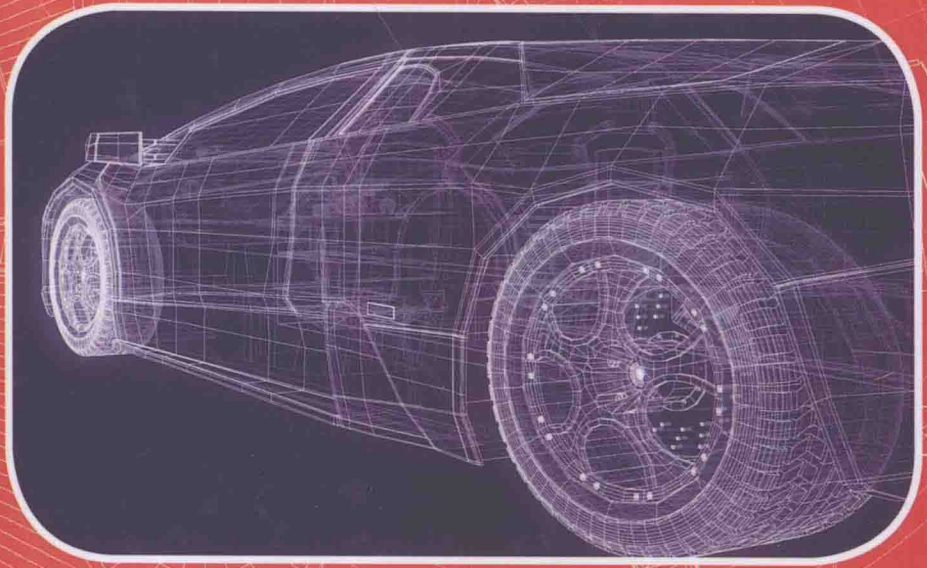
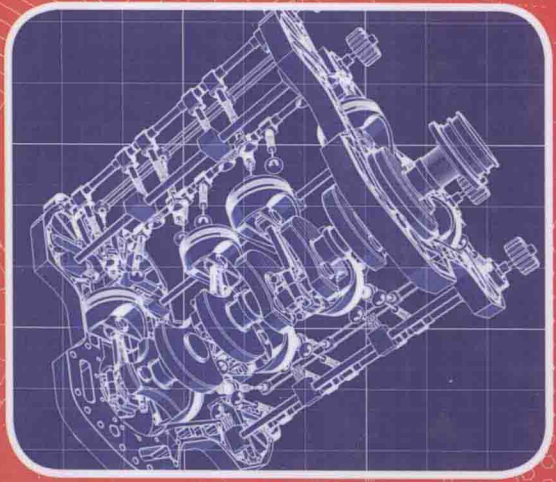
COMPUTER AIDED DESIGN

A Conceptual Approach





Jayanta Sarkar

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Knowledge can be in any form and worthwhile.

Jayanta Sarkar

For my parents and my sister, who support me unconditionally.

Preface

CAD is now becoming a necessity for the design of any equipment or any system. Designers think and create new ideas for products. CAD helps to create ideas, make visualizations, and produce drawings. Often, CAD simulates engineering problems to see the extent of its effect, which may not be possible in real life or without such low cost and convenience.

As industrial competition increases day by day, more optimized designs within lesser time are becoming a continual goal. The design process needs skill, accuracy, engineering expertise, and the ability of mathematical calculations. Obviously, creativity is the generation of the human mind; however, CAD helps to produce faster designs with great accuracy. Nowadays, CAD programs contain various automation functionalities to make customized command sequences or user-defined programs. These user-defined programs are useful to produce 3-D models or drawings with the selection of predefined objects.

This book illustrates effective ways to use CAD in the design process. The various outputs of CAD like drawing generation, automation, and dimensional analysis can be used in effective ways to achieve the designer's goal. Readers are advised to use any advanced software to practice; however, readers may get a clear idea of design based on CAD.

The readers of this book will have a clear idea about the use of CAD in effective ways to lessen design time with the aid of automation and achieving optimized design. Additional material is available from the CRC Web site: http://www.crcpress.com/product/isbn/9781482208795.

Author

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Introduction

Computer-aided design (CAD) is a computerized system to assist designers in design, development, and revision work. Designers are needed to design new products and modify existing products as per requirements. They often need to make optimized designs to cut down on product costs. In addition, reduction of design time is also a vital requirement to meet the project schedule. CAD provides excellent facilities to designers to fulfill their objective. Its many facilities include excellent visualization of the designed product for better understanding, analysis at different load conditions, and faster drawing generation. Due to its various facilities, CAD became an essential tool to designers for creation of optimized design within the scheduled time. CAD is utilized for component as well as system designs. Process and piping designers are also using CAD from the beginning of projects to the end. CAD facilitates working on different engineering disciplines in the same project and ensures integration of all the data for sharing, verification, and drawing generation. CAD adds some advantages, including automation for reduction of repeated work, mechanism analysis and tracing of curves, and animation for presentation.

Its capabilities are making CAD an unconditional significant requirement to designers.

1.1 CAD System Tools

It is obvious that not all product designs demand the same assistance from CAD. In other words, different product designers demand different sets of tools of CAD for assisting in the creation or modification of their design. A simple product with fewer components or a single component may need only faster 2-D drawing and design tools, whereas a robust design with a large number of components demands a 3-D drawing with advanced simplified presentation tools. Various CAD software is also available with different features and tools to suit the designer's needs of different design requirements. Software focusing on creation of mainly 2-D drawing without the help of 3-D provides plenty of 2-D editing tools. A designer conceptualizes the product and plots orthogonal or isometric views in a 2-D plane. Detail dimensioning and annotations are placed after finalizing the design,

and the final drawing is prepared. In the case of comparatively larger or robust designs, several designers or engineers from different disciplines may be required to work on the same product or project. Partially completed 3-D designed models from different designers are integrated into a system and verified or analyzed for collision/ease of access. Designers also need other CAD facilities like analysis and mechanism at various levels of design, that is, analysis of each component to optimize the cost or analysis of large assembled structures exposed to different load conditions. In such cases, requirement of tools also varies at different levels of design or designers. Normally, high-end CAD software provides most of the tools required for every level of design. Obviously, all the available tools are not required for a single designer or design of a single product or system, and it is also an inconvenience to designers if all the tools are provided on a single screen. Therefore, sets of tools are categorized into modules for specific applications or to suit a designer's specific needs. This way, CAD software provides a choice of selection of modules to customers to suit their specific requirements, thus reducing the cost. Companies making small products use 3-D and 2-D packages with standard available tools, whereas large companies having products in different disciplines use various modules according to their application. Normally, standard packages of 3-D CAD software contain operational design tools for solid modeling. Sheet metal industries use a sheet metal module as an add on. Similarly, surfacing, mechanism, and analysis are also available as add-on modules. The right selection of CAD software for the required work is also very significant.

1.2 CAD Libraries

If the usability of an existing drawing or design increases, a great amount of time and effort is obviously saved. It is always suggested to keep usable drawings or designs in an organized manner to form a library and reuse the items whenever applicable. Modern software is now provided with many libraries like a material library and symbol library. Classification and naming of libraries may also be different in different software. General classifications of libraries in commonly used 3-D software are described in this book. The following libraries are important for the subject's point of view:

1. Material library
2. 2-D symbol libraries
3. 3-D component libraries
4. Customized library

TABLE 1.1

Organizations for Standardization

Abbreviation	Description
ANFOR	Association Française de Normalisation
ANSI	American National Standard Institute
AS	Australian Standard
BSI	British Standard Institution
CNS	National Bureau of Standards for the Republic of China (Taiwan)
CSN	Cechoslovakian Office for Standards and Measurements
DIN	Deutsches Institute for Normung
EN	European Standards
GB	Guojio Biaozhun (China)
GOST	State Standards of Soviet
IS	Indian Standard
ISO	International Organization for Standardization
JIS	Japan Industrial Standards
KS	Korean Standards
PN	Polish Standard
SFS	Finnish Standards
SS	Swedish Standard
STN	Slovakian Standard
UNI	Italian Organization for Standardization

Material, symbol, and component libraries are also available in different units and different countries' standards and codes of engineering practices. Table 1.1 shows some of the most used different countries' codes.

1.2.1 Material Library

Material assignment is an essential requirement especially to 3-D modeled components. When assigning materials to various components, it is well recommended to create and store all the properties of material into a database, thus creates material library. When a material is assigned to a component, all the properties assigned to the material are used for the component. The properties of a material can be subcategorized as follows:

1. Structural properties
2. Thermal properties
3. Miscellaneous properties
4. Graphical/aesthetic properties
5. User-defined properties

TABLE 1.2

Material Properties

Sl. No.	Mechanical	Thermal	Miscellaneous	Graphical	User Defined
1	Poisson's ratio	Thermal conductivity	Hardness	Color	Unit cost
2	Modulus of elasticity	Specific heat capacity	Bend Y factor		Supplier
3	Coefficient of thermal expansion				
4	Ultimate tensile stress				
5	Yield stress				

Subcategorization of material properties may vary and can be different in different software. There can also be many subcategories of properties like chemical, optical, and so forth. Table 1.2 shows some typical properties of materials that are used in most of the 3-D software.

Structural and thermal properties are used for structural and thermal finite element analyses, respectively. Miscellaneous properties like Y factor are used in sheet metal for calculation of developed length. Graphical properties are used for identification and photo-rendering purposes. User-defined properties are very useful for automation. Uses of properties are discussed with practical examples in the latter part of this book.

A material library usually accompanies the software itself. Different sets of data for different materials are stored in the database and available to the software itself. Comprehensive separate material database software is also available in the market, for example, Key to Steel.

1.2.2 2-D Symbol Library

A symbol library consists of 2-D drawings, sketches, or pictures. Most of the 2-D drawings contain a large number of standard 2-D objects. Annotation symbols for welding, standard views for piping components, or structural elements are the most used symbols in 2-D drawings. Organized storing and categorization of these symbols form useful symbol libraries. Further, symbol libraries can be classified as follows:

1. Structural symbol library
2. Fastener symbol library
3. Piping symbol library
4. Annotative symbol library