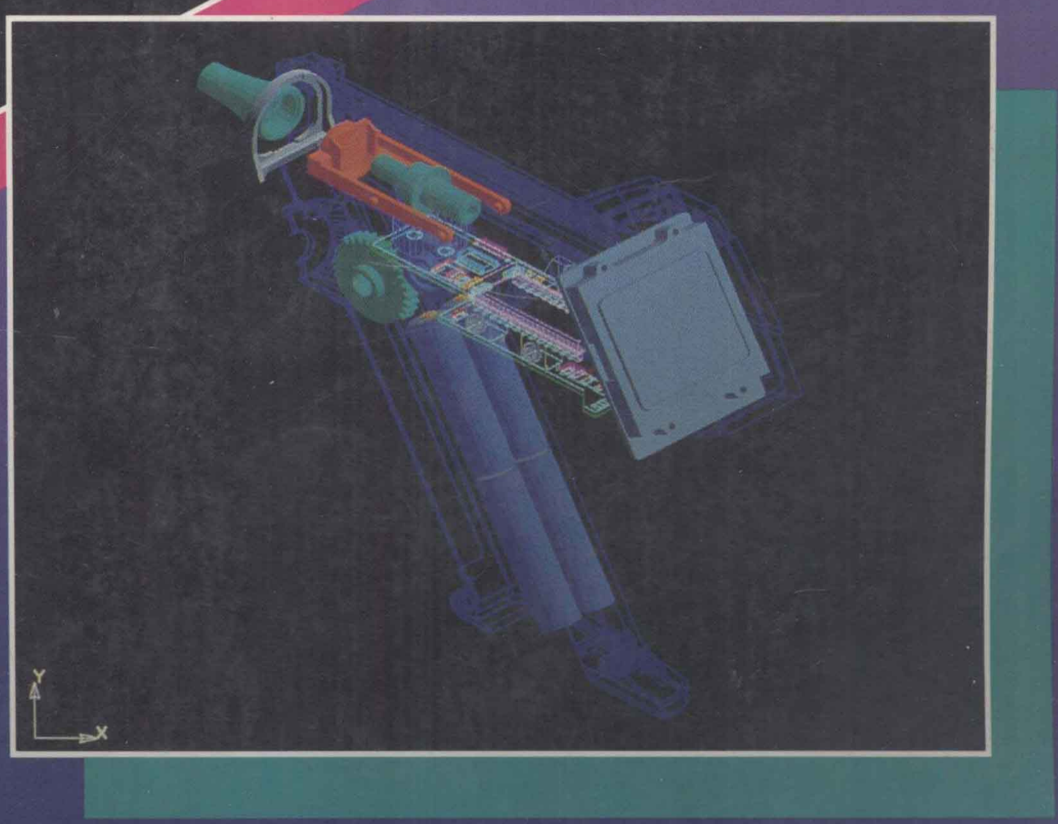
An Introduction to CAD Using CADKEY® 5 and 6

HUGH F. KEEDY

Third Edition



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CADKEY

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Preface

This third edition of *An Introduction To CAD Using CADKEY* covers the CADKEY 6 and CADKEY 5 versions. All versions prior to these are included in the Second Edition, Revised Printing of the same title, which remains in print.

Users of any previous version of CADKEY will find that the latest versions excel in two ways. First, the same basic commands of previous versions are retained but numerous new features have been added, or old features have been expanded to provide more capabilities. Second, access to some commands has been improved by the use of dialog boxes, especially in CADKEY 6. All features of CADKEY 6 and CADKEY 5 are discussed. Though all new and expanded features are covered, such as DXF and Slides, those that relatively few users will need are discussed in less detail. In those cases, users are directed to appropriate CADKEY reference materials that provide further information.

Two types of users are assumed: students in a classroom setting and individuals who wish to learn CADKEY on a self-study basis. The multiple options offered for each exercise make the text usable, without duplication of assignments, for two or more semesters of classroom use. Individual users as well as students should experience a good learning curve that progresses smoothly and quickly to competence in 3D CAD.

Scope of the Material

The first edition was developed and class-tested for freshman engineering classes in the School of Engineering at Vanderbilt University, in two consecutive one-semester-hour courses in computer graphics. Later editions have included changes made to strengthen the book's content, organization, and pedagogic value. For classroom use, the material should be ample for three semester-hours of work. All graphics principles through assembly and exploded-view drawings are included in exercises, along with background material needed to complete them.

This edition, like the previous ones, has two objectives. One is to provide an introduction to the basic concepts of CAD, which are nearly universal in the world of CAD. The second is to help the user to develop facility in using CADKEY as a CAD tool. All the basic features of CADKEY are discussed and applied in the exercises. The exercises have been developed to provide practice in using the commands, and include subtleties that provoke thought and challenge the user's understanding of the CADKEY commands. As such, they may lack a ''real-life'' appearance but do model the types of things that engineers and developers need CAD for. Mastery of the basic elements and exercises will prepare the user to delve into the more advanced topics.

Using the Book

This book is divided into two major parts. It begins with 64 sections that are arranged in an order that is intended to move the user from an introduction to CADKEY principles through the basic commands of database creation to manipulations of the database to meet specific needs. An analysis of the table of contents will reveal the following overall arrangement of sections:

Introduction to CAD and CADKEY	Section 1
Mechanics of operating CADKEY	Sections 2-11
Basic concepts of CADKEY	Sections 12-21
Basic manipulations	Sections 22-25
Entity and database creation	Sections 26-34
Modifications of existing geometry	Sections 35-42
Storage and communication	Sections 43-47
Modifications to meet graphics standards	Sections 48-59
Database calculations	Sections 60-61
Advanced topics	Sections 62-64

Following these sections are 15 exercises. Each exercise includes a list of sections that are references for topics not included in previous exercises. Users should work the exercises in order, at least up through Exercise 10. Before beginning each exercise, the topics referenced at the beginning of the exercise should be read and the principles practiced at the computer.

Steps are given for completing each exercise. The purpose of these steps is to outline the process for completing the exercise rather than to provide detailed instructions for constructing each entity. Thus, the user is guided in the proper direction so that he or she may understand the process as well as learn how to use individual features.

An effort has been made to help the user apply the features of CADKEY because, though it is obviously important to learn how to use individual features, value comes when one is able to apply them productively. Much of the material discusses ways to apply the features to commonly encountered design needs. Also, some discussion of the basics of graphics principles is included as a review or as a brief introduction for those who have not had a course in graphics.

Text for this edition was prepared using WordPerfect 5.1and PageMaker 4.0, where the text was assembled for printing. Graphics were created or revised from previous editions, within CADKEY 6. They were plotted to **.plt** files, which were then imported into PageMaker and positioned relative to the text.

I wish to express my gratitude to all those who have contributed to this and to previous editions. In particular, special thanks go to Jonathan Plant, Mary Thomas, and Cathie Griffin of PWS Publishing Company for their help in preparation of this edition, to Paul Mailhot at Cadkey, Inc., and to Judith Abrahms for excellent copy editing . The following reviewers contributed useful suggestions: Scott Danielson, *North Dakota State University*; Kathryn Holliday-Barr, *Pennsylvania State University--Behrend*; George Petrie, *Webb Institute of Naval Architecture*; Warren White, *Kansas State University*; Robert A. Wilke, *Ohio State University*, and Howard Wilson, *Gannon University*. Finally and foremost, I wish to thank my wife, Marge, for her supportive patience for the third time as the manuscript was being prepared.

All comments and suggestions about the book's features will be valued and given careful consideration in the preparation of any future editions.

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Contents

SECTION I

Role of CAD and the Database

Before looking at the details of the CADKEY software, let us look at how it fits into Computer-Aided Design (CAD) and the engineering work world. CADKEY, first introduced in early 1985, was the first true three-dimensional (3D) software CAD package for use on a microcomputer or personal computer (PC). Several versions have been released since; CADKEY 6 is the latest industrial-level package as this book goes to press. This version and the last preceding one, CADKEY 5, are discussed in this book.

Few people today are unaware of the major changes the computer has made in both what can be accomplished and how, including the deep and sweeping changes that CAD has caused in the design and manufacturing process, from conceptualization to delivery to the customer.

1.1 Brief History of CAD

The advent of the computer caused major changes in industry. The first real progress in the use of computers in the manufacturing process came in the late 1950s with the introduction of numerical controlled (NC) and, later, computer numerical-controlled (CNC) machine tools. Data supplied to the machines on tape controlled the motions of the tools that produced the parts of an assembly. There was no direct link between the designer and the manufacturing processes other than drawings and control tapes.

An important change came with the introduction of CAD in the early 1960s. CAD allowed the designer to interact graphically with the computer. Designs could be modified or added to with relative ease, with the result that alternative solutions could be investigated quickly. Previously, with drawings on paper, a designer was limited by time and money in the number of alternatives or modifications that could be investigated.

Early CAD software was strictly two-dimensional, which was and still is sufficient for some applications but very inadequate for many others. The need for three-dimensional databases, large memory, and speed in the auto and aircraft industries led to the development of 3D software packages that required a mainframe computer. As these design packages came into use, it became more evident that the database created by the designer is central to the design and its implementation.

Until the early 1980s little real progress was made in merging the crucial database into other aspects of the industrial operation. Missing was an efficient method for transferring data quickly to a wide variety of software packages used by the manufacturing, materials handling, management, and evaluation departments of a production operation. Although many problems still remain, a big step toward data transfer was taken when the International Graphics Exchange Specification (IGES) system was introduced in 1981. Any software package compatible with IGES can receive data from or send data to any other package that is also IGES compatible. Other data exchange methods proposed or developed since then further facilitate transfer.

Advances in microcomputer technology provided the next major step in CAD progress. The amount of memory and the speed required by CAD systems were available only on mainframes when CAD first came into use. However, the memory capacity and speed of the PC increased rapidly, and the early 1980s saw the introduction of 2D CAD software that could be run on PCs then available, especially if the system had a hard disk and math coprocessor to augment its memory and speed.

The first PC software with a true 3D database was introduced in early 1985 by CADKEY. The declining costs of PCs and the increasing sophistication of CAD software have generated a trend toward doing more CAD work on standalone and networked PCs and on workstations. As an impetus to this trend, numerous third-party software packages have been marketed to do analysis and design work using CAD interactively in fields ranging from medicine to manufacturing to architecture.

A number of acronyms have become associated with the role of the computer in the manufacturing process. These include CAD (Computer Aided Drafting, or Computer Aided Design), CADD (Computer Aided Drafting and Design), CAM (Computer Aided Manufacturing), CAD/CAM (Computer Aided Design and Manufacturing), CAE (Computer Aided Engineering), CIM (Computer Integrated Manufacturing), and FMS (Flexible Manufacturing System). Without being more specific about the distinctions between the areas represented by these acronyms, it is sufficient to say here that the computer is central to each. But, most important, it is the computer that provides the vital link between design and production, the database that is generated and stored electronically.

1.2 The Database as the Central Product of CAD

To see the importance of having a 3D database, remember that we live in a three-dimensional world and that the products we design and produce are all three-dimensional. True, in many cases the third dimension is constant or not important (in circuit design, for example), in which case a two-dimensional analysis and a 2D CAD software package will suffice.

To further see the effects of CAD software on the design and manufacturing process, first picture an engineering office before the advent of the computer. In order to solve a problem or create a new product, an engineer conceptualized three-dimensional objects as solutions. Properties of these three-dimensional objects were routinely communicated to others by preparing two-dimensional drawings on paper using standard drafting procedures. These drawings, the central product of the design process, were sent to the shop where a machinist or production engineer used them to fabricate the object. Inspection was also related to the drawing.

Contrast yesteryear's process with a typical modern design process. A designer begins by interactively creating a database using 3D software. The primary database, in which each point is located by its x, y, and z coordinates, defines the geometry (sizes and shapes) of the design and is stored electronically.