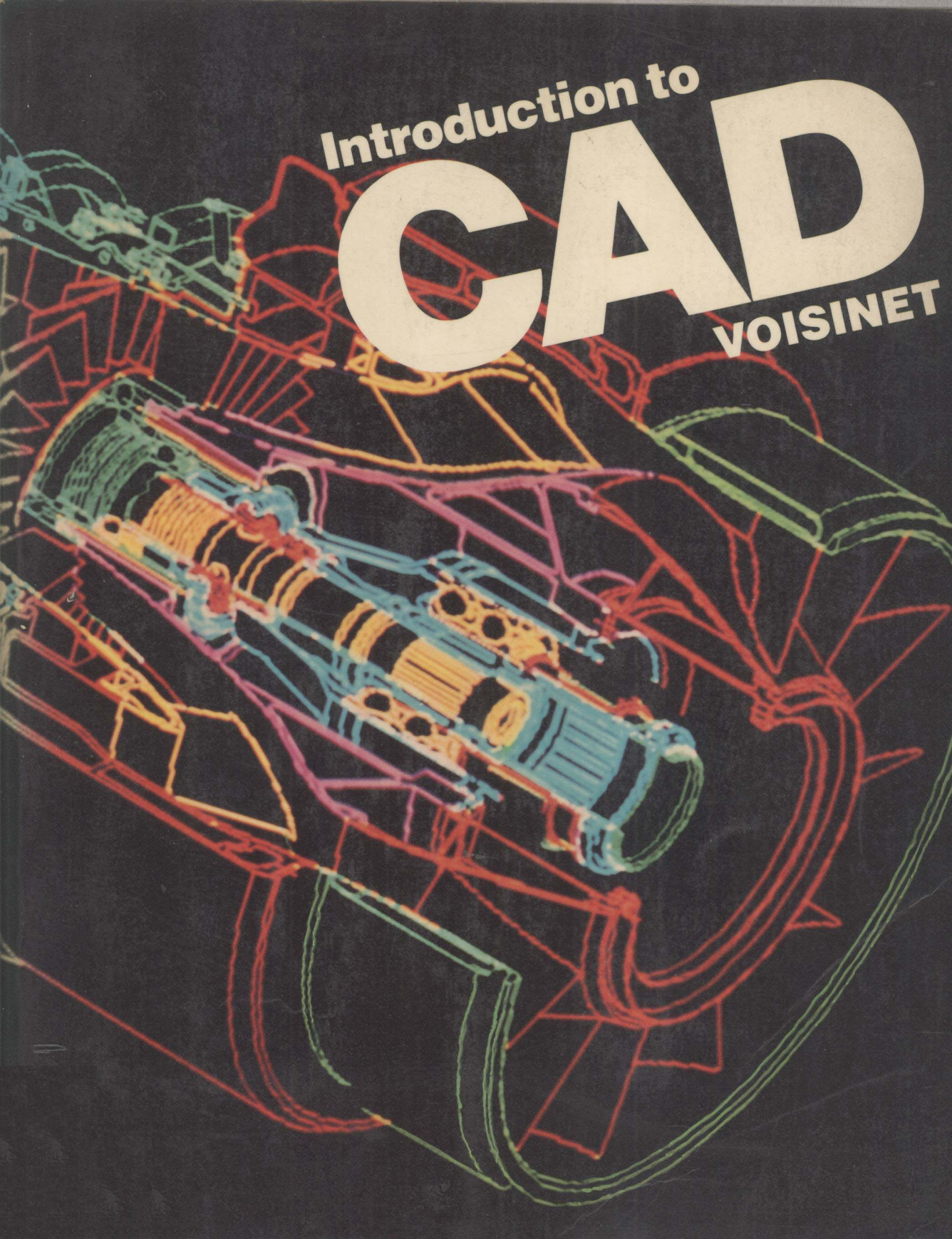
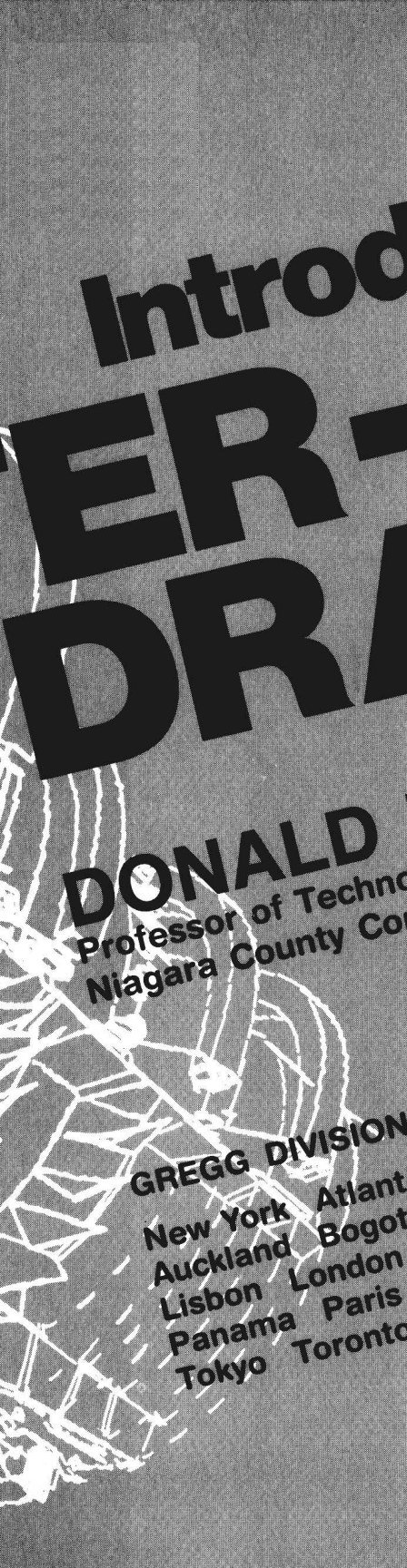
Introduction to CAD



VOISINET

Introduction to
ER-AIDED DRAFTING

DONALD D. VOISINET
Professor of Technology
Niagara County Community College Sanborn, New York



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PREFACE

The wide-scale use of the integrated circuit chip in electronics is revolutionizing the way we work and play. It has dramatically changed the mode of worldwide communications at all levels—personal, industrial, and in every facet of modern-day life. It's on our wrist (quartz digital watches). It's used to solve math problems (hand-held calculators). It entertains (video games) and it helps run businesses (computers). These technological changes are affecting many careers. Retraining people and upgrading job skills is now a necessity in many areas. Drafting is in the forefront of the changes. CAD (computer-aided drafting) is fast becoming a very familiar acronym. Any drafter who wants to upgrade job skills must understand CAD and how it affects his or her career. *Introduction to CAD* will help in understanding how the traditional roles of the drafter are changing. The text presents CAD concepts in a logical, straightforward manner. Anyone possessing interest and a basic knowledge of drafting fundamentals will be able to benefit from this text.

This text was not written with any specific machinery in mind. Rather, the reader can learn enough about general concepts to use a variety of machinery. While it would be best to be able to sit down at a machine during the time you use this text, it is not required to understand the material presented here.

The contents of this text include:

- Why computer-aided drafting is used.
- Types of computer-aided drafting equipment.
- Ways computer-aided drafting is used.
- Preparation of engineering drawings by various methods.
- Commonly used equipment from several manufacturers.

Introduction to CAD is not about computer programming. Drafters do not normally have to know how to program. Drafters use prepared programs to assist in creating drawings. This book explains the basic concepts that a drafter or potential drafter needs to know about CAD. Thus, it will serve as an excellent introduction to this topic.

The text will relate the three categories of CAD equipment. These include micro (or home) computers, mini-computer systems, and mainframe host computer systems. The concepts presented will be valuable because CAD will most certainly become a vital part of virtually every drafter's working career in just a few short years.

Donald D. Voisinet

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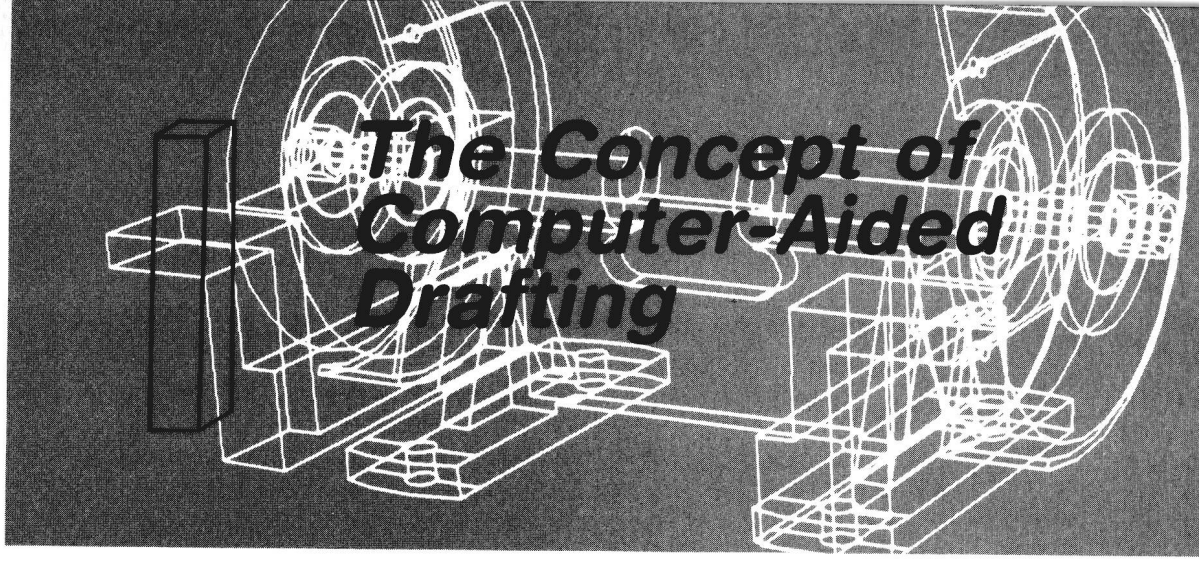


The Concept of Computer-Aided Drafting

1-1 Introduction

The engineering drawing has been an integral part of industry for many years. It is the link between engineering design and manufacturing. Information is quickly communicated to manufacturing in the form of drawings prepared according to prescribed drafting standards. It is said that a picture is worth a thousand words. Actually, a picture is worth much more. The speed of graphic comprehension can approach a rate 50,000 times that of reading.

CAD Definition

An engineering drawing may be prepared by means other than using the conventional tools. Traditionally, drafting instruments have been used to apply lead or ink on vellum or Mylar. The popular alternative now is to prepare the drawing with the aid of a computer. This method is known as *computer-aided drafting* or *computer-aided design and drafting*. It has rapidly replaced the handmade drawing. Computer-aided design and drafting is abbreviated *CAD* or *CADD*. Several other terms are also used. Some of these are:

- Computer-assisted drafting.
- Computer-augmented drafting.
- Computer-automated drafting.

These and other similar terms are used synonymously. They will be abbreviated as CAD throughout this textbook.

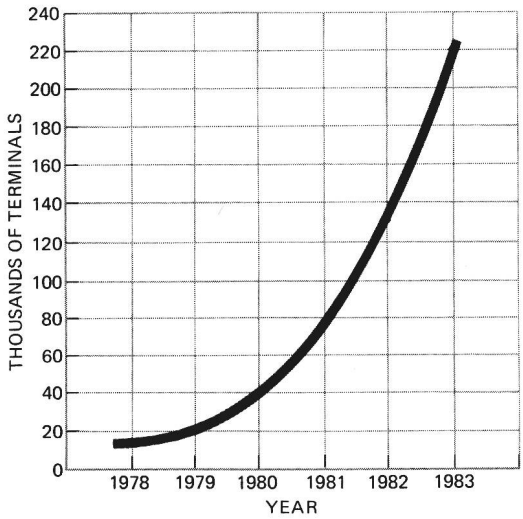
CAD History

Commercial computer-aided drafting was introduced in 1964, when the International Business Machines Corp. (IBM) made it commercially available. The first *turnkey* (complete) system was made available in 1970 by Applicon Incorporated. Only recently, however, has the dramatic impact of this new technical tool been felt. By the end of 1982, over 4500 systems were being used by United States industry. The revolution is continuing. The market potential is a tenfold increase by the late 1980s. Although the implementation of CAD in the early 1980s was beginning to develop in the large companies, it now has even much more dramatic effects. This is seen in Fig. 1-1. Note the exponential growth rate in the use of computer graphics terminals.

The *C* in *CAD*

The computer, at first, appears to be a mysterious machine. It is actually, however, an electronic device with no brain. Its capability is limited to basic logical functions. These functions must be determined by a human. They must also be fed into the computer by a human. Each function is performed in sequential order. Such functioning allows the machine to be used for addition, subtraction, etc. To perform a process, the functions must be logically ordered.

Fig. 1-1 The boom in computer graphics.



This means that simple events are repeated several times. For example, a multiplication process is conducted as an addition sequence. To multiply 5×4, the computer executes $5 + 5 + 5 + 5$. The larger the number, the larger the required sequence. The redeeming qualities of the computer lie in the following features.

- The extraordinarily large *number* of functions that can be performed.
- The great *speed* at which each function can be performed.
- The *accuracy* and capacity for repetition of operation.
- The *memory* or *storage* system.

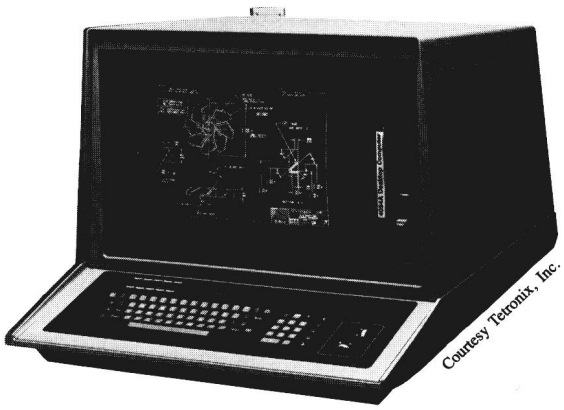
A typical computer terminal is shown in Fig. 1-2.

Computer Programs

A computer's memory enables an individual to program the computer. A *program* includes a written set of detailed instructions. The instructions are set up by a computer programmer. A drafter or designer will normally never need to program. He or she will usually use developed programs. CAD is intended to make the computer accessible to nonprogrammers.

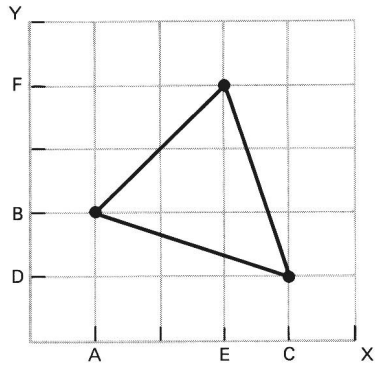
A programmer addresses the computer with a line-by-line format. Each function, or event, is displayed on a horizontal line on the screen. The computer operation and output is limited to the group of functions used. For example purpose only, a partial simple program is shown in Fig. 1-3(a). This program is used to graph-

Fig. 1-2 A sample computer.



```
100 HOME
110 PAGE
120 INPUT A, B
130 INPUT C, D
140 INPUT E, F
150 MOVE A, B
160 DRAW C, D
170 DRAW E, F
180 DRAW A, B
190 END
```

(a)



(b)

Fig. 1-3 A sample program.

ically display the triangle shown in Fig. 1-3(b). Detailed instructions can also be used to define, analyze, and chart the flow of problems. However, a program that is much more complex than that of Fig. 1-3 would be required to perform such functions. Computer instructions are given in one of several recognized standard languages. The language known as *BASIC* is shown in Fig. 1-3(a). Numerous computer programming courses are available. Course work teaches the programmer methods for preparing any set of detailed instructions. But, again, it is not necessary for a drafter or designer to learn computer programming methods. Numerous programs, known as *software,* exist and are available for use.

The Microprocessor

The advancement in commercially produced microcomputing equipment has led the way in CAD implementation. The term *microminiaturization* refers to the use of integrated circuit (IC) chip technology. This has launched what some have called the technical revolution. Discrete component printed circuit (PC) boards in computers have been replaced by microprocessors (the processing unit of a computer). An example of typical PC and IC components is shown in Fig. 1-4. The PC shown at the top of Fig. 1-4 has been drawn 4 times larger than actual size. The IC pattern, shown at the bottom, appears to be the same size. It is not, however, since it has been drawn 50 times larger than actual size.

The IC chip has made possible the development of microprocessors. The microprocessor fits into small computers giving them a huge capacity. The microprocessor is considered to be the most

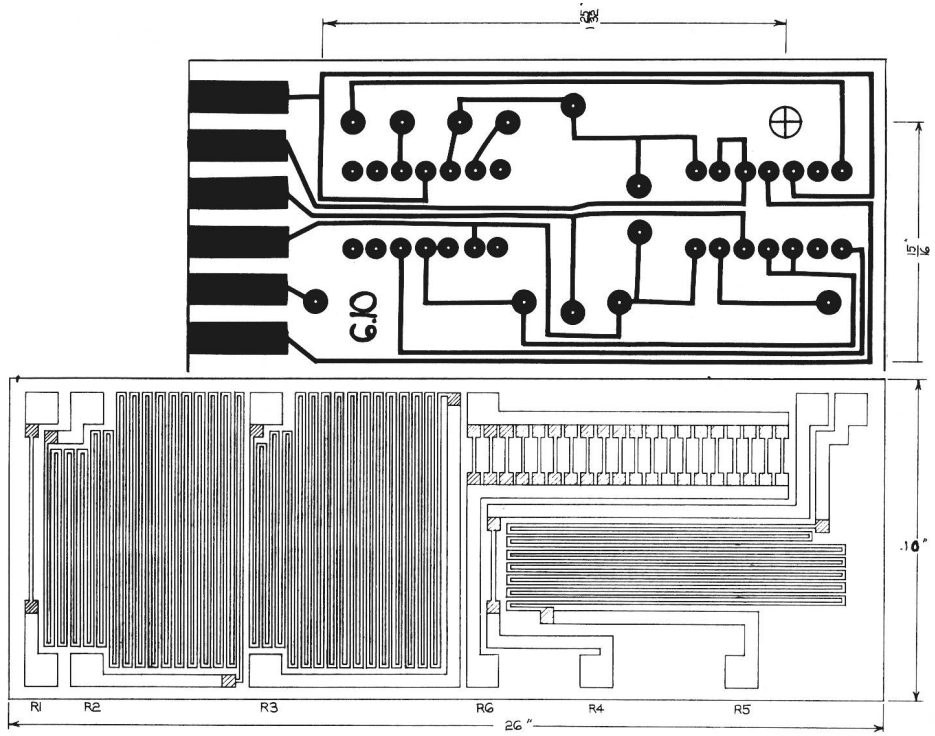


Fig. 1-4 Printed circuit (top) and integrated circuit drawing (bottom).

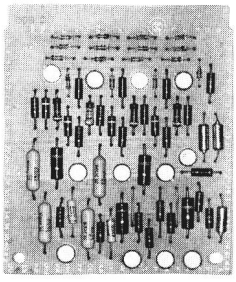


Fig. 1-5(a) A PC board and an IC chip before packaging.

up-to-date, or state-of-the-art, electronic invention. It contains many times the functional capability of an equivalent-sized transistor PC board. Fig. 1-5(a) shows a comparison between the size of a PC board and an IC chip. The chip, at the bottom, replaces all the resistors (dark cylinders) on the board at the top—at least half of the total number of components. The significant reduction in size is apparent. The size of only the IC chip is shown in Fig. 1-5(a). After the chip has been packaged, it becomes larger, because of the required size of the terminals. But there is still a significant size and weight reduction. Fig. 1-5(b) compares a PC with an IC after packaging.

Cathode-Ray Tube

Another innovation has led to the widespread use of CAD—the development of the graphics display station using a *c*athode-*r*ay *t*ube (CRT). The CRT allows you, the user, to project an image on a screen. The CRT screen resembles a television screen. Its slang

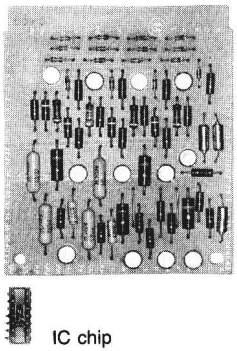


Fig. 1-5(b) A PC board and an IC chip after packaging.

name in industry is the "tube" or "scope." It is the interface between the computer and the computer user, as shown in Fig. 1-6. This interface sets up a two-way (*interactive*) communication. You have control of the unit by the use of an input device. The result of your input is an immediate graphic display of computer calculations. You can then promptly analyze the design or drawing and make a decision about the next step of the process. The procedure may be repeated as many times as necessary. Communication with the computer is not broken. An example of a graphics display is shown in Fig. 1-7. An automobile steering mechanism is displayed on a CRT.

1-2 Social Effects

Social aspects of CAD can be devastating to the unfamiliar individual. To make the change from the conventional drafting board to the CRT may cause frustration for several reasons. One primary reason is fear of the unknown. How will this technology affect you as an individual? Deep concern arises as to its effect on your job and your life. Beyond that, human nature generally resists the threat of change.

To help overcome this resistance, industry began introducing CAD as a parallel new system. Traditional methods remained unchanged. Some employees were selected to work on the CRT; others either voluntarily or involuntarily remained on the board. The newer and younger employees were more likely to be selected for the CRT. There were a variety of reasons for this. The most obvious is that they are more easily expended for that task. They have not yet achieved sufficient job experience. Thus, their worth to the company as designers is less. Also, some managements feel, rightly or wrongly, that the younger employee is more innovative and more familiar with computing equipment and, thus, quicker to grasp the CAD concept. This kind of thinking obviously can set up a separation of employees and loom as a threat, particularly to older employees, with regard to job security.

All these concerns will undoubtedly cause problems. In time, they will be solved. Younger employees, for example, will be recognized as having value to the company. It is only through reliance upon them that a company will survive into the future. By the same logic, the company realizes that it is the older employees who possess the experience. They are the backbone of the company. Also, all employees, whether young or old, have the ability to learn.

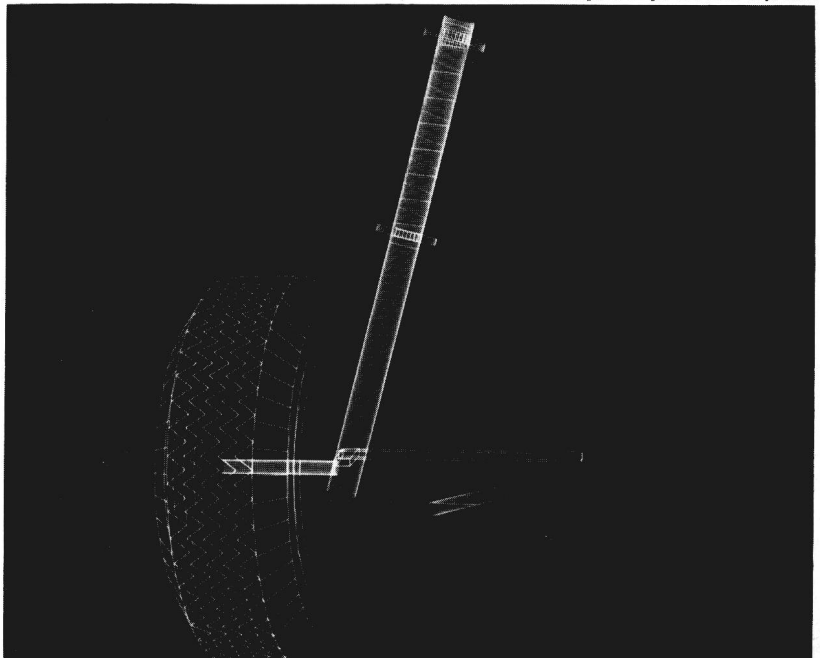
Courtesy Megatek Corporation

Fig. 1-6 Interactive graphics: computer, CRT, and user.

They will continue to learn new technologies as those technologies emerge. Maintaining a positive attitude is the critical factor. Even those who are reluctant at first lose their inhibitions quickly. Human concern will be further relieved as the separatist philosophy disappears—that is, when the CAD room and the design drafting room become one. This will occur as each designer and drafter acquires a CAD tool.

Fig. 1-7 Automobile steering mechanism displayed on a CRT.

Courtesy Evans & Sutherland Computer Corp., Salt Lake City, Utah



Other social implications involving the use of CAD have emerged. These should be recognized. Because the equipment is state-of-the-art, its use improves company image. A large initial financial outlay for *hardware,* or equipment, is required. For the hardware to be cost effective, higher efficiency is mandated. CAD offers this increased productivity. Pressure on CAD employees to produce more drawings might result. This sometimes makes the individuals possessive of the equipment. At the very least, it puts them on the defensive. A stress situation is likely to be created. Management must strive to alleviate these potential conditions. A motivating and stimulating work environment must be created and maintained. Employees must also understand that it is a higher level of challenge and opportunity that is being offered. Those who understand and accept these factors will become the successful CAD personnel. Remember, as an employee, be enthusiastic and retain a positive attitude.

1-3 System Effects

Positive Aspects of CAD

Computer-aided drafting systems relieve the drafter and designer from tedium. Handmade drawings are no longer required. CAD cannot, however, replace the individual. It cannot think for us. In fact, as earlier stated, computer programmers must instruct computers with considerable detail. A CAD system should be thought of as an additional tool at your disposal. Consider it like a template which helps you to draw more accurately and quickly. The computer is a tool, however, that performs at a high rate of speed. Drawings now can be revised and changed much more quickly and accurately than by hand. Thus, it is economically sound to let it prepare and revise drawings.

Reducing drafting time in a company is of prime importance. The drafting part of a project is considered to be a bottleneck. Traditional industrial drafters spend approximately two-thirds of their time "laying lead." Only one-third is spent for all the other job functions combined—including design. The implementation of CAD changes this. Drawings and design changes can be accomplished much more rapidly. This results in quicker turnaround time. Consequently, projects flow better through a company. The traditional drafting bottleneck is eliminated.

Besides contributing speed, CAD replaces some of the basic tech-