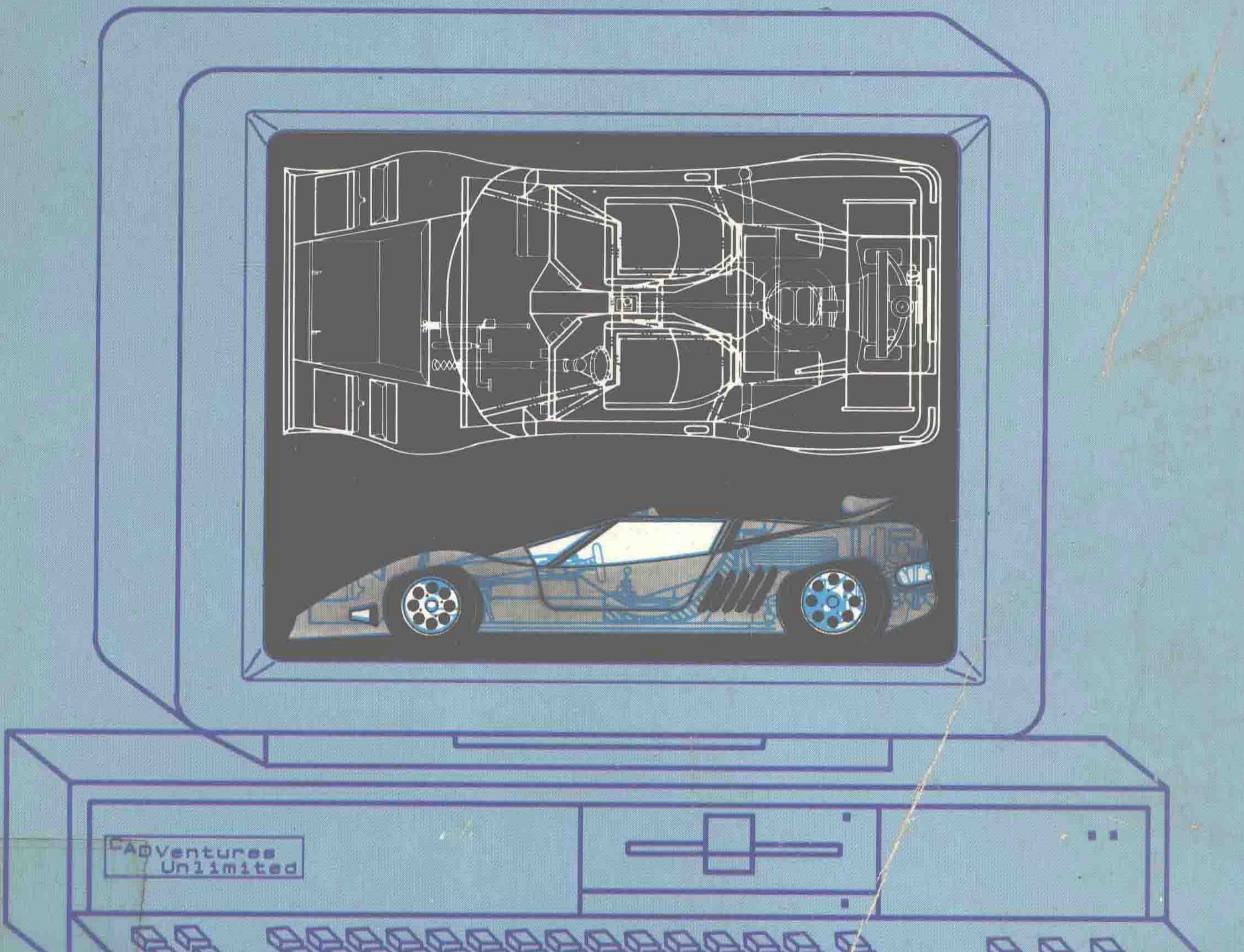
CAD-TUTOR®

A Sequential Teaching Manual For

VERSACAD® Design

The Total Design Solution



• SUNYOGH • KRIMPER • MANIFOR • BEAUCHEM

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A Sequential Teaching Manual For VERSACAD® Design

The Total Design Solution

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PREFACE

The first five years of the decade of the 1980's was to a great extent marked by the dramatic expansion of the use of microcomputers in the business and industrial environment. Hardly a business, large or small, is without its microcomputer or without a microprocessor that controls or drives some device or mechanism in that business. And, in design and manufacturing, the appearance of low-cost microcomputer-based CAD systems has caused a revolution in the way drafters and engineerers approach their craft. CAD and CAD systems, the use of computers in the design and drafting process, are almost as prominent in engineering and manufacturing as word processing and word processors are for the secretary in business.

The dramatic growth of CAD combined with the revolution in microprocessors and microcomputers has made it possible for schools to play an important role in preparing designers, drafters and engineers for the effective use of CAD as a productivity tool. And, in the past four years, the CAD-TUTOR series of sequential training manuals has helped over five hundred schools around the country to implement CAD training and effectively incorporate it into industrial arts, drafting, design or engineering curricula.

CAD-TUTOR: A SEQUENTIAL TEACHING MANUAL FOR VERSACAD DESIGN continues that important tradition. Through a careful evaluation of the many new and powerful features of VERSACAD DESIGN the authors have been able to produce an effective teaching tool that structures the presentation of those features in a logical sequence, provides supportive and reinforcing post tests at the end of each tutorial, integrates a variety of problems from different drafting disciplines that illustrate the effective use of the features introduced in each tutorial, and incorporates within the text a number of aids to facilitate learning and understanding the actual 2D/3D CAD drafting system.

The VERSACAD DESIGN CAD drafting program enables you, the CAD operator or designer, to create a symbolic drawing using the microcomputer keyboard, a digitizer for input and a graphics screen for displaying a sketch of your drawing. A copy of your work file can then be permanently stored on a diskette; and a hard copy of the drawing can be produced using a graphics printer or a high quality, high resolution plotter.

Tutorial 1 focuses on providing information about the use of your microcomputer for CAD drafting and design and introduces you to the primary vocabulary, drawing concepts and principles of operation of the VERSACAD DESIGN 2D CAD drafting program.

All CAD drawings are built upon basic elements or objects that you select and place on the display screen. Tutorial 2 focuses on introducing you to those basic elements from the VERSACAD DESIGN ADD Menu options. The ADD elements and objects introduced in Tutorial 2 include: Line, Detached Line, Polygon, Rectangle, Point, Circle, Text (line), Guide, Sketch, Escape, Quit, and Exit.

In addition, a selection of other options designed to assist you in establishing the key characteristics of your drawing and in locating objects to be modified, including several of the Function Keys, are also introduced in this tutorial.

Tutorial 3 focuses on the options in the MODIFY Menu that enable you to manipulate elements and objects and to modify aspects of a drawing that are incorrect or do not appear quite right on your display screen. When you select options from the MODIFY Menu the object to be modified is "pointed to" by the 2D CAD drafting program. When you turn the tracking mode on that object blinks repeatedly on your display screen. The MODIFY options introduced in Tutorial 3 include Copy, Move, Scale, Rotate, Text and Handle.

Each tutorial is designed to expand upon activities and functions previously discussed; and to introduce additional options that enable you to perform new functions or operations and to continue to increase your drawing productivity. Therefore, Tutorial 3 also introduces you to a number of additional options in the ADD, FILER and OUTPUT Menus.

Before creating any drawing it is first necessary to establish its working parameters or limits. Tutorial 4 focuses on the system features that enable you to define or customize each of the parameters or limits of your drawing. Using the options in the UNITS and PROPERTIES Menus and the Update Function Key enable you to establish or make immediate changes in the parameters or working limits of your 2D CAD drawing.

Tutorial 4 also introduces the options in the CONSTRUCT Menu that enable you to perform precision geometric constructions including tangents, parallels, perpendiculars, extending and trimming, and fillets and rounds which are necessary for an accurate drawing.

In Tutorial 5, the options in the WINDOW Menu that are presented enable you to work on a selected portion of the display screen or drawing with either greater or lesser detail. In addition, the VERSACAD DESIGN 2D CAD drafting program also provides a variety of ways for objects to be dimensioned. These various options for dimensioning using the ADD Menu and for entering dimension text, as well as additional options from the MODIFY, PROPERTIES and FILER Menus, are also presented in this tutorial.

Specialized input and output functions are introduced in Tutorial 6. The VERSACAD DESIGN 2D CAD drafting program provides two different ways for transmitting information to your computer: the "free" mode and the "coordinate input" mode. The options in the Free mode make for a very visual form of input because you can always see, and immediately change, the relationship between the various objects and elements of your drawing. The three options in the coordinate input mode allow you to use the keyboard to type in actual X-Y coordinates. The method for providing Absolute, Relative and Polar coordinate input are introduced in this tutorial.

The (plotter) Specs option in the OUTPUT Menu enables you to create one or more unique or customized sets of plotter specifications for your drawing. You can use the plotter Specs option to determine what part of a workfile or saved drawing is plotted, where on the plotter surface, and to what scale. The plotter Specs option, the Drive option in the FILER Menu and the options that relate to the manipulation of drawing levels in the PROPERTIES and SWITCHES Menu are also presented in this sixth tutorial.

Tutorial 7 focuses on the concept of groups. A "group" in the VERSACAD DESIGN 2D CAD drafting program is an arbitrary collection of objects or entities built or assembled by you the user of the program. The options in the GROUP Menu provide you with convenient ways of manipulating basic components of complex drawings and of storing these complex figures. By using the various options in the GROUP Menu you can easily identify or "build" elements of your drawing into a meaningful group and then modify these elements as one entity.

Two Menus containing several of the more sophisticated operations in the VERSACAD DESIGN 2D CAD drafting program, the HATCH and INQUIRE Menus, are introduced in Tutorial 8. Often it becomes necessary to produce section lines for the cut or broken surfaces of an object, to cross-hatch sectional views of walls, or to fill in a space and make it appear shaded or even solid. The options in the VERSACAD DESIGN HATCH Menu enable you to achieve these effects with relative ease and efficiency by automatically creating equally spaced parallel lines on any angle within an area bordered by objects or text.

The various options in the INQUIRE Menu enable you to request such information about those objects and to have that information determined or calculated by the program and then presented on your display screen.

Each element that you draw or primitive object that you create has certain attributes or primary characteristics that are referred to in the VERSACAD drafting program as "properties." Tutorial 9 presents the options in MODIFY (object) Properties that enable you to selectively change any one or several of the properties of an object or element in your drawing. Like objects, Groups also have specific definable attributes or characteristics that are called properties in the VERSACAD DESIGN CAD drafting program. By using the options in the GROUP Properties sub-menu, also in Tutorial 9, you can selectively change any one or more of the several properties of any group you have built or constructed for your drawing.

CAD contributes to increased productivity in a variety of ways. It is especially helpful in this regard when objects or groups of objects are used repeatedly in a drawing or in a family of similar drawings. Most professionals using CAD purchase or establish on their own sets or "libraries" of symbols that represent industry standards. The options in the VERSACAD DESIGN LIBRARY Menu discussed in Tutorial 10 permit you to create, delete, plot out as an overlay, and in other ways to manipulate symbol libraries. In addition, methods for adding symbols to your drawing workfile, and for manipulating those symbols using options in the SWITCHES Menu are also introduced.

Tutorial 11 is designed to provide an overview of general 3D concepts and more particularly an introduction to some of the basic concepts, features and functions of VERSACAD 3D. It is assumed that the reader has already mastered the basic concepts, features and functions of VERSACAD 2D (discussed in Tutorials 1 through 10) prior to this tutorial. Given the complexity of the 3D component of VERSACAD Design, projected revisions and updates, and the overall intent and scope of CAD-TUTOR, only the primary concepts, features and functions are highlighted in this tutorial.

The authors would like to make a note of special thanks to the following people who assisted in the design, development and preparation of CAD-TUTOR. As always, the students at Rio Hondo College were instrumental in pilot-testing the new tutorials and the problems in them; and they often pointed out ways in which particular features of the system could be described or expressed more clearly and the problems solved with greater efficiency. Jonathan Perry, one of those students, designed the automobile that is displayed on the cover.

We would also like to thank those at VERSACAD CORP. — especially Tom Lazear and Glen Johnson — who have continued to lend their support and technical expertise to this CAD-TUTOR in the full realization that the sequential teaching tutorials are a real aid to the acquisition of proficiency on the VERSACAD DESIGN system. Selected portions of the VERSACAD DESIGN User's Manual, the prompts from the program, an occasional illustration, and the actual screen photos are all used by permission of VERSACAD CORP.

And, finally but foremost, we would like to acknowledge the continued support, encouragement and direct contribution of our wives — Gayle, Faye, Cheryl and Marie — who were patient with us during the long and often trying hours of preparation and development of the VERSACAD DESIGN addition to the CAD-TUTOR series.

The Authors

NOTICE OF LIMITS OF LIABILITY

CAD-TUTOR: A Sequential Teaching Manual for the VERSACAD DESIGN 2D/3D Drafting System has been designed and executed to provide tutorial information on VERSACAD Corporation's VERSACAD DESIGN microcomputer-based CAD program. CAD-TUTOR was developed with the assistance and support of VERSACAD Corporation and every effort has been made to make this text as complete and accurate as possible. Because software is dynamic and because the development and use of that software is outside the control of the authors no warranty is made as to the appropriateness or fitness of this text.

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INTRODUCTION

THE MICROCOMPUTER REVOLUTION

The microcomputer revolution of the last decade has dramatically impacted every aspect of our daily life. All around us microprocessors — the brains of any microcomputer — perform complicated functions and tasks that make our lives more comfortable, easier and safer. They calculate the price of groceries at the market, they warn us when our automobile brakes are wearing dangerously down, they help us to maximize efficient energy consumption at home and at work, and they assist us in preparing complex meals in a fraction of the time they would take using more conventional methods.

The recent impact of microcomputers on education and training — one predicted for more than a decade and now finally appearing to become a reality — has been equally dramatic. As microcomputer hardware has continued to advance technologically and to decline in price, the number of microcomputers introduced into classrooms at all grade levels and most corporate training environments has quadrupled in each of the last five years. And, with the development of an abundance of high quality and diversified software the application and use of these microcomputers has expanded to all areas of the curriculum. Hardly an elementary school is now without its Apple, Commodore, Tandy or IBM PC.

Computer stores, with their special short classes in everything from operating systems to advanced business applications, have mushroomed up in almost every neighborhood and no respectable shopping center is without one. High schools are hard pressed to stay ahead of junior high schools or middle schools, and college instructors are often forced to admit — at least to themselves if not directly to their students — that entering freshmen know more about application programs for microcomputers and programming than they themselves do. At the post-secondary level, colleges and technical training institutes have evolved relationships of necessity with business and industry in their service areas and are continually attempting to meet the ever-increasing demands for trained technical personnel.

The business world has not escaped the revolution caused by microcomputers. Certainly, the direct impact has been felt everywhere and is seen most directly in the office with the widespread expansion of desktop word processing and engineering stations. In the manufacturing environment there has been an ever-increasing shift away from manual devices to manufacturing tools that operate with microprocessors as their brains. These developments have spawned whole new industries that have contributed to changing ways that we do things in our schools, our offices and our factories.

MICROCOMPUTERS IN DESIGN AND MANUFACTURING

Within the industrial and manufacturing environment one area that has experienced rapid growth and fundamental change is that of the use of microcomputers in the design and manufacturing process. Recent auto advertisements in national magazines and on television have underscored this change and have highlighted the growing importance of Computer-Aided Drafting/Design (CADD or CAD), Computer-Assisted Manufacturing (CAM) and Computer-Aided Engineering (CAE) to American business and industry as they move toward the realization of the fully automated factory of the future, Computer Integrated Manufacturing (CIM). Microcomputers in the industrial and manufacturing environment contribute directly to increased productivity, and in the arena of international competition for markets and sales productivity — the timely and efficient design, development and manufacturing of better products than one's competitors — may well prove the difference between success or failure, profits or losses, growth or decline, jobs or plant shutdowns. In an increasingly wide array of industries, CAD or CAD/CAM systems are being used by designers, drafters and engineers to create, display, analyze, modify and refine, and store in memory the product designs, manufacturing processes, analytical tables and documentation of everything from a small machine tool part or a space shuttle destined for space exploration.

CAD/CAM provides industry with the ability to integrate a variety of manufacturing processes and thus both increases the efficiency of each individual task and the overall efficiency of the entire manufacturing process from conception and design to manufacturing and distribution. Through the use of CAD/CAM a common "data base" (descriptive information about a part, product or concept) can be created to be used by the engineer or designer, the drafter or machinist. This data base essentially contains all the relevant information about the design of a particular product and all the information required to actually place that design into production. Even advanced automation processes such as robotics can call on this data base for information related to the assembly and manufacture of the product.

CAD/CAM APPLICATIONS

The current applications of CAD/CAM are already as diverse as the mind can conceive. At the least sophisticated level of operation CAD can be used to produce schematics, overheads, or simple diagrams. At the next level, CAD has applications in the areas of general and technical illustration or can be used to prepare ads or artwork. Managers can use CAD systems to generate flow or organizational charts. More advanced applications include mapping, 3D, isometric and perspective drawing, and mechanical and architectural drawing.

CAD systems can be thought of as either two dimensional or three dimensional, and functionally perform either special purpose or general purpose tasks. Although, over time, the various acronyms associated with CAD tend to be used interchangeably, CADD generally refers to three dimensional (3D) systems that enable you to build and then modify an actual model of the design on your display screen, and thereby tends to automate both design and drafting. CAD generally refers to the concept of computer-aided drafting and to two dimensional systems (2D) that support drafting more directly.

You can think of a two dimensional system as a computer system that replaces the traditional tools of a drafter — a drafting table, T-square, pencil and eraser. Increasingly, drafters are becoming as dependent upon two dimensional CAD systems as secretaries are dependent upon their wordprocessors. In two dimensional systems the designer constructs the design and then the designer — or a second person, the CAD operator — transfers that design into the computer and onto the display screen.

Three dimensional systems are more complex and are especially more advanced in facilitating the design process. In a 3D system, the designer actually uses the features and functions of the system to aid in the design of the model. Each time the model is updated the computer calculates the various changes in the different views of the model maintaining and updating a complex data base to support the three dimensional aspect of the model. As such, the computer facilitates the design process and tends to automate the drafting process.

In addition to being distinguished by their two dimensional or three dimensional characteristic, CAD systems can also be viewed as being general or special purpose systems. Systems in the special purpose category were designed to perform a narrow range of tasks extremely well. These systems may be functionally well suited to specialize in the design of printed circuit boards, contour mapping or piping. Special purpose systems are often referred to as vertical systems — narrow in application but doing what they were designed to do extremely well.

General purpose systems were designed to serve a variety of users doing a variety of tasks. These systems tend to have many more features but are noted for their breadth of application rather than their specialization. As a result, general purpose systems are often referred to as horizontal systems.

Two dimensional and three dimensional systems can be either special or general purpose. In terms of cost two dimensional general purpose systems tend to be the least expensive and three dimensional special purpose systems the most expensive. No one system is the best for all applications and you may find that a company uses a combination of such systems to perform its diverse design and manufacturing tasks.

Traditional CAD/CAM mainframe or minicomputer-based systems users can be divided into a variety of categories including: aerospace; automotive; commercial electronic;, commercial manufacturing and production; architectural, engineering and construction (AEC); and the military.

In aerospace, applications focus primarily on 2D and 3D design capabilities of CAD systems and, more recently, on the direct manufacturing capabilities of CAM. These applications include the design and development of specialized and proprietary configurations for wings, fusilages and engines; enhanced detail drawings; and component and system tolerancing.

In the automotive industry, the fierce competition from Japanese and European auto manufacturers has forced American automobile manufacturers to adapt CAD/CAM to their design and manufacturing processes as a means of maximizing productivity and reducing design costs. In the automotive industry applications include the graphic use of 2D, 3D design and modeling, and the graphic display of wind, stress and vibration patterns.

The commercial electronics industry has made use of CAD/CAM to reduce the tedium and complexity of customized circuit board design. Applications in this area would include improved documentation of schematics, the automatic tracing of circuits, and reduced time for PCB design simulation. In the commercial manufacturing and production industry successful applications of CAD and CAD/CAM have included specialized design for packaging and marketing, improved data base management, and improved interaction between the manufacturing and resource planning sectors.

In the architectural, engineering and construction category CAD successes have been documented in design and structural analysis. A variety of specialized software packages have been developed for architects and for engineers that have contributed to increased productivity and the acceptance of CAD as an AEC tool. Successful applications in this area, and in the military category, very much replicate those described in the categories above.

At any moment in the country a variety of CAD/CAM applications may be in process. A major aerospace contractor in southern California has the complete designs and detailed documentation of an advanced weapons system on CAD. In Vancouver, a small architectural firm is able to present clients with rapidly redrawn alternate sketches of the floor plan for a four story office building. In upstate New York, a secretary for a major national insurance company is preparing organizational charts for the company's network of insurance underwriters. In Atlanta, architects and planners at a major department store chain are using their CAD system to design the floor plan of their newest suburban department store. In Fairbanks, some construction engineers are using their remote graphics terminal to review plans for a major hospital heating system. At the Philadelphia manufacturing facility of an internationally known fashion designer, a new CAD system has replaced the large lighting and cutting tables once used to layout patterns and to cut the material for the Fall line of dresses and women's suits. And, in Cleveland, a small group of programmers are reviewing the proposed cutting path for a new tool they have developed.

THE GROWTH OF MICROCOMPUTER-BASED CAD/CAM SYSTEMS

In 1981 the total sales of high cost, very sophisticated, 2D and 3D color CAD and CAD/CAM systems exceeded one billion dollars for the first time. Industry sales forecasts for the coming years predicted a doubling of sales by the end of the decade. In 1984 the major vendors of mainframe or minicomputer-based CAD systems showed revenue growth of 50%. In 1985 that growth declined to an estimated 30%.

During the same period, 1981 through 1985, advances in microcomputer technology, the development of new high level computer languages, and the development of powerful software applications programs have enabled a number of manufacturers of relatively low cost CAD systems to enter the industrial and educational markets. Though relatively low cost (usually selling for under $20,000 per station complete), these 2D and 3D (or "2 1/2D") microcomputer-based systems that do not have the power or sophistication of their more powerful mainframe or minicomputer-based "brothers and sisters" but still have an ever-expanding variety of extremely important applications.

A microcomputer-based CAD system receives information as input from a keyboard or digitizer pad (sometimes referred to as a graphics tablet). It processes that information and displays the result as output on your screen or a printer or plotter. For the 2D CAD drafting system the microcomputer uses data (the input) provided by you, the CAD designer, to produce (by processing data) a drawing (the output).

A typical microcomputer-based CAD system consists of the following five basic hardware components:

1. The central processing unit (CPU) and keyboard.
2. The floppy disk drives (mass storage unit) and/or one or more fixed disks (high density mass storage).
3. The display monitor (the CRT or screen).
4. The digitizer input device (or mouse).
5. The graphics printer or plotter (output device).

The graphics monitor is used to display either or both text and graphics. The keyboard and digitizer pad (or mouse) are used for entering information into the microcomputer. The CPU processes the information entered — the input — by you, the CAD operator. After input, the information is stored on a removable recording media called a floppy disk or diskette. A diskette is a thin piece of plastic encased in a protective jacket with a surface that can be magnetized to store data. The graphics printer or plotter is used to provide a "hard copy" of the drawing entered into the microcomputer.

In addition to their standalone functionality, microcomputer-based CAD systems can effectively be used as pre-processors to larger systems thereby relieving the storage and processing burden on the larger system. As pre-processors, smaller drawings can be produced without constantly relying on the processing power or storage capacity of the larger system. Since they cost less, many more stations can be made available to designers, engineers and drafters at a fraction of the cost of larger stations. And, since many of the less expensive systems have the ability to communicate upward with larger systems, drawings can be processed and stored by the larger or host system when they are completed on the smaller standalone microcomputer station. The increasing speed and functionality of these microcomputer-based CAD systems and their relatively low cost for complete systems is likely having its impact on larger systems that range in cost from $50,000 to $150,000 per station. And, in a recent report, Daratech Inc., a highly respected research firm based in Cambridge, Massachusetts, estimated that 42,000 microcomputer-based CAD systems had been installed by March 1985 — with more than one third of all CAD, CAD/CAM and CAE stations now based on microcomputers.

THE IMPACT OF MICROCOMPUTER-BASED CAD ON TRAINING AND EDUCATION

Earlier in the decade, National Computer Graphics Association (NCGA) report predicted that there would be a need for over 100,000 additional CAD operators by 1985. By all measures, this prediction, made before the real explosion of low-cost microcomputer-based CAD systems was apparent, greatly understates the need for well-trained CAD operators with technical expertise in a variety of industrial, manufacturing and engineering disciplines.

The same report discussed the almost prohibitive cost of training on larger systems. The report indicated that when all costs were fully accounted for — including lost time on the system (and other lost opportunity costs) — it was not unusual for training costs per trainee to exceed $10,000; with 120 hours of training over a period of six weeks required to acquire an 80% level of proficiency with the system. The authors of the NCGA report then suggested that a viable alternative to training on these larger and more sophisticated systems would be to put training into the schools using low cost microcomputer-based CAD systems. They calculated that in only four years industry could save almost 500 million dollars in training costs and still benefit from an increased pool of well-trained and proficient entry-level CAD operators.

In addition to being an exceptional industry-quality design and drafting tool, VERSACAD DESIGN provides an opportunity for schools and industry to promote the development and implementation of CAD and to assure that there will be an ample supply of well-trained and highly proficient CAD operators in the decades ahead. The fundamental principles of design, function and operation of any CAD system can be acquired from the use of VERSACAD DESIGN. And once a relatively high level of proficiency has been