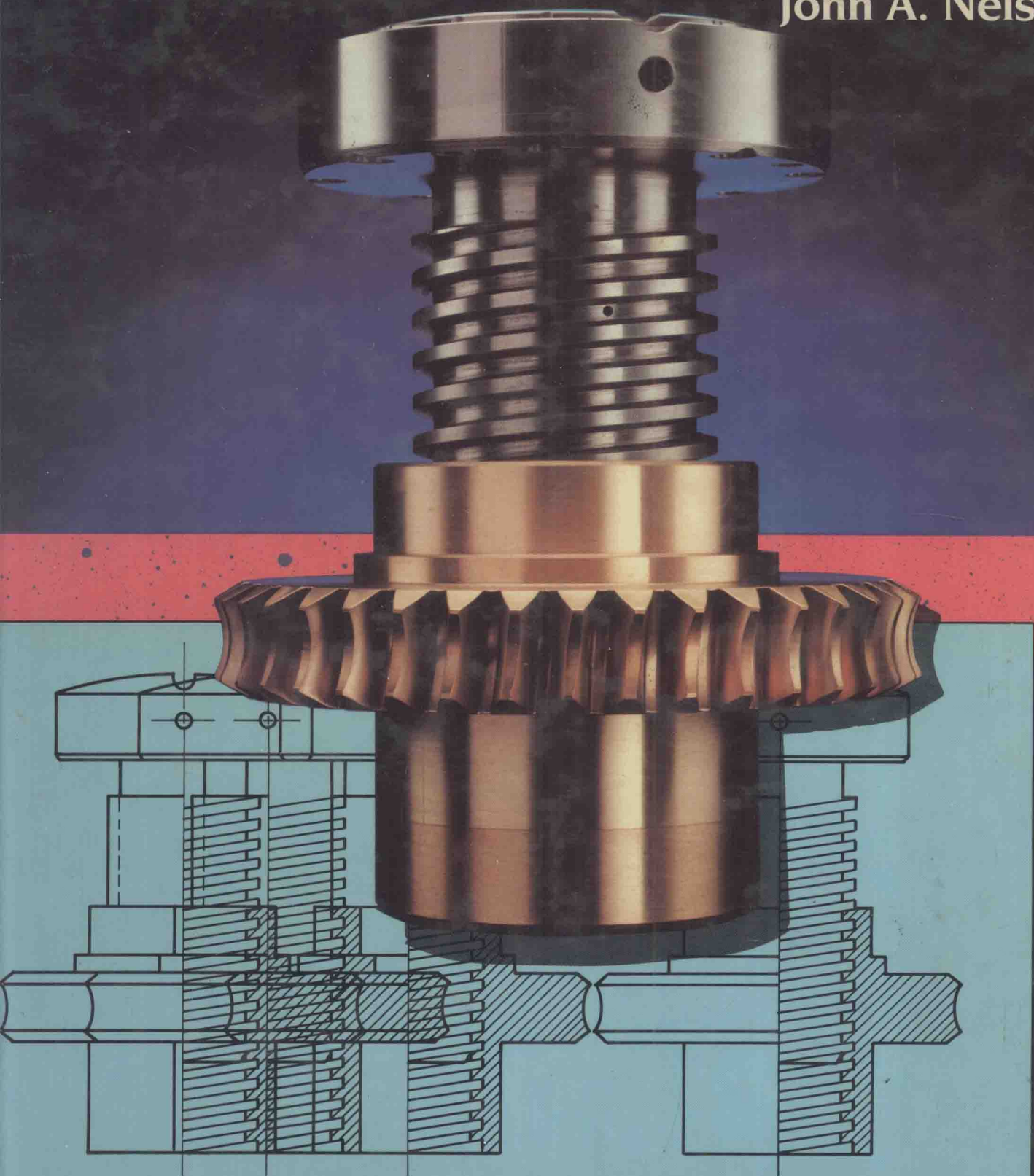


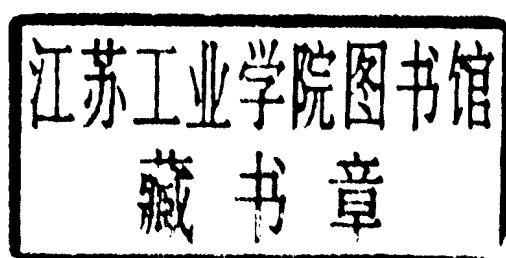
TECHNICAL DRAWING AND DESIGN

David L. Goetsch
John A. Nelson



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Preface

Purposes *Technical Drawing and Design* is intended for use in such courses as basic and advanced technical drawing, basic and advanced drafting, engineering graphics, descriptive geometry, mechanical drafting, machine drafting, tool and die design and drafting, and manufacturing drafting. It is appropriate for those courses offered in comprehensive high schools, area vocational schools, technical schools, community colleges, trade and technical schools, and at the freshman and sophomore levels in universities.

Prerequisites No prerequisites are necessary. The text begins at the most basic level and moves step-by-step to the advanced levels. It is as well suited for students who have had no previous experience with technical drawing as it is for students with a great deal of prior experience.

Innovations An advantage of the text is that it evolved during a time when the world of technical drawing and design is undergoing a period of major transition from manual to automated techniques. Computer-aided drafting (CAD) is slowly but steadily gaining a foothold. This transitional period will last at least until the turn of the century, with CAD gaining greater acceptance every year.

This transition has created a need for a major text that deals with both traditional knowledge and skills and CAD-related knowledge and skills. *Technical Drawing and Design* fills this need. Even when the world of technical drawing and design has become fully automated, drafters and designers will still need to know the traditional basics and technical drawing fundamentals. These basic factors will not change. Therefore, the traditional fundamentals are treated in depth in this text.

What is changing, and will continue to change, is the way that drafters and designers prepare technical drawings. For this reason, CAD is also treated in depth, and many of the drawings and illustrations were prepared on various CAD systems. Along with this treatment, *Technical Drawing and Design* offers students and teachers a special blend of the manual and automated knowledge and techniques that are needed now through the turn of the century, and even beyond.

Another advantage of the text is that it was written after the latest update of the most frequently used drafting standard — ANSI Y14.5. This standard was updated with major revisions in 1982, and is now ANSI Y14.5M - 1982. Consequently, all dimensioning and tolerancing material in *Technical Drawing and Design* is based on this most recent edition of the standard.

Grouping of Chapters The authors combine more than 32 years of classroom experience and 18 years of industrial experience. When using various textbooks, they were never satisfied with the grouping or sequencing of chapters. To solve this problem and, in turn, to make *Technical Drawing and Design* a more effective teaching tool, the authors came up with five major sections for the book: Basics, Technical Drawing Fundamentals, Computer-aided Drafting, Design Drafting Applications, and Related Technology.

All chapters are sequenced under one of the major section headings in such a way as to correspond with normal teaching and learning patterns. The basics are treated first. Technical drawing fundamentals that should be learned using traditional manual tools and techniques are discussed next. The third section deals with CAD. This section allows teachers the option of progressing into advanced chapters using the manual approach, the CAD approach, or a combination of both. Section Four contains the advanced technical drawing and design chapters for those programs that go beyond the fundamentals. All of the non-drawing or reference chapters are grouped together in Section Five, thus allowing teachers and students to turn to any one comprehensive reference section as needed.

Comprehensive Listing of Contents The detailed Contents listing is designed to give students and teachers an all-inclusive but easy to follow "roadmap" for locating material in the text. In addition to the chapter titles, the Contents contains a complete breakdown of the major topical headings for each chapter so that students and teachers can turn readily to information that is needed without having to guess as to its location in the text. A brief Contents is also provided for quick reference to subject matter.

Simply Written Students often find the language of technical drawing books verbose, abstract, and complicated. Many of the principles covered in such books ARE complicated, but this does not mean that their explanations must be. This text is written in such a way as to communicate plainly and simply the most complex principles and concepts so that students can concentrate on what they are learning, rather than trying to unscramble overly complicated explanations.

Well Illustrated The text is copiously illustrated for all of the concepts and principles presented. A second color has been used freely to better illustrate important points. The color not only enhances the book's appearance, making it more readable, but it also simplifies some of the more complicated concepts presented.

Review Sections Each chapter contains a Review designed to test the students' knowledge of all theories, principles, and concepts presented. In order to answer the reviews, students must comprehend the material that has been presented. Teachers may use the reviews as homework or student self-tests, or for classroom discussions.

Application Problems Each drawing chapter contains numerous drawing problems that range from the simple to the intermediate to the complex in terms of the material covered. Chapter 17 contains major drawing projects that can be used to challenge and stretch the stamina of the students' attention span.

CAD Drawing and Industry Prints This text contains many drawings prepared on various CAD systems. These drawings allow students to become accustomed to the differences between manually prepared and computer-aided drawings. In addition, 10 chapters contain an industry print, each of which was prepared by the design and drafting departments of specific industrial firms. These prints are accompanied by questions for students to answer. This activity gives students experience in dealing with "real world" drawings while still in the classroom, and is designed to allow students to serve an in-school internship.

Instructor's Guide An Instructor's Guide is provided to make the teacher's job easier. The guide contains learning objectives for each chapter, answers to the reviews, answers to the questions accompanying the "real world" drawings, and four test drawings with solutions for each chapter that involves drawing. Instructors may use end of chapter drawings for learning activities, skills development, and practice drills, while reserving the test drawings in the Instructor's Guide for conducting evaluations.

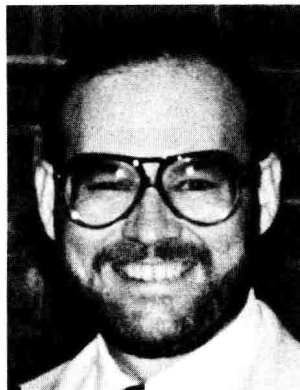
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J. Douglas Frampton The Ohio State University Columbus, OH	George Pruitt Ridgecrest, CA
Robert F. Franciose Chairman Y14 American National Standards Institute	Paul Salvucci Boston Gear Quincy, MA
Steven F. Horton San Jacinto College Pasadena, TX	Edwin B. Thomas Grambling State University Grambling, LA
Mark Knott Texas State Technical Institute Harlingen, TX	James R. Vandervest Gulf Coast Community College Panama City, FL
Richard Latimer The University of Alabama University, Alabama	

David L. Goetsch
John A. Nelson

ABOUT THE AUTHORS David L. Goetsch is Director of Occupational Education, Head of Drafting and Design, and Professor of Computer-aided Design and Drafting of Okaloosa-Walton Junior College in Niceville, Florida. His drafting and design program has won national acclaim for its pioneering efforts in the



David L. Goetsch

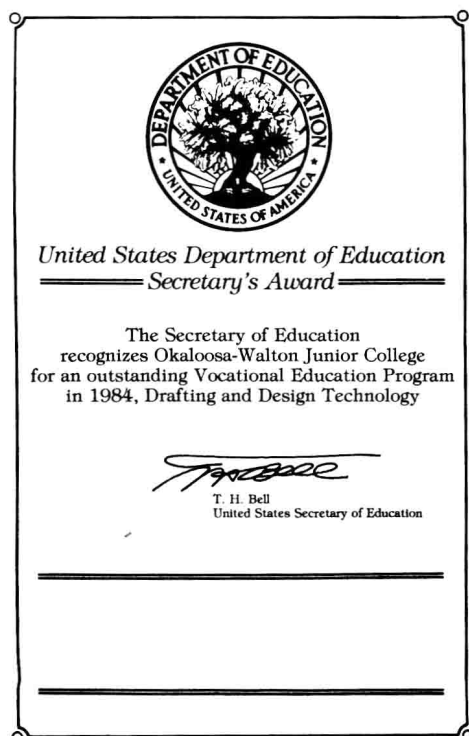
area of computer-aided drafting (CAD). In 1984, his school was selected as one of only ten schools in the country to earn the distinguished Secretary's Award for an Outstanding Vocational Program. Goetsch is a widely acclaimed teacher, author, and lecturer on the subject of drafting and design. He won Outstanding Teacher of the Year honors in 1976, 1981, 1982, 1983, and 1984. He entered education full time after a successful career in design and drafting in the private sector where he spent more than eight years as a Senior Drafter and Designer for a subsidiary of Westinghouse Corporation. This is his 12th book.

John A. Nelson has a strong background in industry and the classroom. Before entering education full time, Nelson spent 11 years in drafting and design in the private sector, beginning as a detailer and work-



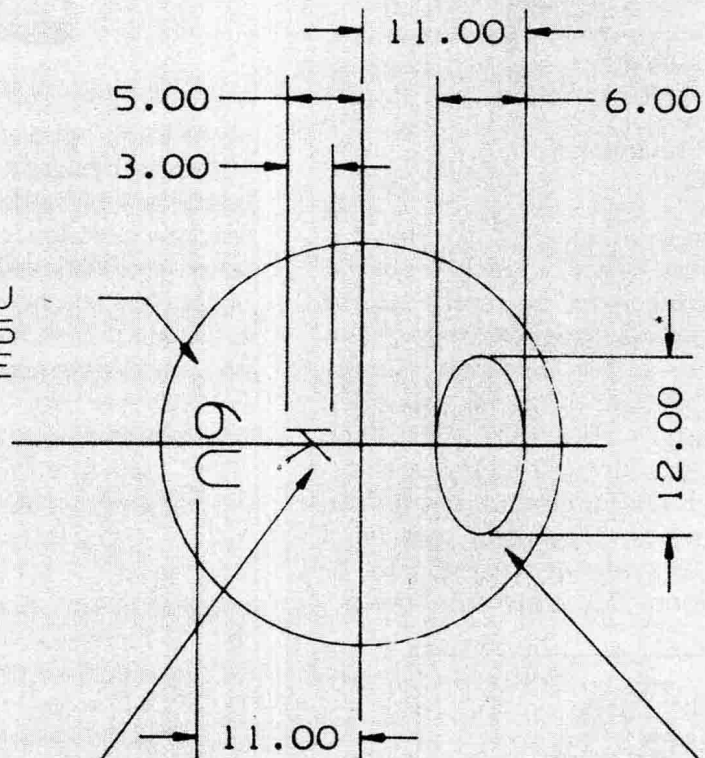
John A. Nelson

ing up to designer. He currently continues to freelance in this field. He has more than 20 years of teaching experience in the classroom at both the high school and college levels, and was New Hampshire's Vocational Teacher of the Year in 1982. He holds the associate in arts, bachelor of science, and master of education degrees. This is his 16th book.



C

ENGRAVING 6U
▽ 3.0 X 0.15
GORTON STYLE



B

LOGO AS PER ART WORK
▽ 0.15 SIZE AS SHOWN

CAVITY IDENTIFICATION
LETTER K
▽ 3.0 X 0.15
GORTON STYLE

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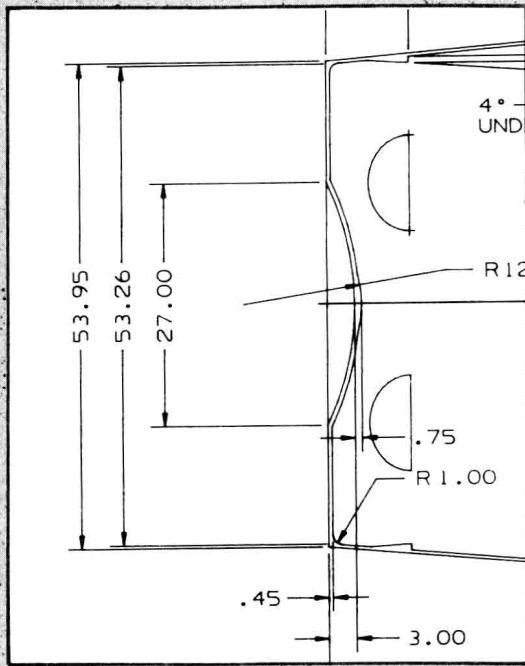
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This introduction to Technical Drawing and Design presents the concept of technical drawing and traces its evolution from primitive manual techniques to modern computer-aided drafting (CAD) techniques. Major topics covered include: drawings described; types of drawings; types of technical drawings, their purpose, applications, and regulation; and a checklist of what students of technical drawing and drafting should learn.

Introduction

Drawings Described

A *drawing* is a graphic representation of an idea, a concept or an entity which actually or potentially exists in life. The drawing itself is 1) a way of communicating all necessary information about an abstraction, such as an idea or a concept; or 2) a graphic representation of some real entity, such as a machine part, a house, or a tool, for example.

Drawing is one of the oldest forms of communication, dating back even farther than verbal communication. Cave dwellers painted drawings on the walls of their caves thousands of years before paper was invented. These crude drawings served as a means of communicating long before verbal communications had developed beyond the grunting stage. In later years, Egyptian hieroglyphics were a more advanced form of communicating through drawings.

The old adage "one picture is worth a thousand words" is still the basis of the need for technical drawings.

Types of Drawings

There are two basic types of drawings: artistic and technical. Some experts believe there are actually

three types: the two mentioned and another type which combines these two. The third type is usually referred to as an illustration or rendering.

Artistic Drawings

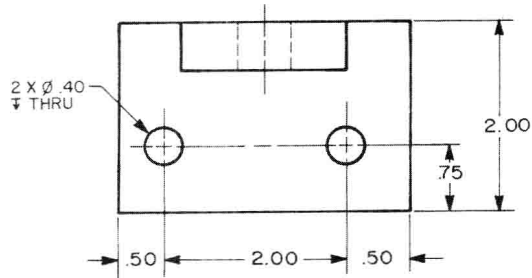
Artistic drawings range in scope from the most simple line drawings to the most famous paintings. Regardless of their complexity or status, artistic drawings are used to express the feelings, beliefs, philosophies or abstract ideas of the artist. This is why the lay person often finds it difficult to understand what is being communicated by a work of art.

In order to understand an artistic drawing, it is sometimes necessary to first understand the artist. Artists often take a subtle or abstract approach in communicating through their drawings. This gives rise to the various interpretations often associated with artistic drawings.

Technical Drawings

The technical drawing, on the other hand, is not subtle or abstract. It does not require an understanding of its creator; only an understanding of technical

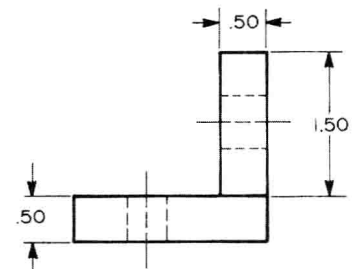
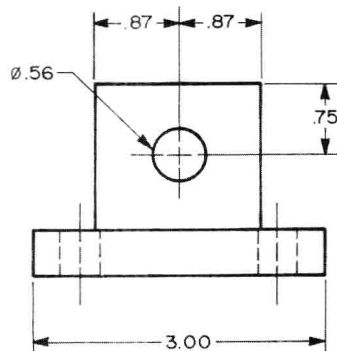
Figure I-1 Technical drawing (mechanical)



MATERIAL: STAINLESS STEEL

MANUFACTURERS NOTE:

FINISH ALL OVER

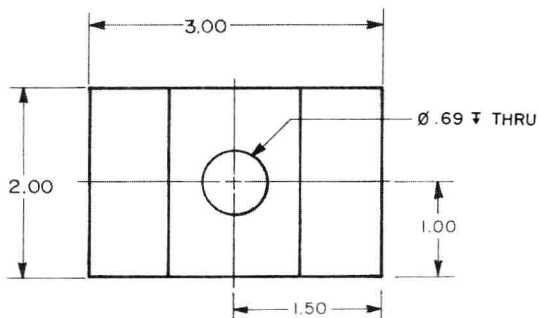


drawings. A *technical drawing* is a means of clearly and concisely communicating all of the information necessary to transform an idea or a concept into reality. Therefore, a technical drawing often contains more than just a graphic representation of its subject. It also contains dimensions, notes, and specifications.

The mark of a good technical drawing is that it contains all of the information needed by individuals for converting the idea or concept into reality. The con-

version process may involve manufacturing, assembly, construction, or fabrication. Regardless of the process involved, a good technical drawing allows the conversion process to proceed without having to ask designers or drafters for additional information or clarification.

Figures I-1 and I-2 contain samples of technical mechanical drawings which are used as guides by the people involved in various phases of manufactur-



MATERIAL: STAINLESS STEEL

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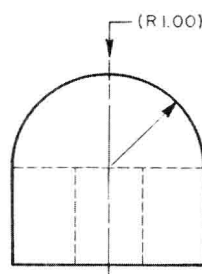
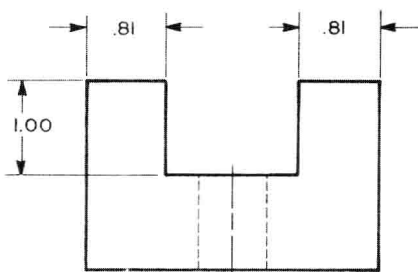


Figure I-2 Technical drawing (mechanical)

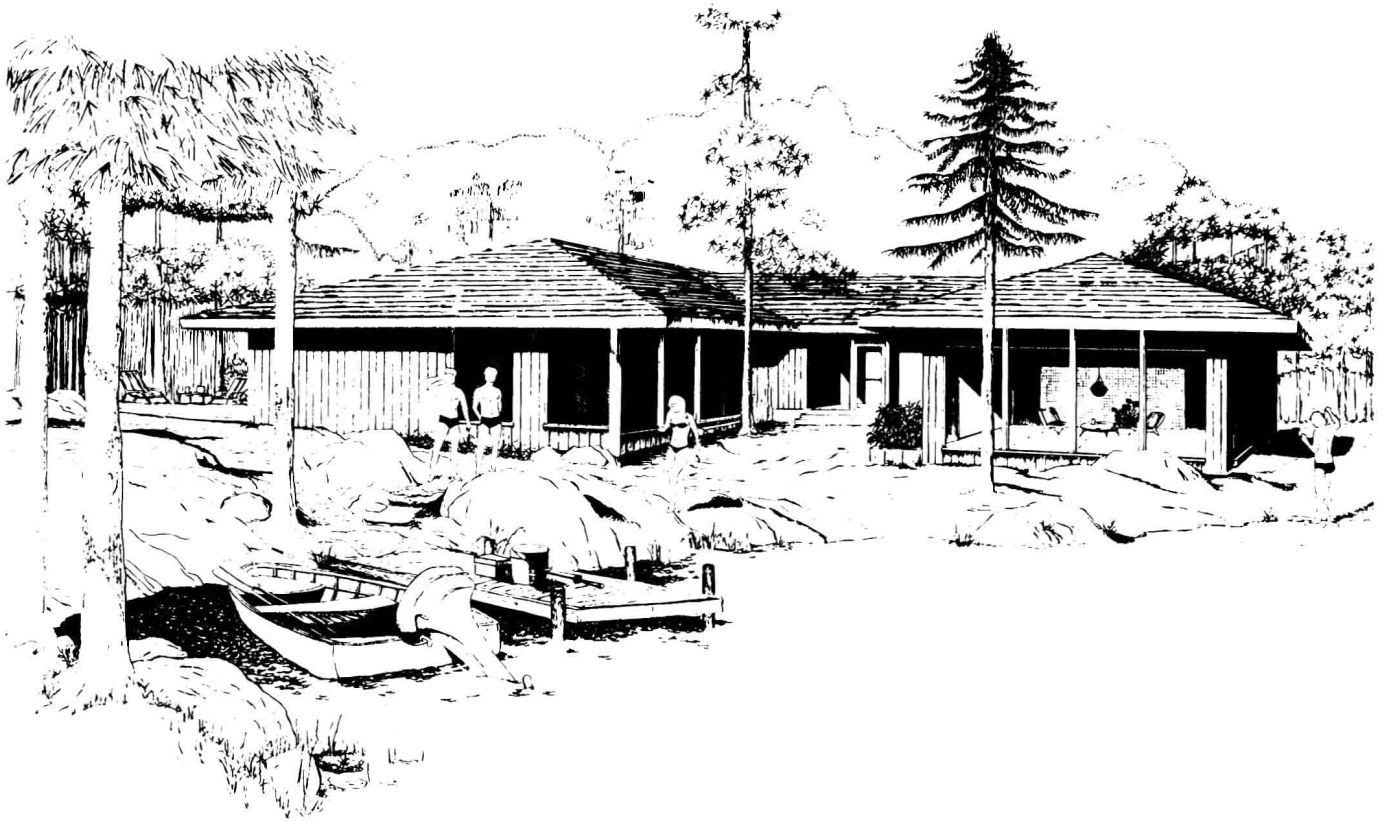


Figure I-3 Rendering



Figure I-4 Rendering

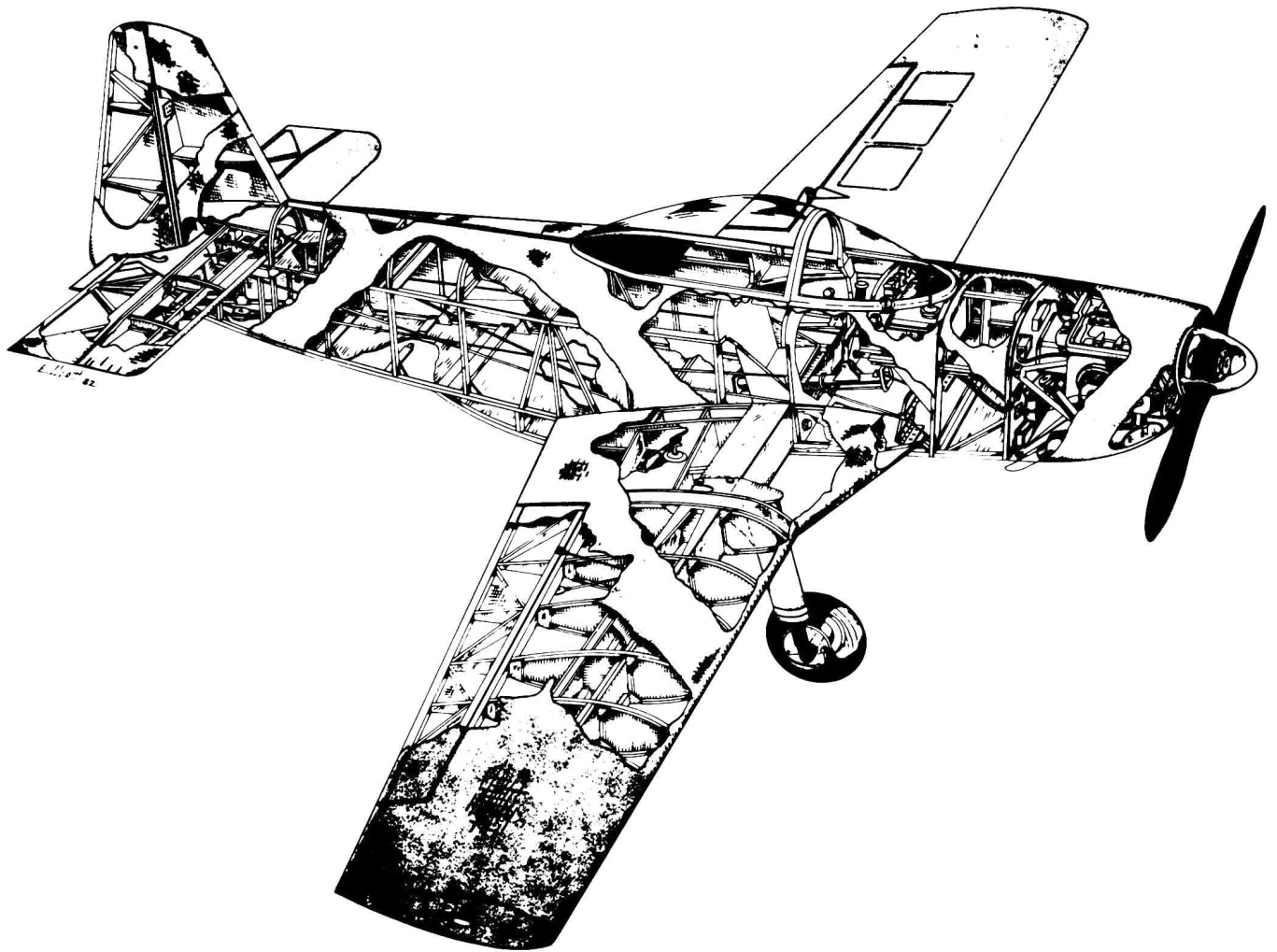


Figure I-5 Mechanical illustration (Courtesy Ken Elliott)

ing the represented parts. Notice that the drawings contain a graphic representation of the part, dimensions, material specifications, and notes.

Illustrations or Renderings

Illustrations or renderings are sometimes referred to as a third type of drawing because they are not completely technical, neither are they completely artistic; they combine elements of both, as shown in Figures I-3, I-4, I-5, and I-6. They are technical in that they are drawn with mechanical instruments or on a computer-aided drafting system, and they contain some degree of technical information. However, they are also artistic in that they attempt to convey a mood, an attitude, a status or other abstract, nontechnical feelings.

Types of Technical Drawings

Technical drawings are based on the fundamental principles of projection. A *projection* is a drawing or

representation of an entity on an imaginary plane or planes. This projection plane serves the same purpose in technical drawing as is served by the movie screen in a theater.

As can be seen in Figure I-7, a projection involves four components: 1) the actual object that the drawing or projection represents, 2) the eye of the viewer looking at the object, 3) the imaginary projection plane (the viewer's drawing paper or the graphics display in a computer-aided drafting system), and 4) imaginary lines of sight called *projectors*.

Two broad types of projection, both with several subclassifications, are parallel projection and perspective (converging) projection.

Parallel Projection

Parallel projection is subdivided into the following three categories: orthographic, oblique, and axonometric projections.

Orthographic projections are drawn as multiview drawings which show flat representations of principal views

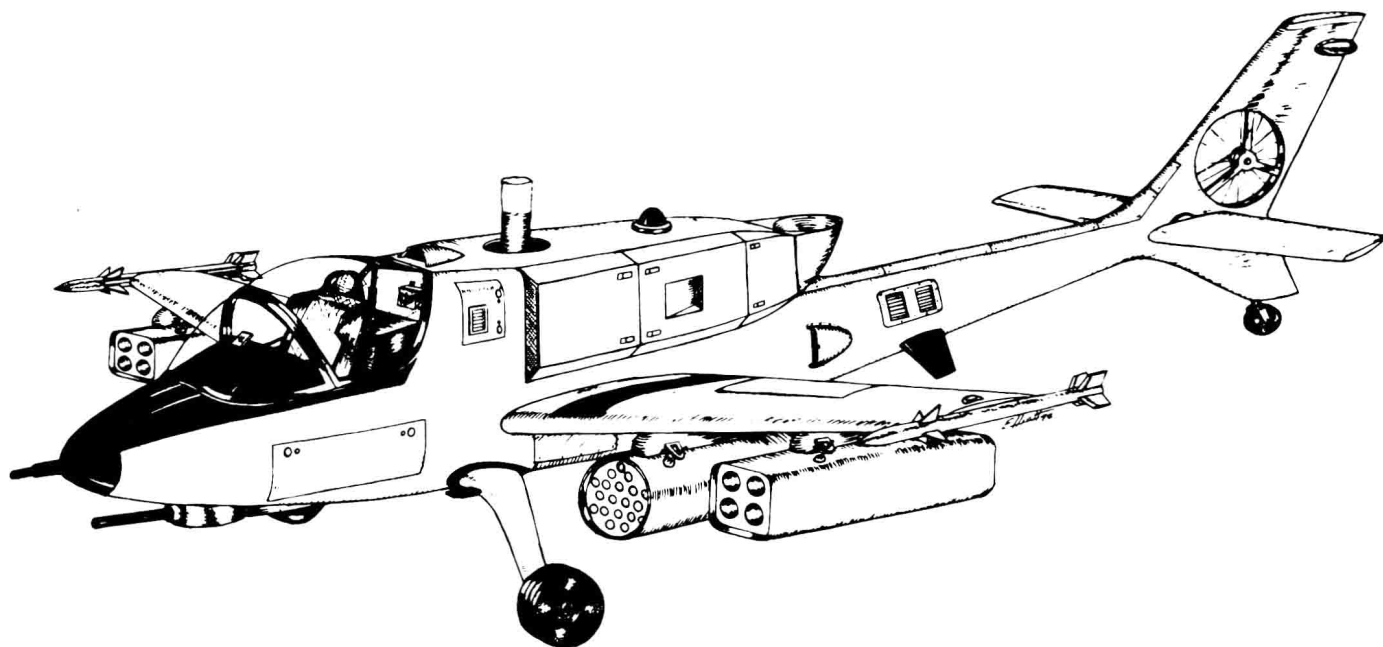


Figure I-6 Mechanical illustration (Courtesy Ken Elliott)

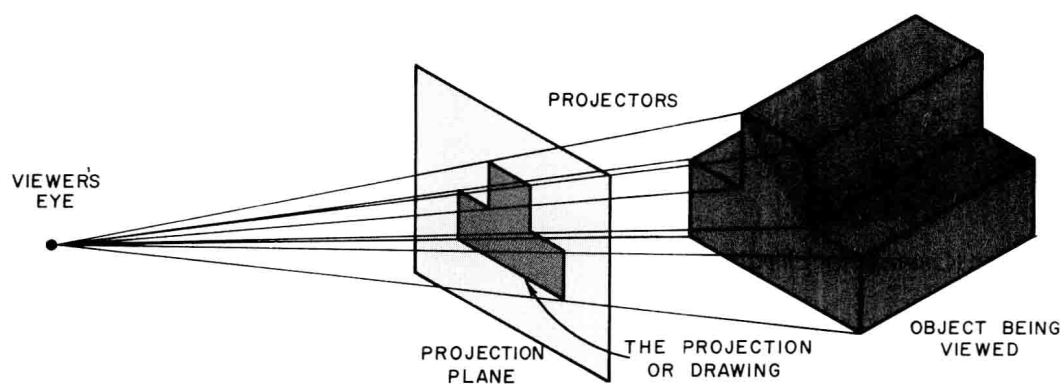


Figure I-7 The projection plane

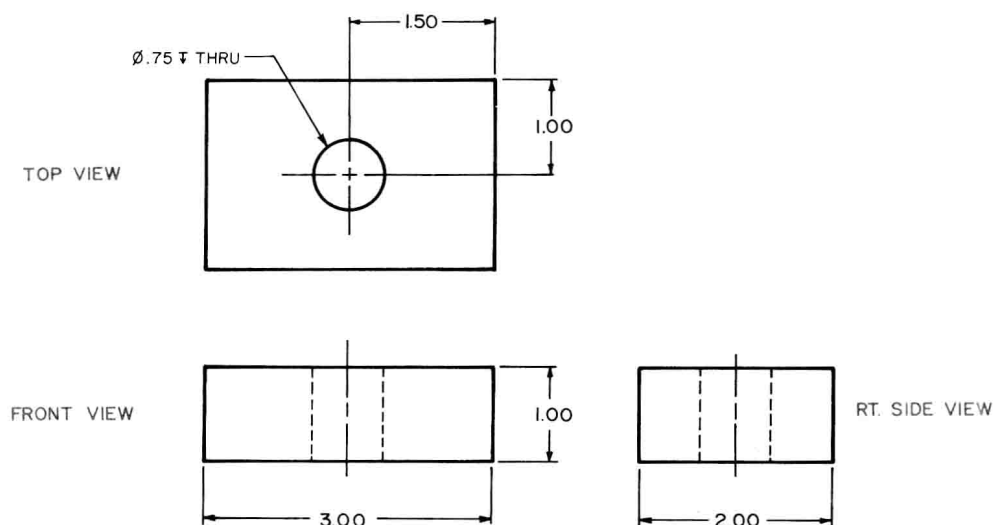


Figure I-8 Orthographic multiview drawing