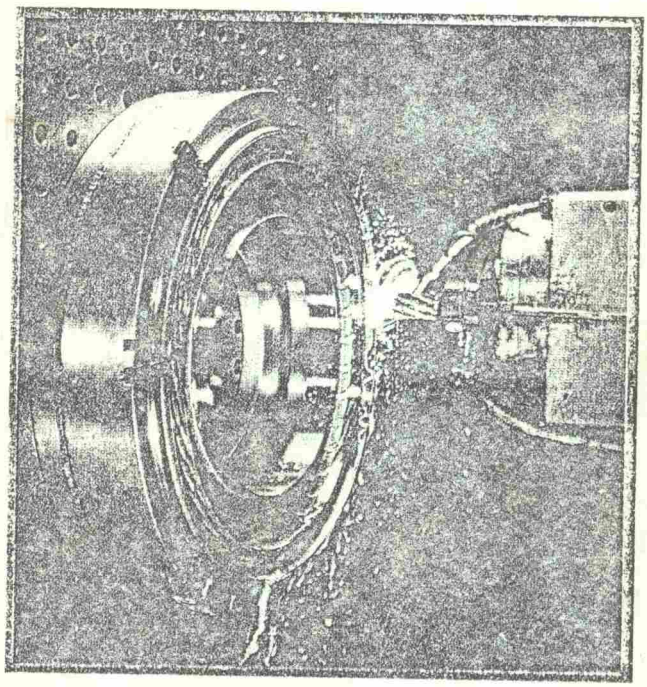
TECHNOLOGY OF MACHINE TOOLS

FIFTH EDITION



Steve F. Krar
Albert F. Check

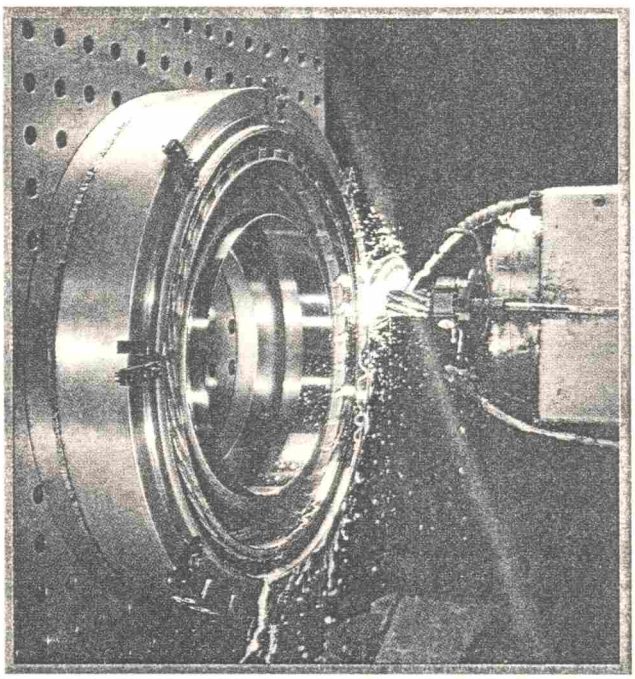
3

GLENCOE

New York, Nev , California Peoria, Illinois

TECHNOLOGY OF MACHINE TOOLS

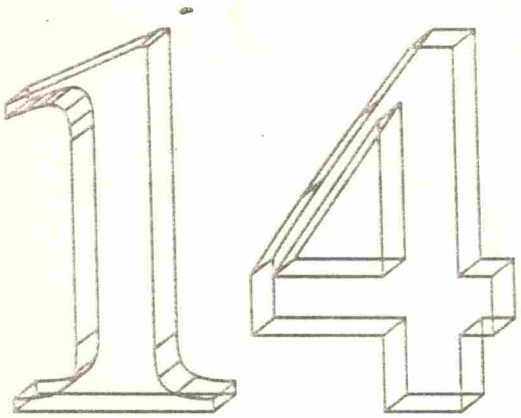
FIFTH EDITION



Steve F. Krar
Albert F. Check

GLENCOE
McGraw-Hill
New York, New York Columbus, Ohio Mission Hills, California Peoria, Illinois

SECTION



COMPUTER-AGE MACHINING

No single invention since the industrial revolution has made such an impact on society as the computer. Today computers can guide and direct spaceships to the moon and outer space and bring them back safely to earth. They route long-distance telephone calls, schedule and control train and plane operations, predict the weather, and produce an instantaneous report of your bank balance. In chain stores, the cash register (connected with a central computer) totals bills, posts sales, and updates the inventory with every entry. These are but a few of the applications of the computer in our society.

During the past two to three decades, basic computers were applied to machine tools to program and control the machine operations. These devices have been steadily improved until they are now highly sophisticated units capable of totally controlling the programming, maintenance, troubleshooting, and operation of a single machine, a group of machines, or soon even a complete manufacturing plant.

UNIT

74

The Computer

OBJECTIVES

After completing this unit, you will be able to:

1. Describe generally the development of computers over the ages
2. Explain briefly the effect of computers on everyday life

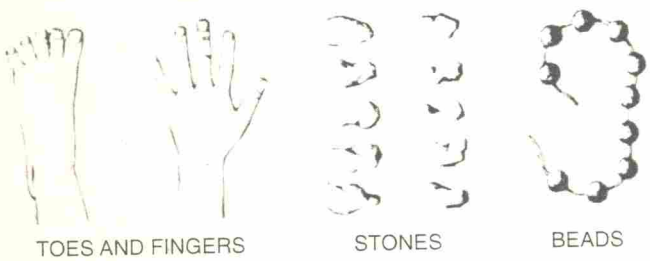


FIGURE 74-1 Primitive means of counting.

Ever since primitive people became aware of the concept of quantity, people have used some device to count and perform calculations. Primitive people used their fingers, toes, and stones to count (Fig. 74-1). In about 4000 B.C., the abacus, really the first computer, was developed in the Orient. It uses the principle of moving beads on several wires to make calculations (Fig. 74-2). The abacus is very accurate when properly used. It may still be found in some of the older and smaller Oriental businesses today.

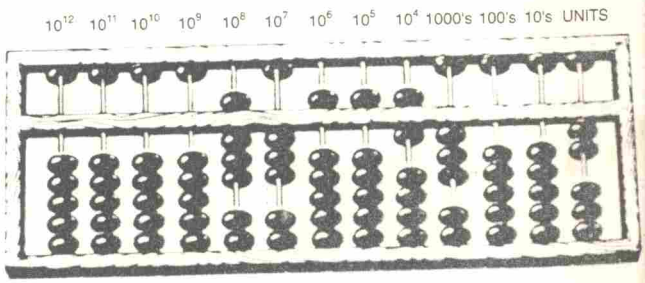


FIGURE 74-2 The abacus was the first real computer.

HISTORY OF THE COMPUTER

In 1642, the first mechanical calculator was constructed by a Frenchman named Blaise Pascal. It consisted of eight wheels or dials, each with the numbers 0 to 9, and each wheel representing units, tens, hundreds, thousands, etc. It could, however, only add or subtract. Multiplication or division was done by repeated additions or subtractions.

In 1671, a German mathematician added the capability of multiplication and division. However, this advanced machine could only do arithmetical problems.

Charles Babbage, a 19th-century English mathematician, produced a machine called the difference engine that could rapidly and accurately calculate long lists of various functions, including logarithms.

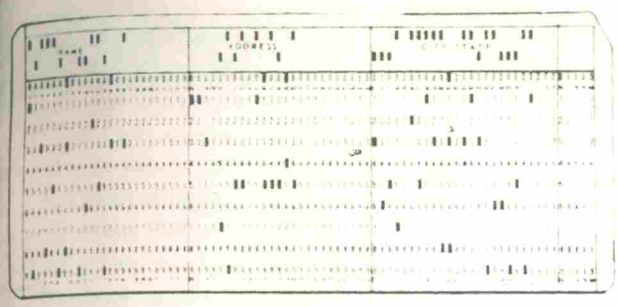


FIGURE 74-3 Punched cards were our first method of data processing.

In 1804, a French mechanician, J. M. Jacquard, introduced a punch card system to direct the operations of a weaving loom. In the United States, Herman Hollerith introduced the use of punched cards to record personal information, such as age, sex, race, and marital status, for the 1890 U.S. census (Fig. 74-3). The information was encoded on cards and read and tabulated by electric sensors. This use of punched cards led to the development of the early office machines for the tabulation of data.

In the 1930s, a German named Konrad Zuse built a simple computer that, among other things, was used to calculate wing designs for the German aircraft industry.

A mathematician named George Stibitz produced a similar device in 1939 for the Bell Telephone Laboratories in the United States. This machine was capable of doing calculations over telephone wires; thus was born the first remote data processing machine.

During World War II, the British built a computer called the Colossus I, which helped break the German military codes.

The earliest digital computers used electromechanical on-off switches or relays. The first large computer, the Mark I, assembled at Harvard University by IBM, could multiply two 23-digit numbers in about 5 seconds—a very slow feat compared to today's machines.

In 1946, the world's first electronic digital computer, the *ENIAC* (*e*lectronic *n*umerical *i*ntegrating *a*utomatic computer) was produced. It contained more than 19,000 vacuum tubes, weighed almost 30 tons, and occupied more than 15,000 ft^2 of floor space. It was a much faster computer—able to add two numbers in $\frac{1}{5000}$ of a second. A machine of this size had many operational problems, particularly with tubes burning out and with circuit wiring.

In 1947, the first transistor was produced by the Bell Laboratories. These were used as switches to control the flow of electrons. They were much smaller than vacuum tubes, had fewer failures, gave off less heat, and were much cheaper to make. Computers were then assembled using transistors, but still the problem of extensive hand wiring existed. This problem led to the development of the printed circuit.

In the late 1950s, Kilby of Texas Instruments and Noyce of Fairchild discovered that any number of transistors, along with the connections between them, could be etched on a small piece of silicon (about $\frac{1}{4} \times \frac{1}{4} \times \frac{1}{32}$ in. thick). These chips, called *integrated circuits* (ICs), contained entire sections of the computer, such as a logic circuit or a memory register. These chips have been further improved, and today thousands of transistors and circuits are crammed into this tiny silicon chip (Fig. 74-4). The only problem with this advanced chip was that the circuits were rigidly fixed and the chips could only do the duties for which they were designed.

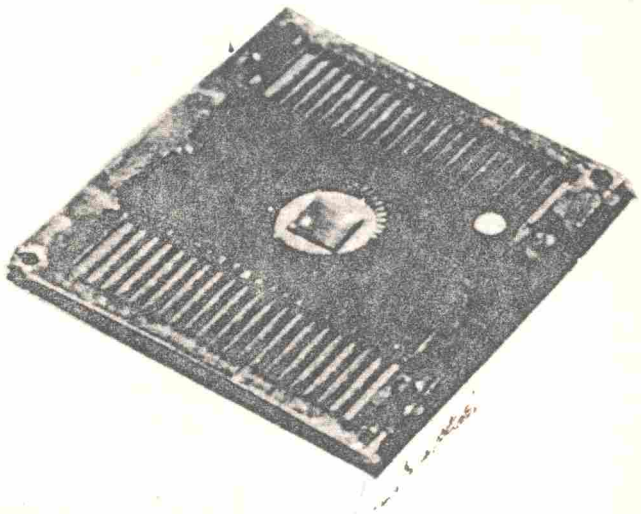


FIGURE 74-4 Thousands of bits of information can be stored on a tiny silicon chip. (Courtesy Rockwell International.)

In 1971, the Intel Corporation produced the microprocessor—a chip that contained the entire *central processing unit* (CPU) for a single computer. This single chip could be programmed to do any number of tasks, from steering a spacecraft to operating a watch or controlling the new personal computers.

THE ROLE OF THE COMPUTER

Although today's computers amaze us (the older generation particularly), they have become part of everyday life. They will become an even greater influence in the years to come.

We are amazed that some computers today can perform 1 million calculations per second because of the thousands of transistors and circuits jammed into the tiny chips (ICs). Computer scientists can foresee the day when 1 billion transistors or electronic switches (with the necessary connections) will be crowded into a single chip. A single chip will have a memory large enough to store the text of 200 long novels. Advances of this type will decrease the size of computers considerably.

The prototype of a thinking computer incorporating *artificial intelligence* (AI) was introduced in the 1990's. The commercial product followed about 5 years later. This

machine is able to recognize natural speech and written language and to translate and type documents automatically. Once a verbal command is given, the computer acts, unless it does not understand the command. At this point the machine asks questions until it is able to form its own judgments and act. It also learns by recalling and studying its errors.

Computers today are used in larger medical centers to catalog all known diseases with their symptoms and known cures. This knowledge is more than any doctor could remember. Doctors now are able to patch their own computer into the central computer and get an immediate and accurate diagnosis of the patient's problem, thus saving many hours and even days of awaiting the results of routine tests.

Because of the computer, children will learn more at a younger age and, as may be expected, future generations will have a much broader and deeper knowledge than those of past generations. It was said that in the past we doubled our knowledge every 25 years. Now with the computer, the amount of knowledge is said to double every 3 years. With this greater knowledge, the human race will explore and develop new sciences and areas that are unknown to us today (much the same as the computer has affected the older people of this era).

In other areas, the computer has been and will continue to be used to predict weather; guide and direct planes, spaceships, missiles, and military artillery; and monitor industrial environments.

In everyday life, everyone is and will continue to be affected by the computer. Department store computers list and total your purchases, at the same time keeping the inventory up to date and advising the company of people's buying habits. Thus, the computer permits the company to buy more wisely. Credit bureau computers know how much every adult owes, to whom, and how the debt is being repaid. School computers record students' courses, grades, and other information. Hospital and medical records are kept on anyone who has been admitted to a hospital.

Police agencies have access to a national computer that can produce the police records of any known offender. The census bureau and tax department of any country have information on all its citizens on computer.

On the office front, computers have relieved the accountants of the drudgery of repetitious jobs such as payroll processing. Many office workers work at home on a company computer. This eliminates the necessity of traveling long distances to work and the need for baby-sitting services required by so many young working families today.

In air defense control systems, the position and course of all planes from the network of radar stations are fed into the computer along with the speed and direction of each. The information is stored and the future positions of the planes are calculated.

In the manufacturing industry, the computer has contributed to the efficient manufacture of all goods. It appears that the impact of the computer will be even greater in the years to come. Computers will continue to improve productivity through *computer-aided design* (CAD), by which the design of a product can be researched, fully developed, and tested before production begins (Fig. 74-5). *Computer-assisted manufacturing* (CAM) results in less scrap and more reliability through the computer control of the machining sequence and the cutting speeds and feeds.

Robots, which are computer-controlled, are used by industry to an increasing extent. Robots can be programmed to paint cars, weld, feed forges, load and unload machinery, assemble electric motors, and perform dangerous and boring tasks formerly done by humans.

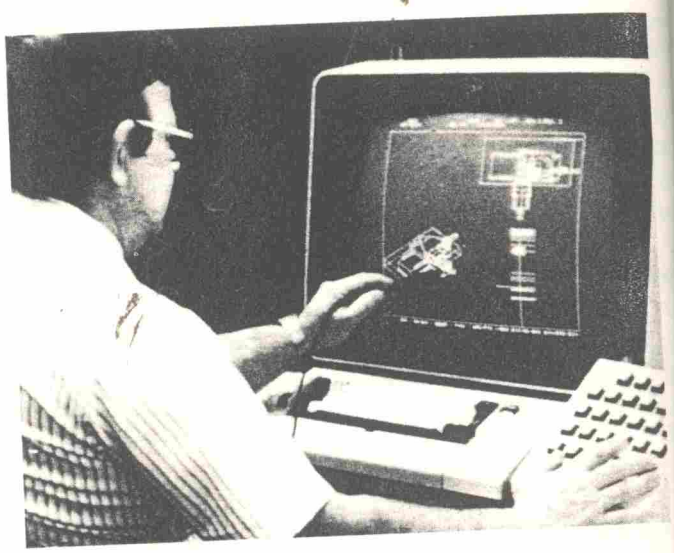


FIGURE 74-5 CAD systems are invaluable to engineers who research and design products.

REVIEW QUESTIONS

1. Name three methods of counting used by primitive people.
2. What was the first computer ever developed?
3. For what purpose were the first punched cards used in the United States?
4. How many transistors and circuits can be found on a silicon chip?
5. How are computers used in medical centers?
6. How are computers affecting the manufacturing industry?

UNIT

75

Computer Numerical Control

OBJECTIVES

After completing this unit, you should be able to:

1. Identify the types of systems and controls used in computer numerical control
2. List the steps required to produce a part by computer numerical control
3. Discuss the advantages and disadvantages of computer numerical control

Numerical control (NC) may be defined as a method of accurately controlling the operation of a machine tool by a series of coded instructions, consisting of numbers, letters of the alphabet, and symbols that the *machine control unit* (MCU) can understand. These instructions are converted into electrical pulses of current, which the machine motors and controls follow to carry out machining operations on a workpiece. The numbers, letters, and symbols are coded instructions that refer to specific distances, positions, functions, or motions that the machine tool can understand as it machines the workpiece. The measuring and recording devices incorporated into computer numerical control machine tools ensure that the part being manufactured will be accurate. *Computer numerical control* (CNC) machines minimize human error.

THEORY OF CNC

Computer numerical control (CNC) and the computer have brought tremendous changes to the metalworking industry. New machine tools, in combination with CNC, enable industry to consistently produce parts to accuracies undreamed of only a few years ago. The same part can be reproduced to the same degree of accuracy any number of times if the CNC program has been properly prepared, the computer has been properly programmed, and the machine properly set up. The operating commands that control the machine tool are executed automatically with amazing speed, accuracy, efficiency, and repeatability.

THE ROLE OF A COMPUTER IN CNC

The computer has also found many uses in the overall manufacturing process. It is used for part design using computer aided design (CAD), testing, inspection, quality

control, planning, inventory control, gathering of data, work scheduling, warehousing, and many other functions in manufacturing. The computer is having profound effects on manufacturing techniques, and will continue to have in the future. Computers fill three major roles in CNC:

1. Almost all machine control units (MCUs) include or incorporate a computer in their operation. These units are generally called *computer numerical controls* (CNC).
2. Most of the part programming for CNC machine tools is done with off-line computer assistance.
3. An increasing number of machine tools are controlled or supervised by computers that may be in a separate control room or even in another plant. This is more commonly known as *direct numerical control* (DNC).

TYPES OF COMPUTERS

Most computers fall into two basic types, either analog or digital. The *analog computer* is used primarily in scientific research and problem solving. Analog computers have been replaced in most cases by the digital computer. Most computers used in industry, business, and at home, are of the electronic digital type. The *digital computer* accepts an input of digital information in numerical form, processes that information according to prestored or new instructions, and develops output data (Fig. 75-1).

There are generally three categories of computers and computer systems: the mainframe, the minicomputer, and the microcomputer.

- The *mainframe computer* (Fig. 75-2), which can be used to do more than one job at the same time, is large and has a huge capacity. It is generally a company's main computer, the one that performs general-purpose data processing such as CNC part programming, payroll, cost accounting, inventory, and many other applications.

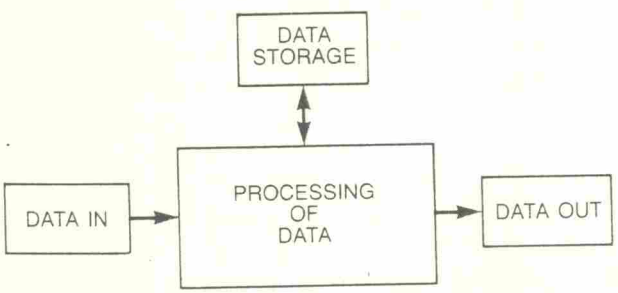


FIGURE 75-1 The main function of the computer is to accept, process, and output data.

FIGURE 75-2 The mainframe computer, which can do many jobs simultaneously, is larger and has more capacity than other computers. (Courtesy Hewlett-Packard Company.)

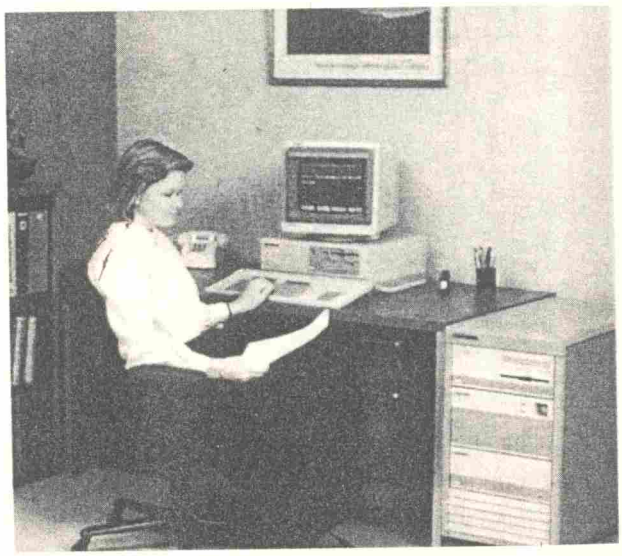


FIGURE 75-3 The minicomputer is generally a dedicated type and performs specific tasks. (Courtesy Hewlett-Packard Company.)

- The *minicomputer* (Fig. 75-3) is generally smaller in size and capacity than the mainframe computer. This type of computer is generally a "dedicated" type, which means that it performs specific tasks.
- The *microcomputer* (Fig. 75-4) generally has one chip (a microprocessor) that contains at least the arithmetic-logic and control-logic functions of the central processing unit (CPU). The microprocessor is usually designed for simple applications and must be accompanied by other electronic devices, on a printed circuit board, for more complex applications.

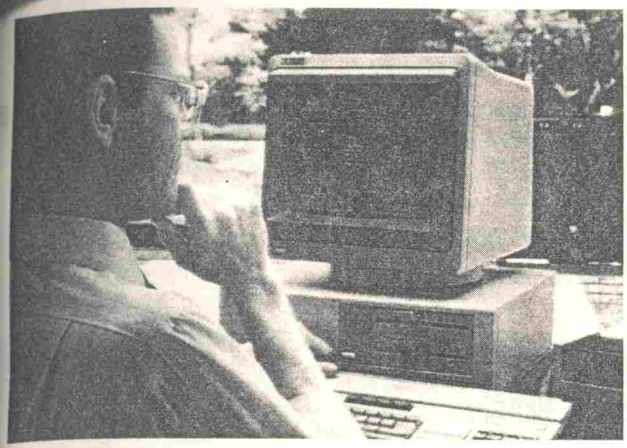


FIGURE 75-4 The microcomputer generally contains only one chip and is designed for simple applications. (Courtesy Hewlett-Packard Company.)

COMPUTER FUNCTIONS

The function of a computer is to receive coded instructions (input data) in numerical form, process this information, and produce output data that causes a machine tool to function. Many methods are used to put information on a computer, such as punched or perforated tape, magnetic tape, floppy disks, and specially designed sensors (Fig. 75-5). The most commonly used method to input data is directly through the computer.

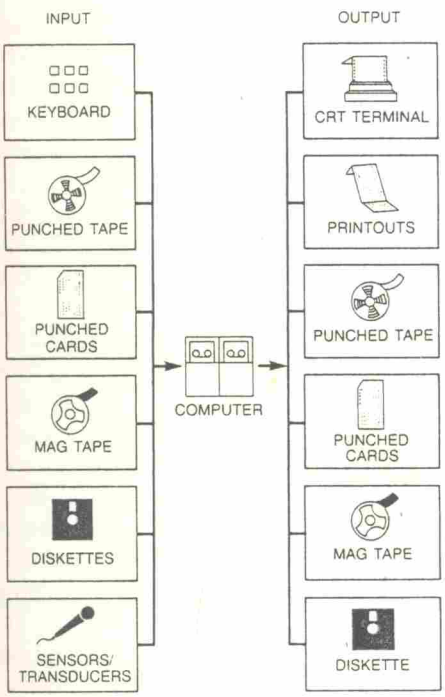


FIGURE 75-5 Common methods used to provide input into and out of the computer. (Modern Machine Shop.)

CNC PERFORMANCE

CNC has made great advances since NC was first introduced in the mid-1950s as a means of guiding machine tool motions automatically, without human assistance. The early machines were capable only of point-to-point positioning (straight-line motions), were very costly, and required highly skilled technicians and mathematicians to produce the tape programs. Not only have the machine tools and controls been dramatically improved, but the cost has been continually lowered. CNC machines are now within the financial reach of small manufacturing shops and educational institutions. Their worldwide acceptance has been a result of their accuracy, reliability, repeatability, and productivity (Fig. 75-6).

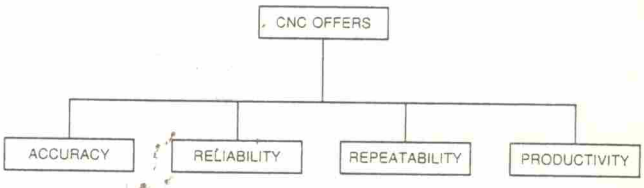


FIGURE 75-6 CNC offers industry many advantages. (Courtesy Kelmar Associates.)

Accuracy

CNC machine tools would not have been accepted by industry if they were not capable of machining to very close tolerances. At the time CNC was being developed, industry was looking for a way to improve production rates and achieve greater accuracy on their products. A skilled machinist is capable of working to close tolerances, such as ±.001 in. (0.025 mm), or even less, on most machine tools. It has taken the machinist many years of experience to develop this skill, but this person may not be capable of working to this accuracy every time. Some human error means that some of the product may have to be scrapped.

Modern CNC machine tools are capable of consistently producing workpieces that are accurate to within a tolerance of .0001 to .0002 in. (0.0025 to 0.005 mm). The machine tools have been built better, and the electronic control systems ensure that parts within the tolerance allowed by the engineering drawing will be produced.

Reliability

The performance of CNC machine tools and their control systems had to be at least as reliable as the machinists, toolmakers, and diemakers for industry to accept this machining concept. Since consumers throughout the world were demanding better and more reliable products, there was a great

Bạn đang có trong tay thông tin cơ bản của một trong số những tài liệu có hàm lượng chất xám cao, với những thông tin vô cùng hữu ích cho quá trình học tập và nghiên cứu của bản thân bạn !

Bạn đã và đang trải qua những ưu tư, trăn trở của bản thân mình trước biển kiến thức mênh mông vô hạn và đang tìm hướng đi cho riêng mình bằng việc biến kiến thức thành tài sản tri thức của riêng bạn !

Hãy để Thư viện trường Đại học Sư phạm Kỹ thuật Tp. HCM chia sẻ những khó khăn và trăn trở đó cùng bạn!

Hãy đến với Thư viện trường Đại học Sư phạm Kỹ thuật Tp. HCM để cùng nhau, chúng ta xây dựng vương quốc khoa học và trí tuệ của chính mình !

THƯ VIỆN

Cùng với bạn, Thư viện ĐH Sư phạm Kỹ thuật Tp. HCM mong ước góp phần duy trì và phát triển văn hóa đọc !

THƯ VIỆN

Hãy đến với chúng tôi - Thư viện trường Đại học Sư phạm Kỹ thuật Tp. HCM để cảm nhận, trải nghiệm và biến ước mơ khoa học của bạn thành hiện thực !

Hân hạnh được đón tiếp và phục vụ bạn tại
Số 1 – 3, Võ Văn Ngân, Phường Linh Chiểu, Quận Thủ Đức, Tp. HCM
ĐT: (08) 3896 9920 – Email: thuvienspkt@hcmute.edu.vn
http://www.thuvienspkt.edu.vn – http://thuvien.hcmute.edu.vn

Thông tin tài trợ!

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

Bạn đang có trong tay thông tin cơ bản của một trong số những tài liệu có hàm lượng chất xám cao, với những thông tin vô cùng hữu ích cho quá trình học tập và nghiên cứu của bản thân bạn !

Bạn đã và đang trải qua những ưu tư, trăn trở của bản thân mình trước biển kiến thức mênh mông vô hạn và đang tìm hướng đi cho riêng mình bằng việc biến kiến thức thành tài sản tri thức của riêng bạn !

Hãy để Thư viện trường Đại học Sư phạm Kỹ thuật Tp. HCM chia sẻ những khó khăn và trăn trở đó cùng bạn!

Hãy đến với Thư viện trường Đại học Sư phạm Kỹ thuật Tp. HCM để cùng nhau, chúng ta xây dựng vương quốc khoa học và trí tuệ của chính mình !

THƯ VIỆN

Cùng với bạn, Thư viện ĐH Sư phạm Kỹ thuật Tp. HCM mong ước góp phần duy trì và phát triển văn hóa đọc !

THƯ VIỆN

Hãy đến với chúng tôi - Thư viện trường Đại học Sư phạm Kỹ thuật Tp. HCM để cảm nhận, trải nghiệm và biến ước mơ khoa học của bạn thành hiện thực !

Hân hạnh được đón tiếp và phục vụ bạn tại
Số 1 – 3, Võ Văn Ngân, Phường Linh Chiểu, Quận Thủ Đức, Tp. HCM
ĐT: (08) 3896 9920 – Email: thuvienspkt@hcmute.edu.vn
http://www.thuvienspkt.edu.vn – http://thuvien.hcmute.edu.vn

Thông tin tài trợ!

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....