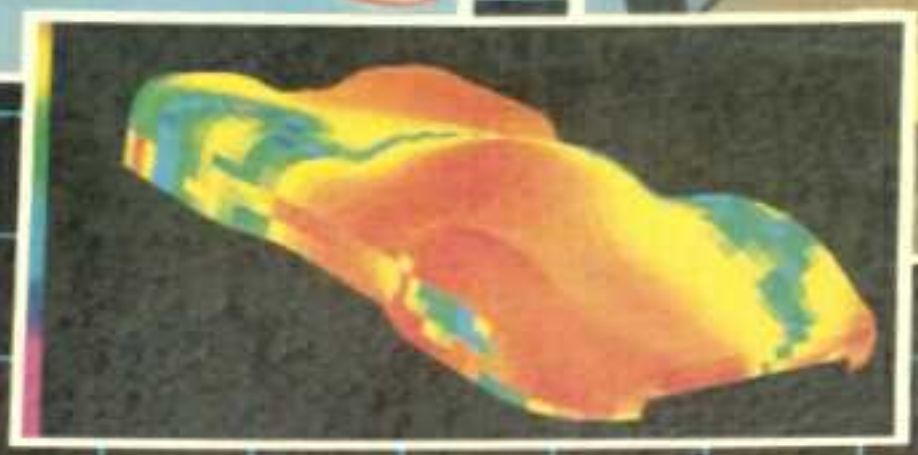
Engineering Graphics Fundamentals

Second Edition



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McGRAW-HILL INTERNATIONAL EDITIONS
Engineering Drawing Graphics Series

SECOND EDITION

ENGINEERING GRAPHICS FUNDAMENTALS

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PREFACE

■ TO THE STUDENT

Engineering graphics is a cornerstone of engineering. The essence of engineering—that is, design—requires graphics as the means of communication within the design process. Graphics serves as the common thread between design and the manufacturing and construction processes.

Study of the fundamentals of engineering graphics is one key to your success as an engineer. Being able to describe an idea with a sketch is a prerequisite of the engineering profession. The ability to put forth a three-dimensional geometry in a form that can be communicated to other engineers, scientists, technicians, craftspersons, and nontechnical personnel is a valuable asset. Of equal importance is knowing how to read and understand the graphics prepared by others.

Your study of engineering graphics is occurring in a period of rapidly changing graphics technology. The traditional tools of graphics, such as the *T*-square, compass, and drafting machines, are being displaced by computer hardware and software. You are in an exciting era in which you will experience the transition from scales, triangles, and dividers to a computer keyboard and from blueprints to databases. The computer will enhance your ability to communicate graphically, but it will not do the engineering for you. You must therefore learn the fundamentals of graphics, develop a measure of expertise for applying these fundamentals to your upcoming engineering analysis and design courses, and, finally, use your graphics capabilities to advantage as a practicing engineer.

The material coverage and organization of the topics in this book are designed to help you effectively develop your graphical communication abilities during your brief introductory study of engineering graphics. The skills and fundamental knowledge acquired during your initial study of engineering graphics will serve you well as you pursue a career in engineering.

■ TO THE INSTRUCTOR

The second edition of *Engineering Graphics Fundamentals* has a goal to provide a modern, coherent treatment of engineering graphics for supporting the engineering design activity. The classical engineering graphics books used the engineering drawing as the focal point. The techniques and skills necessary to produce paper drawings were extensively developed in these books. Engineering drawings were the common thread in the design process; thus, the first course in graphics naturally emphasized the production of the various drawings necessary for the design and manufacture of a device. The development of a design idea and subsequent geometric analysis were performed entirely with pencil and paper graphical methods.

Today, modern engineering design utilizes the computer and CAD software to develop and convey

design ideas. Electronic databases of geometry and other design characteristics are the common thread in the design process. The engineering drawing (blueprint) is rapidly becoming a byproduct of the process, used primarily for records, on-site construction, and shop manufacture. The development of the final design is handled through the building and manipulation of an electronic database.

This second edition presents engineering design graphics in a modern arena where basic pencil and paper communication skills are integrated with the CAD techniques to provide the engineering student with a solid foundation with which to operate effectively in a design environment.

The book is conveniently divided into five parts, which enables you to select the topics in a variety of sequences for achieving your course objectives. Part One (Chapters 1 to 4) begins with a brief outline of the historical aspects of engineering graphics and definition of key terms that appear in modern design graphics (Chapter 1). Chapter 2 develops the freehand skills of lettering and sketching, which remain extremely important in engineering design for the initial development of ideas and concepts. Instruments which are useful for rapid and accurate drawing are described in Chapter 3. In Chapter 4, the techniques of generating graphics with a computer are described. Thus, Part One, "The Graphic Language," establishes the tools of communication for engineering graphics which are then utilized throughout the remainder of the book.

Part Two, "Graphical Representation of Geometries," develops the procedures for generating the databases to describe an idea or concept. From these databases the appropriate analyses and design documentation can be derived. A key element, the cartesian coordinate system, is used as the basis to describe a geometry. Therefore, elements of the geometry are defined in numerical terms which enable mathematical procedures to be used in display and analysis of the geometry. Chapter 5 presents the concept of a *geometric model* in three dimensions. From the model, one can display the geometry in a two-dimensional environment (multiview representation) or a three-dimensional format (pictorials, Chapter 6). Chapter 7 brings to the engineering student the most significant development in computer-aided design, that of solid modeling. The concept of assembling an object from a series of primitives or from sweeping a two-dimensional area is explained along with the Boolean operations of union, difference, and intersection. Solid modeling casts an entirely new perspective on the representation of a design. Students can now design in a totally three-dimensional environment rather than thinking in 3D, drawing on a 2D surface, and then trying to visualize the result again in 3D.

Part Three is a series of traditional graphics topics that support the design function. The treatment in Chapters 8, 9, and 10 is much the same as that in classical textbooks with the emphasis on correct techniques as specified in the ANSI standards. Chapter 11, "Communication of Design Information," describes the contents of a complete geometric description of a design. Computer-produced drawings and pencil and paper graphics are both illustrated.

Part Four develops the procedures for analyzing geometries that have been developed with the procedures outlined in Chapter 5. Because the geometry is defined in numerical terms, mathematical methods are available for geometric analysis. Chapter 12 introduces vector algebra and analytic geometric concepts and Chapter 13 follows with specific applications to polyhedra. Examples of geometric properties that can be found by mathematical computation and with certain CAD software are true length, area of a plane, slope angle of a line and plane, angle between a line and a plane or two planes, and shortest connector. These mathematical procedures replace the traditional descriptive geometry methods which use the 2D paper environment to develop graphical solutions for geometry problems.

Part Five describes the engineering design process and carries through an example of the development of a design. Chapter 14 shows the important interrelationship of graphics and design and focuses on the use of graphics to accomplish design objectives.

SI and English units are both used throughout the text. The appendixes include standards for both and chapter problems include both units.

Although the text is written with the assumption that the students have no experience in graphics, a background in algebra and trigonometry is required.

■ ACKNOWLEDGMENTS

The authors wish to express their gratitude to many who supported the concept and development of this textbook. We thank our graphics teachers who, during our formal education, developed within us an

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