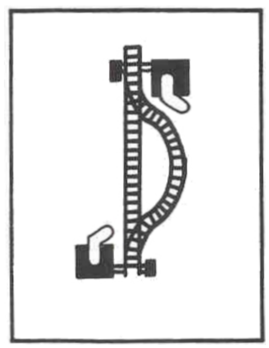
c. Looping

d. Simple sequence

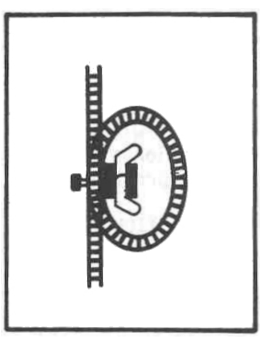
12. _____



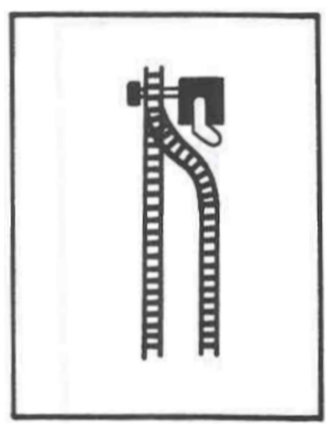
13. _____



14. ______



15. _____



16. The first thing to do when purchasing a computer system is to select:

a. Hardware and then the software that will go along with it.

b. Programs that will permit you to do the kinds of things you need to do.

c. Type of printer you can afford.

d. The CPU that will give you maximum storage capacity.

17. A computer program provides the computer with:

a. Strategies for problem-solving using reason, intelligence, and intuition.

b. General instructions that the computer can then break down into specific steps.

c. Step-by-step instructions that anticipate conditions that might arise.

d. Instructions that tap into the innate intelligence of a computer.

18. During the problem-definition phase of program writing, the programmer considers the desired _________________________ to determine format requirements, avoid omissions and invalid assumptions.

a. Input

b. Output

c. Processing

d. Programming languages

19. By looking at the data that are available, the programmer can determine:

a. Additional input requirements and format for the data.

b. The best way to write the program.

c. If the problem can be solved.

d. If there will be a significant number of bugs in the program.

20. The final step in defining the problem is to identify ________ requirements.

    a. Input

    b. Output

    c. Compiling

    d. Processing

21. Which of the following is NOT used by the programmer in the design phase to develop a tentative program flow?

    a. A flowchart

    b. A pseudocode

    c. Debugging techniques

    d. Logic patterns

22. In the design phase, the programmer uses ________________, a narrative description of the processing steps, to ensure that steps are not left out inadvertently.

    a. A branching pattern

    b. A pseudocode

    c. An algorithm

    d. A low-level language

23. The _______________, a graphic representation of the processing flow, is used in the design phase to avoid errors and omissions, track the evolution of the program, and as a reference for the client for subsequent updating.

a. Flowchart

b. Pseudocode

c. Logic patterns

d. Compiler

24. In addition to being coded to provide the correct solution, a good program is designed to be reliable and _______________________

a. Compatible with any hardware.

b. Easily translated into machine language.

c. Written in a universal language.

d. User-friendly.

25. If a program uses a person's age as input, it should include a test for ages to avoid:

a. Compatibility problems.

b. Syntax errors.

c. The "garbage in, garbage out" syndrome.

d. Program overload.

26. Writing a program in independent segments will:

a. Make revision and updating easier.

b. Enhance readability.

c. Ensure greater reliability.

d. Limit the number of programming languages in which it can be written.

27. The language-translator compiles the program from the language in which it was written into:

a. Other high-level languages.

b. Machine executable form.

c. An error-free form.

d. Assembly language.

28. The language-translator also provides a list of:

a. Error traps.

b. Logic errors.

c. Syntax errors.

d. Invalid input data.

29. One-third to one-half of a programmer's time is spent ______________the program.

a. Compiling.

b. Debugging.

c. Testing.

d. Designing.

30. Logic errors, identified during debugging, arise when the programmer has:

a. Used incorrect grammar.

b. Made punctuation errors.

c. Failed to observe the basic rules of the programming language.

d. Overlooked problems that might arise during processing.

31. The programmer instructs the computer to go to a program line that doesn't exist. This is an example of a/an:

a. Logic error.

b. Syntax error.

c. Error trap.

d. Grammatical error.

32. The age of an individual is incorrectly entered as 420 instead of 42. The error is not detected by the program. This demonstrates a need for a/an:

a. Logic error.

b. Error trap.

c. Flowchart.

d. Pseudocode.

33. During the testing phase, the programmer enters invalid data in order to ensure that it will be:

a. Corrected.

b. Computed.

c. Detected and/or bypassed.

d. All of the above.

34. The pseudocode, sample input-output data, flowchart, and explanation of special techniques used by the programmer are useful ________________________ and should be turned over to the client.

a. In understanding the program.

b. For further updating of the program.

c. For further debugging.

d. For all of the above.

35. The logic pattern that permits the programmer to skip past statements in a program is:

a. Simple sequence.

b. Selection.

c. Looping.

d. Branching.

36. The most common logic pattern, the one that prescribes executing one statement after another in the order given is:

a. Simple sequence.

b. Selection.

c. Looping.

d. Branching.

37. The computer has calculated projected retirement benefits for employee A. It must next perform the same calculations for employee B. What logic pattern would be used to alter the normal sequence, and get the computer to repeat the last 10 steps for employee B?

a. Simple sequence.

b. Selection.

c. Looping.

d. Branching.

38. A programming statement calls for the computer to determine whether a new insurance premium is equal to, less than, or greater than the old premium. What type of logic pattern is involved?

a. Simple sequence.

b. Selection.

c. Looping.

d. Branching.

39. This logic pattern causes the most difficulty when used a lot because it makes the computer jump back and forth.. It is the:

a. Simple sequence.

b. Selection pattern.

c. Looping pattern.

d. Branching pattern.

Check Your Answers on Next Page

SOLUTIONS TO EXERCISES, LESSON 2

1. c (para 2-11a)
2. e (para 2-11f)
3. b (para 2-11d)
4. d (para 2-11b)
5. a (para 2-11e)
6. e (para 2-11c)
7. d (para 2-11h
8. b (para 2-10b)
9. f (para 2-10d)
10. c (para 2-10c)
11. g (para 2-11g)
12. d (para 2-6a(1))
13. a (para 2-6a(2))
14. c (para 2-6a(3))
15. b (para 2-6a(4))
16. b (para 2-3)
17. c (para 2-2)
18. b (para 2-5a)
19. a (para 2-5b)
20. d (para 2-5c)

21. c (para 2-6)

22. b (para 2-6b)

23. a (para 2-6c)

24. d (para 2-7b(3))

25. c (para 2-lb(2))

26. a (para 2-8c)

27. b (para 2-8a)

28. c (para 2-8a)

29. b (para 2-8b)

30. d (para 2-8b)

31. a (para 2-8b)

32. b (para 2-7b(2))

33. c (para 2-8c)

34. d (para 2-9)

35. d (para 2-6a(4))

36. a (para 2-6a(1))

37. c (para 2-6a(3))

38. b (para 2-6a(2))

39. d (para 2-6a(4))

End of Lesson 2

LESSON ASSIGNMENT

LESSON 3 Computer Applications in Business and in Health Care.

LESSON ASSIGNMENT Paragraphs 3-1 through 3-32.

LESSON OBJECTIVES After completing this lesson, you should be able to identify by selecting from alternatives:

3-1. Three ways in which computers are used by management.

3-2. Six types of computer systems and their uses in health care facilities.

3-3. Communication devices of the medical information system.

3-4. How a computer tracks patients to discharge.

3-5. The advantages of computer-assisted instruction in training health-care providers.

3-6. Uses of the computer in the radiology department.

3-7. Pros and cons of computerization.

3-8. Solutions to the problems associated with computerization.

SUGGESTION After completing the assignment, complete the exercises of this lesson. These exercises will help you to achieve the lesson objectives.

Section I. MANAGEMENT APPLICATIONS

3-1. INTRODUCTION

The electronic wizardry of the computer is changing the looks and operations of modern-day offices and hospitals. Twenty years ago, it would have been difficult to find very many computers. Even 10 years ago, only the largest businesses could rationalize the expense and cautiously ventured into electronic data processing. Today, it is hard to visualize not having computers. The automated office combines electronics with data processing. There are now terminals where typewriters used to be, machines that make and answer routine phone calls, conferences conducted by video rather than around a table, electronic and audio mail instead of the printed kind, software files instead of filing cabinets, and so on. This lesson explores the uses of the new technology in business (management applications) and in health care (medical information systems).

3-2. WORD PROCESSING

a. **What It Is.** Word processing, writing with a computer, is the most common use of computers, both in business and in the home. Word processing makes it possible to prepare material in a manner far more efficient than writing by hand or typing. Words appear on a visual display screen rather than on paper. Also, part of the word processing system are a printer that can print letter-quality type, a keyboard from which the user enters text, and an auxiliary storage (that normally uses cassettes, floppy disks, or hard disks) to store documents for revisions or reuse. A stand-alone microcomputer system includes the same basic components as a larger system. In a larger system, the computer may be a large centrally located machine that does many other data processing functions on a time-sharing basis. Such a system may include several terminals, keyboards, auxiliary storage devices, and printers, all controlled by one CPU. Users work at terminals that are functionally their own personal word processing systems.

b. **What It Can Do.** Word processing is a more efficient way of writing. Because the draft appears on the screen, you can correct mistakes, change margins, and delete or insert paragraphs as you compose text. You can also merge documents already in storage or merge documents to new text before printing. In addition, a spelling program can check for spelling errors. While only a portion of the entire text (about half a page or 24 lines) appears on the screen at one time, if you need to check your document for flow you can print a hard (paper) copy with just the press of a key. In addition to providing sophisticated word processing functions, computers can merge data with text, process files, perform mathematical functions, generate the output of photocomposition devices, facilitate paperwork management (electronic filing), accept input from optical character recognition devices, and accept (typewriter-created) text for transfer into word processing systems. Some systems can communicate with other word processing systems and distribute text after it has been created, allowing documents prepared in one location to be printed in other locations.

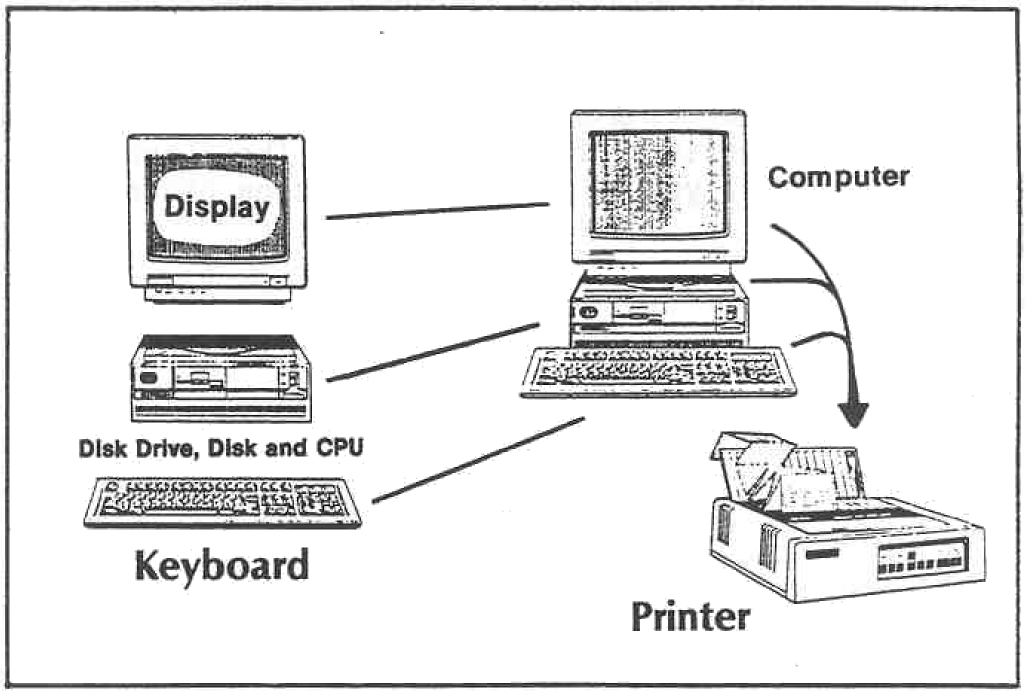


Figure 3-1. Word processing system components.

3-3. DATA BASE MANAGEMENT SYSTEMS

a. **Management Information Systems.** Organizations have always had management information systems (MIS), that is, methods of gathering, processing, and distributing data. With the widespread use of computers in the work place, managers began to recognize the potential for using computers beyond simple reporting. They realized the computer could be used for generating information to support decision-making. This application, known as management information, requires some form of general data storage so that multiple users with varied applications can have access to the right information at the right time, to make informed decisions.

management information systems: a formal computer information network that allows multiple users with different applications access to both routine reports and on-the-spot information for decision-making.

b. **Data Base.**

(1) <u>Traditional data storage</u>. The traditional way of designing files was for the programmer to create a file (group of records) for each application. It is meant that the same data might be found in many different files, creating significant duplication. Every program using the same file had to describe that file in detail. This design method was expensive, since duplication meant extra storage space. It was also inefficient: to change the file in any way meant that every program using that file had to be changed.

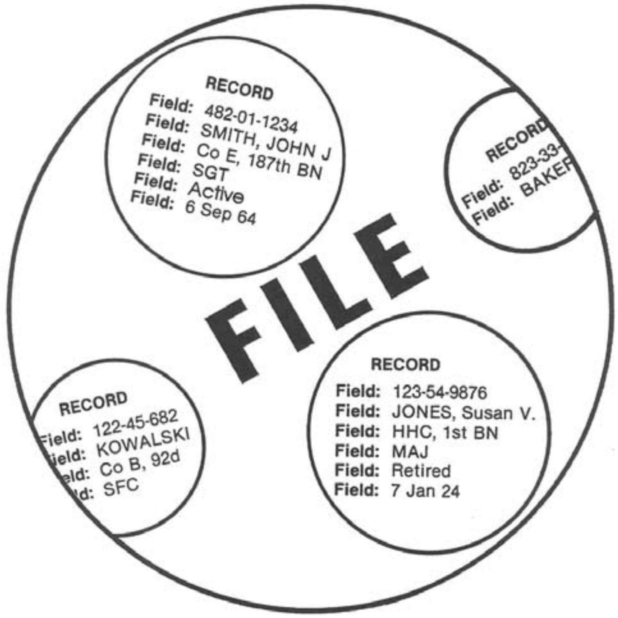


Figure 3-2. The data base contains fields, records, and files.

file: a group of related records.

record: a collection of fields relating to a single unit.

field: a meaningful item of data in a file, that is, a Social Security number.

(2) Database. The database, a general data storage system developed in the 1960s, is at the heart of the modern management information systems. Designed to eliminate the ills of more traditional data storage methods, it serves the needs of a variety of users with a minimum of duplication. Data are described according to inherent characteristics and independently of the instructions that process it in application programs. For example, patient data for radiology might best be filed according to type of radiographic exam. However, to make these data generally adaptable to the needs of all departments, they would be entered in the data base according to patient name.

c. **Independent Data.** A database promotes efficiency because records can be added, changed, or deleted without changing all of the application programs that refer to that data. The data are, thus, independent.

database: the basic data, a collection of interrelated records, structured to meet the information needs of a wide variety of users with a minimum of duplication.

d. **Other Features of a Database.** The database, however, is more than just a collection of files, it is a collection of data elements that have various relationships to one another. Think of the files in a database like the books in a library. In a library, there are many books (files). Some books have footnotes. These footnotes establish relationships between data elements in one book (file) and data elements in other books (files). The footnotes establish relationships between different books that go beyond book (file) boundaries. Similarly, a database, through its cross- referencing, establishes relationships between different files.

e. **Data Base Management System.** The software that enables a data base to be defined, created, retrieved, and modified by a variety of users as needed is called a database management system (DBMS).

> **database management system:** a set of programs that provides a method of storing, manipulating, retrieving, and displaying information in the database. These methods minimize duplication, permit changes easily, and feature- a capability to handle direct inquiries.

(1) <u>Consists of versatile programs</u>. The DBMS consists of a series of versatile programs that can sort information in many different ways. Information, entered in the form of records, contains all the necessary information about a specific item in the database. The programs in the DBMS can selectively sort records or generate lists. The main function of the DBMS is to create, maintain, and process the database independently of the application programs that need to use it. The programmer specifies the data elements that are needed for the program and the form in which they should appear. The DBMS finds those elements, arranges them as desired, and presents them to the program.

(2) <u>A set of tools for accessing information</u>. The data base management system is a set of tools that provides users with access to data in a database. Data base management systems vary as to efficiency and speed with which information can be retrieved from the database. The quality of a DBMS will depend on the skill of the data base designer and user in structuring the data base so that data can be accessed with a minimum of steps.

3-4. SPREADSHEETS

a. **An Electronic Financial Worksheet.** In 1980-81, the spreadsheet, an electronic version of the financial worksheet, provided yet another important tool for management. Anyone who has tried to plan a budget knows how time-consuming it can be to enter columns and rows of figures accurately and efficiently. Too much time is spent unproductively recalculating totals that have to be changed every time one or another number in the worksheet is changed.

A	B	C	D	E	F	G
		PATIENT EXAMS – TMC				
		1987	1988	1989	Increase 88–89 Actual	Increase 88–89 Percent
Chest		450	492	520	28	5%
Skull		81	78	101	23	23%
Spine/Abd		123	135	122	–13	–11%
Extremity		224	254	278	24	9%
Other		59	73	82	9	11%
TOTAL		937	1,032	1,103	71	6%

Figure 3-3. The electronic spreadsheet computerizes the preparation of columns and rows of figures.

b. **Advantages.** Spreadsheet software products eliminate this type of error and make it possible for financial analysts to produce more iterations of numbers in the same format. Since spreadsheet software has the potential to do the same amount of work in a lot less time or to do more work in the same amount of time, managers can do a lot more “what if” thinking. By changing the data in any column, row, cell or formula, planners can predict the consequences of any number of changes. Some spreadsheets can integrate with word processing programs, thus allowing calculated information to be presented in table format.

Section II. COMPUTER SYSTEMS IN HEALTH CARE

3-5. INFORMATION IN A HEALTH CARE ENVIRONMENT

Accurate and efficient information processing is crucial for any medical system or hospital. A hospital exists, after all, to permit doctors to gather information about their patients, and order therapy based on that information. Treatment depends, first, on relaying findings correctly and quickly, and second, on conveying the physician’s orders with equal speed and accuracy. It is quite common for hospital employees to spend one-fourth to one-third of their time dealing solely with information. Nurses can spend -up to two-thirds of their time in this way. And, just as computers have become an integral part of airline reservations systems, automated banking transactions, and telephone system dialing and billing, they have also become central to the speedy and accurate dissemination of information in hospitals and medical systems.

3-6. BENEFITS OF AUTOMATION

Through a variety of computer systems, data are stored and sent automatically, upon request, for action by the appropriate health care provider. Use of the computer offers the advantage of a greater level of speed and accuracy to the information transmitted throughout the hospital. In addition to data processing tasks, such as: sorting, copying, filing, summarizing, and checking for abnormal data, the computer does such things as preparing bills for services and supplies. The computer performs a variety of tasks that would otherwise be accomplished by physicians, nurses, technologists, clerks, and other hospital personnel. And it processes both medical data (physician's orders, test results,and so forth) and administrative data (responsible party statements, insurance coverage, and so forth).

3-7. TYPES OF SYSTEMS

Six major types of computer system are used in health care facilities.

a. **Office Automation Systems.** Scheduling, memo keeping, and record keeping are handled on this system, which combines word processing and data processing with new advances, such as electronic data processing.

b. **Financial/Administrative Systems.** This type of system is generally operated on a large mainframe or on minicomputers, and automates patient billing, accounts receivable, accounts payable, general ledger, personnel/payroll, and property management.

c. **Departmental Information Systems.** Designed to assist individual departments, such as, radiology, with their information management; these -function independently, but may share some information with other systems.

d. **Decision Support Systems.** Systems, such as, financial modeling, planning, and case-mix analysis help managers analyze data produced by other computer systems.

e. **Microcomputer Systems.** Microcomputers are used to download (copy) data from a minicomputer or mainframe, so that data can be manipulated without having to use the slow time-sharing speed of the central computer. Microcomputer systems are also used as initial input devices for order entry or results reporting. A third use is independent word processing or financial analysis.

download: receive or capture electronically; copy a file or any portion thereof.

f. **Medical Information System--**(known also as automated hospital information system, patient care system, patient information system, or order entry and communications system). A medical information system can track a patient from admission to discharge. It also permits outpatient clinics and physician offices to communicate with inpatient areas and other services.

3-8. MEDICAL INFORMATION VS. DEPARTMENTAL SYSTEMS

a. **Degree of Intercommunication.** A variety of computer systems with varying degrees of intercommunication and integration co-exist in the hospital setting. Departmental systems, like those in radiology or pharmacy, process the information for which they are responsible, but also have a limited capacity for sharing information. Departmental systems contribute less to the other departments' need for information than hospital-wide systems. The medical information system, a comprehensive data system for patient care and hospital management, provides direct communication among all departments and wards.

b. **A Medical Information System Permits Hospital-Wide Communication.** A pharmacy department's computer can print labels for a drug order, but first the orders have to come from the nursing stations, and be entered on the computer one at a time. A hospital-wide medical information system allows a doctor, nurse, or clerk to enter ALL patient orders at a computer terminal on a nursing floor. These orders can specify not only medications, but also x-rays, diet, lab work, and so forth. The computer can store all the orders and automatically send instructions to the departments to carry them out: x-rays in the radiology department, diet orders in the dietary department, lab work in the laboratory department, and drug labels in the pharmacy department. Therefore, a hospital-wide medical information system has the capability of receiving, storing, distributing, and reproducing, on demand, all the information relevant to a patient's care throughout the hospital.

3-9. COMPONENTS OF A MEDICAL INFORMATION SYSTEM

The medical information system is integrated throughout the hospital to permit a two-way flow of information among all major departments. Components of a medical information system include one or more computers located in the hospital, or hooked up to the hospital by phone lines. Terminals, usually television screens, located throughout the hospital, permit users to enter and retrieve information, such as, lab results, time and dose of last medication. The screen comes equipped with a keyboard and sometimes a light pen. The screen, keyboard, and light pen combination are known as the video matrix terminal (VMT) system. The television screen displays lists of items, such as, lab tests. A specific item is selected by pointing the light pen at the desired word (or phrase) and pressing a switch on the barrel of the pen. Using the light pen, a physician can select the specific patient, and then "write" a full set of medical orders (lab work, medications, x-ray, diet, activity, vital signs, and so forth). The computer then stores the orders and sends appropriate documents (lab requisitions, pharmacy labels, x-ray requisitions, and so forth) to the proper hospital departments. The keyboard is used to write special instructions or orders that are not available for light pen selection. Each user is assigned an authorization code, based on his position and clearance level. The authorization code limits the individual's capability for sending and receiving information within the system. Printers located throughout the hospital make it possible to produce hard copy documents, such as, patient care plans, medication-due lists, laboratory specimen pickup lists, cumulative test result summaries, radiology reports, and discharge summaries, wherever they are needed. Printers come in various sizes depending on the manufacturer, but all apply printed text to paper.

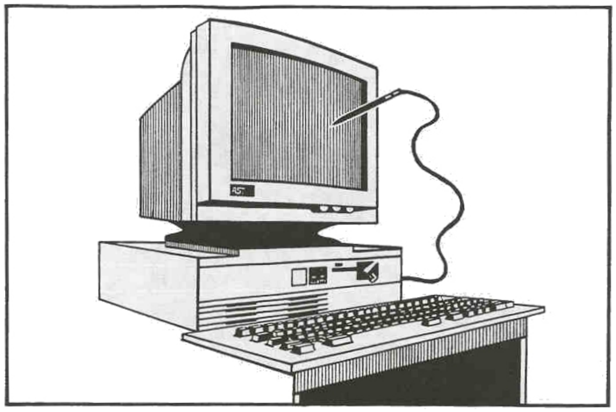


Figure 3-4. The video matrix terminal (VMT) consists of a screen, a keyboard, and a light pen.

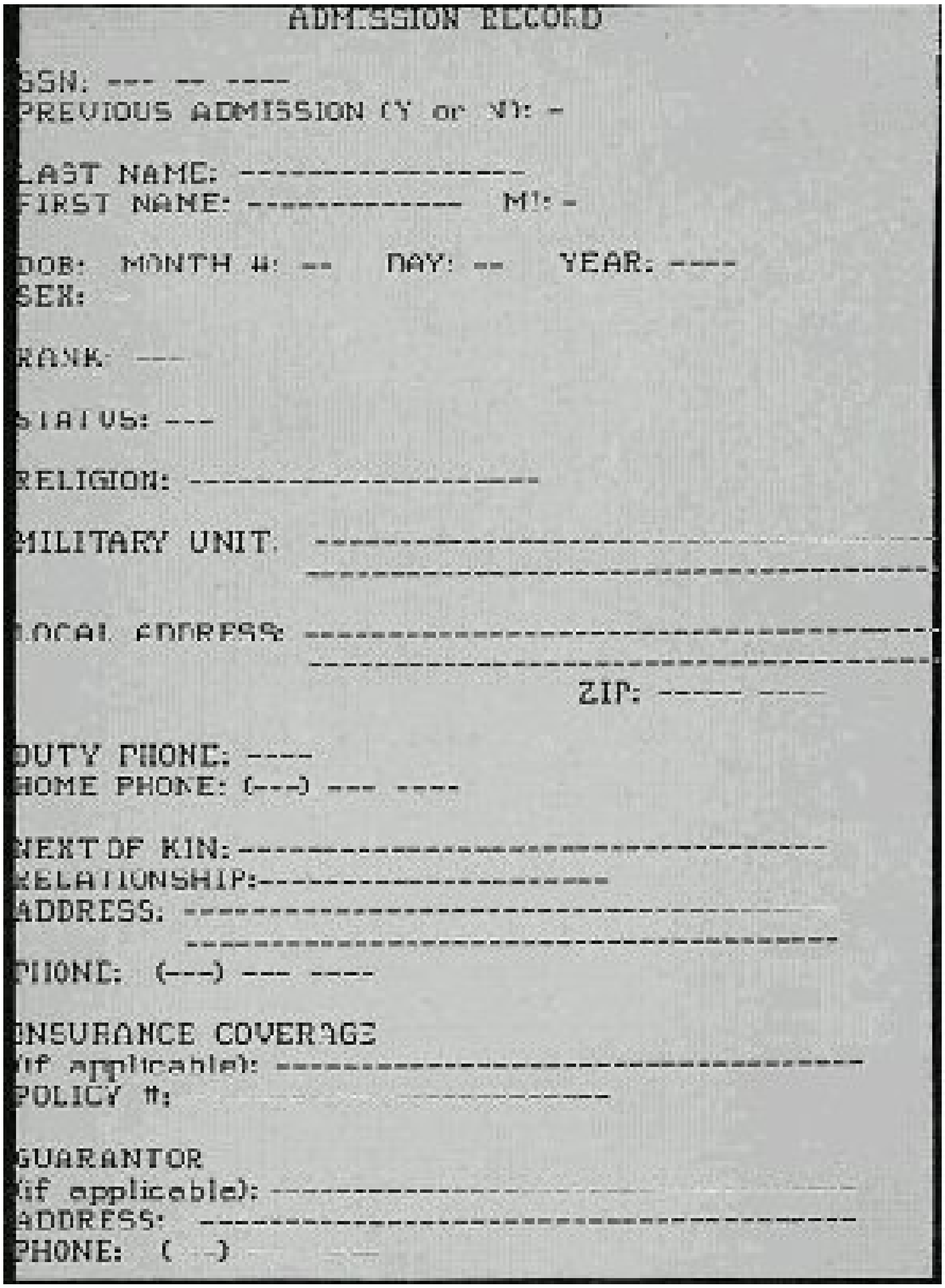
Section III. ADMISSION TO DISCHARGE PROCEDURES

3-10. ADMISSIONS

a. **Admissions Data.** The admission clerk uses the special video matrix terminal display to initiate the patient's basic record upon admission (or preadmission). The content, which is similar in format to a conventional admitting form, is stored on the computer. Patient information (name, rank, social security number (SSN), age, sex, address, insurance coverage for dependents or civilian) is now available for use by physicians, nurses, and other hospital personnel who may need the information.

b. **Physician's Orders.** When the physician enters his access code at a VMT, a list of patients, known as the patient list display, appears on the screen for his review. By selecting a particular patient he can find out what has been done so far, write new orders, for example, an x-ray for the gastrointestinal (GI) tract, or an order to report to the lab for blood work. He may discontinue previous orders. The new orders are automatically printed as service requisitions and are sent to the appropriate departments.

c. **Requisitions.** Requisitions are formatted to facilitate and minimize handling, that is, appropriate information is provided with a minimum of duplication. The worksheet for lab work, for example, includes space to fill in test results. Specimen pickup lists to be done by the wards are resorted by ward and bed number. For each drug order, all necessary documents are automatically printed in the pharmacy: a prescription record, gummed label for medication bottle, allergy alert notice, and patient medication profile (for pharmacies that employ "unit dose" dispensing).



ADMISSION RECORD

SSN: --- -- ----
PREVIOUS ADMISSION (Y or N): -

LAST NAME: ----------------
FIRST NAME: ------------- MI: -

DOB: MONTH #: -- DAY: -- YEAR: ----
SEX:

RANK: ---

STATUS: ---

RELIGION: --------------------

MILITARY UNIT: ------------------------------------

LOCAL ADDRESS: ------------------------------------
ZIP: ----- ----

DUTY PHONE: ----
HOME PHONE: (---) --- ----

NEXT OF KIN: ----------------------------------
RELATIONSHIP: --------------------
ADDRESS: --------------------------------------
PHONE: (---) --- ----

INSURANCE COVERAGE
(if applicable): ---------------------------------
POLICY #: ------------

GUARANTOR
(if applicable): ---------------------------------
ADDRESS: ---------------------------------------
PHONE: (-)

Figure 3-5. Admissions display.

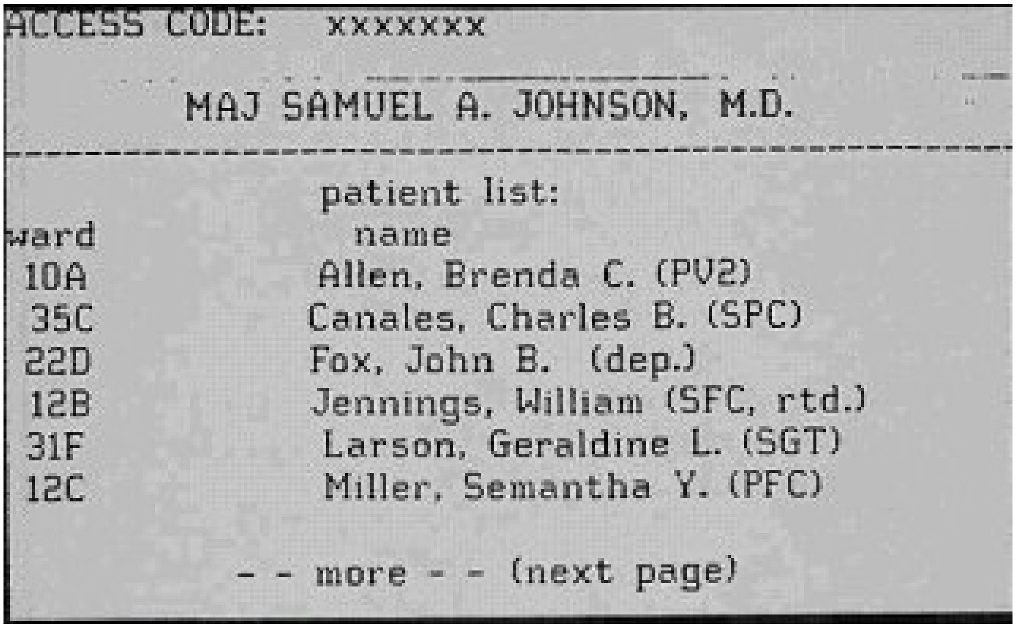


Figure 3-6. Physician's patient list display.

3-11. DIAGNOSIS AND TREATMENT

a. **Preliminary Diagnosis.** The physician has access to a data bank network that can assist him in diagnosing conditions and planning treatment. By simply entering the patient's symptoms, the computer will provide a list of associated diseases and conditions. (See figure 3-7.) It will also identify tests that can confirm, rule out, and/or supplement the initial diagnosis. A new tool, outcomes research, is becoming available. Outcomes research provides historical data on success rates of various alternative treatments.

b. **Patient Monitoring.** Other kinds of computers continually monitor the patient's condition. Analog computers monitor many body functions such as heartbeat, blood pressure, brain waves, and emotional stress (based on acidity of the skin, and alkalinity of the stomach). Unusual variations from the norm will trigger an alarm that results in immediate action by the front desk, the nurse, and/or the attendant. Battery-operated computers can give electrical stimulus to a patient, as in a pacemaker. They may also dispense medication. Diabetics, for example, may have insulin pumps imbedded in the abdomen. Computers may provide other remedial treatments, as well.

c. **Aids to Movement.** Artificial prostheses, or artificial limbs, may, in some cases, be controlled by a small computer chip, that translates impulses of certain nerves and muscles into finger, wrist, and ankle movements. As computers continue to get smaller, applications are foreseen in which a computer chip is imbedded in a patient's body to sense or control certain functions. An otherwise disabled patient will become more independent and normal in his functioning thanks to computer technology.

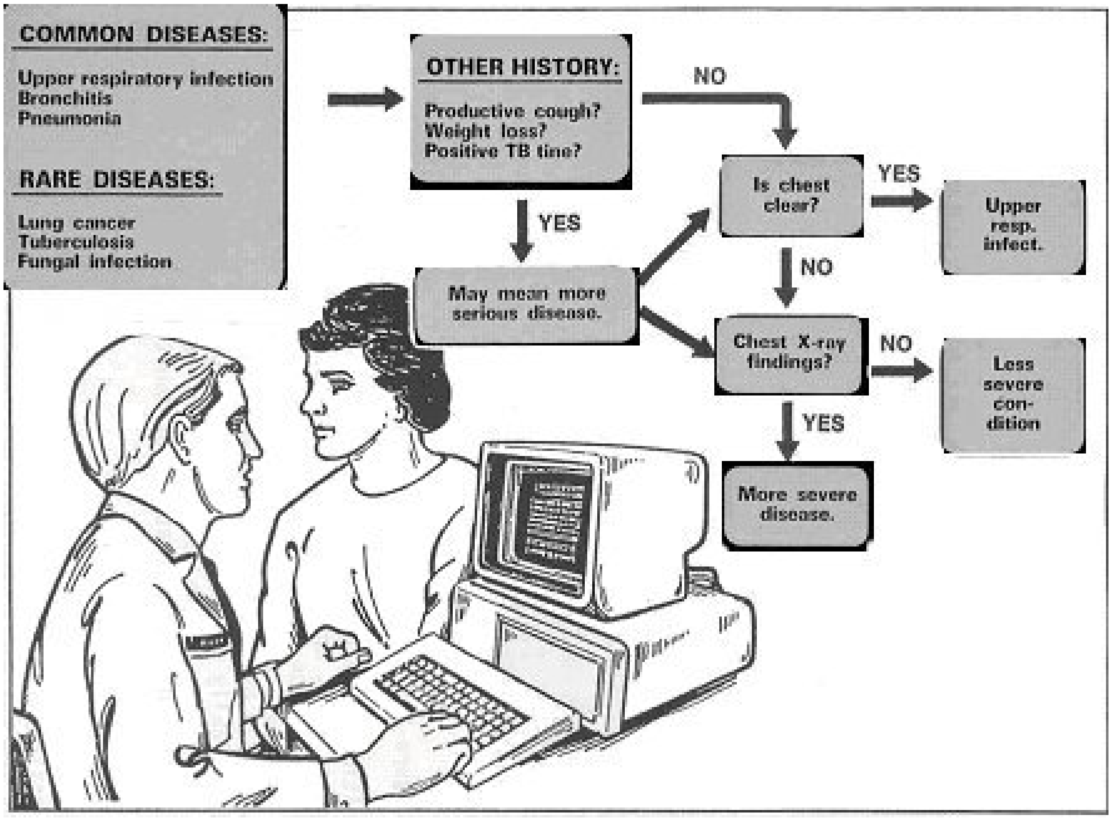


Figure 3-7. The doctor has entered the symptoms of a 25-year-old female suffering from low grade fever and night sweats, who has smoked a pack of cigarettes per day for the 12 years. Using a personal computer, linked by a modem, to a minicomputer with an expert system, the doctor obtains a list of likely diseases. Through a process of elimination, the expert system helps to pinpoint the probable cause.

3-12. AUTOMATIC SCHEDULING

Automatic scheduling has been a strong selling point of the hospital- wide medical information system. This feature allows the physician to check which patient is scheduled for what treatment, at any given time, from any VMT in the hospital. The physicians orders will cause the computer to generate follow-on documents. Medication-due lists can be printed at each nursing station for each hour of the day. These will specify that the patient in bed four, for example, needs a certain type of medication at specified times. The computer can generate daily order summaries that can be sorted by bed number or time of day. These will indicate what personnel on the wards need to do at any given hour. Order summaries show both new and current orders. The computer can also print reminder notices for overdue laboratory work, medications, and so forth. For this system to work, personnel have to remember to log into the computer the tests or other procedures that have been done. As the orders are complied with, they have to be logged in. Otherwise, the computer will generate erroneous overdue notices.

3-13. TEST REPORTING

The computer can print out diagnostic tests, examinations, or lab results. As test results are entered into the computer, they become immediately available for screen retrieval by authorized personnel. In addition, the computer can periodically print all lab and test results at the nursing station for each patient. High priority tests receive special processing throughout the system. The lab can assign “RUSH” (immediate) processing to any test that was ordered without a special priority, but whose results warrant immediate attention by the physician.

3-14. PRESHIFT CARE PLAN

a. **Patient Care Plan.** Local management policies will vary. However, the computer has the capability of printing copies of a patient care plan for each patient, before each shift. One might be used for the head nurse and the other for the nurse responsible for providing care. Listed in this printout would be: the diet and fluid balance order, medications to be administered, lab work needed, nursing instructions, and any special patient data, such as, “speaks Spanish,” or "wears dentures." (Denture information is important to the x-ray department when a skull series or a sinus series has been ordered.)

b. **Shift Change Report.** The patient care plan may be used to generate a shift change report, which, as the name suggests, is generated at each change of shift. Care given during the shift can be entered here. Again, usage will depend on local policy.

c. **Nursing Station Updates.** The nurses update the patient’s file to reflect medication given, intake and output, all care provided, and other patient data. Updates are simple to accomplish using the video display and light pen. As items indicated for the patient are taken care of, they are checked off using the light pen. However, when the computer mainframe is down, business must go on, as usual. Therefore, provision must be made for alternative methods, to cover computer malfunctions of a few minutes, a few hours, or even a day or two.

3-15. BILLING

In civilian hospitals, the patient’s record is reviewed daily by the computer to determine daily charges accrued for hospital services, medication, and lab work. When the patient’s release time approaches, the computer does a search of the patient’s file to pull the pertinent data. Even military hospitals have to keep track of expenses when treating civilians. They also need this information as a management-planning tool.

Brooke Army Medical Center

DATE: 1/5/90 0832 hrs **PATIENT CARE PLAN**
Mary Smith, SSG SSN # 111-222-3333
DOB: 6/15/56
ADM: 1/3/90 Cutter, Harold, M.D. Neurosurgery

DX:

Left Lumbar (Ls) Radiculopathy.

PT CARE PLANNING:

Allergic to penicillin.
Apprehensive about myelogram.

DIET AND FLUID BALANCE:

Regular diet.

HYGIENE/ACTIVITY/SAFETY:

Bed rest with bathroom privileges.
Side rails up at night.

PROCEDURES:

Myelogram scheduled 1/8/90.

MEDICATIONS:

Acetaminophen with Codeine, po, 2 every 6 hours, prn.
Temezapam 15 mg, po, 1 at bedtime, prn.

OTHER DEPT:

Physical Medicine —	EMG	1/5/90
	NCS	1/5/90
Radiology —	Myelogram	1/8/90
	CT Scan	1/8/90

Figure 3-8. Patient care plan display.

3-16. FINAL FORMS

a. **Final Forms Preparation**. After the patient is discharged, the computer does a search of the patient's entire file and prepares a series of documents, including a test results summary, insurance forms, the patient's bill, and a medical record abstract.

b. **Permanent Storage of Documents**. During the patient's hospital stay the computer has printed a set of documents. Upon discharge, these same documents become a part of the hard copy medical chart filed in medical records. The patient's complete record is also kept on magnetic tape at the computer center as a backup. It is usually retained as long as dictated by local policy, so that files can be available in the event of readmission. Older records are generally purged out of the computer because the amount of memory available is limited.

3-17. COMPUTER-ASSISTED INSTRUCTION

The computer can vividly simulate real-live emergencies in which a patient must be treated quickly and efficiently. These simulations offer a valuable tool in the training of doctors, interns, residents, and anyone working in a medical environment. After setting the scene and outlining the symptoms, the computer challenges the student to save the patient's life before a certain time runs out. The student must select a logical progression of diagnostic tests and treatments. The computer interacts with the students, providing immediate feedback on each decision made. It points out student errors immediately, providing explanations and further opportunities to test areas of weakness.

Section IV. RADIOGRAPHIC APPLICATIONS

3-18. GENERAL

Like other departments, radiology uses VMTs and printers to interact with the management information system computer data network. The network gives the department direct access to a wide range of information on radiology patients and immediate contact with other hospital personnel.

3-19. ORDERS FOR X-RAY EXAMS AND ROUTING

X-ray requests are entered on the VMT display by the physician using standard radiographic terminology. The display is formatted to encourage physicians to provide "indications," reasons for ordering the examination, which can be helpful to the radiologist in understanding why the patient has been designated to have an x-ray. The history and symptoms provided in the indications, for example, may prompt the radiologist to suggest alternate or additional x-ray series. As soon as the new x-rays are ordered, the requisitions are printed, unless they have been scheduled for a future date. High priority (STAT) orders, specially marked to activate a bell and light in the radiology department, will prompt immediate action.

PERSONAL DATA – PRIVACY ACT OF 1974 – 5USC522a
BROOKE ARMY MEDICAL CENTER SF 519B
RADIOGRAPHIC REPORT

Date Initially Printed: 89/11/15
20-123-45-6789

Jones, Sara
DOB: 63/10/01
Sex: Female
Exam Date: 89/11/06 Patient ward: Outpatient
Exam: KN001 Knee Series
Requesting Location: Orthopedics
Patient Response to Pregnancy Question: Negative
Provisional Diagnosis or Clin History:
Request Entry Date: 89/11/06 Requestor: Harrison, Robert R.
Scheduler: Gunther, Rick R.

Figure 3-9. X-ray order display.

3-20. X-RAY REQUISITIONS

An x-ray requisition will show the patient's name, age, sex, case number (if it is local policy to use a case number), bed location, attending physician, diagnosis, test ordered, and indications. It will also specify whether the exam is to be done in the clinic or on the ward using a portable machine.

3-21. PREPARATION AND RELEASE OF RADIOLOGY REPORTS

The radiologist dictates the x-ray interpretation following normal conventions for x-ray reporting. The only difference is that the computer provides a repertoire of standard phrases. These are permanently stored in the computer for the radiologist's use, if he so desires. Radiology secretaries type the reports. Once a report has been verified by the radiologist, the secretary enters a verification signal into the VMT, triggering release of the report into the system and printing of a copy at the patient's nursing station.

3-22. RETRIEVING OTHER PATIENT DATA

Using the VMT, the radiologist can obtain information on previous current-stay radiology reports, reports occurring within the same hospital stay. He can also obtain information on medications being taken, secondary diagnoses, and so forth.

PERSONAL DATA – PRIVACY ACT OF 1974 – 5USC522a

BROOKE ARMY MEDICAL CENTER SF 519B
RADIOGRAPHIC REPORT

Date Report Printed: 90/01/05
Date Initially Printed: 89/11/15
20-123-45-6789

Jones, Sara
DOB: 63/10/01
Sex: Female
Exam Date: 89/11/06 Patient ward: **Outpatient**
Exam: KN001 Knee Series
Requesting Location: Orthopedics
Patient Response to Pregnancy Question: Negative
Provisional Diagnosis or Clin History:
Request Entry Date: 89/11/06 Requestor: Harrison, Robert R.
Scheduler: Gunther, Rick R.

LEFT KNEE, 6 NOV 89, 0921 HOURS:

INTERPRETATION:

Patient is status post-ACL reconstruction. Cortical screw and washer are present in the distal femur and in the proximal tibia. Deformity and sclerosis are present in the lateral aspect of the distal femur inferior to the screw. Similar changes are present in the anterior tibia. These suggest removal of prior internal fixation screws. The study is otherwise unremarkable.

JMB/ebc

s/MAJ John M. Bauman, MD/MC

Figure 3-10. Radiology results report.

3-23. PATIENT BILLING

Whenever reports are entered into the VMT, a procedure number (a standard number provided by the insurance industry) is also keyed in. This number is used by the computer to look up the applicable charge, and enter it on the patient's billing file. A copy of the bill is printed and provided to the accounting department.

3-24. DEPARTMENTAL ANALYSES

a. **General.** One of the great advantages of a computer system is its versatility. While it keeps track of patient-specific information, it is also sorting data in other ways that are useful to management for planning and assessment purposes. It keeps track of the number of patients that came through the hospital, the number of sinus and other exams performed. It also codes this information by physician, and referring department, that is, Eye, Nose, & Throat (ENT). At the end of the year, the department manager has solid statistical information on what has been done by whom.

b. **Workload Reports.** The chief technologist and the radiologist generate information needed by radiology administrators in compiling workload reports, to include dates, exposure room, and frequency of exams requested. It is expected that there will be higher traffic at certain periods. During pollen season, for example, there will be a higher incidence of allergy testing. Data on frequency of exams will be provided by routine, e.g., chest radiography, and by the physician and clinic.

c. **Management Tool.**

(1) Manpower and equipment. The reports generated by the medical information system can provide justification for additional manpower and equipment. For example, a statistical report, indicating 30 percent more patients and only 10% more employees, may provide the basis for hiring additional technologists.

(2) Problem areas. The reports can also pinpoint problem areas. Upon analysis, a reported increase in certain radiographic views may prove totally justified or may be attributable to a new and overzealous physician, requesting more sinus films than warranted. Once the problem has been revealed, the radiologist can tactfully suggest that not every patient with a headache needs a set of sinus films.

(3) Repeat rates. Repeat rates are reported by routine, technologist, and room. Again, gathering the information in these three different ways helps to pinpoint the source of the problem. For instance, a high repeat rate for a specific room may suggest either a need to recalibrate the x-ray machine or a need for retraining. If the repeat rate is limited to only certain technicians using that room, then it may be a training problem. Thus, repeat rate analysis is useful in identifying training needs. This type of analysis may also reveal other types of problems, such as, a conflict of interest, a highly controversial and thorny problem. A conflict of interest may exist when physicians with a financial interest in a particular radiographic clinic send patients there for an excessive number of radiograms. Repeat rate analysis will reveal the high number of radiograms. Further investigation will identify the conflict of interest. Repeat rate analysis can also identify over consumption of such items as contrast media or barium sulfates. Therefore, the report can serve as a tool in streamlining costs and consumption.

3-25. DIGITAL IMAGING

Radiology uses a technique called digital imaging to produce higher quality x-rays. Digital imaging involves the transfer of images composed of dots from one computer screen to another by digital means. Digital imaging got its start in the 1970s, with the space program. Incredible images from satellites were produced by manipulating digital images before photographing them for presentation to the public. In a similar manner, it is possible to manipulate medical images by computer. This technology reconstructs various physiologic densities to produce layer-by-layer images of body parts. (See figure 3-11.) The use of dots makes it possible to obtain multiplane exposures, so that, for example, a radiologist can look at the ethmoid sinuses as well as the pituitary fossa, immediately posterior. Digital imaging is of great value in diagnosing patient abnormalities, diseases, and disorders. Digital imaging could make the film screen cassette, as we know it, obsolete, as resolution and storage problems are overcome. There are some clinics converting to this system of image storage at the current time.

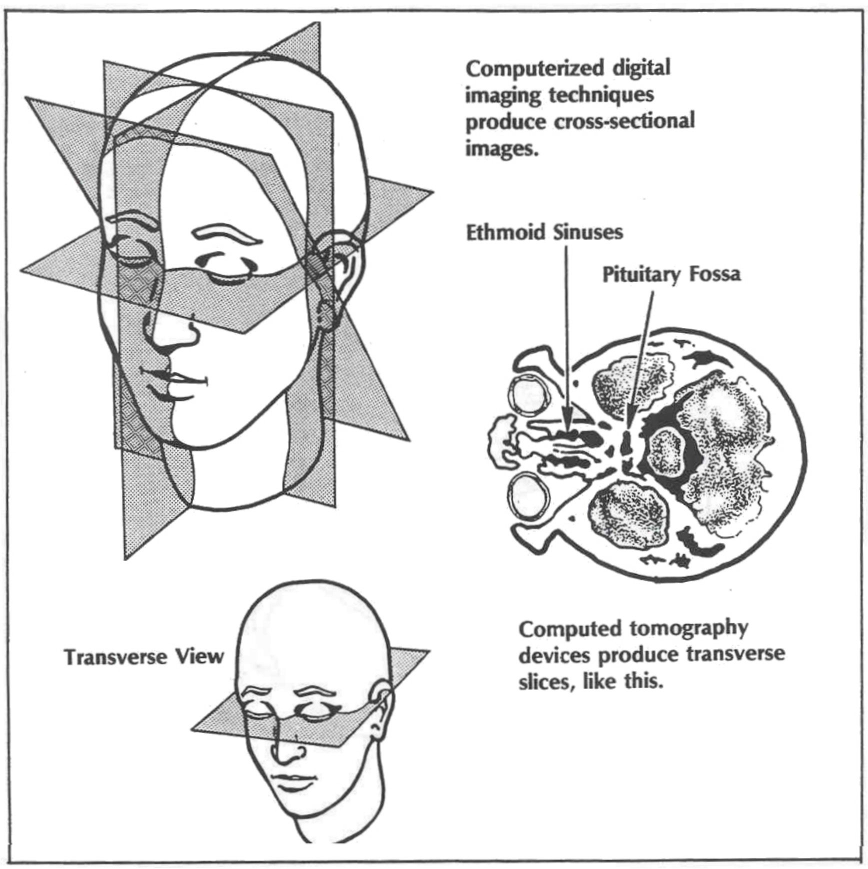


Figure 3-11. Computerized imaging produces visual slices of the human body in any direction. Seeing the body from the precise angle, and having the option to emphasize certain tissues by the turn of a knob, makes the difference between estimating a condition and pinpointing its exact nature.

3-26. RADIATION THERAPY TREATMENT PLANNING

The computer can be used to produce a precise radiation therapy treatment plan. The technologist simply keys in the relevant patient information, such as, diagnosis, condition, and overall treatment. The computer will then generate a printout specifying type, number, and schedule of treatments.

3-27. NUCLEAR MEDICINE APPLICATIONS

This technology uses radioactive isotopes and computerized scanners to provide accurate determinations about the presence or absence and nature of abnormalities. In liver or brain scans, for example, a radioisotope is injected into the body. The computerized scanner detects the degree of concentration of the radioisotope energy received from the patient. It stores this data for recall so at the radiologist can examine the area of interest, plane by plane. Higher or lower concentrations of the radioisotope energy in a certain area indicate the presence or absence of an abnormality, such as a tumor.

3-28. ULTRASOUND APPLICATIONS

Ultrasound technology uses the sound waves reflected by anatomical structures to determine size and location of tumors, fetuses, and so forth. The relationship of one echo relative to another is what helps localize the body anatomy. A device called a transducer is placed in direct contact with the patient. With its flexible cord arms, the transducer can accurately follow the contours of the body without repositioning the patient. The transducer produces and receives sound waves that a small computer stores and recalls. The sound waves are used in calculating the alignment of the echoes relative to each other, which determines size and location of the anatomic structures.

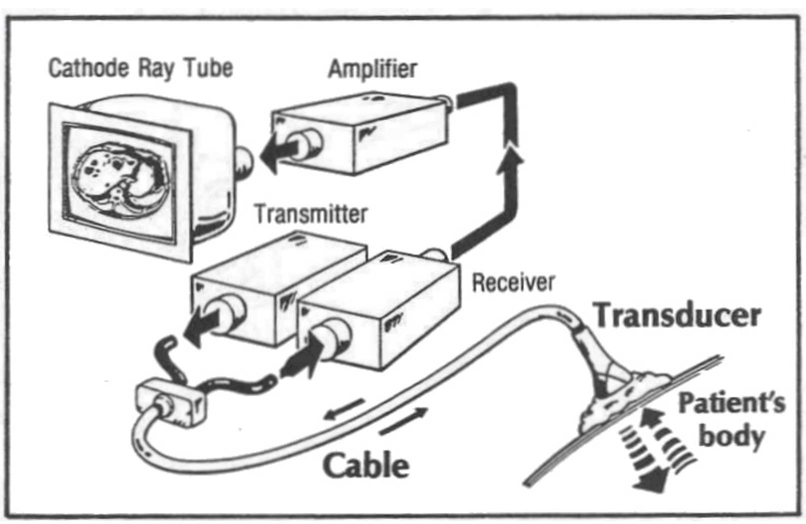


Figure 3-12. Using the transducer, a view of the abdomen is produced on the CRT screen. The dark round spots on the liver (large gray mass on the left) may signal a tumor.

Section V. PROS AND CONS OF COMPUTERIZATION

3-29. ADVANTAGES OF COMPUTERIZATION

a. **General.** Computer information systems have proven invaluable in carrying out predetermined operations and helping decision-makers clarify their ideas and plans. Computer speed makes possible extended calculations and rapid retrieval of stored information. Computer memory facilitates the storage and availability of vast amounts of data.

b. **Increased Timeliness and Accuracy of Patient and Administrative Information.** With the help of computers, information and reports can be transmitted and delivered much more rapidly than before. Diagnostic answers formerly delayed until a disease actually manifested itself in the patient can now be obtained in a matter of minutes. Patient studies that used to take 15 minutes now take 15 seconds.

c. **Greater Individual Productivity.** With the use of the computer, predetermined operations are simplified, thus reducing the time it takes to do a job, and permitting employees to take on additional responsibilities. Reports prepared from statistics compiled by hand, formerly taking days, are now available in several minutes.

d. **Improved Quality of Care.** By using a computer program called Physician Data Query that identifies the latest cancer treatments, physicians can find the right therapy for a patient with any type of cancer. Up to now there has been a shortage of information on which treatments work best for what kind of patients because little research had been done on the outcome of patients' treatments. Treatment patterns for the same condition vary according to geographic locale. (Within a given area, doctors reach a consensus on how to practice, but that consensus may not be the same in another area.) Hospitals, clinics, health-maintenance organizations, and other medical groups are now collecting data on how well various treatments work. By 1991, at least 100 patient-outcomes projects should be under way to study cataracts, diabetes, and broken hips. Outcomes research, made possible by the computer, will provide hard data on success of treatment that will help improve the quality of medical care.

e. **Reduced Personnel Costs and Inventory Levels.** Hospitals have reported significant annual savings due to the installation of computer systems. Increased revenues, a reduction in accounts receivable and costly inventory are benefits attributable to computerization.

f. **Faster, Better Analysis by Administrators.** With access to daily, weekly, and monthly statistics, administrators can make more informed decisions, spot trends, strengths, and weaknesses that would have previously gone unnoticed. They also can engage in “what if thinking. Interoffice information systems, that tie key administrative and management personnel together electronically, reduce time spent in meetings, increase productivity, and cut down on administrative support staff.

3-30. PROBLEMS OF COMPUTERIZATION

a. **A Mixed Blessing.** Despite the promised and proven benefits of automation, management has yet to harness the full potential of computers. Along with the benefits have come a host of unresolved problems that have made the computer a mixed blessing, at best. Those who have tried to correct an erroneous automated hospital bill, or get off a mailing list, can relate to this assessment.

b. **Computer Error and Downtime** is realities with which most users are well familiar. A client becomes hypertensive while waiting for a medical record number because a computer is down. Patients are billed incorrectly or not at all because of “computer error.” Computer error and downtime can affect productivity and profits.

c. **Data Pollution**, also known as information overload, is a less publicized problem. It exists when organizations are so overwhelmed with information they are literally polluted with data. Information overload in health care operations means that the very tools designed to simplify and improve operations contribute to the problem, which can create a large financial drain on an institution.

d. **Data Manipulation without Safeguards.** It is a simple matter to change the data stored on a computer system. It can be done without leaving a trace of any tampering. A college student paid a friend in the computer center to change his "D" transcript to straight “A’s.” Based on the fraudulent transcript he was accepted for membership in Phi Beta Kappa, a prestigious academic society. It was only by chance that a physics professor discovered the crime 3 years after the student had graduated, when he noticed a discrepancy between his own handwritten grade sheet and the printed transcript.

e. **Misuse of Equipment and Data by Authorized and Unauthorized Users.** There are known cases of employees using an organization’s computer to run a business. In San Jose, California, for example, two employees used two million dollars worth of government computer time to establish their own company. Misuse of data is an even more serious problem. Health care workers and criminal justice officials, for example, have obtained sensitive personal information to embarrass, bribe or harm individuals.

f. **Computer Viruses.** Viruses are bits of computer codes entered into a system through software. Some viruses have even been detected in commercial software programs. A virus can infect a disk, scrambling or erasing files. Other viruses are “trapdoors” that allow unauthorized access to information or exploitation of the system. Recent court decisions have found perpetrators guilty of a crime, with penalties including jail and high monetary loss, because viruses could have a devastating effect on the flow of information. There have been no major incidents affecting Army computers where proper precautions were taken.

(1) Personal computer contamination. Personal computer (PC) viruses, to date, have resulted from a user knowingly loading software containing a virus onto an Army PC without license. The virus subsequently damages the files stored on the hard disk. United States (US) law requires government employees to refrain from loading unlicensed software, including shareware, onto government computers. (Shareware is copyrighted software, obtained through bulletin boards or by way of mailed diskettes. The manufacturer asks users to voluntarily send in payment if using the shareware. The few who comply cover costs for the majority who use and pass around software by copying it onto diskettes). United States Army Information System Command (USAISC) policy requires USAISC bulletin board operators to examine public domain and Army licensed shareware for viruses before placing software on bulletin boards. End users would be wise to do the same for such software obtained from other sources.

(2) Network viruses. Network viruses are greater threats, as they spread themselves across a network, transferring infected files between hosts and propagating the virus to other computer systems on the network. Simple actions are sufficient to protect against most threats. The following measures have been sufficient up to now: not allowing "guests" publicly known passwords; not allowing users to invent their own passwords (they should use randomly generated passwords that are harder to figure out); not allowing more than three successive unsuccessful log-on attempts per user; changing passwords at least semi-annually.

(3) The operations environment. In addition, it is important to consider the working environment of these systems. Many systems have "holes" which are known to some communities. The Morris Internet Virus exploited several of the known "holes" in the Unix computer system. The operating system and security products in use should be examined and accredited by the National Computer Security Center (NCSC). The USAIC has established an Army Computer Emergency Response Team (CERT), which has the technical expertise to deal with computer emergencies, contamination, and intrusion which may affect USAISC systems. The User Coordinating Center (UCC) is the focal point of contact for the Army CERT, AUTOVON 879-6255.

g. **Cost.** It has always been difficult to place computer hardware and software costs in perspective vis-a-vis anticipated payoffs. Until now, hardware has been the big-ticket item. Now software and personnel costs are taking center stage as the important cost factors. Large hospitals are spending millions on medical information systems, as they underestimate costs and overestimate payoffs, and the costs are rising each year.

h. **Legal Problems.** Freedom of Information laws require organizations to make available information that they hold. At the same time, Privacy laws place limits on information processing. Today, with the dramatic proliferation of data collected and stored, it has become harder for organizations to comply with these laws. On the one hand, data must be made available under the Freedom of Information law. On the other hand, that same data must be protected under Privacy laws, and "computer error" is not a valid excuse for noncompliance with these laws.

i. **User Resistance.** Perhaps the paramount problem posed by the new technology is user resistance. Ironically, though the single most important problem, it has been underappreciated to successful implementation of computers in health-care organizations. Keypunch operators have been known to purposely jam terminals. Caseworkers have avoided entering data on computer-compatible forms. Doctors have kept their own handwritten records on the side rather than use computer printouts and terminals. Even managers have resisted computerization because the new technology has increased accountability. Health program managers, doctors, and hospital administrators are resistant because they are afraid of the strange technology; they are also afraid of changes in organizational structure (shifts in power and changes in informal groups). Finally, they may have been disappointed by vendors' promises that were never realized, a terminal that went down, or a printout that was incorrect. The undeniable reality is that in the face of user resistance, a technically sound computer becomes useless.

3-31. COMPUTER SECURITY

a. **General.** Computer security, the protection of an organization's equipment and data, is a serious problem that has yet to be dealt with adequately. Computers are built with ease of use and speed, not security, in mind. The security problem is a growing one as more and more people gain access to and become adept at using computers. It is getting easier to access systems through phone lines. Billions of dollars are stolen each year caused by of computer tampering, and the monetary loss is the least of the problem. The unauthorized access and the tampering with privileged information are the more serious side of the problem. The fact that a group of children could wreak havoc with a sophisticated computer system illustrates the magnitude of the problem. Eighth graders at New York's Dalton School penetrated the computer systems of several major corporations in Canada from a small terminal in their Upper East Side school. They managed to disrupt operations of one system and seize control of another, destroying some data in the process. The problem is compelling and it is multifaceted.

b. **Physical Security of the Equipment.** Systems have been physically sabotaged, flooded, and vandalized. Protective measures for the physical equipment are much the same as for any other equipment.

c. **Loss of Data.** Stored data can be lost. Loss of data is a more challenging aspect of the security problem because it can't be handled by traditional security methods. One Chicago firm lost its entire accounts receivable file through a "fluke" accident involving a vacuum cleaner. The file, which was stored on the bottom shelf of a tape library, was accidentally erased by the magnetic coil of a new heavy-duty vacuum cleaner. No bills went out that day, and several hundred thousand dollars in receivables were at stake.

3-32. TOWARD SOLVING COMPUTER PROBLEMS

a. **Better Management of Technology and People.** For the most part, the problems cited are not technical in nature. Rather, they involve the unenlightened use of technology. Even computer downtime, a seemingly technical problem, can be attributed, in part, to a failure on the part of management to control the system, i.e., manage the people and technology. Probably the single most important factor in success of computerization is the attitude and support of top management. Managers have to gain a better understanding of what a computer is and what it can do, and institute policies accordingly.

b. **Gaining User Acceptance.** Good training programs and ongoing support of employee efforts, incentives for computer literacy, can help in overcoming user resistance. An organizational culture that embraces computerization from top management down is also important.

c. **Storage of Data.** This is an organizational responsibility requiring cooperation at an individual level. Since there is often no hard copy for the data that is stored on computer, the individual user must be trained to create backup. A tongue-in-cheek rule of thumb that should be taken seriously cites the three rules of data files as: BACKUP, BACKUP, and BACKUP. Backup should be done on a daily basis, and the backup copy should not be stored in the same place as the original.

d. **Security.** The onus is on management to institute a broad range of policies that ensures computer security. Specific measures are beyond the scope of this course. They should include mechanisms for ensuring the consistency and accuracy of data, provide for a formalized surveillance system, establish authorization levels, and assign security responsibilities. At an individual user level, employees should be aware that data and hardware must be protected from individuals who rightfully do not have access. Personnel should be educated on the use of computers and the rights of access to information.

Continue with Exercises

EXERCISES, LESSON 3

INSTRUCTIONS. The following exercises are to be answered by marking the lettered response that best answers the question or best completes the incomplete statement or by following the special instructions.

After you have completed all the exercises, turn to, "Solutions to Exercises" at the end of the lesson and check your answers.

SPECIAL INSTRUCTIONS: MATCHING. For exercises 1 through 6, match each term to the appropriate description or example. Enter the letter you have selected in the space provided. (There is one extra lettered statement that will not be used.)

1. Data base ____
2. Data base management system _____
3. Field _____
4. File _____
5. Record _____
6. Downloading _____

a. The catalogue number for a government issue desk.

b. The catalogue number, item description, price, and quantity available of a government issue desk.

c. The catalogue number, item description, price, and quantity available for 100 different government issue supply items.

d. Computer information network.

e. Electronic copying of a file.

f. Software that provides the means of access to stored data.

g. The basic data of a computer system, designed to serve multiple applications with a minimum of duplication.

SPECIAL INSTRUCTIONS: MATCHING. For exercises 7 through 12, match each term to the appropriate description. Follow the same directions as for the previous exercise.

7. Spreadsheet _____
8. Management information systems _____
9. Medical information system _____
10. Financial/administrative system _____
11. Office automation system _____
12. Decision support system _____

a. Computer information network serving multiple users.

b. Handles billing, accounts receivable, payroll, etc., on a mainframe or minicomputer.

c. Electronic version of the financial worksheet.

d. Hospital-wide computer network that tracks a patient from admission to discharge and handles administrative needs.

e. Combines word processing, data processing, and electronic data processing to handle scheduling, memo-keeping, and record-keeping.

f. A file that is created with a specific application in mind.

g. Designed to help managers-analyze data produced by other computer systems.

13. Unlike older, more traditional ways of designing files, the data base method:

    a. Creates data files for each application.

    b. Stores data according to inherent characteristics.

    c. Includes the instructions relevant to specific applications.

    d. Avoids cross-referencing that establishes relationships between data files.

14. The data base management system processes the data base ________ the applications programs needed to use it.

    a. Independently of.

    b. In conjunction with.

    c. In terms of.

    d. On the basis of.

15. By using a _____________, a physician can enter all patient orders at a computer terminal at one time.

    a. Departmental information system.

    b. Microcomputer system.

    c. Medical information system.

    d. Decision support system.

16. The ______________ is composed of a "television" screen, a keyboard, and a light pen.

    a. Video display terminal.

    b. Cathode-ray tube.

    c. Software.

    d. Video matrix terminal.

17. Lab worksheets with space for test results, specimen pickup lists presorted by ward and bed number, drug orders that automatically trigger the printing of prescription records; these are all examples of the way in which computerized:

    a. Requisitions are formatted and processed to minimize handling.

    b. Diagnoses minimize patient contact.

    c. Admissions data become available to all those who might need data.

    d. Diagnosis and treatment enhance the quality of patient care.

18. A new tool becoming available to physicians in diagnosis and treatment is a data bank network, outcomes research, which provides:

    a. A list of diseases and conditions associated with a given set of symptoms.

    b. A list of tests that can confirm, rule out, or supplement initial diagnosis.

    c. A list of billing codes that insurance companies are likely to accept.

    d. Historical data on success rates for alternative treatments.

19. A _________________ can monitor the patient's condition, dispense medication, and give electrical stimulation to the patient.

    a. Medical information system.

    b. Battery-operated computer.

    c. Video matrix terminal.

    d. Robot.

20. Artifical limbs, controlled by a _____________, can translate nerve and muscle impulses into finger, wrist and ankle movements.

    a. Mainframe.

    b. Cathode-ray tube.

    c. Computer chip.

    d. Computerized pulley.

21. _____________ allows the physician to check which patient is due for what treatment, at any given time and from any terminal.

    a. Automatic scheduling.

    b. Preshift care planning.

    c. The nursing station update.

    d. Outcomes research.

22. Computerized medication-due lists in the example described in the text are printed:

    a. At the lab three times daily.

    b. At the dispensary twice a day.

    c. At the clinic once a day.

    d. At each nursing station on an hourly basis.

23. The daily order summary, which indicates what personnel on the wards need to do at any given hour, covers:

    a. New orders.

    b. Current orders.

    c. Current and future orders.

    d. New and current orders.

24. If lab work or medications are overdue, the computer:

    a. Issues a RUSH processing order.

    b. Adds a STAT entry to the order.

    c. Issues overdue notices.

    d. Stops printing all reports on that patient.

25. The computer periodically prints all ___________________ for each patient at the nursing station.

    a. Records.

    b. Billing information.

    c. Lab and test results.

    d. Prescriptions.

26. Before the start of each shift, the computer can print copies of:

    a. All follow-on documents.

    b. The patient care plan.

    c. Test reports.

    d. Order summaries.

27. Personnel must be sure to log in test results on a timely basis in order to avoid triggering unnecessary:

    a. Procedures.

    b. Scheduling.

    c. Overdue notices.

    d. Preshift care.

28. The preshift care plan lists diet and fluid balance order, medications, lab work, nursing instructions, and:

    a. Special instructions.

    b. A patient medication profile.

    c. Requisitions.

    d. Accomplishments of the previous shift.

29. In efficient medical information systems, the computer reviews and updates the patient's records _______________ to reflect services, medication, and lab work.

    a. Monthly.

    b. Bi-weekly.

    c. Weekly.

    d. Daily.

30. An x-ray technologist is preparing to perform a sinus series on a patient. Which printout would reveal whether or not the patient wore dentures?

    a. The preshift care plan.

    b. The shift change report.

    c. The nursing station update.

    d. The physician's orders.

31. ____________ is used to train health care providers to respond quickly and logically to life-threatening emergencies. The student must beat the clock and "save" the patient by choosing the right tests and treatments.

a. Dramatic reenactment.

b. "What-if" thinking.

c. Computer-assisted instruction.

d. The medical information system.

32. The computerized x-ray request is formatted to encourage the inclusion of ____________which may be helpful to the radiologist in suggesting additional or alternate x-ray series.

a. A diagnosis.

b. Indications.

c. Personal observations.

d. Health insurance information.

33. As soon as the physician orders new same-day x-rays:

a. The x-ray is taken.

b. A bell and light are activated in radiology.

c. The order is noted on the workload report.

d. A requisition is printed.

34. Computerized x-ray reporting allows the radiologist the option of:

a. Using standard phrases stored in the computer.

b. Using nonstandard terminology.

c. Using special codes assigned by the insurance companies.

d. Delegating the report to the radiology secretary.

35. With the press of a verification signal, the verified typed x-ray report is released into the system and a copy is printed:

    a. In the billing department.

    b. In the workload report.

    c. At the patient's nursing station.

    d. At the lab.

36. A special marking on STAT orders activates ____________ in the radiology department to prompt immediate action.

    a. A bell and light.

    b. Verification signal.

    c. Special access code.

    d. An alarm.

37. Through the hospital-wide computer system, the radiologist can access information on any actions (secondary diagnoses, medications being taken, and other radiology reports) occurring within the same:

    a. Year.

    b. Quarter.

    c. Month.

    d. Hospital stay.

38. Whenever reports are entered into the VMT, a procedure number is keyed in to facilitate:

    a. Departmental analyses.

    b. Billing.

    c. Workload reporting.

    d. Release of radiology reports.

39. _______________ on frequency of exam, types of exposure by room, dates of heavy traffic, provide analyses that enable managers to pinpoint problem areas.

    a. Workload reports.

    b. Patient comments.

    c. Projections.

    d. Questionnaires.

40. A computer technique that produces radiographic images composed of dots is:

    a. Tomography.

    b. Fluoroscopy.

    c. Digital imaging.

    d. Computer graphics.

41. The diagnostic procedure involving injection of radioisotopes to identify abnormalities is a technique of :

    a. Nuclear medicine.

    b. Ultrasound.

    c. Radiation therapy.

    d. Tomography.

42. The diagnostic procedure involving the use of echoes to determine size and location of a growth is a technique of:

a. Radiation therapy.

b. Nuclear medicine.

c. Ultrasound.

d. Tomography.

43. When data pollution occurs, it means that:

a. The volume of available data is hampering efficiency.

b. Data have been tampered with.

c. Dirt in the hardware and/or software has created downtime.

d. Viruses have contaminated the data.

44. The single greatest challenge associated with computerization is:

a. Underestimating costs in relation to payoffs.

b. Protecting an ever-increasing volume of information under privacy laws while releasing it under Freedom of Information laws.

c. Overcoming user resistance at all levels of the organization.

d. Computer errors and downtime.

45. A student with a friend in the computer center arranges to have his “C” transcript changed to straight "A’s”. This is an example of:

a. User resistance.

b. Data manipulation.

c. Contamination by a virus.

d. Data pollution.

46. _____________ can scramble or erase files.

a. Data manipulation.

b. Data pollution.

c. Downtime.

d. Viruses.

47. The loss of art entire accounts receivable file through a “fluke” accident involving a vacuum cleaner was a problem of :

a. User resistance.

b. Computer data security.

c. A virus.

d. Data pollution.

48. As more people use computers and as phone lines become an increasingly ready means of access to computers, the problem of _________ is gaining importance.

a. Viruses.

b. User resistance.

c. Data pollution.

d. Computer security.

49. Most of the problems associated with computerization could be solved through better;

a. Computer security.

b. Management of technology and people.

c. Analysis of costs in relations to payoffs.

d. Employee training for new and seasoned users.

Check Your Answers on Next Page

SOLUTIONS TO EXERCISES, LESSON 3

1. g (para 3-3c)
2. f (para 3-3e)
3. a (para 3-3b(l))
4. c (para 3-3b(l))
5. b (para 3-3b(l))

6. e (para 3-7e)
7. c (para 3-4)
8. a (para 3-3a)
9. d (para 3-7f)
10. b (para 3-7b)

11. e (para 3-7a)
12. g (para 3-7d)
13. b (para 3-3b(2))
14. a (para 3-3b(2))
15. c (para 3-8)

16. d (para 3-9)
17. a (para 3-l0c)
18. d (para 3-11a)
19. b (para 3-11b)
20. c (para 3-11c)

21. a (para 3-12)
22. d (para 3-12)
23. d (para 3-12)
24. c (para 3-12)
25. c (para 3-13)

26. b (para 3-14)
27. c (para 3-12)
28. a (para 3-14a)
29. d (para 3-15)
30. a (para 3-l4a)

31. c (para 3-17)
32. b (para 3-19)
33. d (para 3-19)
34. a (para 3-21)
35. c (para 3-21)

36. a (para 3-19)
37. d (para 3-22)
38. b (para 3-23)
39. a (para 3-24b)
40. c (para 3-25)

41. a (para 3-27)
42. c (para 3-28)
43. a (para 3-30c)
44. c (para 3-30i)
45. b (para 3-30d)

46. d (para 3-30f)
47. b (para 3-31c)
48. d (para 3-31a)
49. b (para 3-32a)

End of Lesson 3

LESSON ASSIGNMENT

LESSON 4 Future Trends.

LESSON ASSIGNMENT Paragraph 4-1 through 4-22.

LESSON OBJECTIVES After completing this lesson, you should be able to identify (by selecting from alternatives):

4-1. Future computer applications.

4-2. Emerging safety issues.

4-3. Measures designed to minimize eyestrain and body aches.

4-4. Features of an ergonomically sound workstation.

SUGGESTION After completing the assignment, complete the exercises of this lesson. These exercises will help you to achieve the lesson objectives.

Section I. FUTURE APPLICATIONS

4-1. INTRODUCTION

a. **General**. Computer technology and its applications is such a rapidly developing field that you can read almost daily about new breakthroughs. It is almost too difficult to keep up with the latest developments, for what is groundbreaking today, can be superseded by something else tomorrow. In the first section of this lesson, we shall attempt to describe some of the trends and future applications of computer technology. Some of them, no doubt, will have become “old hat” by the time you read about them in this subcourse. But it is a fascinating topic that deserves some attention, nevertheless.

b. **Miniaturization**. Data retrieval from computer chips is much faster than from disks, and chips are less delicate, so computer components will continue to become smaller and faster as the technology is improved. But there are limits to miniaturization resulting from design problems. As the size of one transistor shrinks almost to that of the wavelength of light itself, it gets harder to engrave circuits (even using the most sophisticated light-based methods such as laser beams). Also, smaller is not always better. The tiniest transistors, some smaller than bacteria, operate on so little energy that they are vulnerable to heavenly interference. A burst of energy from cosmic rays, fast-moving atomic particles, or temperature variations can cause the transistor to switch on and off erroneously.

Figure 4-1. A chip compared to a dime. This incredibly tiny microchip, the brain of an entire computer, is equivalent to 450,000 transistors.

4-2. NUMBER OF TRANSISTOR CIRCUITS PER CHIP

By 1981, only 10 years after their introduction, microprocessers became more powerful than the CPUs of many contemporary mainframe computers. Their speed, multiplying two 32-bit numbers in 1.8 millionths of a second, comes from an array of 450,000 transistors linked by 18 yards of vapor- deposited tungsten wire. All of this occupies a silicon chip scarcely a quarter of an inch square. This is less space than a single transistor required before the invention of the integrated circuit. This mind boggling shrinkage of components is likely to continue into the 1990s, when scientists foresee incorporating as many as 10 million components on one fingernail--sized chip. Scientists see this as the upper ceiling of the microelectronics revolution because of the design problems described earlier.

4-3. NEW STORAGE MEDIUMS

a. **Bubble Memory.** Bubble memory, magnetized spots (or bubbles) resting on a thin film of semiconductor material, was introduced in the late 1970s as a storage medium. Data are stored by shifting the positions of the bubbles on the surface of the material. When data are read, the presence of a bubble indicates a zero bit. A bubble memory module only slightly larger than a quarter can store 20,000 characters of data. Just as disks represented a more efficient storage medium over magnetic tape, bubble memory will become an inexpensive and popular alternative to magnetic disks, as existing production difficulties are overcome. Disks, while more convenient and accessible than tape, do not lend themselves to storing large volumes of information. Since large volumes of information can be stored on magnetic bubbles, they will present a popular alternative to disk storage.

bubble memory: recently developed compact memory device represented by magnetized spots or bubbles. Bubbles rest on thin wafers of garnet, a semiconductor material, in a magnetic field. Data on bubble memory are not lost when the power is shut off.

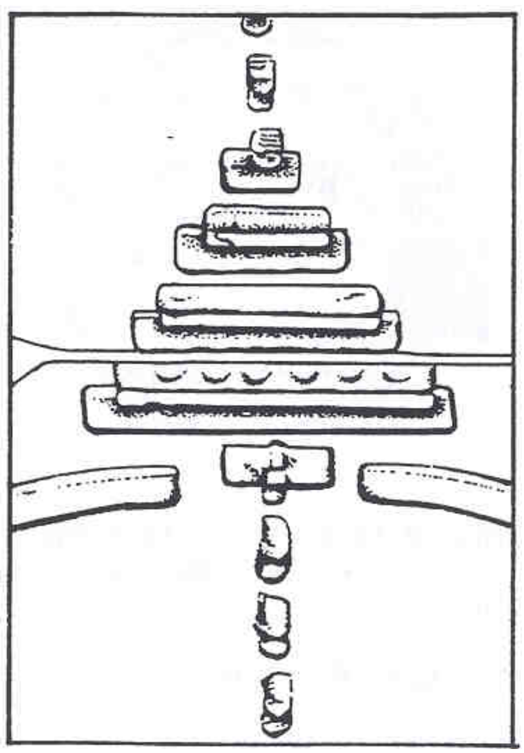


Figure 4-2. A section of bubble memory magnified 1500 times. Bubble memory could be a popular alternative to disks one day.

b. **Smart Cards.** Smart cards may well become more common than bubble memory as the storage medium of the future. Currently 200 times faster then floppy disks in retrieving information, they are small enough to fit into a wallet. As with a disk, information can be input and erased. On a space the size of a credit card, 4 million bytes can be stored, far exceeding the current capacity of floppy disks (1.25 million bytes). This vast amount of information can be retrieved on a reader (current price: $300) as rapidly as one can switch from one television station to another. Floppy disks with improved disk storage capacity will provide some competition for large- capacity smart cards. Smart cards will become the first-choice of consumers because they are small, fast, high capacity, and they require low-cost readers. Currently the cost of a blank card is somewhat prohibitive, pricing in at $200. This cost should shrink as time goes by.

smart card: storage medium larger in capacity than a floppy disk, and smaller in size. Likely to become the preferred storage medium.

4-4. SPEECH INTERPRETATION

a. **General.** Efforts are now underway to program computers to understand speech. No simple matter, as there is such variation in intonation, pitch, pauses, errors, hesitations, incomplete words, and pronunciation differences among speakers. To date, machines have been programmed to perform specified tasks in response to spoken commands, using a very limited vocabulary and simple sentence structure.

b. **Chess.** One such system accepts spoken commands to move chess pieces, using only thirty-one words and a small number of action statements like “move” and “check.”

c. **The Handicapped.** An anticipated application will increase the self-sufficiency of handicapped persons and children. With a wheel chair controlled by a computer that understands spoken commands, the user will instruct the computer to move the wheelchair in certain directions. A mechanical arm will be instructed to manipulate eating utensils.

d. **A Means of Identification.** The human voice may also find wide acceptance as a means of identification. Instead of needing a card to access a bank account, for example, the computer could be programmed to recognize the account holder’s voice.

4-5. TRANSLATION DEVICES

Software programs now exist to translate printed documents. Thanks to cheaper, more powerful computer chips, computerized language translators that recognize and translate a user’s speech will soon be available. One of these, a Spanish/English system (costing $2000), is already on the market, with a

Japanese/English version expected soon. A break-in period is required for the computer to learn to recognize the user' s voice. Arid, the machine can only be used by the person who has verbally programmed it.

4-6. MOBILE OFFICES

With business professionals spending so much time away from the office and often working while traveling, manufacturers have recognized a need to create "mobile offices" for those on the go. Rolling workstations feature desks, cellular phones, cellular fax machines, and upscale, office-type interior decorations, all installed in a regular-sized van. Within a few years, technological miniaturization will provide laptop computers with a cellular phone and fax machine all combined into one devise. Small, limited-function computers (appointment books, calculator, note-takers, and so forth) and mini-fax machines also are expected to appear soon, as in-dash components for automobiles.

fax: an acronym for facsimile transmission, that is, transmission of images over a communication system.

4-7. LASERS

Lasers like the ones used in grocery store scanners will be increasingly common for both storage and transmission of data. Laser printers, which provide very high-quality hard copy will become cheaper and more widely used.

4-8. COMPUTER NETWORKS

Computer networks will continue to become more widespread and their applications will increase. In the future, it will be possible, for example, to sign onto a computer to order groceries. The shopper will simply indicate the items he wants and when he will pick them up. The groceries will be bagged and ready for pickup, upon arrival.

4-9. ELECTRONIC FUNDS TRANSFER

Electronic funds transfer will continue to reduce paperwork. When an individual purchases gasoline on a credit card, for example, the stated amount will be subtracted on the spot, from the bank account, using of electronic funds transfer. With the payment made instantly, the need for an oil company credit slip will be eliminated. Special news analyses will also be brought into the home through home computer and modem by electronic means.

modem: a device situated between the conwnunications line and the terminal or between the CPU and the conuuunications line. It transmits and receives computer data over ordinary telephone lines by changing analog signals to digital and vice versa.

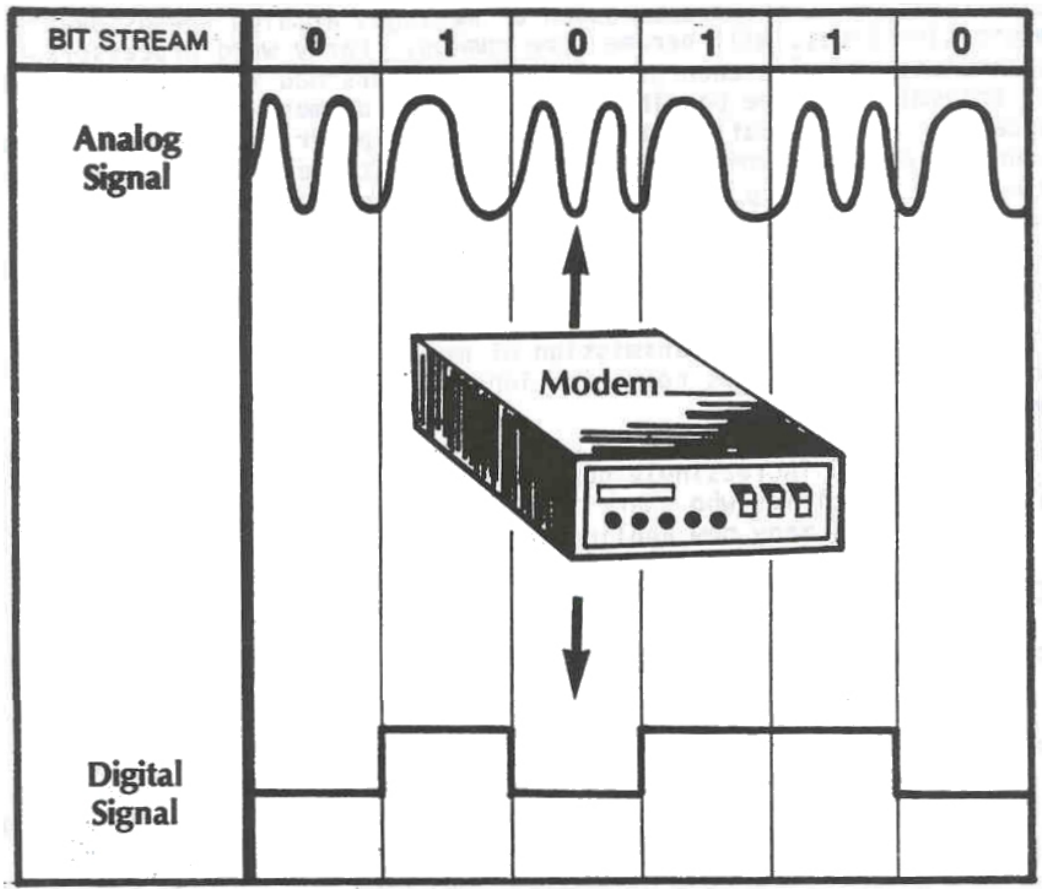


Figure 4-3. A modem, situated between the computer and telephone lines, translates analog signals of the phone lines into digital signals that the computer can understand, and vice versa.

4-10. COMPUTERIZED CREDIT CHECKING

Computerized credit checking technology will be used to speed up the payment process. In an attempt to increase the convenience factor, fast food chains are also experimenting with ways to speed up the payment process. Arby's, McDonald's, and Wendy's are experimenting with credit card use in limited areas. With the latest technology, payment can be processed in as little as two or three seconds. (As an added bonus, chains have discovered that the average credit card user spends double the amount of a customer who opts for gold-fashioned" cash.)

4-11. ELECTRONIC MAIL

Electronic mail, the transmission of messages at high speeds over telecommunication lines, will become more common. Early word processors could not communicate with each other; text transfers had to be done manually. Now, text transmissions are possible, and any type of message can be sent electronically. Since about one trillion pages of paper are exchanged between US businesses and government agencies each year, the capability to transmit text can enhance efficiency. People using such electronic mail can be in remote locations and need not be using the system at the same time to send and receive messages. The message is placed in a special storage area from which it can be retrieved and printed on the other end at anytime. Bulletin boards are an increasingly popular way of corresponding by computer with people in other cities who share the same interests. This trend will continue and will find many new applications.

electronic mail: the transmission of messages at high speeds between workstations, either by communications network facilities or local area networks.

4-12. COMPUTER MAINTENANCE

Computer maintenance will be monitored by the machines themselves. Already, some repairs are being made by simply replacing a computer chip.

4-13. TRANSPORTATION SYSTEMS

Computers will not only monitor, but actually control transportation systems. This is being done to some extent already. For example, the Southern Railway Company, located in Sheffield, Alabama, is linked to a large computer in Atlanta, Georgia with a five-kilobit memory. The Atlanta computer, which in turn is linked to minicomputers in outlying local areas, monitors train sequence, hours, destination, weight, and so forth. If a problem occurs on a track, the train is diverted by the computer without human intervention.

4-14. HEALTH CARE

a. **Diagnosis of Disease.** Computers will play a greater role in helping to diagnose disease, monitoring and controlling bodily functions, and providing some kinds of treatment. A doctor will be able to enter a list of symptoms into the computer, and obtain a list of possible diseases and recommended tests. Automated injection systems will be activated at certain times to push the drug into the bloodstream at specified times. Computer chips are currently used in pacemakers to regulate the rate of heart contraction.

b. **Computerized Signal Analyzers and Vibration Sensors.** Computerized signal analyzers and vibration sensors, called accelerometers, will make it possible to diagnose hurt knees by their snapping, cracking, and popping sounds. Doctors have used creaky knee sounds as diagnostic indicators for over a century, but background noises and other problems have interfered. With the new accelerometer technology, knee sounds can be registered without picking up extraneous noises. Thus, doctors will be able to tell, for example, if a basketball player with a twisted knee needs surgery to mend torn cartilage. Preliminary tests have shown accelerometer technology accurately diagnosed knee problems that later were confirmed by surgery. More testing is underway. Such devices might help monitor patients with rheumatoid arthritis. Amplified noises from such patients' hurt knees sound like fingernails running down a blackboard, whereas, normal knees sound like a smooth-running seesaw. This is just one example of the many uses of computers in health care; many more will follow.

4-15. INCREASED ACCEPTANCE OF COMPUTERS

Computer phobia will be alleviated through a better understanding of computers, increasingly user-friendly programs, and built-in safeguards for computer systems. The reluctance to accept computers, especially by those who did not grow up with computers, will be overcome, as companies convert their operations to computer systems.

4-16. ROBOTICS

Robots will be used more and more in industry to do tasks that are boring or dangerous for humans. Robots currently paint cars, assemble appliances, and mine coal. They also work in high-radiation environments to handle parts too hot or cold for humans or to clean up the radiation of damaged nuclear reactors. The military plans to use robots in place of soldiers to patrol-restricted areas and battle zones. Robots are being designed to pluck chickens, shear sheep, care for the sick, aid nurses, and doctors during surgery, and fight crime. Someday, robots may be common in the home. Robots are desirable for repetitive tasks because they provide a higher measure of standardization and quality.

4-17. ARTIFICIAL INTELLIGENCE

Computers solve problems using mathematics and logic. People often solve problems using intuition, creativity, and intelligence. Artificial intelligence research attempts to program computers for tasks normally assumed to require human intelligence - tasks such as thinking, reasoning, remembering past experiences, and making logical deductions from these experiences. Researchers are trying to develop computers that can understand human speech, read and summarize news stories, compile data about a sick person, and diagnose the illness. Intelligent computers would be able to read books and periodicals, and prepare summaries. They could do library research and suggest possible courses of actions and outcomes. In medicine and law, computers would use and apply specialized knowledge. If artificial intelligence applications proved practicable, computers could learn from their experiences to some limited degree. The result would be computer chips that made decisions like the human mind.

Section II. SAFETY AND COMFORT

4-18. VIDEO DISPLAY TERMINALS (VDT)

a. **Safety**. Safety may emerge as an issue of increasing importance in the years to come. Currently, most private firms, agencies of government, and computer vendors maintain that there are no health hazards associated with working at the video display terminal. There is some evidence, however, to suggest that prolonged exposure to the Video Display Terminal (VDT) can pose a health hazard, especially to pregnant women. A cathode ray tube uses very high voltage to throw a beam of energy on a phosphor-coated screen. The result is a discharge of low-level electromagnetic radiation (EMR) that some scientists believe to be hazardous. (Most VDTs are of the cathode-ray tube variety. Of the other two types of VDTs (Liquid Crystal Display (LCD) and plasma)), LCDs have also been implicated. The prevailing opinion is that low-level magnetic fields are harmless and that VDTs pose no threat to human health, no matter how many a hours a user spends before a terminal. But a debate has sprung up, which will be fully resolved only as more scientific data are gathered.

b. **Growing Evidence**. California's Kaiser Permanent Medical Group studied 1583 pregnant women, and found miscarriage rates twice the norm for women using VTDs more than 20 hours per week. At Johns Hopkins University, researchers found that microwave radiation, at levels far below what was previously considered safe, could cause cellular changes and biological damage.

c. **Growing Government Interest**. The government's Office of Technology Assessment asked researchers at the Carnegie-Mellon University's department of engineering to develop a position paper on VDT safety. Congress' Office of Technology Assessment plans to use the Carnegie-Mellon University paper to debate the issue and eventually formulate a policy. The paper points out that "studies over the last 15 years have demonstrated unequivocally that under certain circumstances the membranes of cells can be sensitive to even fairly weak externally imposed low-frequency electro-magnetic fields. Extremely small signal changes can trigger major biochemical responses critical to the functioning of the cell." This conclusion is still being debated by scientists.

d. **Prudent Avoidance and Low-Cost Preventive Measures Recommended**. Carnegie-Mellon advised a policy of "prudent avoidance," essentially, taking low-cost countermeasures until science conclusively proves how serious the problem is. Public health regulators, manufacturers, and corporate users have been slow to respond. They are waiting for more solid evidence.

(1) Protective shield. Some companies claim to have come up with a low-cost way of shielding users from radiation. Shields that cost $75 to $150 are attached to the front of the VDT screen by Velcro strips. They are designed to reduce EMR as well as glare. Vendors report that entire municipalities in California are buying shields as local governments, there, begin to pass legislation mandating VDT safety. Federal

agencies are also reported to be buying shields in a piecemeal fashion, rather than part of a unilateral policy on VDTs.

(2) Other low-cost measures. The Fund for the City of New York, a nonprofit organization, established by the Ford Foundation, has designed its offices so that all VDT operators sit at least 28 inches from their own terminals, and about 40 inches from other terminals. (Terminals emit EMR from the front, sides, and back.) At these sitting distances the electromagnetic radiation drops significantly.

e. **Legislating Video Display Terminal Safety**. Twenty-five states are currently considering changes in the law to cover possible VDT harm in the workplace. Since the government has long required TV screens and VDTs to be shielded from X-rays, they may well legislate electromagnetic shielding requirements, as well.

4-19. LANDMARK SUFFOLK COUNTY LEGISLATION ON VIDEO DISPLAY TERMINAL SAFETY

The growing importance of VDT safety as an issue is evidenced by the fact that legislation, mandating safety measures, has spread from California (the traditional vanguard of social change in the US) to New York. In a piece of landmark legislation, Suffolk County, on New York's Long Island, passed a law requiring companies with more than 20 terminals to provide adjustable furniture, special lighting, detachable keyboards, and work breaks, and to pay 80 percent of VDT workers' eye-care bills. This decision may point the way toward a growing trend toward legislated computer safety.

4-20. REPETITIVE STRAIN INJURY

a. **What It Is.** Tens of thousands of workers, ranging from factory workers to white-collar professionals, are being injured by repetitive, continually twisting motions on the job. Since the early 1980s, repetitive strain injury (RSI) has been widely reported in many service-sector jobs. It now afflicts supermarket clerks, who use price scanners at checkout lines, as well as airline flight attendants who constantly press the handbrakes of food carts used to serve passengers. It has struck thousands of office workers who use computers for a living, from telephone operators and data-entry clerks to newsroom reporters and editors. With about half of the nation's office workers using computer terminals daily, RSI looms as the occupational disease of the l990s. Strategies will have to be found to restructure the way work is organized. In the service sector, the organization of work has followed the traditional industrial model that uses technology to create smaller, repetitive tasks as a means of increasing pace and, ultimately, productivity. As more RSI-related workers' compensation claims crop up, safety experts will have to devise ergonomically improved workstations (workstations that factor in human comfort). They will also have to offer preventive training. In addition, employees will need to be more aware of the work conditions that foster RSI.

b. **Magnitude of the Repetitive Strain Injury Problem.** In 1987, RSI replaced skin disease as the leading cause of occupational illness in the nation, with nearly 73,00 cases reported. It is suspected, though, that many more cases go unreported, because even those afflicted often fail to recognize RSI as a job-related illness. Symptoms such as pain, numbness or tingling, are usually more severe at night hours after the suffering worker has left the job. Office workers (who do not expect to be injured in the modern, computerized workplace) often do not associate their pain with work. In addition, it may take years to develop, and since there are few consistent patterns, it is often confused with arthritis or simply the “wear-and-tear” of getting old. Repetitive strain injury is an illness, not an injury. It is caused by constant exposure over time; it is a cumulative condition, not a single traumatic injury.

c. **History.** Repetitive strain injury is not a new occupational hazard. Two hundred years ago, Bernadino Ramazinni, an Italian physician, reported that serious occupational diseases could develop from “irregular motions and unnatural postures of the body.” For years, craftsmen have experienced a variety of musculoskeletal disorders associated with their trades, ailments with colloquial labels like “fruit packer’s hand,” carpenter’s elbow,” “bricklayer’s shoulder,” and stitcher’s wrist.” In the early l990s, telegraph operators reported cases of painful arms and “glass elbow,” similar to many of the data processing ailments reported today.

d. **Carpal Tunnel Syndrome.** A September 1989 issue of the “Weekly Federal Employees’ News Digest” reported the following entry: “More and more federal and postal employees, especially those who use computer terminals, handle heavy files, and sort mail are suffering from ‘carpal tunnel syndrome,’ an inflammation of the wrist, according to union officials.” For those working at computer terminals, carpal tunnel syndrome, a form of RSI, is believed related to repetitive key-stroking. The carpal tunnel is formed by the carpal bones and the transverse carpal ligament. When the carpal tunnel swells, it squeezes the median nerve against the transverse carpal ligament. This causes numbness, burning, and pain in the fingers and hands.

e. **Medical Costs.** Experts estimate that costs for carpal tunnel cases, in lost time, turnover, medical expenses, legal and consulting fees, often range from $20,000 to $100,000 per case. Some companies spurred by active unions and growing RSI-related medical costs are beginning to question the way modern work is organized. Some are instituting joint company-union programs to train workers, redesign tools, and reevaluate workstations and tasks that pose repetitive strain injury risks.

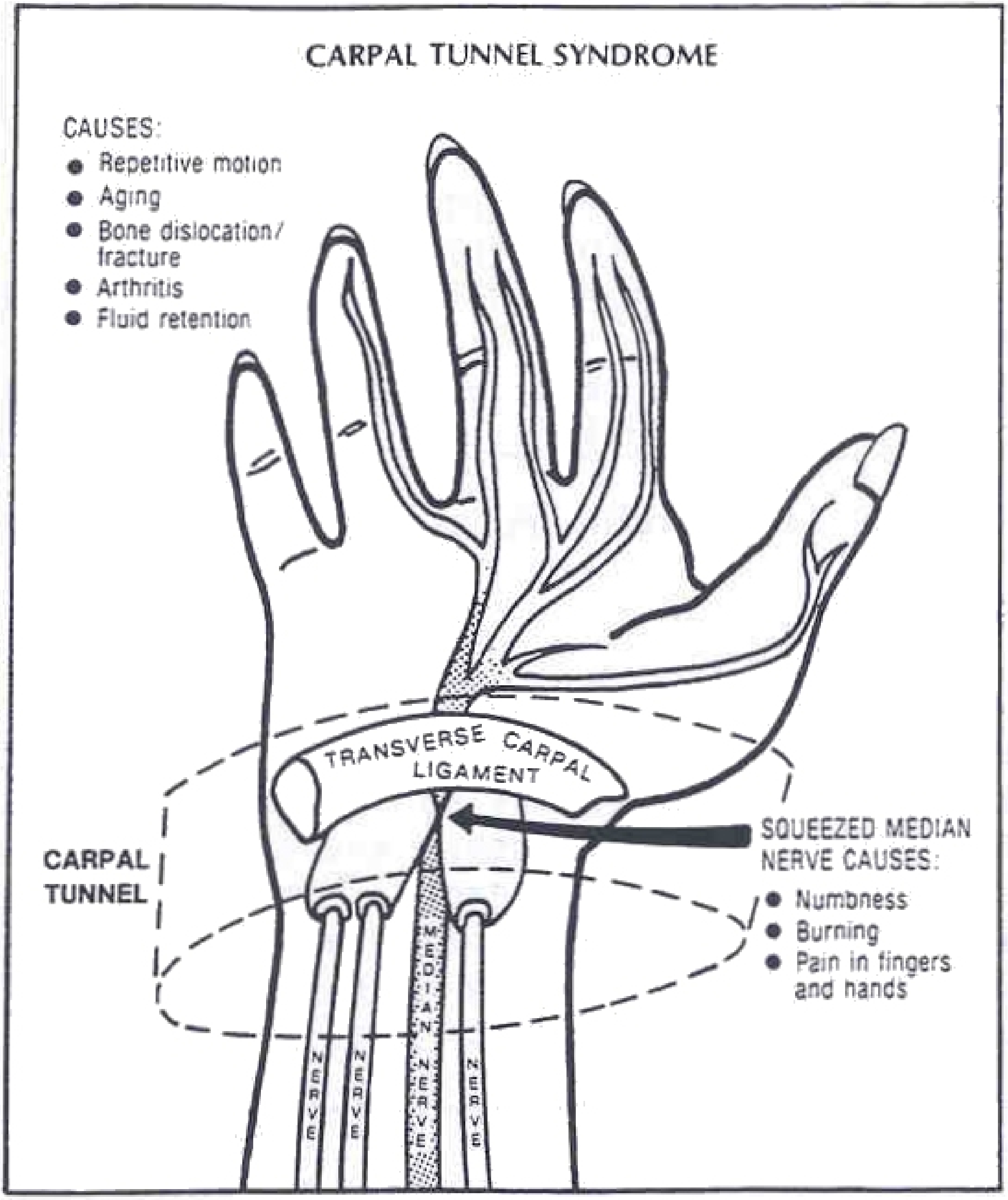


Figure 4-4. Carpal tunnel syndrome affects, among others, those who handle heavy files, sort mail, or use computers. When the carpal tunnel (formed by the carpal bones and the transverse carpal ligament) swells, it squeezes the median nerve against the transverse carpal ligament, causing pain, numbness, and burning.

f. **Treatment and Recovery.** This is a murky area. While workstation improvements can help alleviate symptoms, long-term recovery is more elusive. A leave of absence from work may be recommended to eliminate the conditions that caused the illness in the first place. Many times surgery is needed to correct the problem. Once the employee returns to work, the same conditions that caused the original problem prevail. A news reporter took a 10-month leave of absence due to neck, shoulder, forearm, and back problems resulting from repetitive strain injury. The cause was constant note taking and typing. Her doctor advised her she might never recover that she might have to change careers. Thus, a seemingly minor ailment like RSI can have an enormous impact on one's life. The reporter, who continued in her chosen career, coped by setting quotas for what she could handle each day. For example, if she did too much note taking, she could not do dishes that night.

g. **Preventive Measures.** Preventive measures can help to some extent. Here is a quick list.

Keep wrists neutral--don't bend or twist wrists for extended periods.
Minimize repetitive movements and holding onto objects.
Reduce the speed of forceful repetitive movements.
Use the whole hand to grasp objects, not just the thumb and index finger.
Take breaks--switch hands and tasks.
Do conditioning exercises.

Figure 4-5. Preventing repetitive strain injury (RSI).

4-21. VIDEO DISPLAY TERMINAL FATIGUE

a. **General.** Over 75 percent of computer users report some form of visual discomfort as a result of VDT use. With over 50 percent of American workers and 40 million homes slated for computer use by 1990, VDT fatigue will become an issue of increasing concern, for both users and employers. Video display terminal fatigue causes eyestrain. Symptoms can range from headache, blurry vision (both distant and close-up), and double vision, to general eye fatigue. The eyestrain is caused by tired eye muscles and mental eyestrain (a tired brain). The eye muscles most affected by the close work (3 feet or less) involved in reading, writing, and VDT work are the medius rectus and the lateral rectus muscles. Also affected by close work are the ciliary muscles that focus the eye's lens. Between the ages of 35 and 45, as the aging process sets in, the lens of the eye gets rigid, making close work harder. (This ultimately leads to a need for bifocals or reading glasses.)

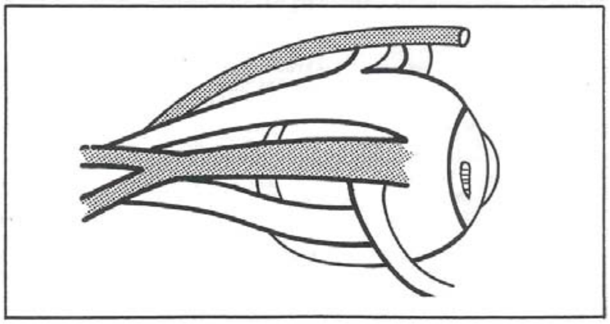


Figure 4-6. Extended computer use strains two of the six muscles that control the eye.

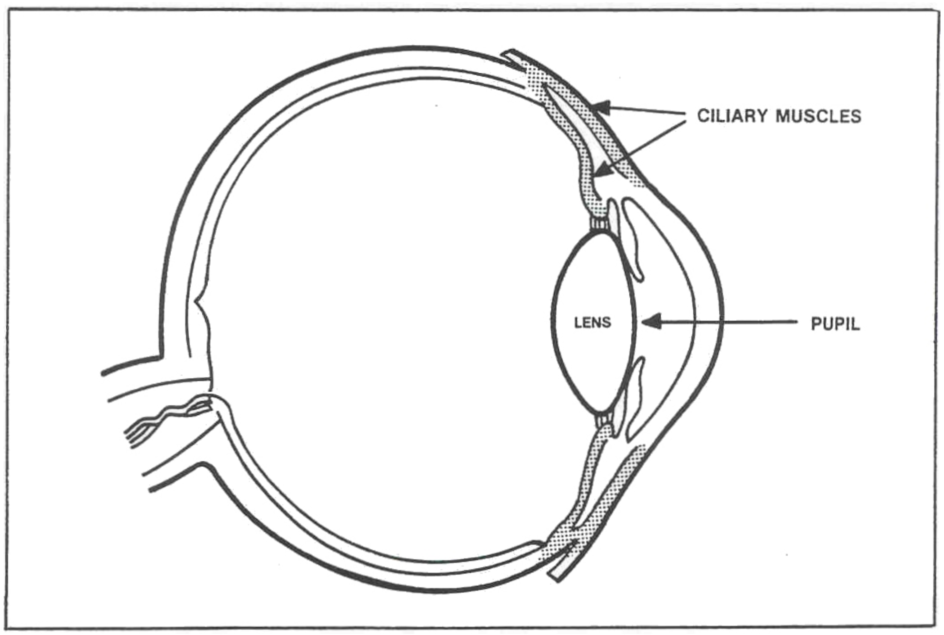


Figure 4-7. The ciliary muscles, which control the lens of eye, must tense up to see objects up close. These muscles are fatigued by extended focusing on a VDT

b. **Causes of Video Display Terminal Strain.**

(1) Change in illumination. The frequent and continual changes in illumination caused by looking from a brightly lit page to the VDT can make muscles ache. Poor vision that is left uncorrected will aggravate the problem.

(2) Existing eye problems. Farsighted people will have more problems with VDT eyestrain, because they don't see well at close range. Slightly farsighted people will be especially prone to fatigue.

(3) Convergence and focusing problems. People who normally can't cross their eyes are candidates for VDT fatigue. Problems in converging the eyes are often accompanied by difficulty in focusing. The constant shifting in focal points from keyboard to screen to paper adds to the problem. Consider the case of a woman working at a computer 4 hours per day, who complained of eye aches and sleepiness. She did not need glasses to correct farsightedness, nearsightedness, or astigmatism. But a simple test, in which she was asked to focus on a pencil as it came nearer, revealed that the image would split in two at 18 inches from her face. Eyeglasses that corrected for this alleviated the VDT fatigue.

Figure 4-8. Your muscles will tire if you look at something close because it causes your eyes to turn in toward your nose.

(4) Tension level. General fear or anxiety will cause the eyes to dilate, thus rendering it difficult to focus. So, it is important to relax in order to reduce VDT fatigue.

(5) Failure to blink. Failure to blink is common because computer work demands extra concentration. People get so engrossed in their work that they forget to blink. If you forget to blink, your eyes will become dry and feel like they are burning. Therefore, make a concerted effort to blink regularly.

(6) Lighting and contrast. Often terminals end up in a place that was not designed for a computer. The area is generally twice as bright as it ought to be for a VDT screen. It is difficult for the eye to adapt to both the bright room and the lower light level of the screen. To reduce this contrast, draw the shades, use lower watt bulbs, and fewer fluorescent lights, if possible. Room illumination should be about half what it usually is in an office. The optimum lighting would be 30 to 50 foot candles (the equivalent of a 60-watt bulb in a small room). If these modifications aren't feasible, consider fitting a hood over the screen to reduce outside light.

(7) Using Video Display Terminal controls. Many users forget to adjust their VDTs. The brightness control regulates overall brightness of the screen. The screen should be three to four times brighter than overall room illumination. The contrast control adjusts brightness of the characters in relation to the screen. Characters should be five to ten times brighter than the background. You should adjust the controls so that characters are not too dim, nor so bright that they flicker.

(8) Video Display Terminal quality. You will experience less VDT fatigue if you are working at a good quality screen. A flickering screen should be avoided. On a good unit, flickering can be eliminated by adjusting brightness. The color of the display is another factor. Green and amber are more restful to the eyes, while red and blue cause the most strain. Legibility of the characters is critical too. If you are working at a five inch screen with tiny letters, your fatigue level will be high. Resolution, the closeness of space between the dots, will also affect legibility and viewing comfort.

(9) Glare and reflections. Glare, one of the biggest problems associated with VDTs, has two sources: glare reflected from light and glare from objects in the background. To detect glare, sit in front of the monitor with the computer off. Whatever you see reflected on the screen will cause glare when the machine is on. Take the time to draw shades, close doors, move or shield lamps, and get rid of bright reflecting lights. To determine when glare is blocked out, move a book or paper in front of the screen. (Notice if that is too much glare that can be reflected from people or objects in the background.) Position the VDT so that there are few objects in the background. If there is a background object reflected on the screen, your eyes will constantly be refocusing from the 2-foot distance of the screen to the distance of the object, that is, a bookcase, ten feet away. An anti-glare filter will very effectively eliminate these problems. If your VDT does not come equipped with a built-in filter, you can purchase an add-on. A tilt or swivel feature on a VDT helps control glare. You can also improvise with books or pads. Finally, even the color of your shirt or blouse will affect glare, with lighter colors contributing to an increased glare problem.

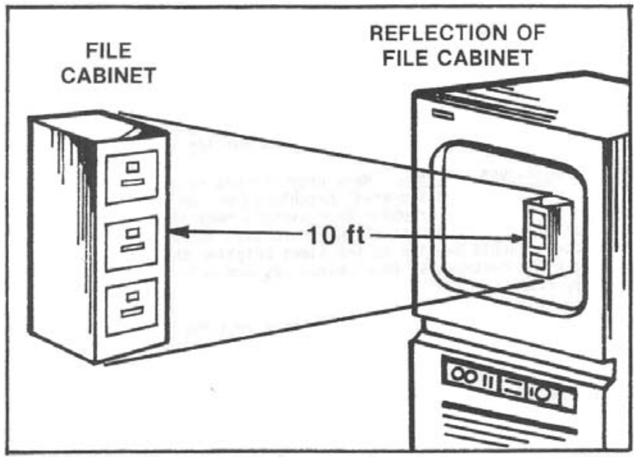


Figure 4-9. Your eyes make a drastic change in focus when shifting from the text to the reflection on the screen. They have to adjust to include the objects distance from the screen.

(10) Glasses. Video display terminal strain can be aggravated by glasses. If you are only slightly nearsighted, and can see the monitor without your glasses, you might suffer less fatigue by not wearing your glasses. Scratched or smudged glasses will contribute to strain, as well as the added weight of glass lenses as compared to plastic. Bifocal wearers have the biggest problems, as they have to contort the head and neck in order to look through the bottom of the lenses in just the right way to see up close. Consider getting bifocals that are a little higher than normal (at least 28 millimeters wide) to ensure ease of computer work. If you are having trouble seeing the keyboard, computer screen, and copy clearly at the same time, you may need cathode-ray tube (CRT) trifocals. These have an extra portion in the middle for intermediate distances.

Figure 4-10. The height of your bifocals may be too low for comfortable computer work. You may end up with neck strain as well as eyestrain.

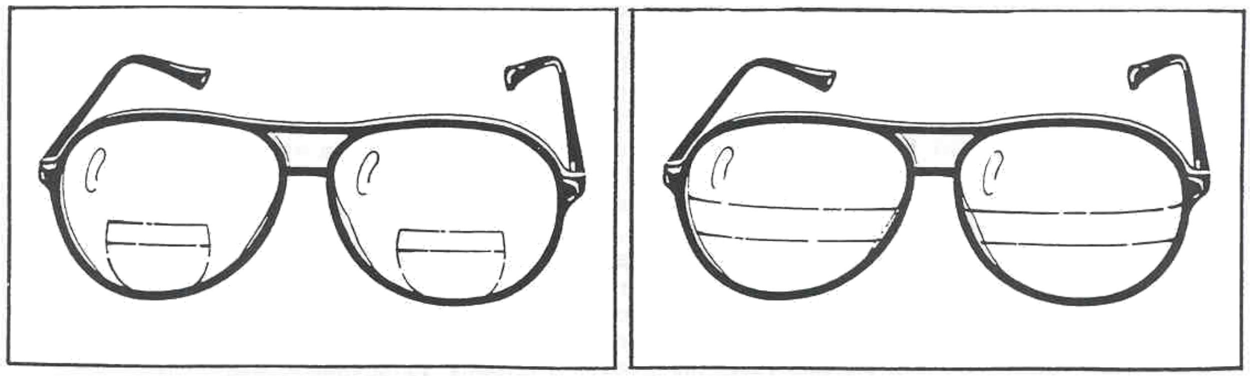


Figure 4-11. Regular vs. CR1 trifocals. The lenses on the right have an extra deep and wide intermediate section for looking at the VDT.

(11) Contact lenses. Some contact lens wearers complain that the only time their lenses pop out is while using the computer. That is because they are forgetting to blink. Be sure to blink, and use the eyedrops recommended by your doctor for the type of lens you wear. More frequent eyedrop use may be necessary if air conditioning is causing your contacts to dry out.

(12) Children. There is some concern that too much close work can cause nearsightedness. Some eye doctors believe that when the eye is focused on close objects too much, the eyeball becomes stretched, thus causing nearsightedness. They are recommending special eyeglasses, as a preventive measure, to reduce the amount of focusing the children have to do.

(13) The workstation. A properly designed workstation will go far to reduce eye and posture strain. Workstation components, chair, screen, and so forth, should be individually adjustable so that proper height can be achieved. Hard copy (papers) should be at the same height and distance as the VDT screen, to minimize head movement and change of focus. The keyboard should be 30 inches from the floor, so that upper arms hang vertically, while forearms angle down slightly. A palm rest to support the wrists is highly desirable. The chair should be adjustable so that the thighs can be parallel to the floor. It should have a backrest and lower back support. A footrest can be used, if needed, so that the feet are flat on the floor. (See figures 4-12 and 4-13.)

(14) Taking rests. If you are using the VDT less than 50 percent of your workday, take 15-minute breaks from computer work, every 2 hours. As you work, remember to look up and focus across the room, from time to time. By following all of these measures combined, you will be doing your part to reduce VDT strain and work more efficiently.

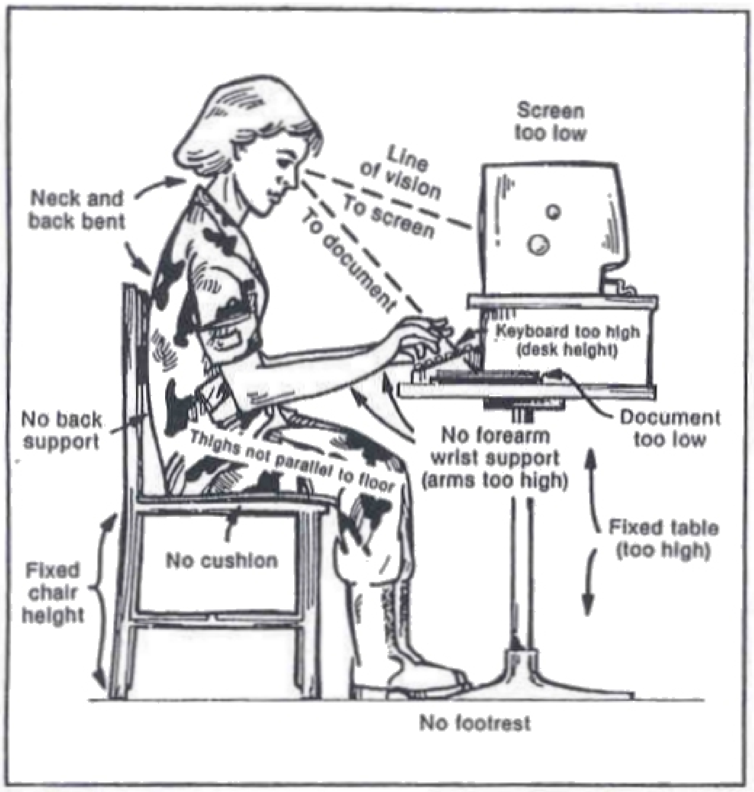


Figure 4-12. A poorly conceived workstation will maximize VDT strain.

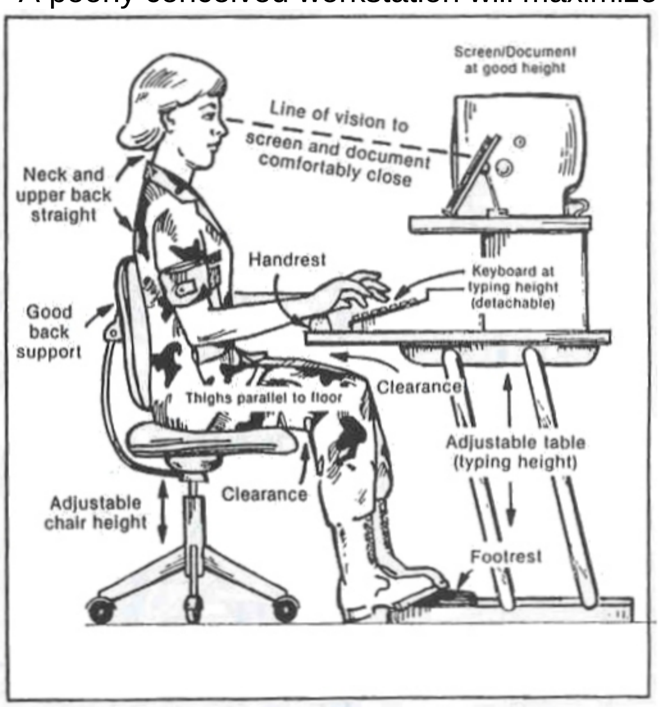


Figure 4-13. A well-conceived workstation will minimize VDT strain.

4-22. ERGONOMICS

Ergonomics, the study of equipment design (computer workstations) that takes into account human comfort and body mechanics, will gain increasing importance. Repetitive strain injury, carpal tunnel syndrome, general fatigue, and eyestrain suffered by the constant computer user will provide the impetus for this. If design factors can prevent conditions with long-term health implications, it is in the best interest of both management and the employee to build them into the equipment. Already, imaginative inventors and entrepreneurs are turning their energies to this end. The worktable, shown at figure 4-14 (the incliner), features a table that can be lowered into the lap. As the tabletop moves lower from its maximum height of 31 inches to 25 inches, the top surface moves the computer forward, bringing both the screen and the keyboard within easy range of the operator. With this model, the more you incline, the more the incliner inclines. It allows the individual to sit on a sofa, instead of a straight-back chair, and work at the keyboard with the computer screen within eye range. Described as ergonomic furniture, one model accommodates small carriage printers and another, laser printers. This model follows ergonomic principles. The body is balanced over its center of gravity, thus preventing neck strain. Backpressure is reduced because the torso is reclining with the legs extended, and circulation is improved. Since the feet are positioned on an incline, pressure on the back and ankles is eased. As such furniture becomes more readily available, prohibitive prices will go down, and they will come into more widespread use.

Figure 4-14. The "incliner," an example of an ergonomically designed workstation.

Continue with Exercises

EXERCISES, LESSON 4

INSTRUCTIONS. The following exercises are to be answered by marking the lettered response that best answers the question or best completes the incomplete statement.

After you have completed all the exercises, turn to, "Solutions to Exercises" at the end of the lesson and check your answers.

1. The miniaturization of computer components

    a. Will continue without limit.

    b. Will continue up to a certain point.

    c. Has reached its limits.

    d. Has resulted in smaller but slower circuits.

2. Micro.processors are ________________ the CPUs of many contemporary mainframe computers.

    a. As powerful as.

    b. Less powerful than.

    c. More powerful than.

    d. Less reliable than.

3. Bubble memory consists of ___________________ resting on a thin film of semiconductor material.

    a. Magnetized spots.

    b. Tracks.

    c. Air bubbles.

    d. Silicon wafers.

4. Which of the following represents a future direction of data storage?

   a. Magnetic disks.

   b. Magnetic tape.

   c. Punch cards.

   d. Smart cards.

5. Computers programmed to understand speech will give the wheelchair-bound more autonomy. It-will also permit ______________ by voice identification.

   a. Shopping.

   b. Commuting.

   c. Banking.

   d. Dining.

6. Translation devices designed to recognize a user's voice can be used by:

   a. The person who verbally programmed it.

   b. Anyone with an access code.

   c. Two people.

   d. Three people.

7. The military plans to use ________ to patrol restricted areas and battle zones.

   a. Artificial intelligence.

   b. Robots.

   c. Remote networks.

   d. Analog computers.

8. __________ attempts to program computers for tasks that require thinking, reasoning, remembering past experiences, and making logical deductions from those experiences.

   a. Robotics.

   b. Speech interpretation.

   c. Artificial intelligence.

   d. Computer design.

9. Some local and state governments are beginning to require that employers establish _____________ policies for those who use VDTs.

   a. Safety.

   b. Budgetary.

   c. Management.

   d. Workflow.

10. ____________ the leading occupational illness in the nation, is caused by constant exposure to small twisting motions, and features pain, numbness, and tingling, as its principal symptoms.

   a. Arthritis.

   b. Skin disease.

   c. Repetitive strain injury.

   d. Chlamydia.

11. Carpal tunnel syndrome, __________, affects among others, those who use computer terminals, handle heavy files, and sort mail.

    a. Damage to the carotid artery.

    b. A muscular condition.

    c. A skin disease.

    d. An inflammation of the wrist.

12. One reason people suffer from eyestrain when working at a terminal is that:

    a. They forget to blink.

    b. The room illumination is too dim.

    c. They have an anti-glare filter on their screen.

    d. They have adjusted their screen to be three or four times brighter than the overall brightness of the room.

13. To avoid repetitive strain injury, eyestrain, and/or overall fatigue, workstation components, such as the chair and screen, should be:

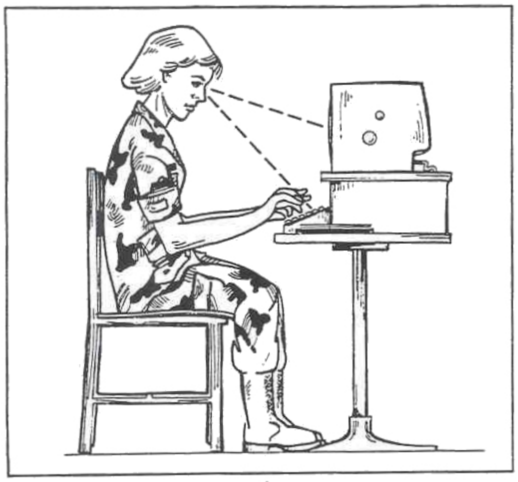
    a. Fixed.

    b. Individually adjustable.

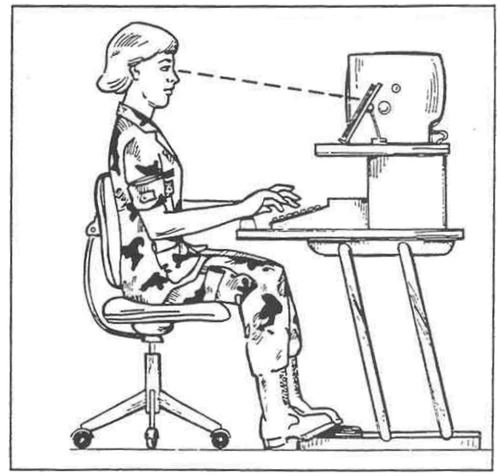
    c. At right angles to each other.

    d. Situated near a bright light.

14. Which workstation is ergonomically sound, a or b?



A.



B.

Check Your Answers on Next Page

SOLUTIONS TO EXERCISES, LESSON 4

1. b (para 4-lb)

2. c (para 4-2)

3. a (para 4-Sa)

4 d (para 4-3b)

5 c (para 4-4d)

6. a (para 4-5)

7. b (para 4-)b)

8. c (para 4-17)

9. a (para 4-18e and 4-19)

10. c (para 4-20a)

11. d (para 4-20d)

12. a (para 4-21b(5))

13. b (para 4-21b(13))

14. a (Figures 4-12 and 4-13)

End of Lesson 4

GLOSSARY

NOTE: This glossary includes terms presented in AMEDD Computer Literacy I and II. Terms first introduced in AMEDD Computer Literacy II are marked by an asterisk; if presented in both subcourses, there is a double-asterisk.

A

abacus: an ancient calculating device composed of a frame of rods representing decimal columns and beads that are moved on the rods to form digits.

access time: the time the computer takes to locate and transfer instructions or data to or from storage.

address: a number identifying a storage location from which data are to be retrieved or inserted.

analog computer: used primarily in engineering or scientific computing, it measures continuous physical or electrical magnitudes, such as pressure, temperature, current voltage, and so forth.

application program: a sequence of instructions written to solve a specific problem.

auxiliary storage: a supplement to the main storage; normally supplied by magnetic disks, magnetic drums, magnetic tape, or magnetic cards.

B

batch processing: a technique in which a number of similar items or transactions are accumulated and then processed periodically as a group or batch. (In contrast to on-line processing.)

***binary code**: a system for representing things by combinations of two symbols, such as 1 or 0, TRUE or FALSE, presence or absence of voltage. (1-1)

***binary number system**: a number system that uses two as its base and expresses numbers as strings of 1s and 0s. (1-5b)

bit: short for binary digit, the smallest unit of information recognizable to a computer. A single bit can be either "on" (1) or *"off" (0*). All computer information is encoded as a string of bits. A 16-bit microprocessor is one that can digest 16 binary digits at a time.

***bubble memory**: a recently developed compact memory device represented by magnetized spots or bubbles. The bubbles rest on thin wafers of garnet (a semiconductor material) in a magnetic field. Data on bubble memory are not lost when the power is shut off.

buffer: internal storage that holds data read to or from input-output devices.

byte: eight bits treated as a unit; the amount of memory needed to store a single letter or number. The smallest unit recognizable to human beings. (The computer can recognize a bit.)

C

central processing unit (CPU): the computer nerve center, coordinates and controls the activities of all the other components, performs arithmetical and logical processes to be applied to data, and stores data.

character: the smallest unit of information recognizable to human beings, as opposed to the smallest unit recognizable to a computer (a bit).

computer: any automatic device capable of performing calculations without human intervention.

conditional control transfer: a machine instruction that transfers control to a designated instruction if some condition is true and continues in sequence to the next instruction if the condition is not true.

D

data: facts, unevaluated messages, the raw material of information.

***data base**: the basic data, a collection of interrelated records, structured to meet the information needs of a wide variety of users with a minimum of duplication. (3-3c)

***data base management system (DBMS)**: a set of programs that provides a method of storing, manipulating, retrieving, and displaying information in the data base. These methods minimize duplication, permit easy change, and can handle direct inquiries. (3-3e)

data processing: operations performed on data, usually by automatic equipment, to derive information; originally manual, later mechanical, and more recently by electronic means. Systematic technique for collecting, manipulating, and disseminating data to achieve certain objectives.

***debugging**: locating, isolating, and eliminating program errors. (2-8b)
*decode: translate from computer to human language. (2-10a)

digital: the representation of data for transmission by discrete signals.

***digital calculator**: a machine, like the abacus, or adding machine, that essentially does counting operations. (1-8b)

digital computer: a computer capable of performing calculations by counting is and Os; data is represented as digital "on-off" states.

direct (or random) access: a type of storage in which access can be made directly to the data in any storage location found on magnetic core, magnetic disk, magnetic drum, or magnetic card).

disk (hard disk): a round magnetized plate, usually made of plastic or metal, organized into concentric tracks and preshaped sectors for storing data.

disk drive: a mechanism that rotates a storage disk and reads or records data.

***download**: receive or capture electronically; copy a file or any portion thereof. (3-7e)

E

electromechanical: composed of both electrical and mechanical parts.

***electronic mail**: the transmission of messages at high speeds between workstations, either by communications network facilities or local area networks; typically for interoffice correspondence, calendars, schedules, short messages between individuals. (4-11)

***encode**: convert information into computer language. (2-4)

F

***fax**: an acronym for facsimile transmission, that is, transmission of images over a communication system. (4-6)

***field**: a meaningful item of data, that is, a Social Security number. (3-3b(1))

file: a group of related records.

floppy disk (diskette): a flexible platter covered with magnetic recording material that permanently stores programs and data. Floppy disks come in two basic sizes: 5 1/4 inches and 3 1/2 inches and hold 360K to 1.4 megabytes of information. Most users need at least 1 to 2 floppy disks or a hard drive.

***flowchart**: graphic representation of the processing that is performed in a program. (2-6c(1))

G

H

hard copy: the permanent readable copy of a computer output.

hard disk (disk): a storage medium that is faster and has more memory capacity than a floppy disk; holds 20 megabytes or more of data; and costs more than a floppy disk.

hardware: the physical apparatus of a computer system.

I

information: data arranged in useful ordered form; the output of manipulated data.

***information theory**: the application of mathematics to language, concepts, processes, and problems in the field of communications. (1-4d)

input-output devices: machines that provide a vehicle for communication between different computer systems or between people and computers (also known as peripherals).

integrated circuit: electronic circuit whose components are etched on a single piece of semiconductor material, usually a silicon chip, less than 1/8 inch square; permits faster, cheaper processing than with transistors.

J

joystick: used principally for games: alternative means of communications with screens electronics.

K

K (kilobyte): RAM and disk capacity are measured in kilobytes, 1K being the equivalent of 1,024 bytes.

L

laser: a device capable of producing a narrow beam of high intensity that can carry data.

laser printer: a nonimpact printer that uses laser beams and electrophotographic technology to form high-quality images.

library: a collection of routines or programs, normally on disk, that may be readily accessible for use by a computer. Most systems have several libraries.

light pen: a pen-shaped object with a light-sensitive cell at one end, used as an alternative to the keyboard to communicate with the screen's electronics.

Local Area Network (LAN): networks of computers and devices connected directly by cable and not by communications lines.

local system: peripherals linked directly to one or more CPUs.

M

main storage: the internal storage of a computer from which instructions are executed; the fastest storage of a computer.

mainframe computer (maxicomputer): full-sized computer that handles a large volume of data for hundreds of users.

***management information systems (MIS)**: a formal computer information network; allows multiple users with different applications access to both routine reports and on-the-spot information for decision-making. (3-3a)

mB (megabyte): 1,000,000 bytes; 1 mB equals 1,024K; RAM and disk capacity are measured in megabytes.

microcomputer: a very small computer, designed for use in small personal business applications; often a special purpose, single-function computer on a chip.

microprocessor: the CPU of a microcomputer; a tiny processor that fits on a single semiconductor chip (more formal, rarely used name, "integrated circuit").

minicomputer: a small computer somewhere in size between a large scale mainframe computer and a microcomputer; with the components of a full-sized system but a smaller memory. (The term is falling into disuse as the distinction between large and "supermini" computers blurs.)

****modem**: a device that transmits and receives computer data over ordinary telephone lines by changing digital signals into analog and vice versa.

mouse: hand-held device used to alter the position of a cursor on the screen. Buttons permit user to issue commands.

N

nanosecond: one billionth of a second (one thousandth of a microsecond); unit of computer access time.

network: several computers and terminals linked by communication channels either on a remote or local basis.

O

off-line: operations performed apart from the computer.

on-line: in direct communication with the computer; cabled to the computer; information that is immediately accessible (stored on a secondary storage that supports direct access to the information).

on-line processing: the entry of data directly into the computer from a terminal in direct communication with the CPU; rapid and random inputting of data without sorting, not instantaneous like real time processing; data manipulation is fast enough to affect the outcome, but not instantaneous.

operating system: a collection of programs that permits a computer to manage itself, reduces CPU idle time, and increases utilization of computer facilities.

P

peripherals: input-output units, secondary storage devices, and other auxiliary equipment. (2-6a)

****program**: a sequence of detailed instructions for performing an operation or solving a problem by computer.

Q

R

RAM: a form of temporary internal storage whose contents can be retrieved and altered by the user; also called "read and write memory. (RAM originally stood for random access memory, a misleading term no longer employed, but the acronym remains in common usage.)

read: to accept or obtain data from some source, that is, a storage device.

real time processing: the capability of a system to receive data, process it, and provide output fast enough to control or affect an activity being performed; response time is instantaneous.

****record**: a group of logically related items (units of data) treated as a unit.

remote system: a communications system in which the terminals are widely separated so that telephone lines, microwave stations, or satellites must be used to link up to the central computer.

routine: an ordered set of general-use instructions.

S

semiconductor: a substance, used in microprocessors, whose electronic conductivity falls between that of a metal and an insulator.

sequential access: a type of storage in which data can only be accessed in the sequence in which it is stored in the device.

silicon: a semiconducting element from which computer chips are made.

silicon chip: very small electronic component, or wafer, capable of storing thousands of computer circuit elements.

***smart card**: storage medium, larger in capacity than a floppy disk, but smaller in size; likely to become the preferred storage medium of the future. (4-3b)

soft copy: nonpermanent visual record.

software: programs used to direct computer problem-solving and oversee operations.

solid state: pertaining to electronic devices, transistors or crystals that can control current without the use of moving parts, heated filaments, or vacuum tubes.

sort: to place a group of records into a desired sequence.

stored program computer model: a design theory upon which most modern computers are based, holding that instructions as well as data should be stored internally in the machine in magnetic form, so they can be altered as the program progresses.

subroutine: a routine that can be a part of another or program.

T

transistor: a type of electronic circuitry found in second-generation computers; smaller, faster, and more reliable than vacuum tubes, but inferior to third-generation integrated circuits.

time-sharing: an arrangement in which two or more users can access the same central computer resources and programs, and receive what seems to be simultaneous results.

U

V

vacuum tube: electronic circuits used in first-generation computers, eventually replaced by transistors and then integrated circuits.

W

word processing: computer-assisted production (creating, recording, editing, and printing) of documents.

word: a set of characters occupying one storage location and treated as a unit.

write: to record or deliver data to a storage device, for example, to punch data on cards in the form of a pattern of holes.

X

Y

Z

End of Glossary