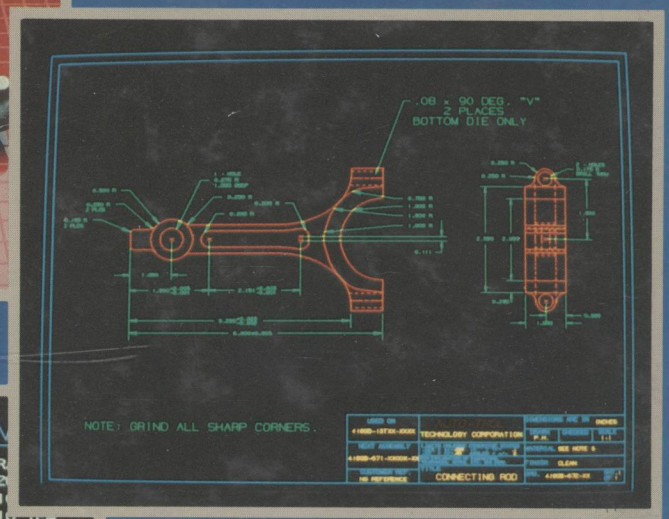
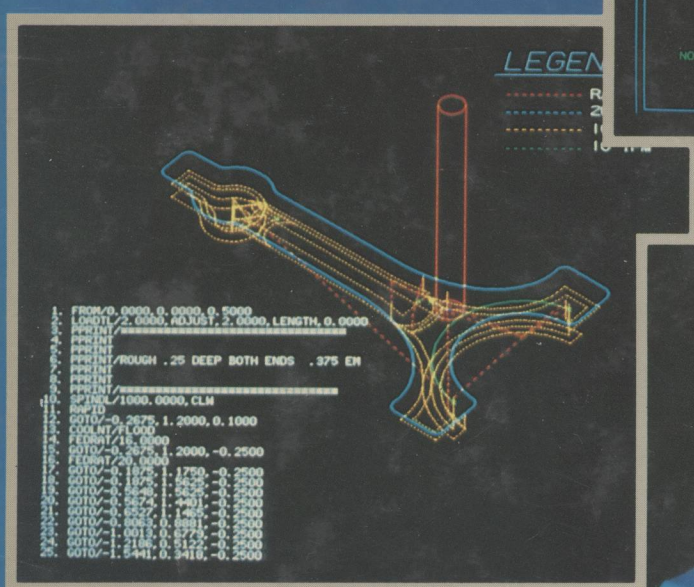
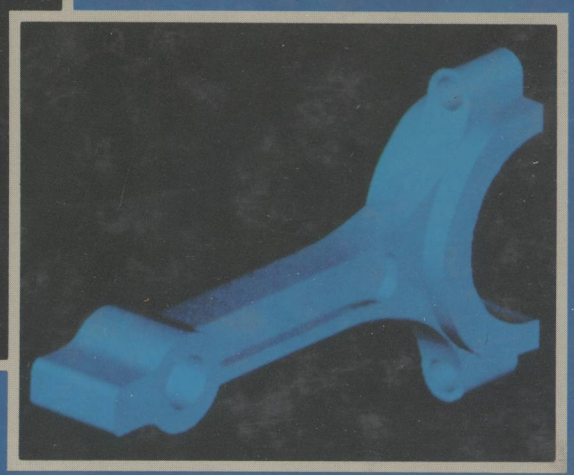
COMPUTER-AIDED DRAFTING AND DESIGN

Concepts and Applications







Donald D. Voisinet

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COMPUTER-AIDED DRAFTING AND DESIGN

Other CAD books

Voisinet: INTRODUCTION TO CAD, Second Edition
Voisinet: MECHANICAL CAD LAB MANUAL
Obermeyer: ARCHITECTURAL CAD LAB MANUAL
Voisinet: AUTOCAD MECHANICAL LAB MANUAL
Obermeyer: AUTOCAD ARCHITECTURAL LAB MANUAL
Cascade: CASCADET STUDENT MANUAL

COURSE OUTLINE FOR INTRODUCTION TO CAD

Lecture Session	Topic	Chapter	Section
1	**Introduction to CAD** The boom, effects, CAD versus TRAD	1	1, 2, 3, 4, 5
2	**Initial Entry Methods** Alphanumeric keyboard, function keyboard, graphics tablet, joystick, light pen, thumb and finger wheel	2	5, 6, 7, 8, 9, 10
3	**CAD Equipment** Input, processing, output, make copy, plot	2	1, 2, 3, 4, 11, 12, 13, 14, 15
4	**Start-up** Boot up, log on, grids	3	1, 2, 3
5	**Shape Description** Points, solid lines (horizontal, vertical, inclined), linestyles (hidden, center, phantom, leader), circles and arcs	3	4, 5, 6 App. I, II, III
6	**Shape Description** SNAP on/off, coordinate input, delete, redraw, zoom, plot	3	9, 10, 11, 12
7	**Size Description** Dimension, text	3	7, 8
8	**Drawings** Working drawings, schematic diagrams	4	1, 2, 3, 4, 5, 6, 7, 8 App. IV
9	**Revision and Modification** Move, copy, rotate	5	1, 2, 3
10	**Revision and Modification** Mirror, scale, edit	5	3, 4
11	**Preservation** Initialize, store, pack	5	5
12	**Geometry Generation** Sectioning, fillets/rounds	5	7, 8
13	**Geometry Generation** Spline, tolerance	5	9, 10
14	**CAD Exclusive Features** Symbol library, groups	5	6, 11
15	**CAD Exclusive Features** Layers, 3-D, bill of materials	5	12, 13, 14, 15
16	**Manufacturer's Equipment** Industrial, educational systems	10	1, 2, 3

COURSE OUTLINE FOR CADD APPLICATIONS

Lecture Session	Topic	Chapter	Section
1	**CADD Exclusive Tasks** Layer/Level Application	5	12
2	**Symbol Library** Use of All Available Libraries	4 5	6 5
3	**Symbol Library** Creation of New Libraries/Assemblies	4 5	8 11
4	**Color** Monitor Graphics, Drawings	6	1
5	**Plotter** Pens, Line Weights	6	2
6	**Pictorials** Isometric, Perspective	7	1, 2, 3, 4
7	**3-D Modeling** Wire Frame, Surface/Solid	7	5, 6, 7
8	**Partial-Programming** Alter Existing Graphics Program	8	1, 2, 3, 4
9	**Advanced Technology** CAD, CAM, Robotics	9	1, 2, 3, 4
10	**Design Drafting Application** Project Continuation/Completion, Calculations		

Preface

The integrated circuit chip has revolutionized the way we work and play. Its introduction has led to an era which is often referred to as the technical revolution. This era has seen dramatic changes in worldwide communications at all levels—personal, professional, industrial—and in every facet of modern-day life. The IC chip is on our wrist (quartz digital watches). It is used to solve math problems (hand-held calculators). It entertains (video games), and it helps to run businesses. The technological changes it has launched are affecting many careers, and retraining to upgrade job skills is now commonplace. Drafting and design are in the forefront of the changes. CAD (computer-aided drafting) and CADD (computer-aided drafting and design) are familiar acronyms that have swept through the profession. The aim of Chapters 1 to 5 of this text is to help present and future drafters and designers understand CAD and how it affects their careers. Concepts and applications are presented in a logical, straightforward manner. Chapters 6 through 9 go beyond the fundamentals of CAD, presenting a thorough treatment of CADD on the applications level. They bring you to the frontiers of this advanced technology.

Computer-Aided Drafting and Design is not written for a machine-specific system. Rather, it presents concepts that are valuable regardless of the system used. Since the fundamental operations are the same for all systems, you will see that skills are transferable from one system to another. For example, all systems have a line command which is located on a menu. If you can determine the menu-item location and access it, the line can be created by picking each endpoint. Also, CAD systems are "user friendly." If you read and follow the instructions, you can be operating a system in no time. In fact, CAD skills can exceed traditional (TRAD) skills in fewer than 120 hours of hands-on time.

Working with a machine during the time you use this text would be helpful but is not necessary in order to understand the material presented here.

The contents of this text include:

- Reasons CAD is used
- Types of CAD equipment
- Ways CAD is used
- Various methods of preparing engineering drawings
- Complete coverage of each drafting function
- Illustrations showing equipment from leading manufacturers
- Graphical representations (ICONs) of every major CAD command
- How CADD is applied
- Graphics programming—why and how
- The leading systems that survived the "shakeout"

The text covers all categories of CADD equipment. These include the:

- New generation of powerful microcomputers
- Popular industrial mini- and super-mini systems
- Mainframe-host computer systems

Computer-Aided Drafting and Design is not about computer programming. Drafters do not program—they use programs to draw. In fact, you will learn in this text that drafters do not draw drawings—they build drawings. Many powerful options unheard of until recently have made CADD possible. An ICON glossary is provided to assist you in understanding these options. Because an *ICON* is a graphical representation or drawing, designers and drafters will recognize it as the most effective way to convey concepts. Be sure to utilize the ICONs.

As we move into the 1990s virtually all drafting and design will be performed on a computer. Anyone serious about the profession had better "bite the bullet." It is hoped that this text will help to make that bite not only painless but exciting and adventurous as well. Enjoy your venture into the world of CAD!

Donald D. Voisinet

Contents

CHAPTER 1

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 the use of 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 manual drawing. Computer-aided drafting and computer-aided design and drafting are abbreviated *CAD* or *CADD*. Several other terms are also used. Some of these are:

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

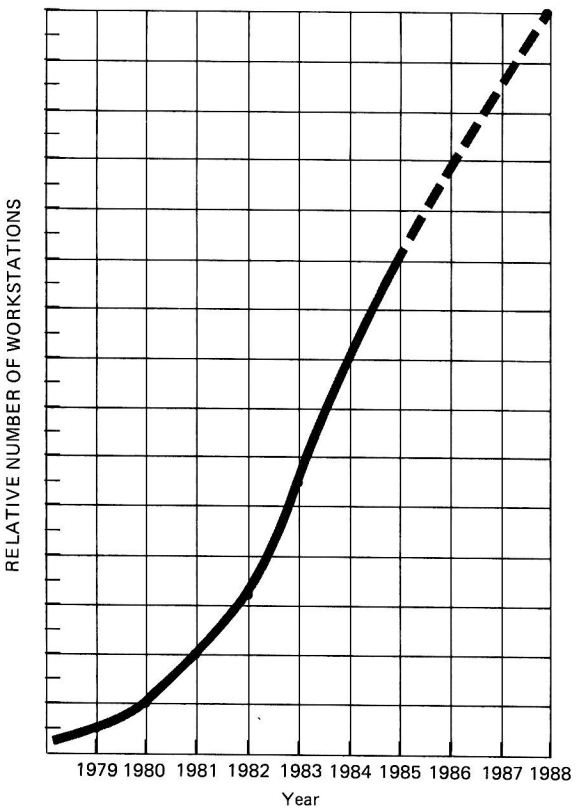
These and other similar terms are used synonymously. They will be abbreviated as CAD throughout this textbook.

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 1981, for example, fewer than 5000 systems were being used in United States industry. Although the implementation of CAD in the early 1980s occurred only in large companies, it now dramatically affects all facets of industry. The market projection is that the number of workstations added each year will grow from 12,000 in 1983 to over 63,000 in 1988. Thus, the "technical revolution" of this "advanced" technology continues, as can be seen in Fig. 1-1. The exact number of workstations is not important. How-

Fig. 1-1 The boom in computer graphics.



ever, the exponential growth rate CAD has been experiencing throughout the 1980s is important. A leveling off as a result of market saturation of CAD systems is not expected during this period.

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. 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:

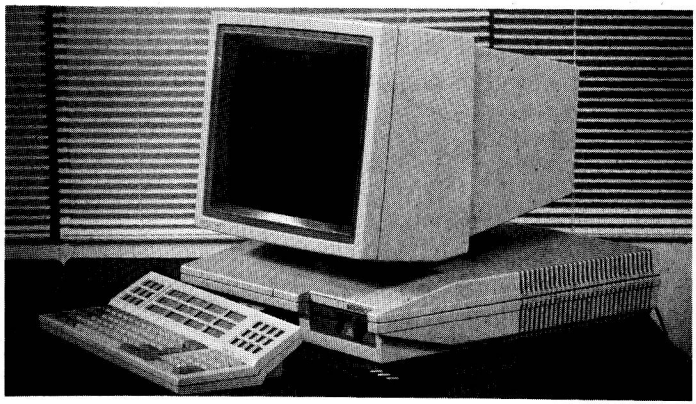
- The extraordinarily large *number* of functions that can be performed.
- The great *speed* at which each function can be performed.
- The *accuracy* and capacity for repetition of operation.
- The *memory* or *storage* system.

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 purposes only, a partial simple program is shown in Fig. 1-3(a). This program is used to graphically 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 in Fig.



Courtesy Intergraph Corporation

Fig. 1-2 A sample computer.

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.

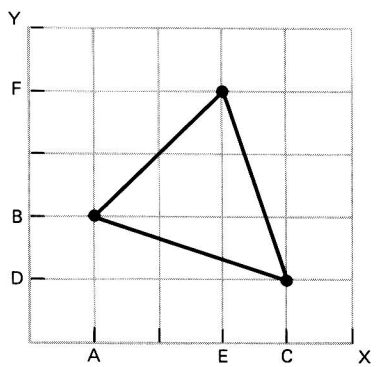
The Microprocessor

The advancement in commercially produced microcomputing equipment has led the way in CAD implementation. The term

Fig. 1-3 A sample program.

```
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)