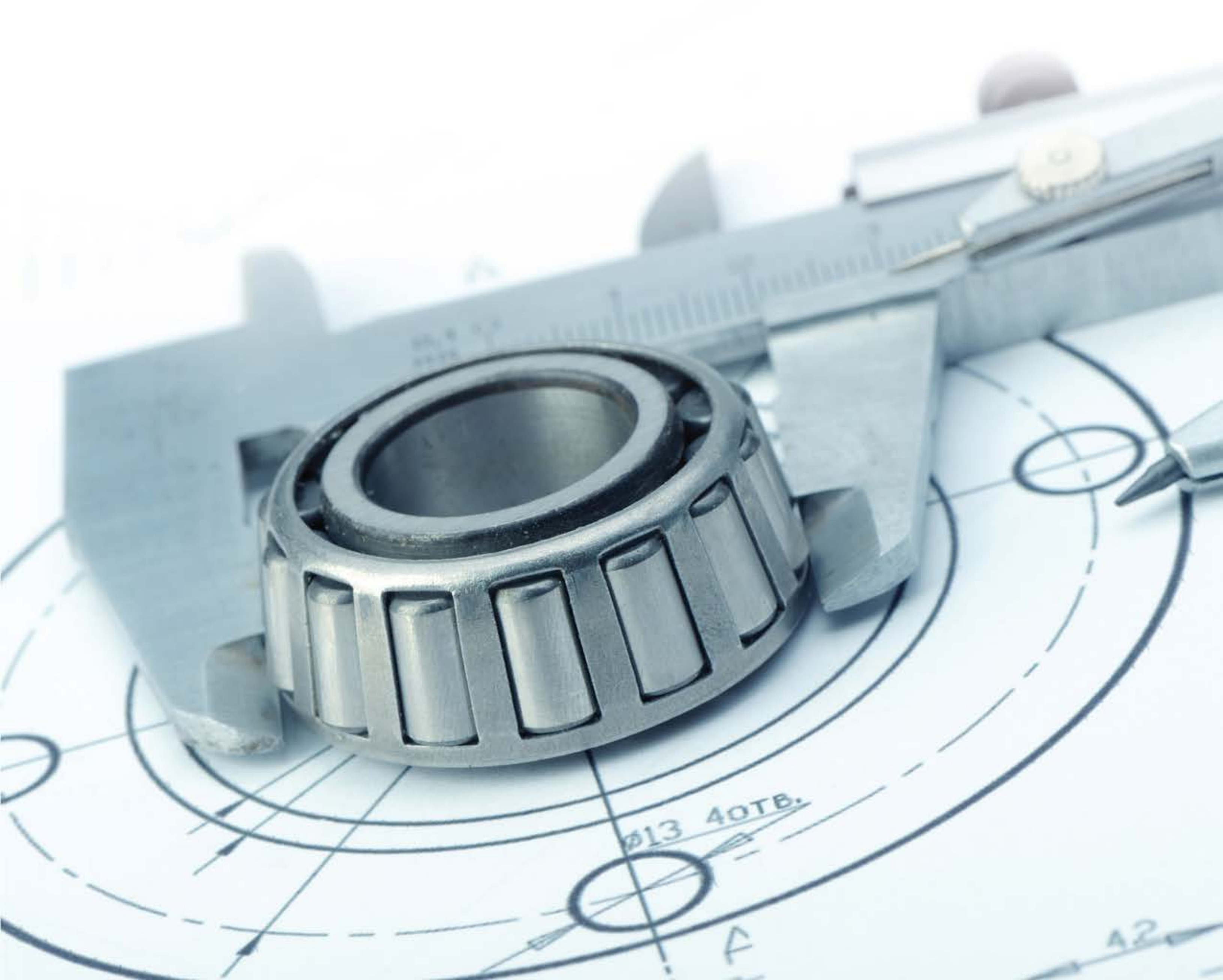
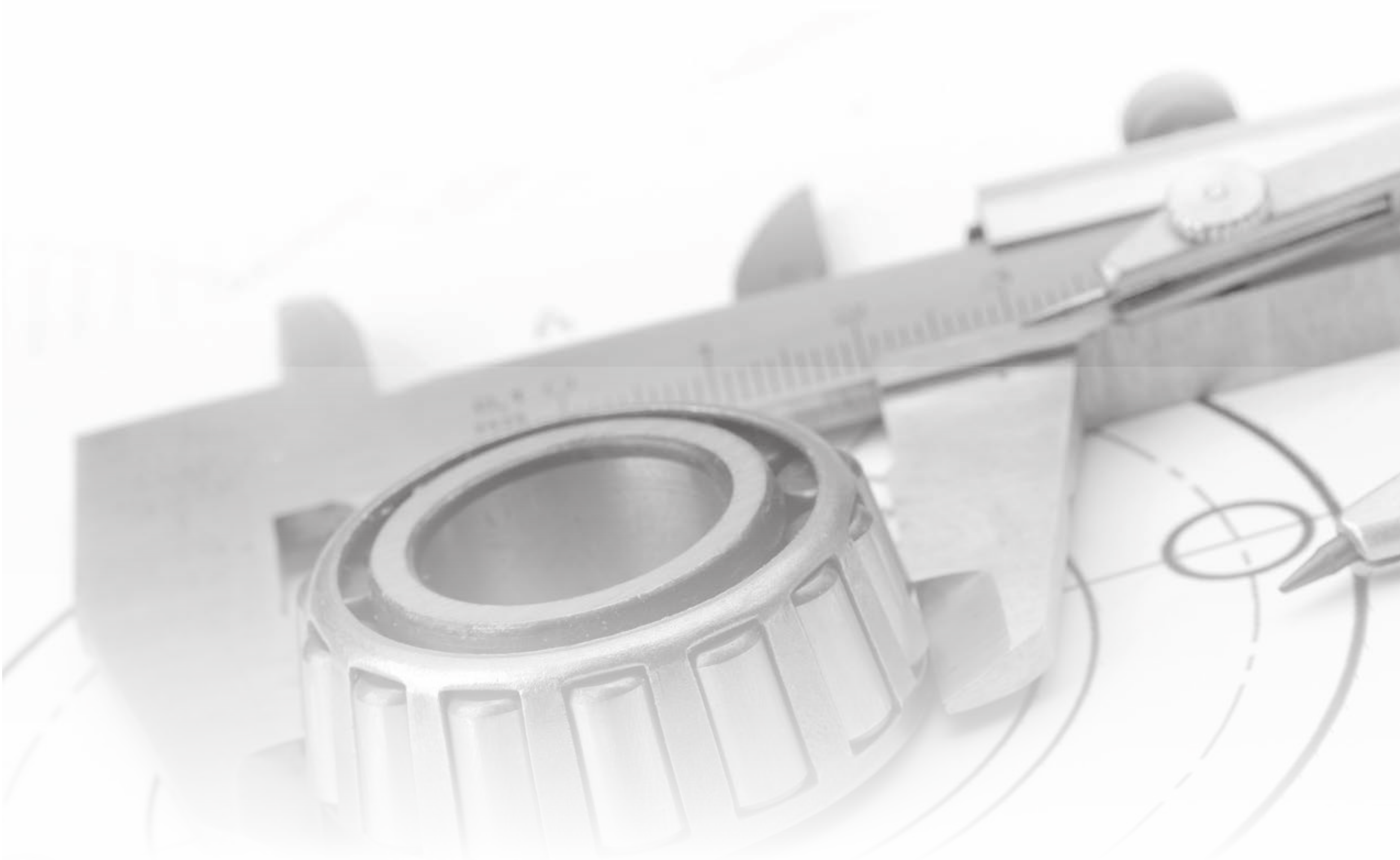
PRINT READING FOR MACHINISTS

SIXTH EDITION | DAVID L. TAYLOR



PRINT READING FOR MACHINISTS

SIXTH EDITION DAVID L. TAYLOR



CENGAGE

Australia • Brazil • Mexico • Singapore • United Kingdom • United States

***Print Reading for Machinists,* 6th edition**
David L. Taylor

SVP, GM Skills & Global Product Management: Jonathan Lau

Product Director: Matthew Seeley

Associate Product Manager: Kelly Lischynsky

Senior Director, Development: Marah Bellegarde

Senior Product Development Manager: Larry Main

Senior Content Developer: Mary Clyne

Product Assistant: Mara Ciacelli

Vice President, Marketing Services: Jennifer Ann Baker

Marketing Manager: Scott Chrysler

Senior Production Director: Wendy Troeger

Production Director: Andrew Crouth

Senior Content Project Manager: Glenn Castle

Art Director: Angela Sheehan

Cover Image(s): © Shutterstock.com/Galushko Sergey

Composition and Production Service: MPS Limited

Library of Congress Control Number: 2017953752

ISBN: 978-1-285-41961-9

Cengage
20 Channel Center Street
Boston, MA 02210
USA

Cengage is a leading provider of customized learning solutions with employees residing in nearly 40 different countries and sales in more than 125 countries around the world. Find your local representative at **www.cengage.com.**

Cengage products are represented in Canada by Nelson Education, Ltd.

To learn more about Cengage platforms and services, visit **www.cengage.com.**

To register or access your online learning solution or purchase materials for your course, visit **www.cengagebrain.com.**

Printed in the United States of America
Print Number: 01 Print Year: 2017

CONTENTS

UNIT 18 Hole Patterns and Revision Blocks

UNIT 19 Angles, Dovetails, and Slots

UNIT 20 Metric Dimensions and Tolerances

UNIT 21 Machining Symbols, Bosses, and Pads

UNIT 22 Surface Texture

UNIT 23 Tapers and Chamfers

UNIT 24 Undercuts and Knurling

UNIT 25 Screw Thread Specification

UNIT 26 Screw Thread Representation and Threaded Fasteners

UNIT 27 Pipe Threads

PREFACE

Most technical professions today require employees to read and interpret industrial prints. Metalworking, quality control, product engineering, process planning for numerical control, computer programming for computer-aided drafting and manufacturing systems, and inspection are just some of the careers that use technical drawings extensively. Students preparing for such careers must strive for excellence in reading and interpreting such drawings quickly and accurately. *Print Reading for Machinists*, 6th edition provides all the basic information a beginning student needs to become skilled at print interpretation.

Features of the New Edition

This resource is designed to present a logical progression of print reading principles in short units of instruction followed by immediate practical application. Each unit contains lessons, examples, review questions, and practice drawings that support the skill development students need most to succeed in the machine trades field.

The basic principles for representing information on a drawing are presented in 31 units. Each unit provides a thorough explanation of specific principles in an easy-to-read style. More than 250 line drawings are provided to illustrate and apply each principle.

To ensure that the student understands industrial practices, 27 end-of-unit assignment drawings are included. The information contained in each unit will enable the student to complete the assignment drawing and answer a series of questions. Additional references are not required to complete assignments.

For ease of learning, these drawings start with relatively simple designs and progress in complexity. As students master new principles and perfect their interpretive skills, the drawings keep pace by providing increasingly challenging assignments.

In addition to assignments relating to the reading of prints, 10 sketching assignments are included to help develop the ability to provide a quick and accurate freehand drawing of a part to be manufactured. *Print Reading for Machinists* conforms to the latest standard of the American National Standards Institute (ANSI), including ASME Y14.5M-2009. The information contained in Unit 29, “Welding Symbols,” conforms to the standards of the American Welding Society. The appendices include a review of basic math principles applied to print reading, descriptions of the use of precision measuring tools, a selected list of ANSI abbreviations used on industrial drawings, and assorted handbook tables for quick reference.

MindTap for Blueprint Reading

MindTap® Blueprint Reading for Taylor’s *Print Reading for Machinists*, 6th edition is a new digital learning solution that can power students from memorization to mastery. It gives instructors complete control of their courses—to provide engaging content, to challenge every individual, and to build confidence. Customize the interactive assignments and assessments, emphasize the most important topics, or add your own material and notes in the eBook.

Instructor Resources

A robust suite of Instructor Resources is available at the Instructor Companion Website, including an Instructor's Guide with answers to each assignment in the text, PowerPoint lecture slides, and Cengage Testing Powered by Cognero®.

About the Author

David L. Taylor is a former Journeyman Tool and Die Maker with more than 20 years' experience in vocational-technical training. He holds a Master of Science degree in Adult Education from Penn State University and a Bachelor of Science degree in Vocational-Technical Education from the State University of New York at Buffalo. Mr. Taylor has taught courses in machine trades, print reading, and design at Erie County BOCES, Lewis County BOCES, Jamestown Community College, and Ivy Tech State College. Mr. Taylor is the author of four blueprint reading texts published by Cengage.

Acknowledgments

The author and publisher would like to acknowledge the following reviewers for their contributions to this edition:

John Battista, Prosser Career Academy, Chicago, Illinois
Andrew Klein, Reading Muhlenberg Career and Technology Center, Reading, Pennsylvania

The publisher especially acknowledges **Larry Lichter** for his patient and detailed technical edit of the work during the drafting stages.

UNIT 1
Industrial Drawings

INTRODUCTION

One of the oldest forms of communication between people is the use of a drawing. A ***drawing*** is a means of providing information about the size, shape, or location of an object. It is a graphic representation that is used to transfer this information from one person to another.

Drawings play a major role in modern industry. They are used as a highly specialized language among engineers, designers, and others in the technical field. These industrial drawings are known by many names. They are called mechanical drawings, engineering drawings, technical drawings, or working drawings. Whatever the term, their intent remains the same. They provide enough detailed information so that the object may be constructed.

Engineers, designers, and drafting technicians commonly produce drawings using computer-aided design and drafting equipment (CAD). The application of computer technology has led to greater efficiency in drawing production and duplication. CAD systems have rapidly replaced the use of mechanical tools to produce original drawings.

COMPUTER-AIDED DESIGN AND DRAFTING

Computer-aided design or ***computer-aided drafting (CAD)*** systems are capable of automating many repetitive, time-consuming drawing tasks. The present technology enables the drafter to produce or reproduce drawings to any given size or view. Three-dimensional qualities may also be given to a part, thus reducing the confusion about the true size and shape of an object. Figure 1.1 shows a typical drawing produced with the help of a computer-aided design system.

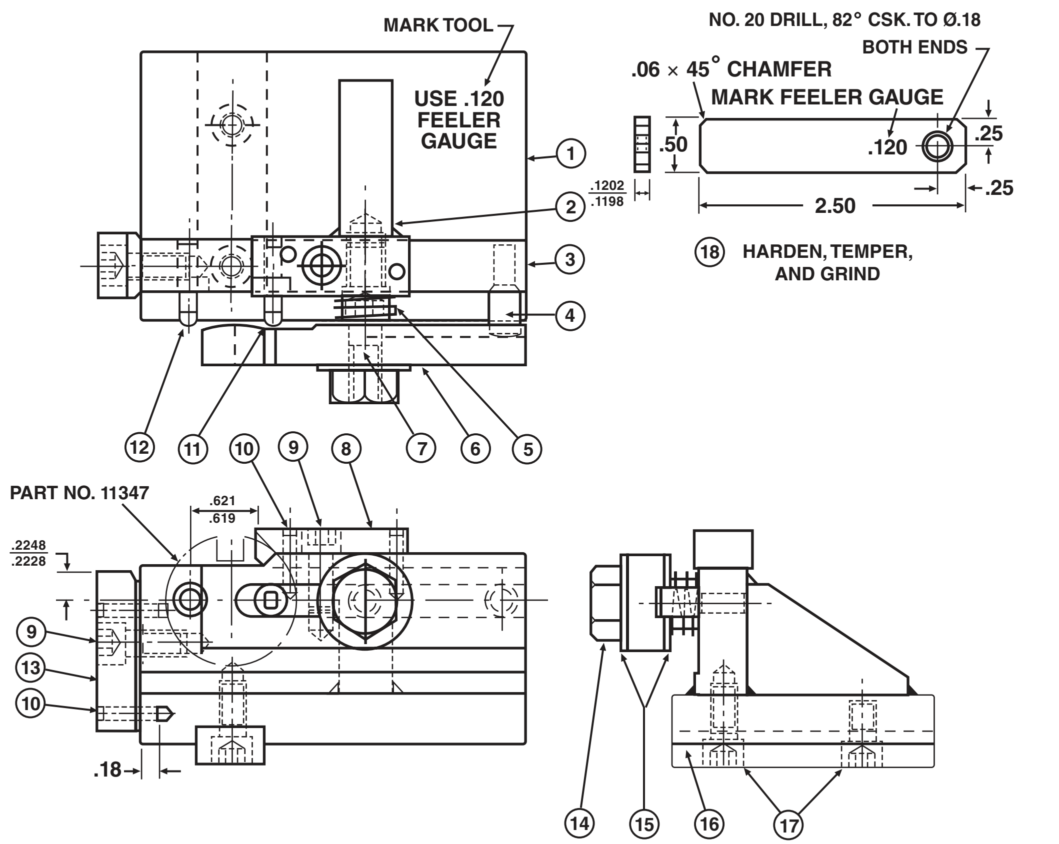
CAD systems usually consist of three basic components: (1) hardware, (2) software, and (3) operators or users. The hardware includes a processor, a display system, keyboard, plotter, and digitizer (often called a "mouse"). Software includes the programs required to perform the design or drafting function. Software packages are available in many forms, depending upon the requirements of the user.

The CAD processor is actually the computer or "brains" of the system. The keyboard, which looks very much like a typewriter, is used to place commands into the processor. The commands or input are then displayed graphically on the system display screen. This screen is commonly a liquid crystal display (LCD) or flat cathode ray tube (CRT). The digitizer or mouse is used to create graphic images for display on the screen. The plotter is a printer that produces hard copies of a design in print form.

Industrial drawings are usually produced on a paper material called ***Vellum*** or on a polyester film material known as ***Mylar***. Mylar is a clear polyester sheet that has a matte finish on one or both sides. The matting provides a dull, granular drawing surface well-suited for pencil or ink lines. Mylar is preferred over vellum in some applications because it resists bending, cracking, and tearing. A completed industrial drawing is known as an original or master drawing.

MARK TOOL NO. AND PART NO. ON TOOL

REMOVE SHARP EDGES WHICH MAY INJURE OPERATOR



FRACTIONAL DIMENSIONS ARE ±.005 UNLESS OTHERWISE SPECIFIED

SHEET NO. 1 OF 3 SHEETS

MATERIAL LIST			
DET	QTY	SIZES	MATL
1	1	$\frac{1}{2} \times 2\frac{1}{2} \times 3\frac{3}{4}$	SAE 1020
2	1	$\frac{1}{2} \times 1\frac{1}{2} \times 1\frac{1}{8}$	SAE 1020
3	1	$\frac{1}{2} \times 1\frac{1}{4} \times 3\frac{3}{4}$	SAE 1020
4	1	Ø $\frac{5}{16} \times \frac{15}{16}$ LONG	DR.RD.
5	1	TO SUIT Ø.020	SP.W.
6	1	$\frac{3}{8} \times \frac{7}{8} \times 3\frac{1}{8}$	SAE 1020
7	1	Ø $\frac{7}{16} \times 1\frac{9}{16}$ LONG	SAE 1020
8	1	$\frac{1}{2} \times \frac{5}{8} \times 1\frac{9}{16}$	SAE 1095
9	2	$\frac{1}{4} - 20 \times \frac{1}{2}$ SOCKET HD. CAP SCR.	STD.
10	4	$\frac{1}{8}$ DOWEL $\frac{1}{2}$ LONG	STD.
11	1	Ø $\frac{5}{16} \times 1\frac{3}{8}$ LONG	DR.RD.
12	1	Ø $\frac{5}{16} \times 1\frac{3}{8}$ LONG	DR.RD.
13	1	$\frac{1}{2} \times \frac{5}{8} \times 1\frac{9}{16}$	SAE 1095
14	1	$\frac{5}{16}$ –18 NUT FIN. HEX.	STD.
15	2	$\frac{5}{16}$ W.I. WASHER	STD.
16	1	$\frac{5}{16} \times \frac{5}{8} \times 2\frac{9}{16}$	SAE 1020
17	2	$\frac{1}{4} - 20 \times \frac{3}{8}$ SOCKET HD. CAP SCR.	STD.
18	1	$\frac{1}{8} \times \frac{1}{2} \times 2\frac{9}{16}$ GROUND STOCK	B&S
E			
D			
C			
B			
A			
LET'R	DATE	CHANGE	AP'D.

TOOL DRAWING	
DRAWN BY C.J.O	UNIT TYPE D5 FOLDING MACHINE
CHECKED BY D.B.C	PART NAME INDEX LOCKING PLATE
APROVED BY L.M.	PART NO. 11347
STAGE NO. 5	TOOL NAME MILLING FIXTURE
DATE 04-03-17	TOOL NO. T-21463

FIGURE 1.1 Example of an assembly drawing.

BLUEPRINTS

Because some original drawings are delicate, they seldom leave the drafting room. They are carefully handled and filed in a master file of originals. When a copy of an original is required, a print is made. The term used for the process of reproducing an original is known as ***blueprinting***. The earliest form of blueprinting produced white line, blue background reproductions. This early process, which was developed in England more than 100 years ago, has since changed. Modern reproductions produce a dark line, white background duplication simply called a ***print***. However, the term ***blueprint*** is still widely used in industry and has been included in the title of this text.

INTERPRETING INDUSTRIAL DRAWINGS

Industrial drawings and prints are made for the purpose of communication. They are a form of nonverbal communication between a designer and builder of a product. Industrial drawings are referred to as a universal language. It is a language that can be interpreted and understood regardless of country. Also, drawings and prints become part of a contract between parties buying and selling manufactured components.

A picture or photograph of an object would show how the object appears. However, it would not show the exact size, shape, and location of the various parts of the object.

Industrial drawings describe size and shape and give other information needed to construct the object. This information is presented in the form of special lines, views, dimensions, notes, and symbols. The interpretation of these elements is called ***print reading***.

PRINT REPRODUCTION PROCESSES

There are several methods available for reproducing drawings.

Chemical Process

The ***ammonia process***, often called the ***diazo process***, is a common method of print reproduction. To produce a copy, the original is placed on top of a light-sensitive print paper. Both the original and the print are fed into the diazo machine and exposed to a strong ultraviolet light. As the light passes through the thin original, it burns off all sensitized areas not shadowed by lines. The print paper is then exposed to an ammonia atmosphere. The ammonia develops all sensitized areas left on the print paper. The result is a dark line reproduction on a light background.

Silver Process

The ***silver process*** is actually a photographic method of reproduction. This process is often referred to as microfilming or photocopying. This method is rapidly gaining popularity in industry due to storage and security reasons. The most common procedure followed is to photograph an original drawing to gain a microfilm negative. The negative is then placed on an aperture card and labeled with a print number. Duplicates of the microfilm are produced with the aid of a microfilm printer using sensitized photographic materials. Enlarged or reduced prints can be produced using this process. The aperture cards containing the microfilm are very small. Therefore, cataloging and filing take very little room for storage. They are also much easier to handle than the delicate originals, which must be kept in large files. Microfilming is often done for security reasons. As many as 200 prints may be placed on one roll of microfilm. They may then be placed in a vault or other secure area.

Electrostatic Process

The ***electrostatic process*** has gained in popularity for industrial drawing reproduction. Although once limited to reproducing documents and small drawings, new machines have been developed that allow large drawing duplication. The electrostatic process, commonly known as xerography, uses a zinc-coated paper that is given an electrostatic charge. The zinc coating is sensitive to ultraviolet light when exposed. Areas shadowed by lines on the original produce a dark line copy.

CAD Process

As previously described, the ***CAD process*** uses computer technology to automate many drawing tasks, and to file and store original drawings electronically. One advantage of a CAD system is its ability to rapidly access stored drawings for reproduction or when a revision is required by simply sending a message from the CAD processor to an output device called a printer or printer/plotter, Figure 1.2.

FIGURE 1.2 CAD printer/plotter. iStock.com/sergeyryzhov

ASSIGNMENT: UNIT 1 REVIEW QUESTIONS

1. List two other names commonly given to industrial drawings.
   a. ______________________
   b. ______________________
2. Industrial drawings should provide enough information so that the object can be ______________________.
3. The paper material on which original drawings are produced is called ______________________.
4. A completed industrial drawing is known as a master drawing or ______________________.
5. Master drawings
   a. Are provided to the machine builder.
   b. Seldom leave the drafting room.
   c. Are developed by the master drafter.
   d. Are always drawn on Vellum.
6. What is the term used for reproducing an industrial drawing?
   ____
   ____
7. Industrial drawings are often referred to as _________________________________ language.
8. Industrial drawings are a form of communication that is:
   a. verbal.
   b. nonverbal.
9. Why is a photograph not used to describe an object?
   ____
   ____
10. The light the print paper is exposed to in the diazo process is:
    a. sunlight.
    b. infrared light.
    c. fluorescent light.
    d. ultraviolet light.
11. The silver process is:
    a. seldom used.
    b. a photographic process.
    c. an ammonia process.
    d. a heat process.
12. List two advantages of microfilming.
    a. ______________________
    b. ______________________
13. Aperture cards
    a. are small.
    b. contain print information.
    c. are used for filing.
    d. all of the above.
    e. none of the above.

14. The heat process uses a chemically coated paper that is sensitive to:
    a. infrared light.
    b. heat.
    c. ammonia.
    d. ultraviolet light.
15. The electrostatic process uses paper that is sensitive to:
    a. chemicals.
    b. ammonia.
    c. heat.
    d. light.
16. The electrostatic process uses a paper coated with:
    a. carbon.
    b. lead.
    c. iron.
    d. zinc.
17. List three components of a CAD system.
    a. ____
    b. ____
    c. ____
18. The display screen used with a CAD system is called a ____________________.
19. What is one advantage a CAD system has over conventional drawing methods?

    ____

    ____
20. What CAD output device is used to produce duplicate copies of original CAD drawings?

    ____

UNIT 2
Title Blocks

All industrial drawings have certain elements in common. They consist of various lines, views, dimensions, notes, and symbols. Other general information is also supplied so that the object may be completely understood. A skilled print reader must learn to interpret and apply all the information provided on the drawing.

TITLE BLOCKS AND TITLE STRIPS

A ***title block*** or ***title strip*** is designed to provide general information about the part, assembly, or the drawing itself.

Title blocks are usually located in the lower right-hand corner of the print, Figure 2.1. Title strips may be used on smaller drawing sheets and extend along the entire lower section of the print, Figure 2.2.

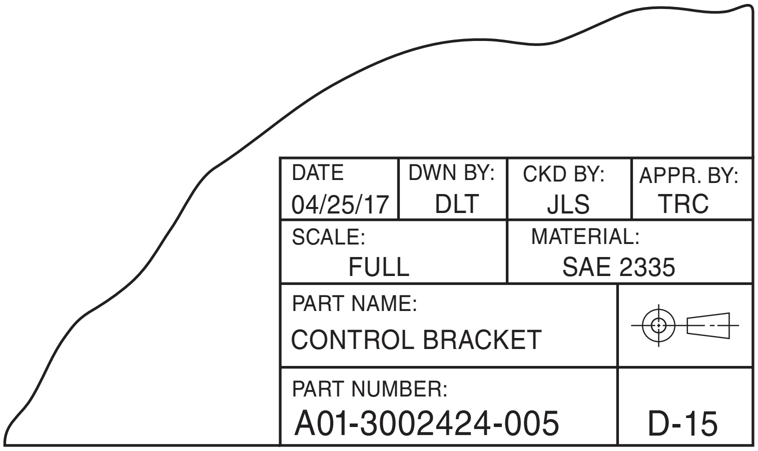


FIGURE 2.1 Title block.

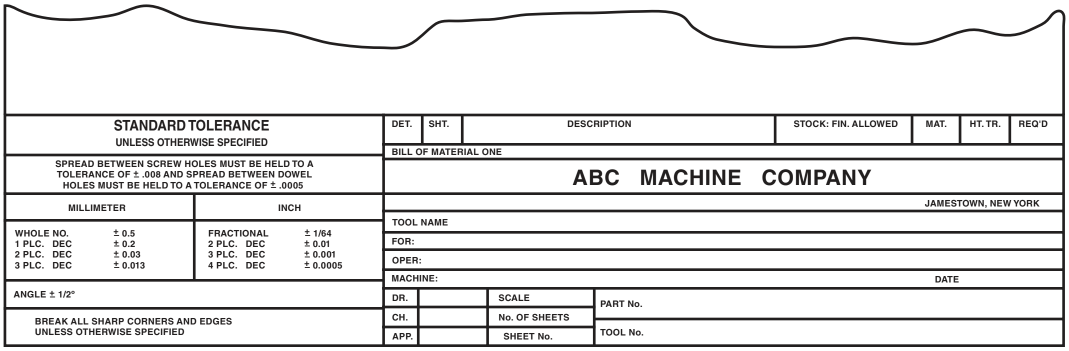


FIGURE 2.2 Title strip.

Most companies select a standard form for their drawings that is printed on the original or master drawing. This enables the drafter to simply fill in the required information.

Some of the most common information found in the title block or strip includes the following:

Company name—identifies the company using or purchasing the drawing.

Part name—identifies the part or assembly drawn.

Part number—identifies the number of the part for manufacturing or purchasing information.

Drawing number—is used for reference when filing the original drawing.

Scale—indicates the relationship between the size of the drawing and the actual size of the part. When objects are drawn actual size, the scale would be full scale or 1:1. Large objects are often drawn smaller than actual size. For example, a large part that may not fit on the drawing paper might be drawn half scale or 1:2. Very small objects are often drawn larger than actual size. For instance, the object may be drawn double the actual size of the part. In this example, the scale would be shown as 2:1.

Tolerance—refers to the amount that a dimension may vary from the print. Standard tolerances that apply to the entire print are given in the title block. Tolerances referring to only one surface are indicated near that surface on the print.

Material—indicates the type of material of which the part is to be made.

Heat treat information—provides information as to hardness or other heat treat specifications.

Date—identifies the date the drawing was made.

Drafter—identifies who prepared the original.

Checker—identifies who checked the completed drawing.

Approval—identifies who approved the design of the object.

Change notes or revision—is an area in the block that records for history changes that are made on the drawing. Often revision blocks are located elsewhere on the drawing.

STANDARD ABBREVIATIONS FOR MATERIALS

A variety of materials are used in industry. The drafter or designer must select materials that will best fit the job application. The ability to do this comes from experience and from understanding material characteristics.

To save time and drawing space, material specifications are usually abbreviated on drawings. Table 2.1 describes the most common abbreviations used. Refer to this table as a guide to material abbreviations used later in the text.

Additional tables are found in the Appendix.

TABLE 2.1 Standard Abbreviations for Materials

Alloy Steel	AL STL	Hot-Rolled Steel	HRS
Aluminum	AL	Low-Carbon Steel	LCS
Brass	BRS	Machine Steel	MST
Bronze	BRZ	Malleable Iron	MI
Cast Iron	CI	Nickel Steel	NS
Cold-Drawn Steel	CDS	Stainless Steel	SST
Cold-Finished Steel	CFS	Steel	STL
Cold-Rolled Steel	CRS	Tool Steel	TS
High-Carbon Steel	HCS	Tungsten	TU
High-Speed Steel	HSS	Wrought Iron	WI

PARTS LISTS

A ***parts list***, also called a ***bill of materials*** is often included with the blueprint, Figure 2.3. This list provides information about all parts required for a complete assembly of individual details. The bill of materials is most frequently found on the print that displays the completed assembly and is known as the ***assembly drawing***. The assembly drawing is a pictorial representation of a fully assembled unit that has all parts in their working positions.

Additional drawings called ***detail drawings*** usually accompany the assembly drawing and are numbered for identification. Each assembly detail found in the bill of materials is also provided with a reference number that is used to locate the detail on the detail drawing. Detail drawings give more complete information about the individual units.

Assembly drawings are covered more completely in a later unit of the text.