Sketching, Lettering, and Text

Learning Objectives

After studying this chapter, you will be able to:

- Explain the role of sketching in technical communication.
- Describe accepted techniques for sketching.
- Identify different styles of lettering.
- List and describe industry standards used for lettering on drawings.
- Explain how guidelines are used to determine the height and slope of lettering.
- Draw single-stroke Gothic lettering.
- Describe the CAD functions used for creating text.

Technical Terms

Centerline method
Enclosing square method
Font
Free-circle method
Free-ellipse method
Freehand sketching
Gothic
Graph paper
Guidelines
Hand-pivot method
Italic
Justification
Lettering
Notes
Obliquing angle
Overlays
Pencil-sight method
Proportion
Rectangular method
Roman
Single-stroke Gothic
Technical pen
Text
Text commands
Text style
Trammel
Trammel method
Transfer type
Unit method

Freehand sketching is a method of making a drawing without the use of instruments. This is a technique essential to anyone who works in a technical field. A good description of the process is "thinking and drafting." When a person sketches, he or she can concentrate on the solution to a problem without being encumbered with manipulation of instruments.

Most drafters and engineers use freehand sketching to "think through" solutions to drafting problems before starting an instrument drawing. Sketching also permits ideas to be quickly conveyed to others. This is especially important in the area of design improvement. Once the design or problem solution has been sketched, it is given to a drafter to prepare an accurate instrument drawing.

This chapter introduces you to the skills and procedures necessary to practice freehand sketching and lettering. The techniques you learn will be particularly useful when combined with the instruction presented in the chapters on instrument drafting, working drawings, pictorial drawings, and dimensioning.

Sketching Equipment

Freehand sketching requires very little equipment or material. Sketching readily lends itself to use by a drafter who is away from the drafting room and in the field or shop. A pencil (typically F or HB grade), soft eraser, and some paper are all that is needed.

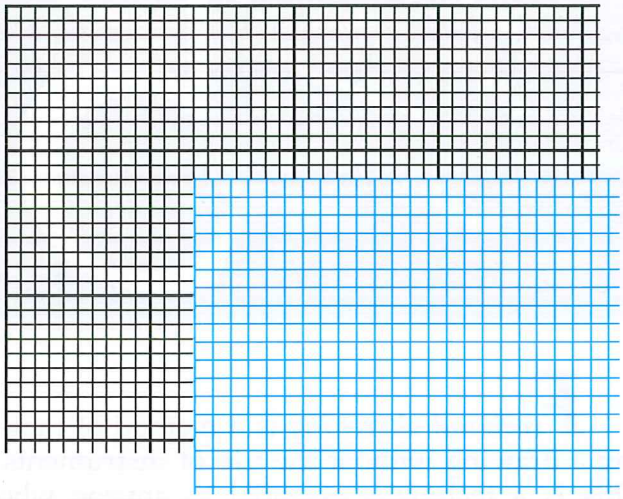


Figure 5-1. Graph paper can be used for freehand sketching.

Paper

Several types of paper are suitable for sketching, depending on the nature of the job. You can use plain, cross-section, or isometric grid paper. (Isometric drawing is a type of pictorial drawing discussed in Chapter 11.) Also available are bond typing paper, drafting paper, and tracing paper.

Graph paper is available in varying grid sizes. This type of paper is helpful in line work and proportions, **Figure 5-1**. Isometric grid paper also aids in these areas and in obtaining the proper position of the axes, **Figure 5-2A**. Graph paper and isometric grid paper may be purchased with nonreproducible grid lines. When the sketch is completed and prints are made, the grid lines do not reproduce, **Figure 5-2B**.

You may want to start with graph paper, but it is best for you to learn to sketch on plain paper as soon as possible. This will help develop your skill and accuracy in freehand sketching without the use of aids.

Sketching Techniques

When sketching, hold the pencil with a grip firm enough to control the strokes. However, do not hold the pencil so tight that you stiffen your strokes or cramp your hand. Your arm and hand should have a free and easy movement. The point of the pencil should extend approximately 1 1/2" beyond your fingertips, a little farther than in normal drawing or lettering, **Figure 5-3**. This will permit better observation of your work and provide a more relaxed position. In addition, your third and fourth fingers can be rested lightly on the drawing surface to steady your hand.

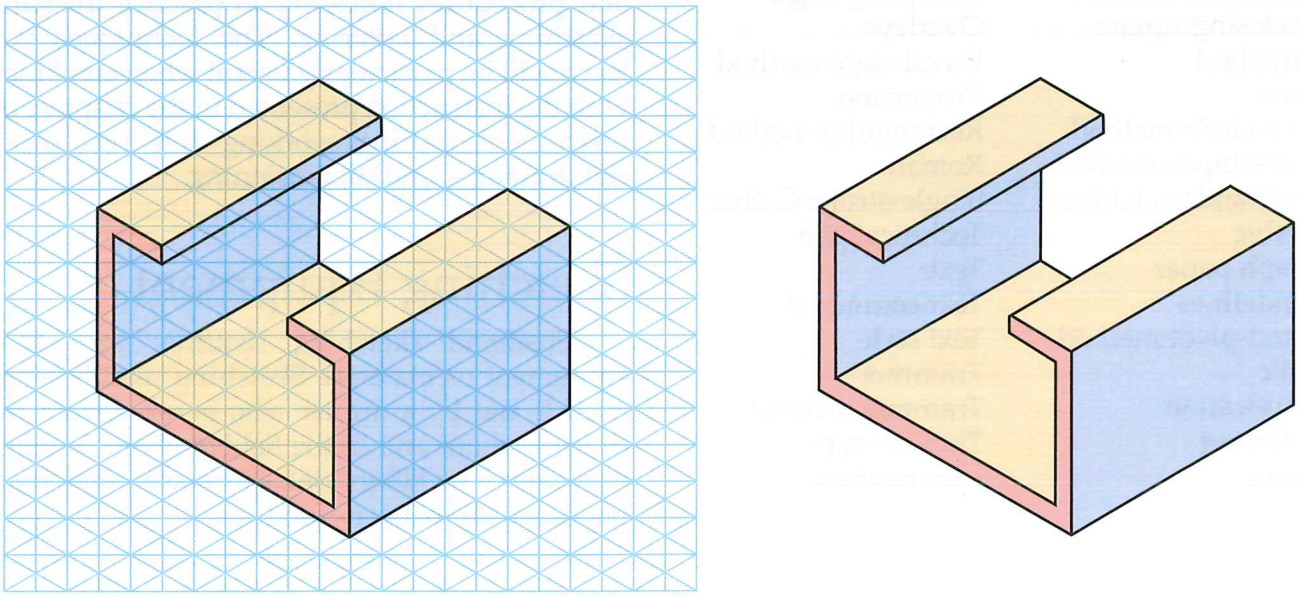


Figure 5-2. A—Isometric grid paper with nonreproducible grid lines is useful for sketching. B—When the sketch is reproduced, the grid lines do not reproduce.

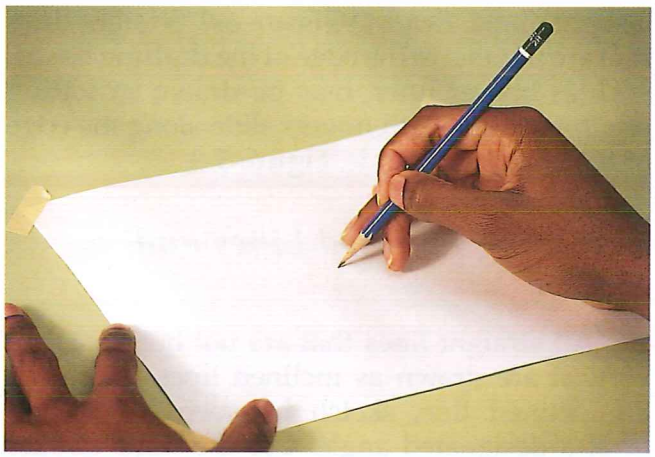


Figure 5-3. When sketching, hold your pencil farther back than you normally would.

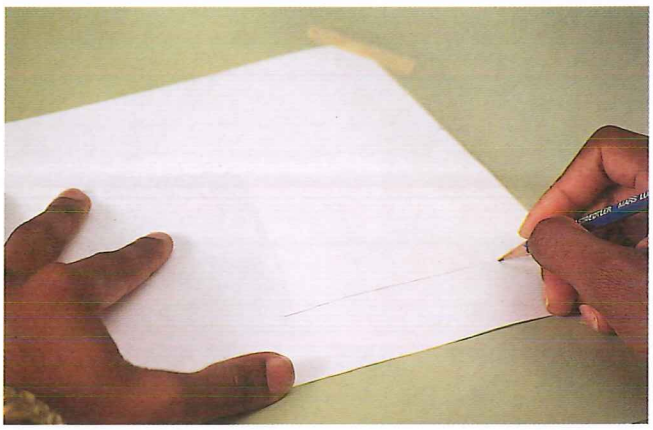


Figure 5-5. When sketching horizontal lines, you should keep your arm approximately perpendicular to the line being sketched.

Rotate the pencil slightly between strokes to retain the point longer and produce sharper lines. Initial lines should be firm and light, but not fuzzy. Avoid making grooves in your paper by applying too much pressure. These grooves are difficult to remove. When sketching straight lines, your eye should be on the point where the line will end. Use a series of short strokes to reach that point. When all lines are sketched, go back and darken in the lines. When darkening in lines, your eye should be on the tip of the lead.

While you should strive for neatness and good technique in freehand sketching, you should expect that freehand lines will look different than those drawn with instruments. Good freehand sketches have a character all their own, **Figure 5-4**.

Sketching Horizontal Lines

Horizontal lines are sketched with a movement that keeps the forearm approximately perpendicular to the line being sketched, **Figure 5-5**. You will find that four steps are essential in sketching horizontal lines. First, locate the end points of the line, **Figure 5-6A**.

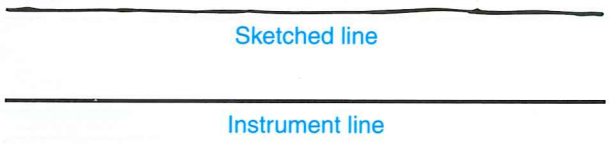


Figure 5-4. Your drawings should be neat even when you sketch. However, a sketched line will look different from a line drawn with instruments.

Next, position your arm for a trial movement, **Figure 5-6B**. Then, sketch a series of short, light lines, **Figure 5-6C**. Finally, darken the line in one continuous motion, **Figure 5-6D**.

Sketching Vertical Lines

Vertical lines are sketched from top to bottom, using the same short strokes in series as for horizontal lines. When making the strokes, position your arm comfortably at about 15° to the vertical line, **Figure 5-7**. A finger and wrist movement, or a pulling arm movement, is best for sketching vertical lines. First, locate the end points of the line, **Figure 5-8A**. Next, position

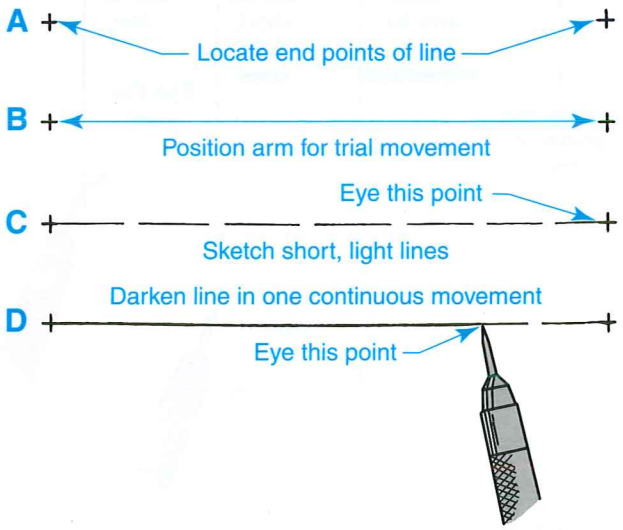


Figure 5-6. There are four basic steps to sketching a horizontal line.

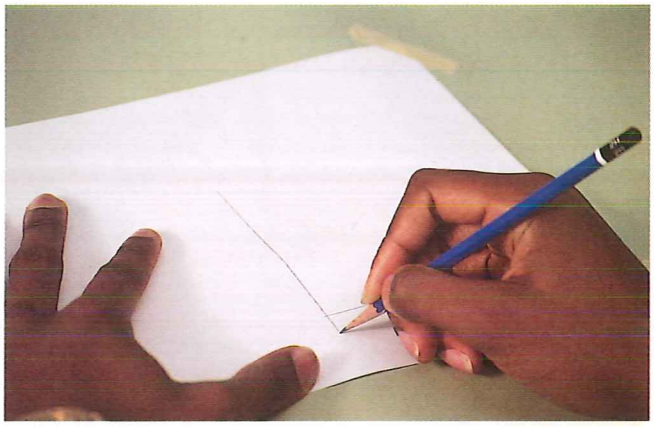


Figure 5-7. When sketching vertical lines, you should have your arm in a comfortable position with the pencil at about 15° to the line being drawn.

your arm for a trial movement in drawing the line, **Figure 5-8B**. Then, sketch several short, light lines. When sketching these lines, you should focus on the end point of the line, **Figure 5-8C**. Finally, darken the line. When darkening the line, you should focus on the point of the lead, **Figure 5-8D**.

You may find it easier to sketch vertical or horizontal lines if the paper is rotated to form a slight angle. Refer to **Figure 5-7**. Straight lines that are parallel to the edge of the drafting board, such as border lines, may be drawn by letting the third and fourth fingers slide along the edge of the board as a guide, **Figure 5-9**.

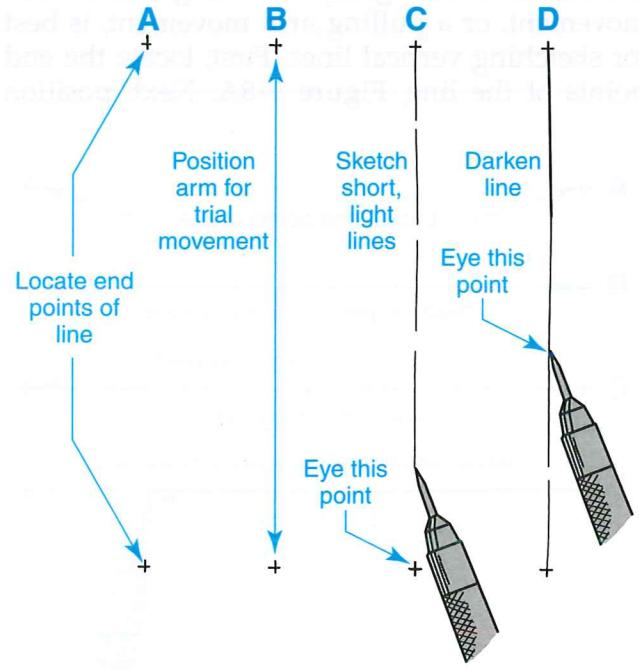


Figure 5-8. There are four basic steps in sketching a vertical line. These steps are very similar to those used to sketch a horizontal line.

Sketching Inclined Lines and Angles

All straight lines that are not horizontal or vertical are drawn as inclined lines. To sketch an inclined line, sketch between two points or at a designated angle. Use the same strokes and techniques as for sketching horizontal and vertical lines, **Figure 5-10A**. If you prefer, rotate the paper to sketch inclined lines as if they are horizontal or vertical lines, **Figure 5-10B**.

Angles can be estimated quite accurately by first sketching a right angle (90° angle), then subdividing it to get the desired angle. See **Figure 5-11**. This illustration shows how to obtain an angle of 30°.

Sketching Circles and Arcs

There are several methods of sketching circles and arcs. All are sufficiently accurate. Familiarize yourself with various techniques to use the method best suited to a particular problem.

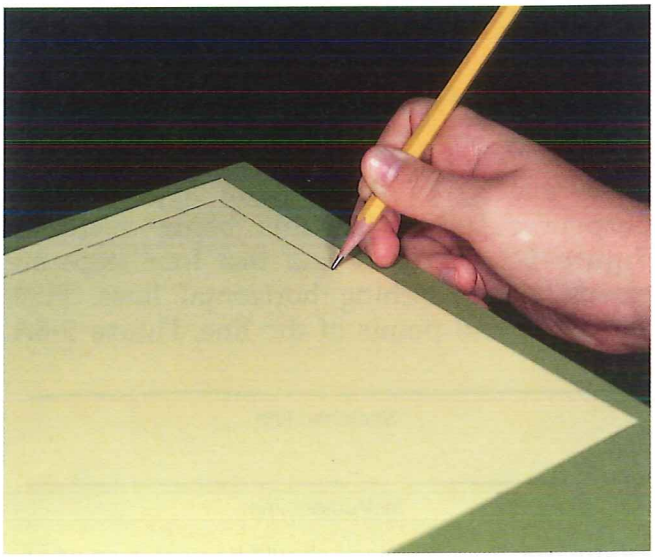


Figure 5-9. Use your fingers along the edge of the drawing board as a guide for sketching straight lines.

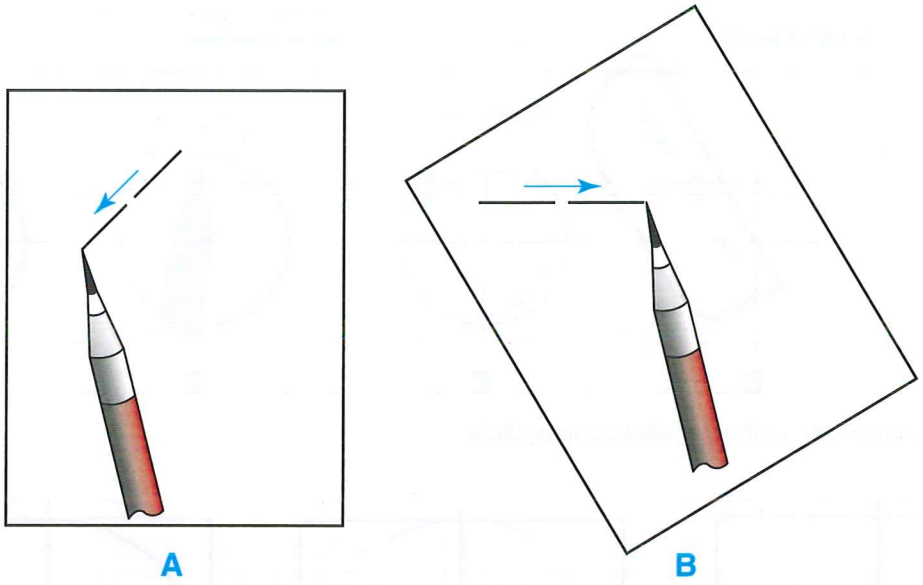


Figure 5-10. When sketching inclined lines, use the same techniques as for horizontal and vertical lines. A—Inclined lines can be drawn with the paper "square" with the drawing surface. B— Inclined lines can also be drawn by rotating the paper so that they "become" horizontal or vertical lines.

Centerline method

Five steps are used in the ***centerline method*** for freehand sketching circles. First, locate the centerline axes, **Figure 5-12A**. Second, use a scrap piece of paper with the radius marked to locate several points on the circle, **Figure 5-12B**.

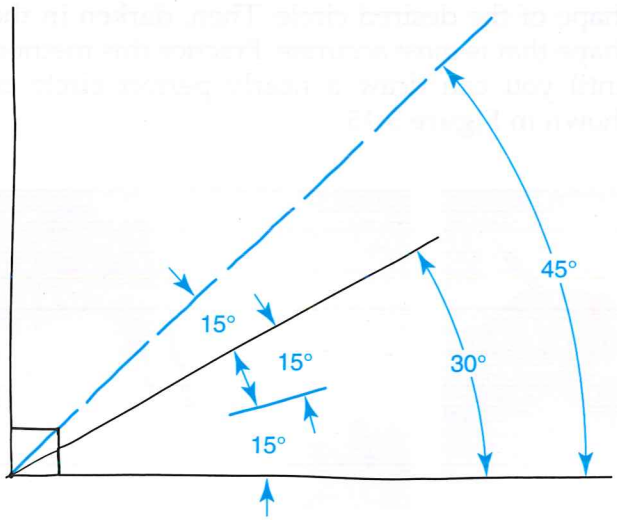


Figure 5-11. Estimating an angle by freehand sketching is first done by sketching a 90° angle. The 90° angle is then divided into the appropriate angle. This should be done by estimation only, without instruments. Remember that one-half of a 90° angle is 45°.

Next, position your arm for trial movement, **Figure 5-12C**. Sketch the circle, **Figure 5-12D**, and then darken the circle, **Figure 5-12E**. Be sure to use light lines first, then darken the final shape later.

Enclosing square method

The ***enclosing square method*** can also be used for sketching a circle. The following steps are necessary. First, locate the centerlines of the circle. Second, sketch a box with the sides the same length as the diameter of the circle, **Figure 5-13A**. Next, sketch arcs where the centerlines meet the box, **Figure 5-13B**. Finally, sketch the circle, **Figure 5-13C**.

Hand-pivot method

The ***hand-pivot method*** is a quick and easy method of sketching circles. There are two ways of using this method. For both methods, first locate the centerlines of the circle. Next, use your small finger as a pivot point while holding the pencil, **Figure 5-14A**. Rotate the paper while holding your finger on the center of the circle, **Figure 5-14B**. A second way to use this method is to hold two pencils in your drawing hand and use one pencil as a pivot point instead of your small finger, **Figure 5-14C**.

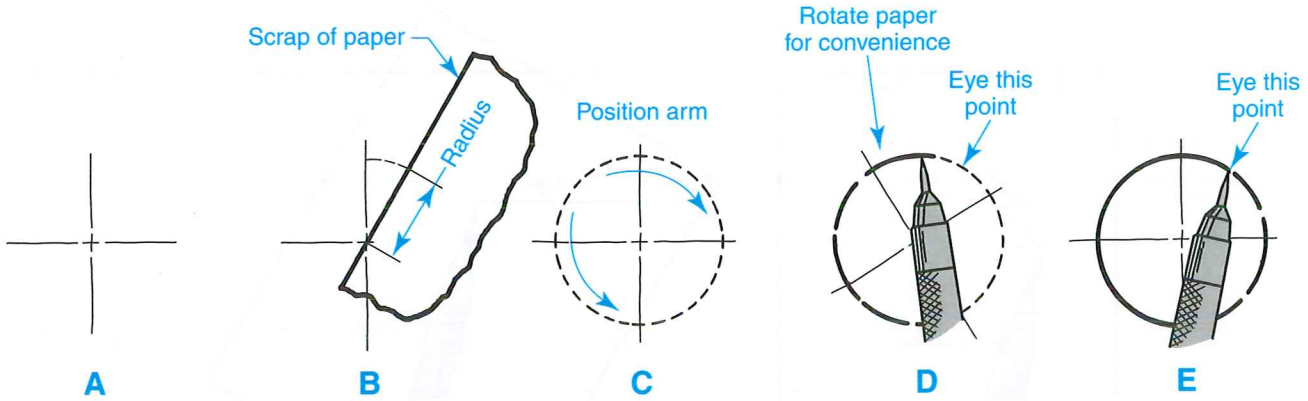


Figure 5-12. The centerline method of sketching a circle.

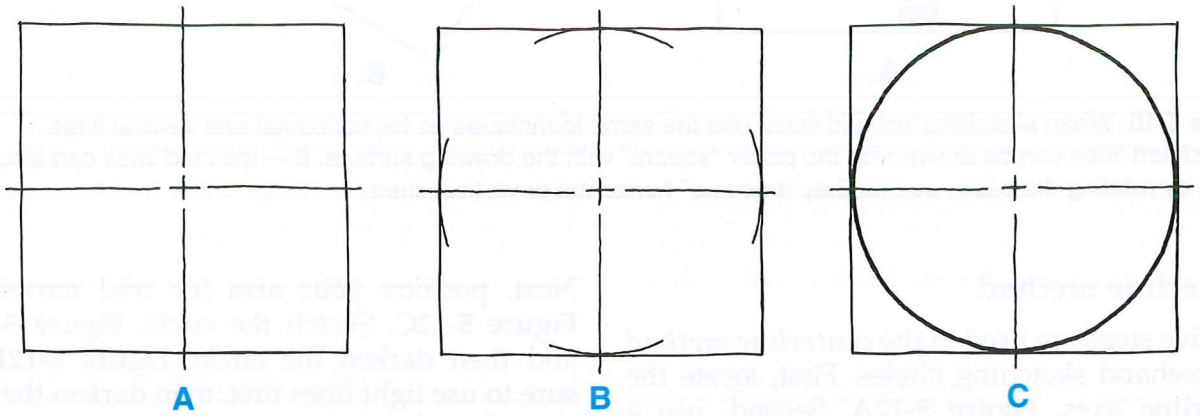


Figure 5-13. The enclosing square method of sketching a circle.

Free-circle method

The ***free-circle method*** of freehand sketching circles involves more skill, but it can be developed with practice. With this method, you do not use any "guides" to help you sketch. You sketch the circle using only your hand-eye coordination and your judgment. First, lightly sketch two or three circles in the approximate shape of the desired circle. Then, darken in the shape that is most accurate. Practice this method until you can draw a nearly perfect circle as shown in **Figure 5-15**.

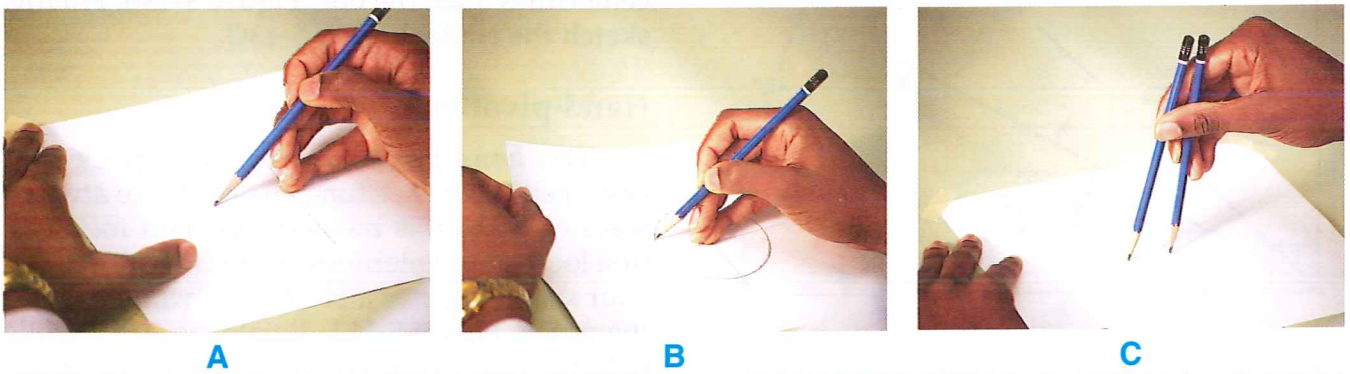


Figure 5-14. There are two ways to use the hand-pivot method to sketch a circle. A—After locating centerlines, sketch the circle by rotating the pencil. Use your small finger as a pivot point. B—With your small finger on the center of the circle, rotate the paper while holding the pencil. C—A second way to use the hand-pivot method is to use two pencils. Use one pencil as a pivot point.

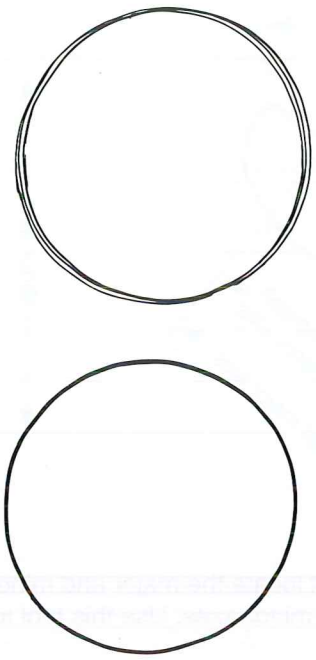


Figure 5-15. When using the free-circle method, first sketch two or three light circles that are approximately the correct size. Then, darken in the most accurate shape.

Sketching Ellipses

Occasionally, it is necessary to sketch an ellipse. Three methods are presented here to aid you in producing a good sketch.

Rectangular method

The ***rectangular method*** is similar to sketching a circle with the enclosing square method. First, locate the centerlines of the ellipse. Then, draw a box with the side lengths equal to the major axis (longest axis) and minor axis (shortest axis) of the ellipse, **Figure 5-16A**. Next, sketch arcs where the centerlines meet the box, **Figure 5-16B**. Finally, sketch the ellipse, **Figure 5-16C**.

Trammel method

There are four steps used to sketch ellipses by the ***trammel method***. A ***trammel*** is a piece of paper marked with points to lay off distances. First, sketch the major and minor axes of the ellipse. Second, mark off three points (A, B, and C) on the trammel. The distance from Point A to Point B should be one-half the minor axis and the distance from Point A to Point C should be one-half the major axis. Next, move the trammel around the ellipse, keeping Point B on the major axis and Point C on the minor axis. Mark several locations along the ellipse at Point A. Finally, sketch the ellipse using the marks made at Point A, **Figure 5-17**.

Free-ellipse method

The ***free-ellipse method*** is similar to the free-circle method. In this method, you use only your hand-eye coordination and your judgment. First, lightly sketch two or three ellipses in the approximate shape of the desired ellipse. Then, darken in the shape that is most accurate, **Figure 5-18**. This method will require some practice to produce an acceptable ellipse.

Sketching Irregular Curves

An irregular curve may be sketched freehand by connecting a series of points at intervals of 1/4" to 1/2" along the path of the curve, **Figure 5-19**. Include at least three points in each stroke. "Lead out" of the previous curve into the next.

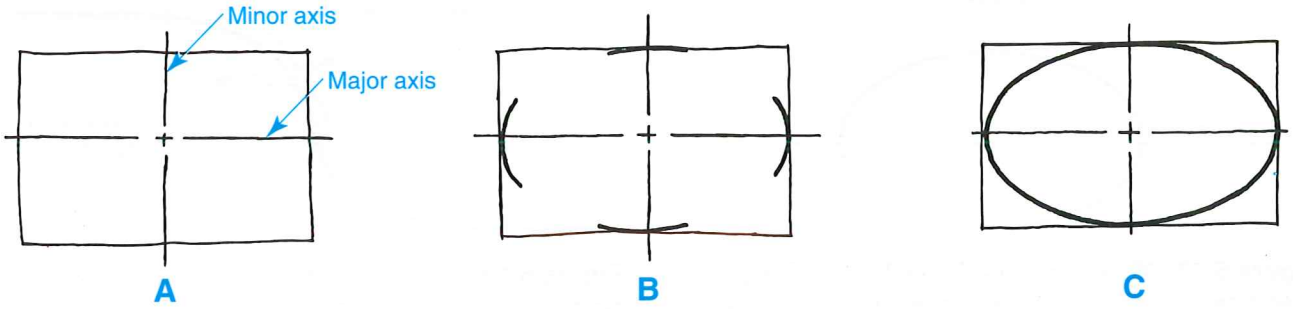


Figure 5-16. The rectangular method of sketching an ellipse is very similar to the enclosing square method of sketching a circle.

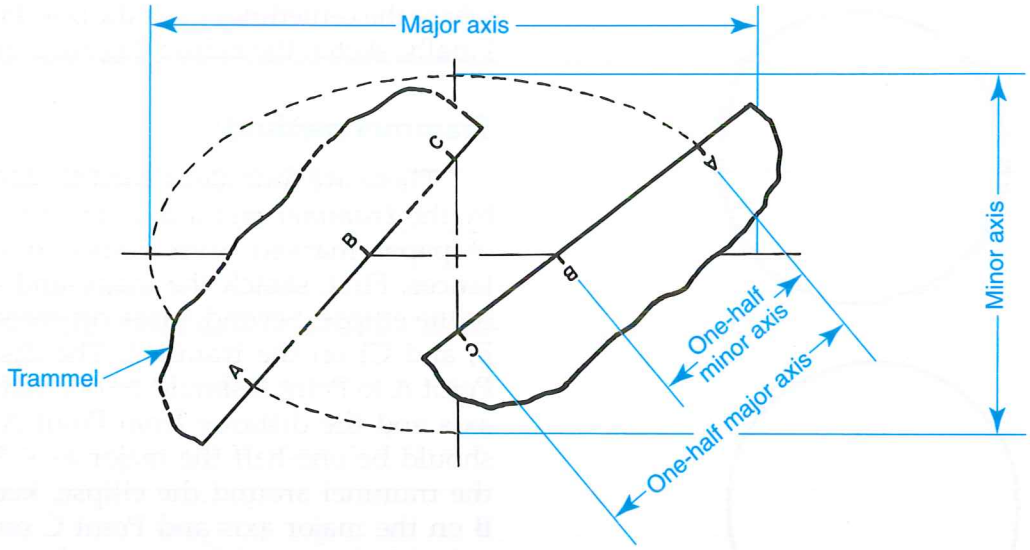


Figure 5-17. When using the trammel method of sketching an ellipse, first locate the major and minor axes. Create a trammel with points marking one-half the distance of the major and minor axes. Use this tool to make an approximation of the ellipse. Finally, darken the ellipse.

Proportion in Sketching

There is more to sketching than making straight or curved lines. Sketches must contain correct proportions. ***Proportion*** is the relation of one part to another, or to the whole object. You must keep the width, height, and depth of the object in your sketch in the same proportion to that of the object itself. If not, the sketch may convey an inaccurate description. There are several techniques that may be used by the drafter to obtain good proportions.

Figure 5-18. When using the free-ellipse method, first sketch two or three light ellipses in the approximate size and shape of the desired ellipse. Then, darken in the correct shape.

Pencil-sight method

The ***pencil-sight method*** is a simple way to estimate proportion. With pencil in hand, extend your arm forward in a stiff arm position and use your thumb on the pencil to gauge the proportions of an object, **Figure 5-20**. These distances may be laid off directly on your sketch. Vary the size by moving closer or further from the object. The pencil-sight method is particularly useful in making sketches of an actual object rather than from a picture of the object.

Unit method

The ***unit method*** is another useful technique in estimating proportion. This method involves establishing a relationship between distances on

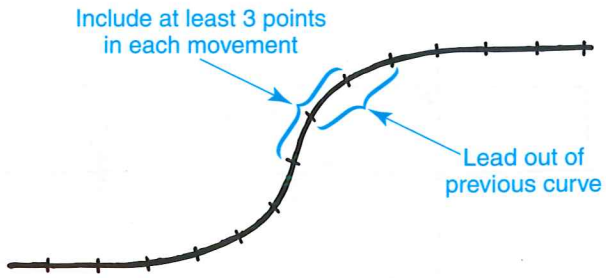


Figure 5-19. When sketching an irregular curve, connect points marked at intervals along the curve. Include at least three points in each segment. Also, overlap each section as you sketch.

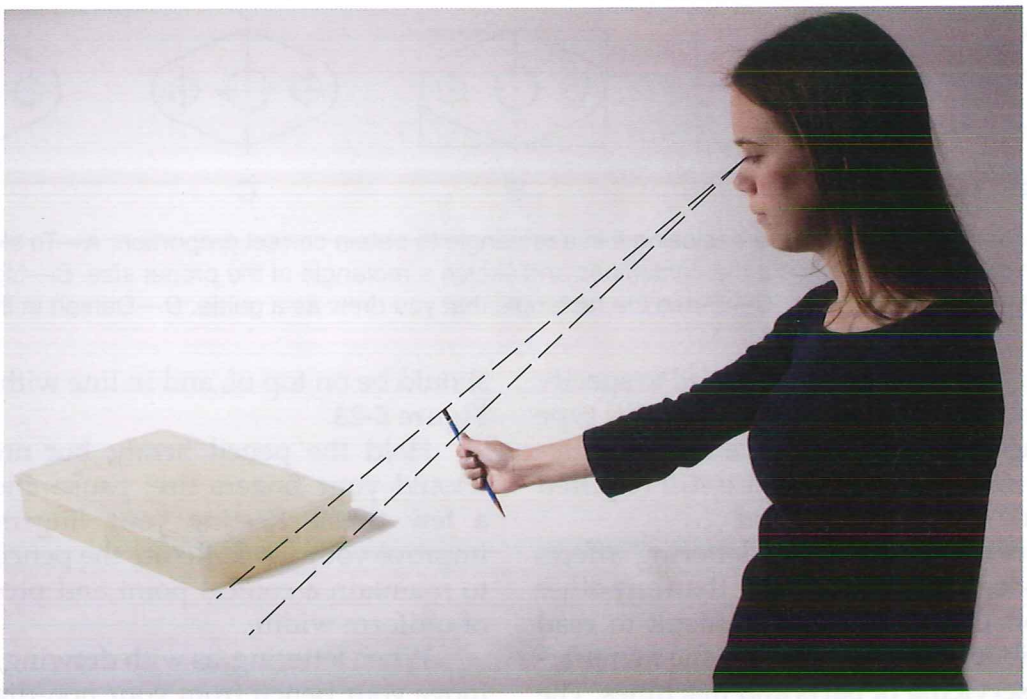


Figure 5-20. To gauge proportions by the pencil-sight method, hold a pencil at arm's length and place your thumb to indicate measurements. Then, transfer these measurements to your sketch. The proportion can be changed by moving closer or farther away from the object.

an object by breaking each distance into units. Compare the width to the height and select a unit measurement that will fit each distance, **Figure 5-21**. Distances laid off on your sketch should be in the same proportion, although the overall size of the sketch may vary. This method is useful when making a sketch from a picture of the object.

Other methods

You may find it helpful in sketching to first enclose the object in a rectangle, square, or other appropriate geometric form of the correct proportion, **Figure 5-22**. Then subdivide this form to obtain the parts of the object. Once the outside proportions are established, the smaller parts are easily divided.

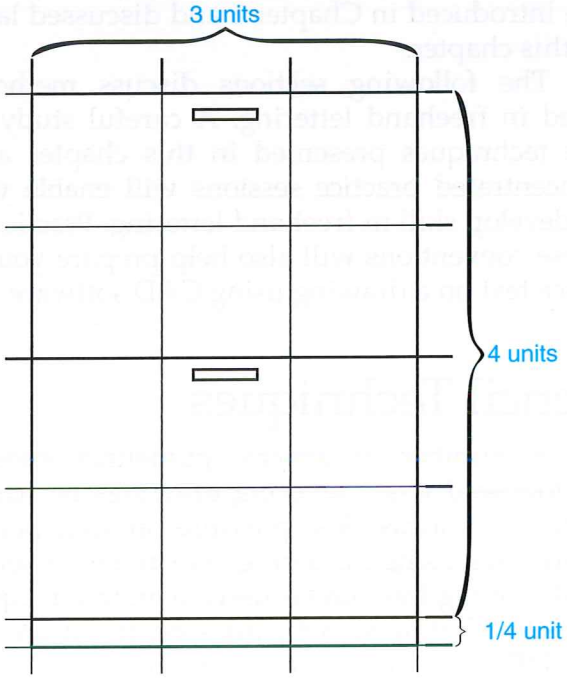


Figure 5-21. To use the unit method, divide the object into equal-size units. The proportion can be changed by either increasing or decreasing the size of the unit distances on your sketch.

Technical Lettering Overview

Lettering is the process of placing text on a drawing. The purpose of lettering is to further clarify the information conveyed by the drawing

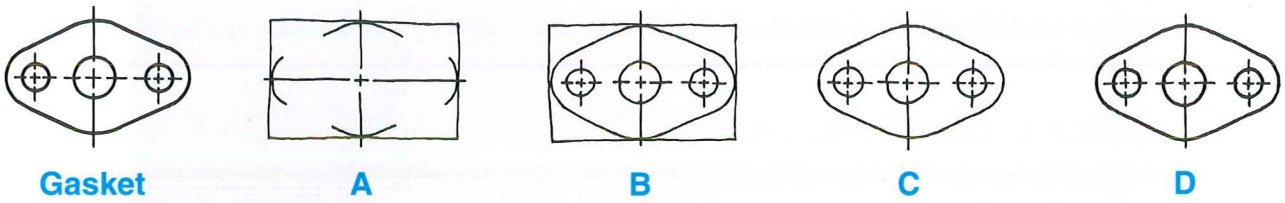


Figure 5-22. Sketching an object by enclosing it in a rectangle to obtain correct proportion. A—To sketch the gasket shown at the left, first lay out the centerlines and sketch a rectangle of the proper size. B—Lightly sketch in all of the features of the gasket. C—Erase the rectangle that you drew as a guide. D—Darken in the lines.

views. For example, notes may be used to specify materials and processes. Although transfer type and lettering devices simplify the task of lettering manual drawings, drafters are still required to letter some drawings freehand.

It is generally agreed that lettering affects the appearance of a drawing more than any other single factor. Lettering that is difficult to read could contribute to costly errors in the manufacturing and servicing of parts and machines. The mastery of lettering techniques is essential.

In CAD drafting, lettering is created as ***text***. Text commands are used to enter text as well as control style, justification, and other text characteristics. CAD methods for placing text are introduced in Chapter 4 and discussed later in this chapter.

The following sections discuss methods used in freehand lettering. A careful study of the techniques presented in this chapter and concentrated practice sessions will enable you to develop skill in freehand lettering. Practicing these conventions will also help prepare you to place text on a drawing using CAD software.

Pencil Techniques

A number of general guidelines should be followed when lettering drawings by hand. Make sure to use less pressure on your pencil than when using a drawing instrument. A softer lead (having less clay) is used to maintain equal density (darkness) with lines on the drawing. An HB, F, or H pencil sharpened to a conical point will produce lettering of sufficient quality to reproduce good prints.

When lettering, your forearm should be fully supported on the table with your hand resting on its side. Your third and fourth fingers should rest on the board and your index finger should be on top of, and in line with, the pencil, **Figure 5-23**.

Hold the pencil firmly, but not too tight. Should your fingers tire, pause and flex them a few times. Resting your fingers may help improve your work. Rotate the pencil frequently to maintain a conical point and produce letters of uniform width.

When lettering, as with drawing, you should move your pencil from your non-drawing hand toward your drawing hand. This will "pull" the pencil across the page. If you "push" the pencil, the point will tend to "dig into" the paper. When drawing vertical components of letters, it is also important to "pull" the point across the page.

Styles of Lettering

Hand letter styles can be classified into four general groups: ***Roman, Italic, Text,*** and ***Gothic***. Roman lettering is characterized by thick and

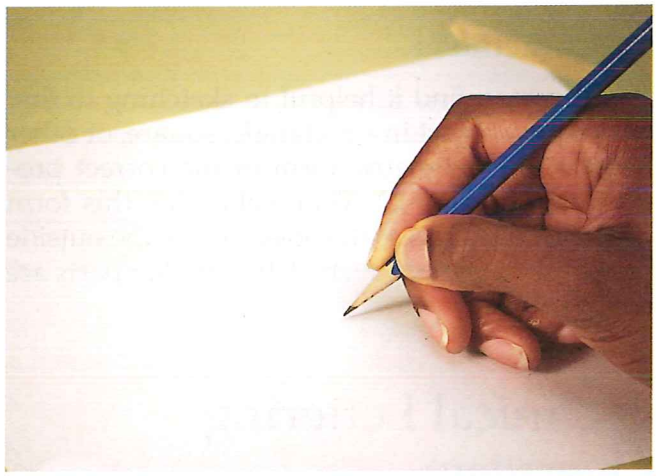


Figure 5-23. When lettering, your hand and forearm should be fully supported on the drawing surface. Your index finger should be on top of, and in line with, the pencil.

Figure 5-24. Four general styles of hand lettering are Roman, Italic, Text, and Gothic. Gothic, also called single-stroke Gothic, is the most common letter style used in industry.

thin lines with "accented" strokes, **Figure 5-24A**. The "accented" strokes are called *serifs*. Italic lettering is similar to Roman, but inclined, **Figure 5-24B**. Text lettering includes all styles of Old English, Church, Black, and German Text, **Figure 5-24C**. Gothic lettering has been used in drafting for many years, **Figure 5-24D**. Gothic letters are made up of lines that are all the same thickness with no serifs. Lettering without serifs is called *sans serif*. The Italic and Text lettering styles are useful in printing, signage, and on specialty drawings, such as maps and technical illustrations.

Gothic lettering is the standard style used in industry. Gothic lettering is commonly known as ***single-stroke Gothic***. *Single-stroke* refers to the width of the various parts of the letters being formed by a single stroke rather than a number of strokes.

Uppercase (capital) letters are recommended for use on machine drawings. The lettering may be either vertical or inclined, but never mixed on the same drawing. Lowercase letters are

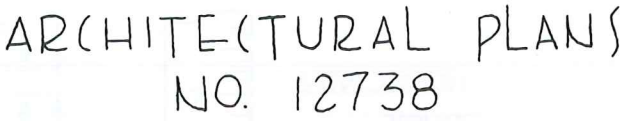


Figure 5-25. Lettering used in architectural work is similar to Gothic lettering, but it has a less "mechanical" appearance.

used for notes on maps and other topographical drawings.

Architectural lettering is similar in style to vertical uppercase Gothic lettering, but less "mechanical" in appearance, **Figure 5-25**. Lowercase letters are sometimes used in architectural work.

Guidelines

Guidelines are used in freehand lettering to maintain uniformity in height and slope. There are two types: horizontal and vertical, **Figure 5-26**. Vertical guidelines may be drawn straight or inclined. Guidelines are very light lines drawn with a sharp pencil. A 4H or harder pencil is preferred, but your regular drawing pencil may be used. However, take care to draw lines that are light enough not to be seen at arm's length from the drawing. This ensures that the guidelines will not reproduce.

Horizontal guidelines may be spaced with dividers or with a scale, **Figure 5-27**. Lowercase letters are two-thirds the height of uppercase letters. Small uppercase letters, when used with large uppercase letters, are two-thirds to four-fifths the height of large uppercase letters.

The spacing between lines of text appears best when the distance is from one-half to one full letter in height. Refer to **Figure 5-27**. Vertical or inclined guidelines are drawn using random spacing with a triangle against the T-square or straightedge.

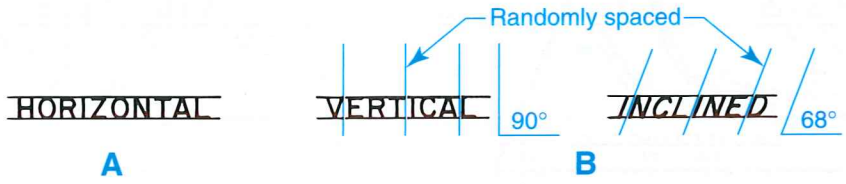


Figure 5-26. Guidelines assist in keeping letters straight and at the correct angle. A—Horizontal guidelines. B—Vertical guidelines can be drawn straight or inclined.

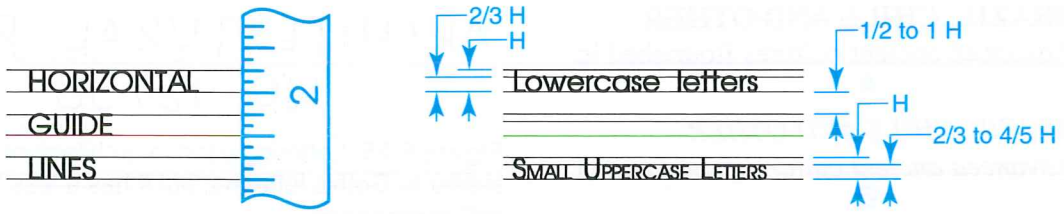


Figure 5-27. Lowercase letters should be two-thirds the full uppercase letter height. Small uppercase letters should be two-thirds to four-fifths the full uppercase (large) letter height. The spacing between lines of text should be a minimum of one-half the full uppercase letter height.

Several useful devices are available for drawing horizontal and vertical guidelines. These include the Ames Lettering Guide, the Braddock-Rowe Triangle, and the Parallelograph.

The Ames Lettering Guide may be used for drawing horizontal guidelines for letters 1/16″ to 2″ in height, **Figure 5-28**. To use the guide, place it in position along the T-square or straightedge. Next, insert the point of a sharp pencil in the holes at the desired spacing. Then, slide the guide along the straightedge to draw the horizontal guidelines.

The Braddock-Rowe Triangle is useful for drawing horizontal and inclined guidelines, **Figure 5-29**. Numbers on the triangle indicate the height for capital letters in thirty-seconds of an inch. For example, No. 8 spacing is 8/32″ or 1/4″ from the top to the bottom lines in each group of three holes.

The Parallelograph is also used to draw horizontal and inclined guidelines, **Figure 5-30**. This instrument provides horizontal guideline spacing in thirty-seconds of an inch and in millimeters. Sloped guides for drawing 68° and 75° inclined letters are also provided.

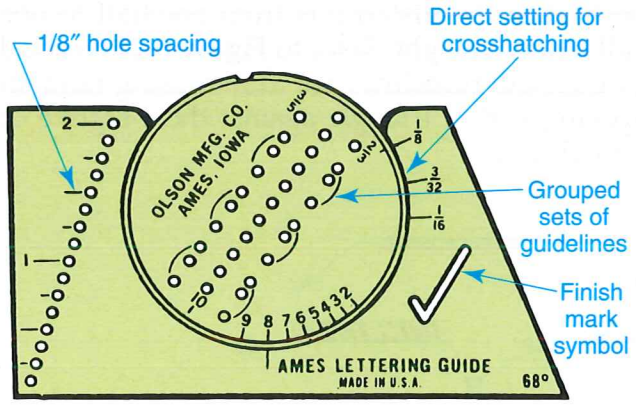


Figure 5-28. The Ames Lettering Guide has a variety of uses.

Single-Stroke Gothic Lettering

Lettering strokes are the "guideposts" to forming good letters. These strokes consist of straight-line stems, crossbars, and well-proportioned ovals, carefully combined to produce a well-balanced letter form.

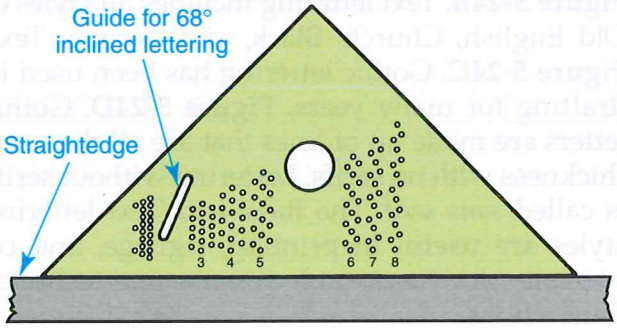


Figure 5-29. A Braddock-Rowe Triangle. (Teledyne Post)

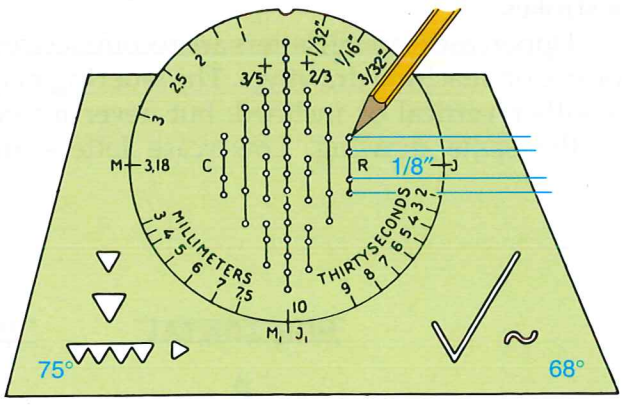


Figure 5-30. A Parallelograph lettering guide has a variety of uses. (Gramercy)

The vertical Gothic alphabet of uppercase letters and numerals shown in **Figure 5-31** is broken into groups of characters of similar strokes. Close study of this illustration will assist you in learning the order and direction of strokes used in forming each letter.

Draw vertical and inclined strokes with a movement of the fingers, **Figure 5-32**. Form

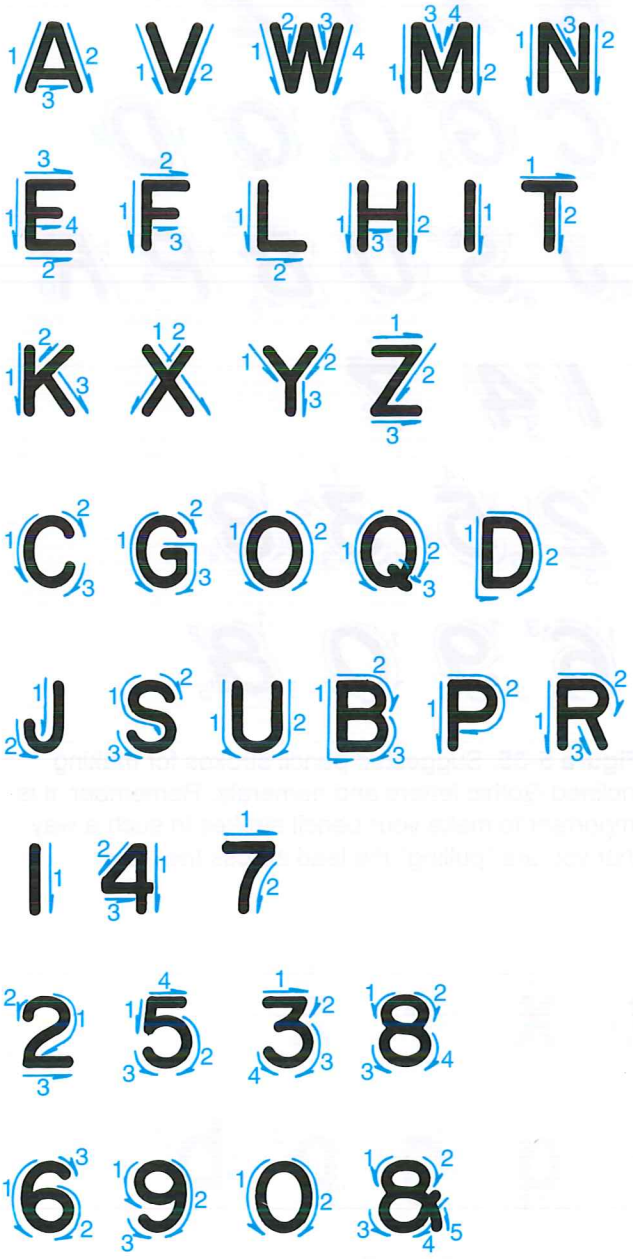


Figure 5-31. Suggested pencil strokes for making vertical uppercase letters and numerals. Remember, it is important to make pencil strokes in such a way that you are "pulling" the lead across the sheet, not "pushing" it.

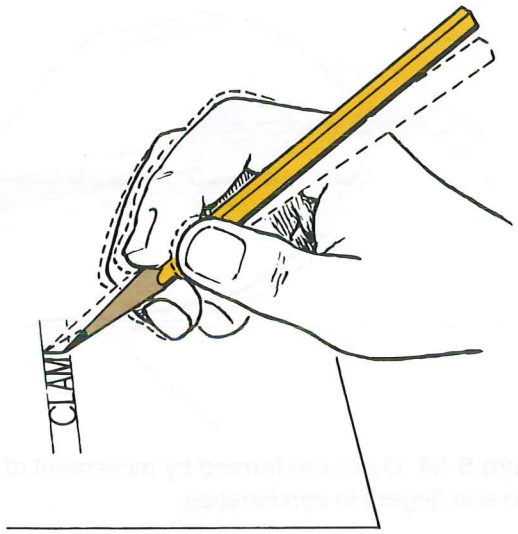


Figure 5-32. Vertical and inclined strokes are made by finger movements only.

horizontal strokes by pivoting the hand at the wrist, with a slight finger movement as needed to maintain a straight line, **Figure 5-33**. Ovals are formed with a combination of hand and finger movement, **Figure 5-34**. Ovals are perfect ellipses with major and minor axes.

Inclined Gothic letters and numerals are drawn in a manner similar to vertical letters and numerals. However, the vertical axis is at an angle between 68° and 75°, **Figure 5-35**.

Lowercase vertical Gothic letters are formed as shown in **Figure 5-36**. The body of a lowercase letter is two-thirds the height of the uppercase

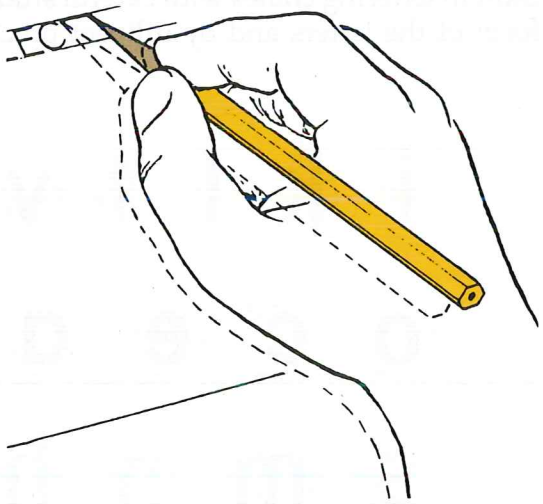


Figure 5-33. Horizontal strokes are formed by a movement of the hand at the wrist, along with a slight finger movement.

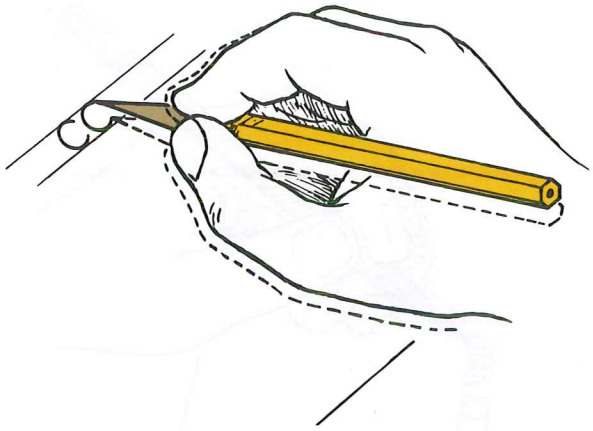


Figure 5-34. Ovals are formed by movement of the hand and fingers in combination.

letter. Ascending or descending stems are equal in length to the height of the uppercase letter. Lowercase inclined Gothic letters are formed as shown in **Figure 5-37**. These letters should be inclined at 68° to 75°.

Combining Large and Small Uppercase Letters

Some drafters use large and small uppercase (capital) letters in combination for titles or notes on drawings. This combination is more easily read than all uppercase letters of the same height, **Figure 5-38**. Height of the small letters should be two-thirds to four-fifths that of the large letters.

Skill in lettering comes with careful study of the form of the letters and by diligent practice.

Figure 5-35. Suggested pencil strokes for making inclined Gothic letters and numerals. Remember, it is important to make your pencil strokes in such a way that you are "pulling" the lead across the sheet.

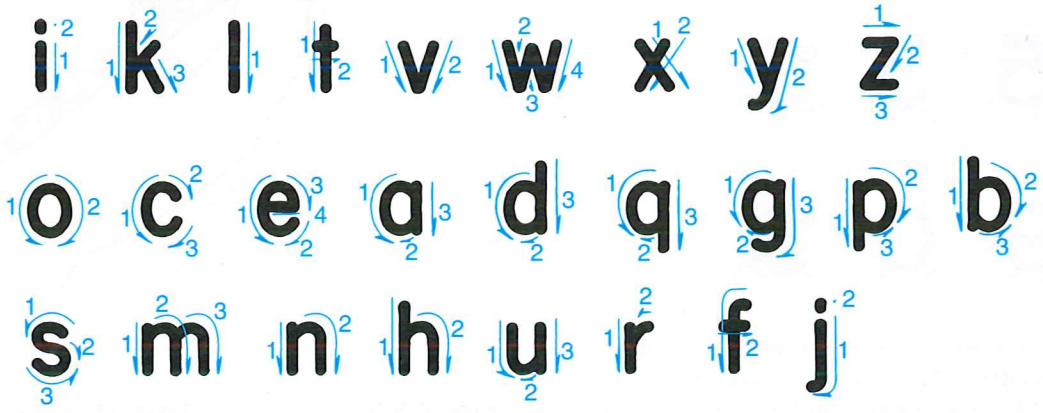


Figure 5-36. Suggested pencil strokes for vertical Gothic lowercase letters. Remember to "pull" the pencil lead across the sheet.

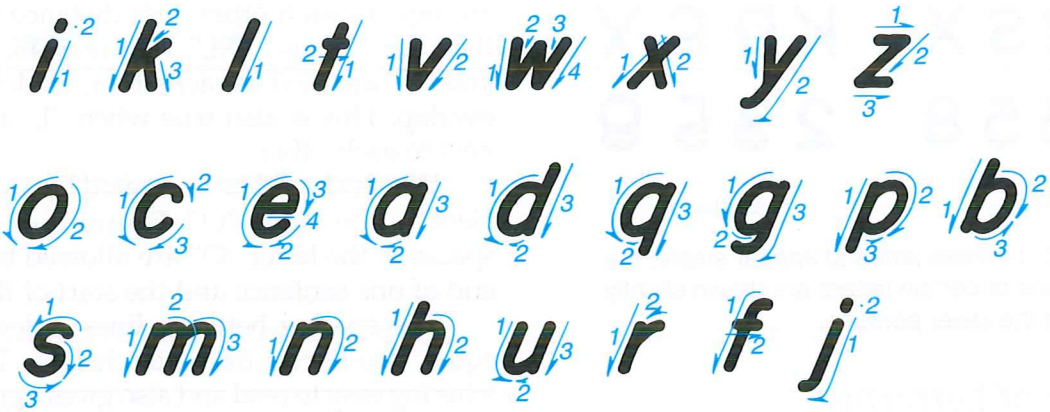


Figure 5-37. Suggested pencil strokes for inclined Gothic lowercase letters. Remember to "pull" the pencil lead across the sheet.

WOOD PATTERN TO BE
ENGINEERING APPROVED

Figure 5-38. Large and small uppercase letters can be used in combination. This combination is easier to read than all large uppercase letters.

With practice, any student with a talent for drafting can learn to produce good letters.

Proportion in Letters and Numerals

Once the technique of forming letters and numerals is understood, care must be given to drawing each element in proportion. Proportion is necessary to present a neat appearance. This is especially important where letters are formed into words and sentences, **Figure 5-39**.

However, there may be times when it is necessary, or desirable, to compress or expand letters or words. This occurs when space is limited or if you want to attract attention, **Figure 5-40**. Keep in mind that you should maintain good proportion when possible.

GOOD PROPORTION BAD PROPORTION

Figure 5-39. Proportion in forming individual letters is important. Incorrect proportion may result in words that look "pulled apart" (at right, top) or "smashed together" (at right, bottom).

NEW HOMES
PROJECT
CARBURETOR

Figure 5-40. Good proportion must be maintained even when it is necessary to expand or compress words.

Stability in Letters and Numerals

Optical illusion is also a factor in lettering. For this reason, it is necessary to place the horizontal bar on letters such as "B," "E," and "H" slightly above center. If not, they will appear top-heavy and unstable, **Figure 5-41.** It is also necessary to draw the upper portion of letters such as "B," "K," "R," "S," "X," and "Z" and the numerals "2," "3," "5," and "8" slightly smaller than the lower portion to show stability, **Figure 5-42**.

B E H B E H

Stable Unstable

Figure 5-41. Some letters such as "B," "E," and "H" must actually be drawn with the horizontal bar just above the true center to make the letter appear correct. This makes lettering appear stable. If the bar is drawn at or below the true center of the letter, then the letter will appear unstable.

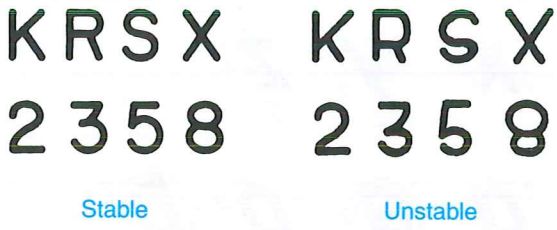


Figure 5-42. To make lettering appear stable, the upper portions of certain letters are drawn slightly smaller than the lower portions.

Quality of Lettering

The appearance of lettering on a drawing is enhanced when the style, height, slope, spacing, and line weight are uniform. The appearance of the drawing and skill of the drafter are reflected in the quality of lettering.

Care should be taken to form each letter correctly. Letters should be formed within the lightly drawn guidelines, and they should also be of the proper line density. Lettering is a special technique that differs from writing, **Figure 5-43.**

Composition of Words and Lines

The way that letters are combined into words and sentences tends to reveal the drafter's lettering skill. Many beginning drafters tend to space the letters of words too widely and crowd the spacing between words. Lettering of this nature is difficult to read, **Figure 5-44.**

Correct spacing of letters within words is based on the total area between two letters, not just the distance between letters. When letters are spaced based only on distance, poor composition results, **Figure 5-45.**

The shape of the letters themselves determines how much spacing should occur between any two letters. For example, when "A" and "M" are next to each other, less distance is required than for "I" and "M," **Figure 5-46.** When "T" and "C" are next to each other, the letters nearly overlap. This is also true when "L" and "T" are next to each other.

Words should be separated by a space equivalent to the letter "O," **Figure 5-47.** Two letter spaces of the letter "O" are allowed between the end of one sentence and the start of the next.

The spacing between lines of letters should equal two-thirds the letter height. This makes lettering easy to read and also gives a good appearance, **Figure 5-48.** Spacing may vary from one-half

Figure 5-43. Lettering requires a special technique that reflects the skill of the drafter. Lettering is different from writing.

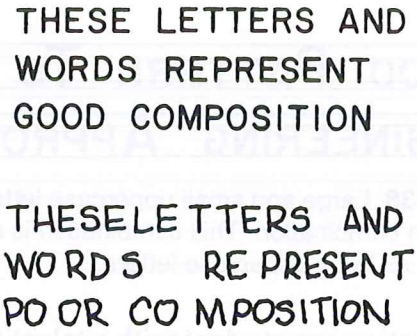


Figure 5-44. Composition is very important when lettering a drawing. If the words are improperly spaced, the result is a drawing that appears to be of poor quality.

Figure 5-45. Equal spacing of letters results in poor composition and lettering that is hard to read.

Figure 5-46. The total area between letters determines the spacing, not the total distance.

Figure 5-47. The letter "0" is used to determine spacing between words and sentences.

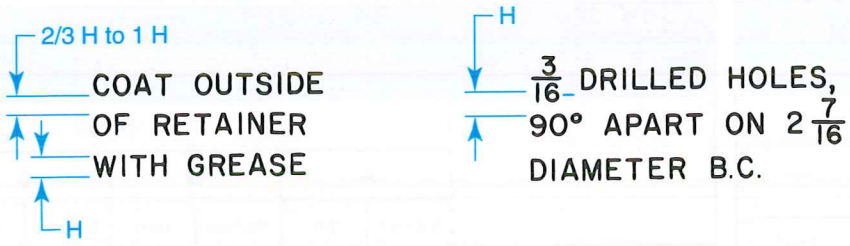


Figure 5-48. Spacing between lines of text should be from 2/3 the letter height to a full letter height. When fractions appear in a line, the lines should be separated by a full letter height in distance.

to one full letter height, depending on the space available, but it should be consistent on a single drawing. Where fractions are involved, spacing between lines should be a full letter height.

Size of Letters and Numerals

Uppercase letters and whole numerals are usually a minimum of 1/8" in height for notes. Height for the drawing title and drawing number is generally 1/4".

The overall height of fractions is twice the height of whole numbers, **Figure 5-49A**. Note that the numerator and denominator are smaller than the whole number, and they are separated by .08" so that they *do not* touch the fraction bar. This prevents confusion in reading fractions on a drawing. Limit dimensions are shown with a space of .08" minimum between the upper and lower dimensions, **Figure 5-49B**.

While these standards normally apply, some companies have created their own specifications for the sizes of letters and numbers on drawings, **Figure 5-50**. These specifications have been created to meet certain needs and to make sure that every drawing produced by, or for, the company is consistent.

Notes on Drawings

Notes are used to supplement the graphic information provided on a drawing. Notes are lettered to be read horizontally. Uppercase letters at least 1/8" high are preferred.

The minimum spacing between lines within a note is two-thirds the letter height. Refer to **Figure 5-48**. A full letter height should be used on drawings to be reduced in size for conversion to microfilm. Spacing between two separate notes should be at least two full letter heights, **Figure 5-51**.

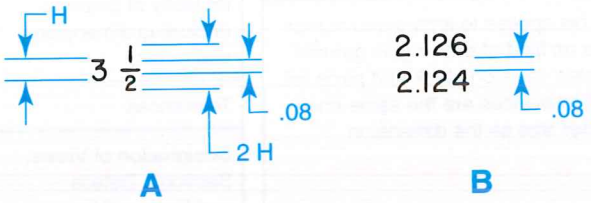


Figure 5-49. Fractions, including the fraction bar, should be a total of twice the full letter height. The denominator and numerator should be spaced .08" from the line. When limit dimensions are given, they should be separated by .08".

Balancing Words in a Space

It is necessary at times to balance (evenly space) words within a limited space, such as a title block, **Figure 5-52**. This may be done by first lettering the title or note on scrap paper using appropriate guidelines. Then, slip the copy under your tracing paper or vellum and adjust it as needed. If you are working on an opaque surface, measure the scrap copy and transfer the starting point to the drawing.

Lettering on Drawings to Be Microfilmed

Drawings to be reproduced for conversion to microfilm require special lettering. The lettering must be large enough and dense enough to reproduce clearly. Generally, the lettering must be readable on a print one-half the size of the original.

Some companies have modified certain letters and numerals used on drawings to be microfilmed. These modifications help improve clarity on blowbacks (enlargements made from microfilm), **Figure 5-53**.

Use	Size (Min.)
Drawing Number	.38
Drawing Title, Code Identification No.	.20
Letters and Numerals	.156*
Tabulated and Section Letters	.40
The Words "Section" and "View"	.20

*This applies to letters and numerals on field of drawing, in general notes, revision block and parts list. All tolerances are the same character size as the dimension.

Minimum Letter Sizes

Item	Sizes							
	A		B		C		D and larger	
	Inches	mm	Inches	mm	Inches	mm	Inches	mm
Drawing and Part Number	.250	6	.250	6	.312	8	.312	8
Title	.125	3	.156	4	.156	4	.188	5
Letters and Figures for Body of Drawing (including dimensions and notes)	.125	3	.156	4	.156	4	.188	5
Tolerances	.100	2.5	.125	3	.125	3	.156	4
Designation of Views, Sections, Details and Datum: "Views," "Section," and "Detail."	.156	4	.188	5	.188	5	.250	6
"A–A," "B," "X–X," etc.	.188	5	.250	6	.250	6	.312	8
Security Classification, Drawing Status, Reference Drawing, etc.	.250	6	.250	6	.250	6	.250	6
Typed Schematics, Dimensions, and Notes on Body of Drawing	.100	2.5	.125	3	.142	4	.142	4

Figure 5-50. Some organizations develop their own specifications for letter sizes. These specifications serve the company's own needs and ensure that all drawings for the company are consistent. (Global Engineering Documents; IBM)

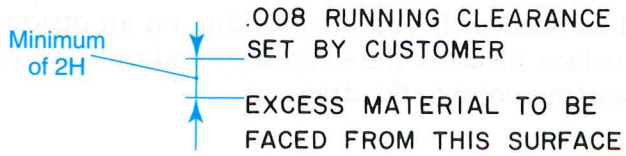


Figure 5-51. The minimum spacing between separate notes is two full letter heights.

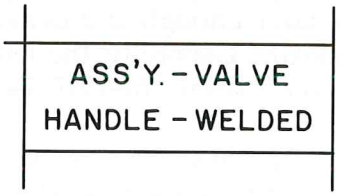


Figure 5-52. When words must be contained within a given space, such as a title block, the words should be "balanced" in that space.

Lettering with Ink

Most drawings to be used for photographic reproductions in technical publications are inked. These drawings are usually presentation drawings. Inked drawings are also made if a number of copies of prints are to be made over a long period of time.

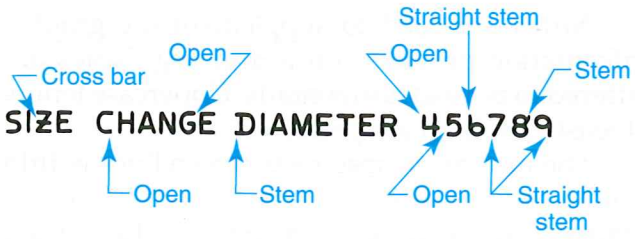


Figure 5-53. When drawings will be transferred to microfilm, some letters and numbers may need to be modified. This ensures that the lettering will be accurately reproduced to, and later from, the microfilm.

Figure 5-54. Technical pens are used to ink drawings. (Alvin & Co.)

Freehand inking of letters on drawings requires a special technique and proper equipment. Several styles of pens are available for inking. Standard lettering pen points come in a range of sizes from very fine to heavy.

Technical Pen

Freehand inked letters should be made with a ***technical pen***, **Figure 5-54**. Technical pens produce more uniform stroke widths in comparison to the more flexible pen points, which may produce variable line widths. Technical pens also may be used for inking lines on a drawing.

Technical pens consist of a pen point (called a *nib*), a needle running through the point to maintain the ink flow, and an ink reservoir, **Figure 5-55**. They are made for use with special inks.

Most technical pens are shaped to permit their use with lettering devices. They also come in a range of sizes suitable for use with various lettering templates.

Mechanical Lettering Devices

Since inking letters and numerals requires considerable skill to achieve satisfactory results, many inked drawings are lettered with mechanical devices. A Leroy lettering device is a special instrument used to ink letters and symbols, **Figure 5-56**.

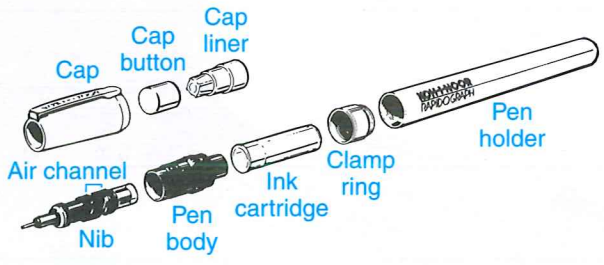


Figure 5-55. Technical pens have a pen point and an ink reservoir. Some pens have reservoirs that are actually cartridges that can be quickly removed and changed. (Koh-I-Noor Rapidograph, Inc.)

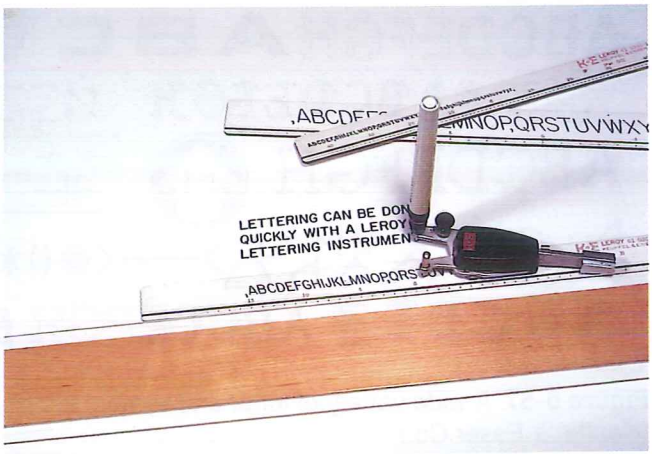


Figure 5-56. A Leroy lettering device is useful for lettering in ink.

A Leroy lettering device consists of a scriber, pen, and template. The scriber traces letters cut into the template and is used to guide the movement of the pen. The device is adjustable for making inclined as well as vertical lettering, and templates are available in a variety of letter styles and sizes. Templates are also available for various graphic symbols, such as electronic and welding symbols, **Figure 5-57**.

Another type of lettering device is a lettering template, **Figure 5-58**. A third type of mechanical lettering device is the height and slant control scriber. This device is similar to a Leroy lettering device. It operates from a template, but it is constructed in a way that permits the expansion or compression of letters. This device allows the height-to-width ratio of the letters to be varied.

Transfer Type and Overlays

Transfer type is used to quickly place letters and symbols on drawings. With this method, type is *transferred* from printed sheets containing pressure-sensitive letters and symbols. Transfer type can be used for lettering, dimensioning, or applying symbols, **Figure 5-59**.

When using transfer type, the letter, number, or symbol is aligned in the correct position on the drawing. Then pressure is applied with a special tool and the type is transferred.

Overlays are adhesive-backed sheets that "lay over" the drawing. These sheets contain materials that adhere to the drawing sheet.

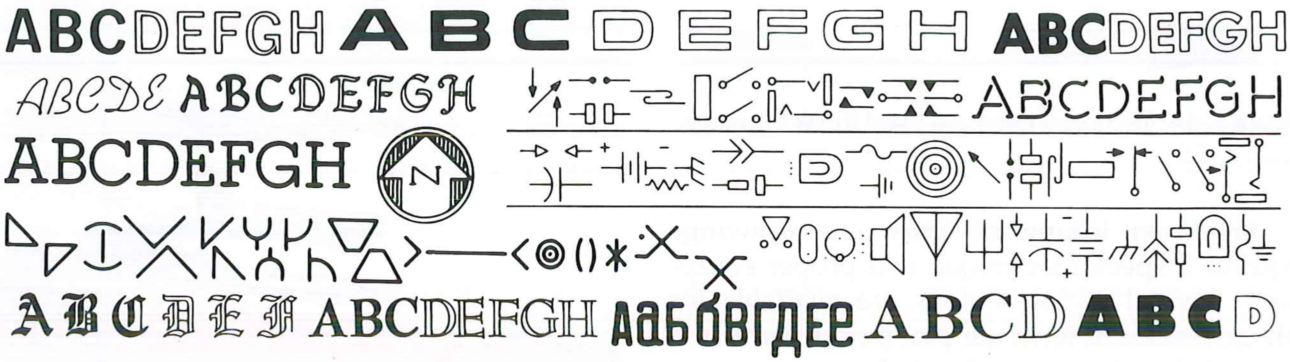


Figure 5-57. A wide variety of letter and symbol templates are available for use with a Leroy lettering device. (Keuffel & Esser Co.)

Overlays are used for items such as title blocks and borders. These materials save considerable time in drafting. They are particularly useful where standard notes or symbols are frequently used.

Creating Text on CAD Drawings

Because of factors such as time, accuracy, and efficiency, CAD is used today by many industries to prepare drawings. There are many advantages to using CAD, but one of the most important is the ability to generate text for dimensions, notes, and other types of drawing annotations. See **Figure 5-60**. CAD greatly speeds the lettering process and enables the drafter to produce uniform, legible text.

There are many advantages to creating text with a CAD system in comparison to freehand lettering. With CAD, you simply specify a text style, pick the desired location on the drawing, and enter a string of text. The text is generated automatically on screen in the style and orientation specified. This simplifies the task of making text appear consistent and accurate. When placing text for dimensions or notes, most programs allow you to insert drafting symbols that conform to industry standards. As is the case with other types of drawing objects, text can also be edited. This is a fundamental capability that takes on added importance when drawings need to be revised.

Text commands are used to place text on a drawing. While command names vary, the steps

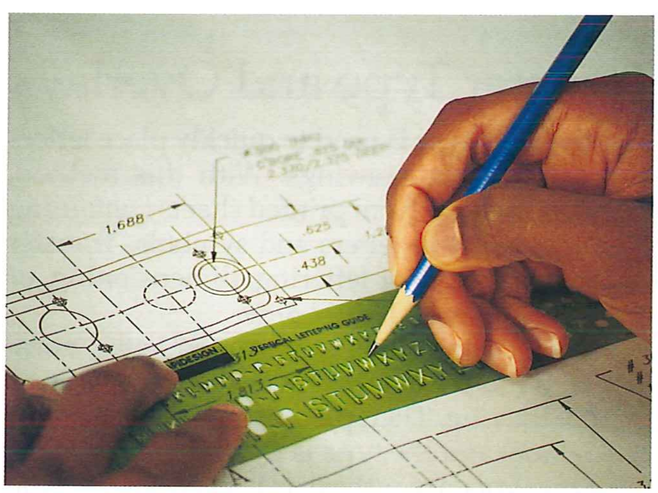


Figure 5-58. Lettering templates are useful tools for lettering drawings.

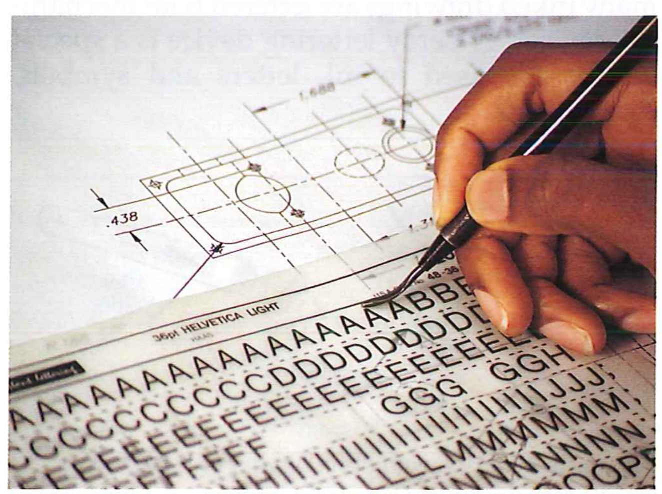


Figure 5-59. Transfer type can be used to quickly place standard symbols and text onto a drawing.

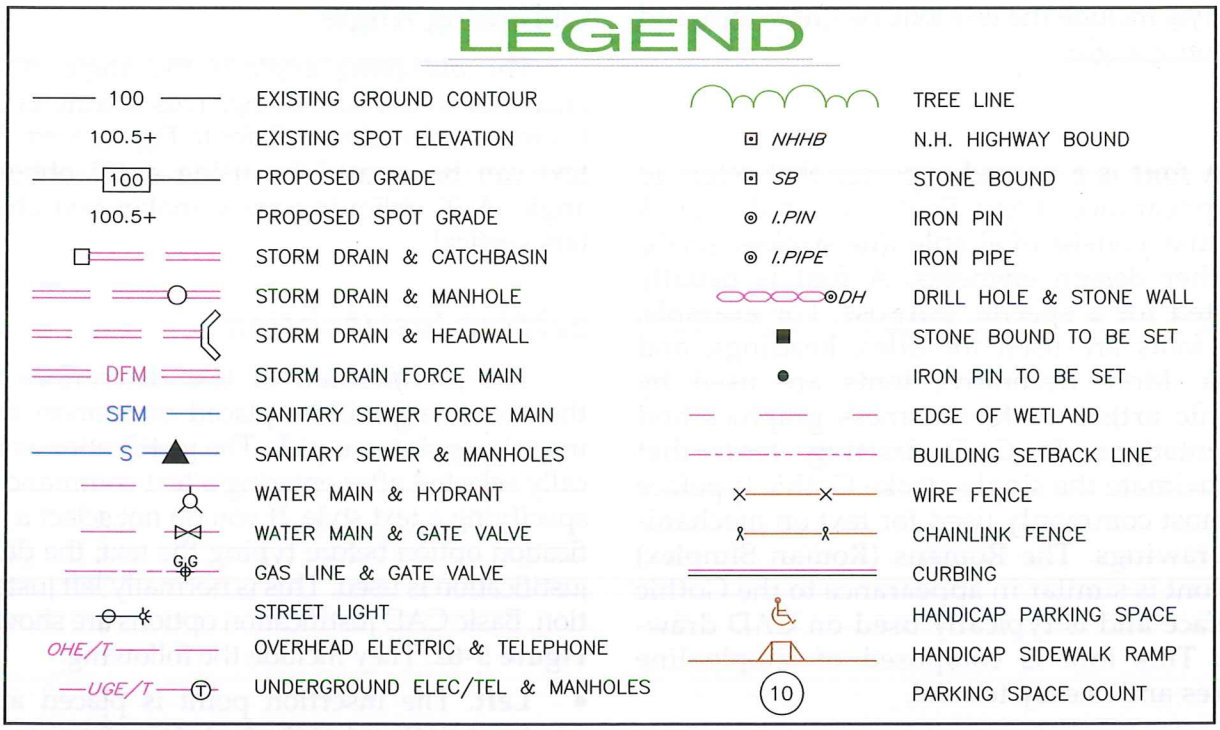


Figure 5-60. The ability to generate and control the appearance of text in a CAD program provides great flexibility for completing drafting tasks. (Autodesk, Inc.)

taken to insert text are much the same among different CAD systems. The following procedure is generally used:

1. Create a text style with the desired settings.
2. Enter the **Text** or **Multiple Text** command.
3. Specify the text justification and rotation.
4. Pick the text insertion point on the drawing.
5. Enter the text to be placed on the drawing.

A variety of settings are used to control the style, justification, and orientation of text. The following sections discuss some of the most common text settings and functions.

Text Style Settings

A ***text style*** consists of settings that define the appearance of text. Different text styles can be created to incorporate unique text elements, such as a user-defined font or an obliquing angle (slant angle) for inclined text. Some drawings may use one text style for notes and dimensions and a different text style for the title block text. Using text styles is an efficient way to make text appear consistent and conform to drafting standards.

Text settings may also be made without first creating a style when entering text, but it is often more effective to define styles with settings that are appropriate for specific applications. As shown in **Figure 5-61**, common settings in a

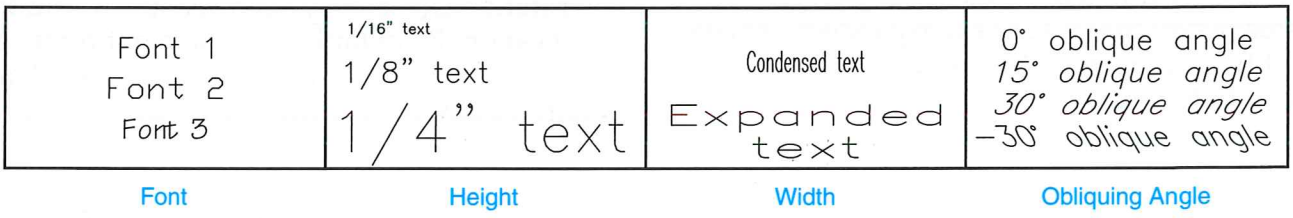


Figure 5-61. A text style typically includes settings for the text font, height, width, and obliquing angle.

text style include the text font, height, width, and obliquing angle.

Font

A ***font*** is a named typeface that refers to the appearance of text. Fonts vary in design. A font may consist of simple line strokes, serifs, or other design elements. A font is usually selected for a specific purpose. For example, bold fonts are used for titles, headings, and labels. More decorative fonts are used by graphic artists or for business graphics and presentations. In CAD drafting, fonts that approximate the single-stroke Gothic typeface are most commonly used for text on mechanical drawings. The Romans (Roman Simplex) text font is similar in appearance to the Gothic typeface and is typically used on CAD drawings. This font is composed of simple line strokes and is easy to read.

Height

The text height is the distance from the bottom to the top of a text character. It is usually based on the height of uppercase characters. Lowercase letters are smaller than the text height.

The standard minimum text height on mechanical drawings is 1/8". For drawing titles, a larger text height (such as 1/4") is used. Although a standard text height can be set when creating a text style, it is also common to set the height at zero so that the setting can be specified when entering text. This allows the drafter flexibility in cases where the text height may need to vary from the standard setting.

Width

Whenever you change the text height, the width automatically adjusts proportionally. However, some CAD programs allow you to set the text width independently. A larger width value makes the text appear expanded; a smaller width value makes the text appear condensed. Refer to **Figure 5-61**.

Obliquing Angle

The ***obliquing angle*** is the angle of each character in the text string. This setting is used to create inclined text. Refer to **Figure 5-61**. Italic text can be created by using a 15° obliquing angle. A 0° obliquing angle makes text characters vertical.

Setting Justification

The ***justification*** of text determines how the text string will be placed in relation to the insertion point you pick. The justification is typically selected after entering a text command and specifying a text style. If you do not select a justification option before typing the text, the default justification is used. This is normally left justification. Basic CAD justification options are shown in **Figure 5-62**. They include the following:

- **Left**. The insertion point is placed at the lower-left end of the text string.
- **Right**. The insertion point is placed at the lower-right end of the text string.
- **Center**. The text string is evenly spaced on both the left and right sides of the insertion point.
- **Middle**. The text string is evenly spaced both vertically and horizontally around the insertion point.
- **Aligned**. The text string is positioned between two base points picked by the user. The text is left justified from the first point picked. If the selected points are at an angle, the text is placed at the angle between the points.

Setting Rotation

The text rotation setting determines the angle of rotation for the entire text string, **Figure 5-63**. After entering a text command, the rotation is typically set after specifying the justification. By default, the text is not rotated.

Rotation is measured from 0° horizontal in a counterclockwise manner. If you enter a positive

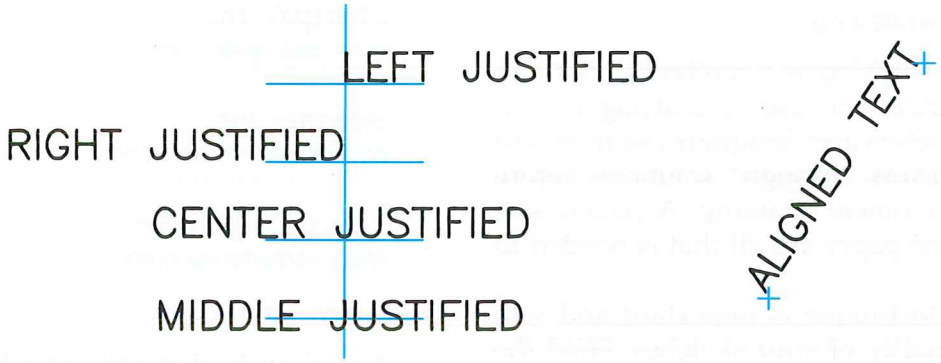


Figure 5-62. Text justification determines how a text string is placed in relation to the insertion point.

rotation angle, the text string is rotated counterclockwise. If you enter a negative rotation angle, the text string is rotated clockwise.

Entering Text

After you have entered a text command and specified the text style, justification, and rotation, you must select an insertion point for the text. You can enter coordinates or pick a point on screen. A text window is displayed, and the screen cursor indicates the current position.

Most CAD systems allow you to enter single text strings one at a time. The text string is defined as a single object. Therefore, if you edit the text by moving or copying, you affect the entire string. If several lines of text are entered during a single command by ending each line with a return, the program treats each line (not the entire paragraph) as a text string.

Some programs allow you to type multiple lines of text as paragraph text. When text is entered in this manner, the entire paragraph is treated as a single object.

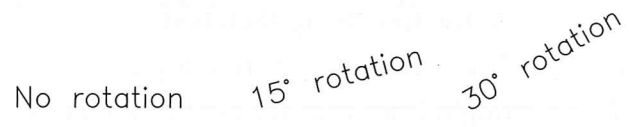


Figure 5-63. Lines of text can be rotated by specifying an angle.

Editing Text

Standard editing commands can be used to edit text objects. Commands such as **Move, Copy,** and **Rotate** affect text strings in the same manner as other objects. Select the text string to edit and make the necessary changes.

To revise the text itself, a text editing command is used. Although command names vary, you can typically pick the text string to make changes after entering the command. In some cases, double-clicking on a text object activates a text editing command automatically.

You can also edit the text settings for text objects, such as the height, justification, or assigned style. Changing a text setting typically requires you to use a command such as **Properties**. As with other types of object properties, you can also assign a different layer or color to a text object.

Checking Spelling

Most CAD programs provide a spell checking feature to check for spelling errors on a drawing. To check spelling, the **Spell** command is typically used. This command allows you to verify the spelling of words that are not recognized by the program's dictionary. This is a useful feature that makes it easy to find and correct misspelled words.

Chapter Summary

Freehand sketching is a method of making a drawing without the use of drafting instruments. Most drafters and designers use freehand sketching to "think through" solutions before starting an instrument drawing. A pencil, soft eraser, and some paper are all that is needed to make a sketch.

Sketching technique is important and will improve the quality of your sketches. Hold the pencil firmly, but not too tight. Your arm and hand should have a free and easy movement. Rotate the pencil slightly between strokes to retain the point. Initial lines should be firm and light, but not fuzzy. Good freehand sketches have character all their own.

Practice sketching horizontal, vertical, and inclined lines before sketching circles, arcs, and ellipses. Several methods are used to sketch circles, arcs, and ellipses. Irregular curves may be sketched using a series of points.

Use good proportion when sketching. Proportion is the relation of one part to another, or to the whole object. Use either the pencil-sight or unit method to accomplish proper proportion.

Master one or more styles of lettering. Single-stroke Gothic lettering has been used in drafting for many years. Use guidelines to maintain proper letter height. Visualize proper spacing between letters and words. The appearance of lettering on a drawing is enhanced when the style, height, slope, spacing, and line weight are uniform.

Most drawings to be used for photographic reproductions in technical publications are inked. Lettering devices are available, but freehand lettering in ink is an ability that should be developed.

Lettering on a CAD drawing is called text. The ability to create text is one of the most important advantages provided by CAD. Text commands are used to create text styles and place text. Text can be easily revised with editing commands if changes are necessary.

Additional Resources

Product Suppliers

Alvin & Co., Inc.
www.alvinco.com

Chartpak, Inc.
www.chartpak.com

Staedtler, Inc.
www.staedtler-usa.com

Vemco Corporation
www.vemcocorp.com

Resource Providers

American National Standards Institute (ANSI)
www.ansi.org

American Society of Mechanical Engineers (ASME)
www.asme.org

International Organization for Standardization
www.iso.org

Review Questions

1. Most drafters and engineers use _____ sketching to "think through"solutions to drafting problems before starting an instrument drawing.
2. Graph paper is available in varying _____ sizes.
3. When sketching, the point of the pencil should extend approximately _____ inches beyond your fingertips.
4. When sketching straight lines, your eye should be on the point where the line will _____.
5. Horizontal lines are sketched with a movement that keeps the forearm approximately _____ to the line being sketched.
6. _____ lines are sketched from top to bottom.
7. All straight lines that are not horizontal or vertical are drawn as _____ lines.
8. Name four methods of sketching circles and arcs.
9. When sketching an ellipse, which method involves using only your hand-eye coordination and judgment?

10. A(n) _____ curve may be sketched freehand by connecting a series of points at intervals of 1/4" to 1/2" along the path of the curve.
11. _____ is the relation of one part to another, or to the whole object.
12. Hand _____ is the process of placing text on a drawing.
13. In CAD drafting, lettering is created as _____.
14. Which pencil hardness is generally used for lettering?
    A. 6B–2B
    B. HB, F, or H
    C. 2H–4H
    D. Any hardness is acceptable.
15. Name the four general groups of hand lettering styles.
16. _____ lettering is the standard style used in drafting.
17. What lines are used in freehand lettering to maintain uniformity in height and slope?
18. To achieve the appearance of stability, place the horizontal bar on letters such as "B," "E," and "H" slightly _____ center.
19. Words should be separated by a space equivalent to the letter _____.
20. Uppercase letters and whole numerals are usually a minimum of _____ inch in height for notes.
21. _____ are used to supplement the graphic information provided on a drawing.
22. Freehand inked letters should be made with what type of pen?
23. What is a Leroy lettering device used for?
24. When using CAD, _____ commands are used to place text on a drawing.
25. A(n) _____ is a named typeface that refers to the appearance of text.
26. Name five basic CAD justification options for text strings.

Problems and Activities

The problems presented here are designed to provide meaningful practice in freehand technical sketching and lettering. Unless directed otherwise by your instructor, use A-size (8 1/2" × 11") sheets of plain paper and a pencil and eraser.

Sketching Problems

Practice sketching strokes on scrap paper as you review the instructions prior to doing each sketching problem. Draw the sketching problems freehand. *Do not use scales and straightedges.*

For Problems 1–3, prepare a layout sheet for each problem. See **Figure 5-64**. Sketch a border, then divide your sheet into four rectangles. Estimate the center point and the dividing points for the rectangles (do not measure). The dimensions given are in inches and metric units (millimeters). There are four sketching activities for each problem.

1. Straight Lines and Angles
   A. Prepare a layout sheet as shown in **Figure 5-64**. Sketch horizontal lines in Rectangle 1. Allow 1/2" spacing between the lines and strive for straight, sharp lines.
   B. Sketch a series of vertical lines in Rectangle 2. Allow 1/2" spacing between lines and work to achieve true vertical lines.
   C. Sketch inclined lines in Rectangle 3. Sketch the first line as a diagonal between the opposite corners of the rectangle. Space additional parallel lines 1/2" from this line. Your lines should be straight, sharp, parallel, and uniformly spaced.
   D. Use the bottom line of Rectangle 4 as a reference line. Starting 1/4" from the left end of this line, sketch angles about 2" in length at 1/4" intervals. Slant the lines upward and to the left at 75°, 45°, and 20°. Sketch a second series of angles in the same manner from the right end of the reference line. Slant these lines upward and to the left at 60°, 35°, and 15°. Sign your name and date the sketch.
2. Circles and Arcs
   A. Prepare a layout sheet as shown in **Figure 5-64**. Sketch, by the centerline method, a 2 1/2" diameter circle in Rectangle 1. Center the circle in the rectangle. Your finished circle should appear as one sharp, freehand line.

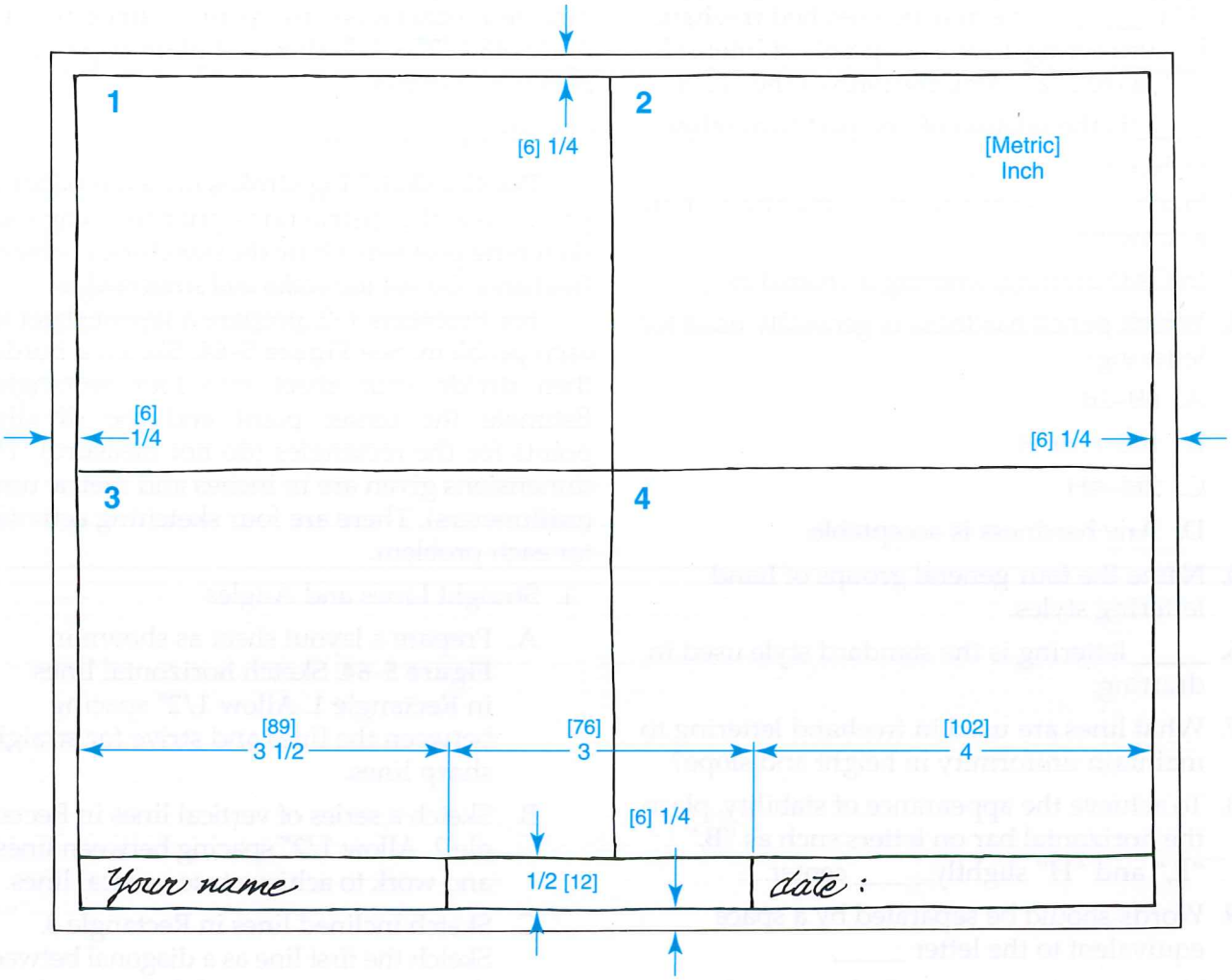


Figure 5-64. A sample layout sheet for sketching problems. The dimensions shown are in inches and metric units (millimeters).

B. Sketch two circles in Rectangle 2, using the enclosing square and hand-pivot methods. Select the size of the circles so that the space is not crowded. Darken the finished circles, but retain the light construction lines for review by your instructor.

C. In Rectangle 3, sketch a 2″ diameter circle using the free-circle method. Locate the circle in the center of the rectangle. Erase your light "trial" circle and darken the finished circle.

D. Lightly sketch a rectangle inside Rectangle 4 at a distance of 1/2″ inside the border lines. Sketch an arc in each of the corners starting at the lower left-hand corner and working clockwise around the rectangle. Draw the arcs with radii of 1/2″, 3/4″, 1″, and 1 1/2″. Darken the finished rectangle and arcs. Sign your name and date the sketch.

3. Ellipses and Irregular Curves

A. Prepare a layout sheet as shown in **Figure 5-64**. Using the rectangular method, sketch an ellipse with a major axis of 4″ and a minor axis of 2 1/2″ in Rectangle 1. Darken the finished ellipse but do not erase your construction lines.

B. In Rectangle 2, sketch an ellipse with a major axis of 3″ and a minor axis of 2″. Use the trammel method. Darken the finished ellipse.

C. In Rectangle 3, sketch an ellipse with a major axis of 2 1/2″ and a minor axis of 1 1/2″. Use the free-ellipse method. Your ellipse should be uniform on both ends. Darken the finished ellipse.

D. On scrap paper, draw an irregular curve similar to the one in **Figure 5-19**. Make the curve a suitable size to fit Rectangle 4 and position it over the rectangle. With a sharp pencil, press lightly to locate points along the curve on the drawing sheet approximately 1/2″ apart. Sketch the irregular curve through these points. To obtain a smooth curve, make sure your strokes "lead out" of the previous curve into the next set of points. Sign your name and date the sketch.

4. Sketch one view of objects in the drafting room as assigned by your instructor. Use plain paper or graph paper and center the view on the sheet. Review the sketching techniques presented in this chapter. Your sketch should reflect your best sketching technique.
5. Select an object at home, work, or in the community and sketch one view that best describes the object. Use plain paper or graph paper and present your sketch in class.

Lettering Problems

The following problems are designed to help you practice lettering. Follow the procedures that are outlined and the directions of your instructor.

For Problems 6–9, prepare a layout sheet for each lettering problem. Use one of the devices discussed in this chapter to lay out horizontal and inclined guidelines on the sheet. Use the layout in **Figure 5-65** or use a commercial lettering sheet as directed by your instructor.

6. Draw single-stroke Gothic vertical uppercase lettering as shown in **Figure 5-31**. Letter the alphabet and numerals as many times as space permits. Make the spacing for letter height 3/8″ (10 mm) with 3/16″ (5 mm) spacing between lines. Use vertical guidelines to keep letters uniform.
7. Draw inclined Gothic uppercase lettering as shown in **Figure 5-35**. Letter the alphabet and numerals as many times as space permits. Make the spacing for letter height 1/4″ (6 mm) with 1/8″ (3 mm) spacing between lines. Use 68° inclined guidelines.

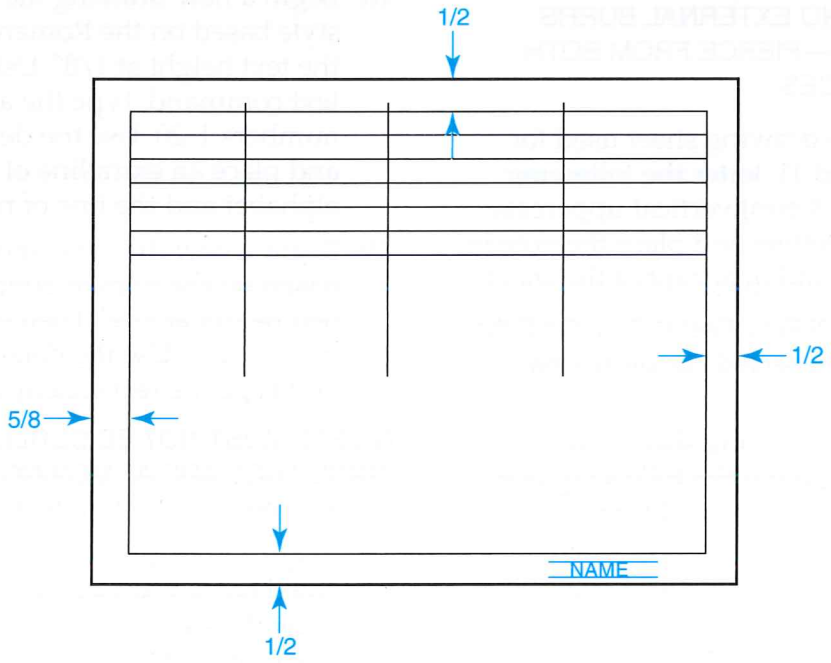


Figure 5-65. A sample layout sheet for lettering problems. The dimensions shown are in inches.

8. Draw vertical Gothic lowercase lettering as shown in **Figure 5-36**. Repeat the alphabet as many times as space permits. Make the spacing for letter height 3/8" (10 mm) with 3/16" (5 mm) spacing between lines. Use vertical guidelines.
9. Draw inclined Gothic lowercase lettering as shown in **Figure 5-37**. Repeat the alphabet as many times as space permits. Make the spacing for letter height 1/4" (6 mm) with 1/8" (3 mm) spacing between lines. Use inclined guidelines.

For Problems 10-13, use an A-size sheet and follow the instructions to complete each lettering activity.

10. Letter the following drawing note in 1/8" (3 mm) vertical uppercase letters on a drawing sheet. Use appropriate spacing between lines and a line length that does not exceed 4". Center the note in the upper left-hand quadrant (quarter) of the sheet, starting 1" from the top border.

DIMENSIONS THROUGHOUT ARE TO 90° BEND AS ASSEMBLED ON PRODUCT.
PART SHOULD BE OVERBENT TO 91° FOR ADDITIONAL TENSION.

11. Using the same drawing sheet used for Problem 10, letter the following notes. Use 3/16" (5 mm) inclined uppercase letters and place the notes in the upper right-hand quadrant of the sheet.

SLOT MUST HAVE NO EXTERNAL BURRS
.203 (5.2) DIA HOLE—PIERCE FROM BOTH SIDES—FOUR PLACES.

12. Using the same drawing sheet used for Problems 10 and 11, letter the following note. Use 1/8" (3 mm) vertical uppercase and lowercase letters and place the note in the lower left-hand quadrant of the sheet.

Note: An Easement Of Four Feet (1.3 m) On Either Side Of This Line Is Reserved For Utility Line Through Properties.

13. Using the same drawing sheet used for Problems 10–12, letter the following note. Use 3/16" (5 mm) combined large uppercase letters and small uppercase letters and place the note in the lower right-hand quadrant of the sheet.

EMBOSS 5/16 (7.9) DIA × 1/16 (1.5) DEEP—INSIDE ONLY—FOUR PLACES.

For Problems 14-19, follow the instructions to complete each activity. Complete the problems as directed by your instructor.

14. Obtain several prints from industry for review. Evaluate the lettering and dimensions as to style, size, uniformity, and quality of reproduction. Be prepared to discuss your findings in class.
15. Select a note from an industrial print and letter the note in the same size and style of lettering. Compare your work with that done by the industrial drafter.
16. Select a title block from an industrial print. Lay this out on a sheet and letter the content in the same size and style. Compare your work with that on the print.
17. Lay out a lettering sheet as shown in **Figure 5-65** for 3/16" (5 mm) lettering. Draw single-stroke Gothic vertical uppercase lettering as shown in **Figure 5-31**. Letter the alphabet and numerals lightly in pencil on the upper half of the sheet and then ink the copy freehand.

For Problems 18-20, use a CAD system and the necessary text commands to complete the activity. Create layers as needed and use standard drawing conventions. Save each problem as a drawing file as directed by your instructor.

18. Begin a new drawing file and create a text style based on the Roman Simplex font. Set the text height at 1/8". Using the desired text command, type the alphabet and the numbers 1–20. Use the default justification and place an extra line of space between the alphabet and the line of numbers.
19. Begin a new drawing and create a text style based on the Roman Simplex font. Set the text height at 1/8". Then enter the following note as text. Use the default justification and type the text exactly as shown.

RIVETS MUST NOT BE CURLED TOO TIGHTLY SINCE THEY ARE AT MOVING JOINTS. RIVET HEADS SHOULD BE OUTSIDE.

20. Begin a new drawing and create a text style based on the text font and height of your choice. Enter the following note as text. Use center justification and type the text exactly as shown.

FORK BRACKET, SPINDLE RAM ASS'Y.

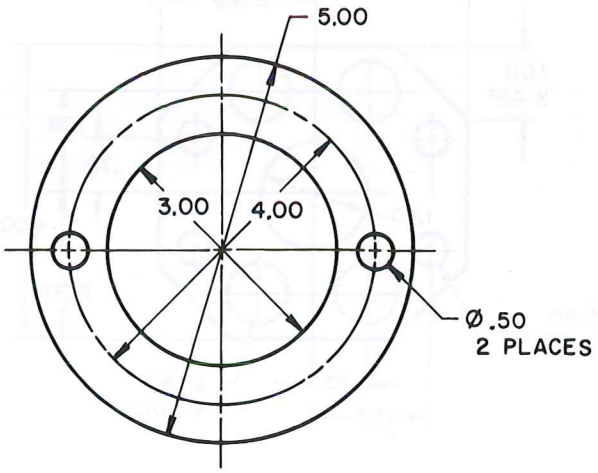
Drawing Problems

Sketch the following problems on A-size sheets of paper. Use bond, drawing, tracing, or graph paper. Sketch the problems as assigned by your instructor. They are classified as introductory, intermediate, and advanced. A drawing icon identifies the classification.

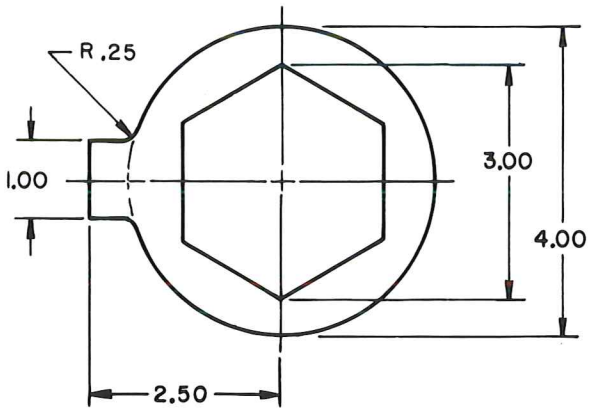
The problems include customary inch and metric drawings. Use one sheet for each problem and do not dimension. Select an appropriate size for each object and keep the sketch in proportion. Strive for good line quality. Prepare a layout sheet for each problem with a border and space for your name, the name of the object, and the date at the bottom of the sheet.

Introductory

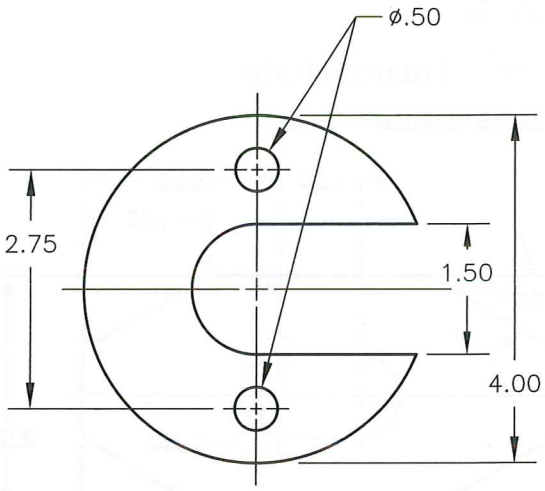
1. Oil Seal Press



2. Holding Tool

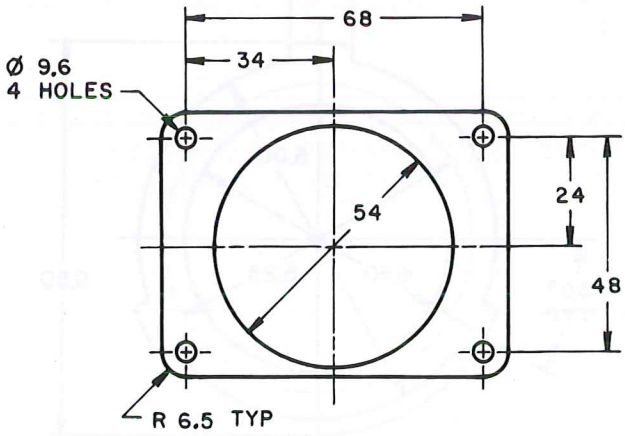


3. C-Washer



Intermediate

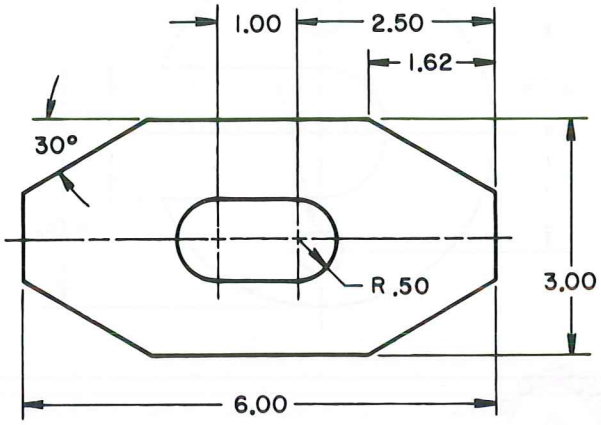
4. Plate Washer



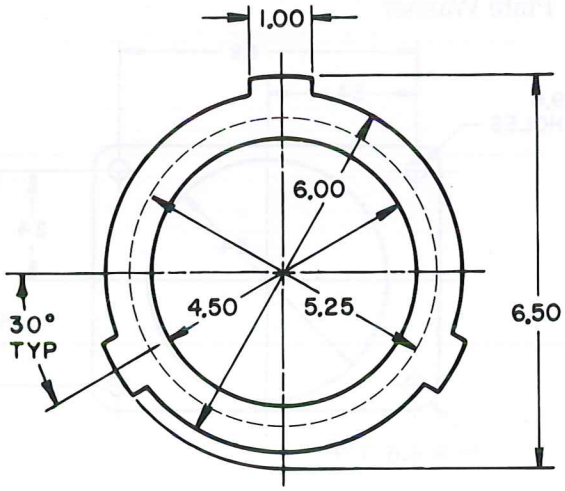
METRIC

Intermediate

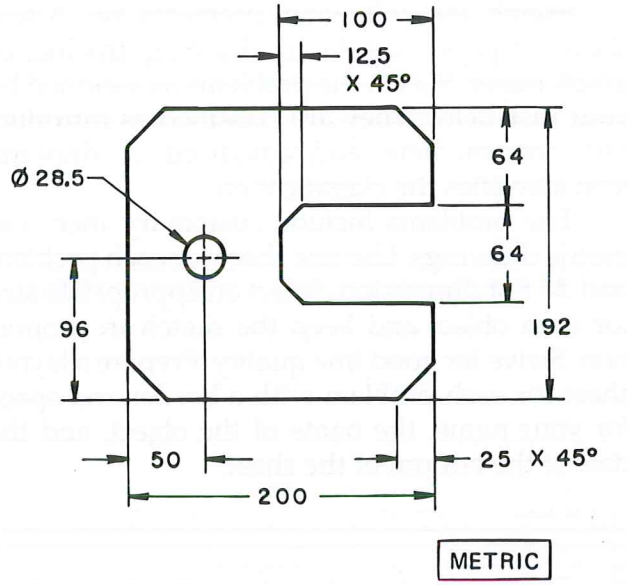
5. Strap Clamp



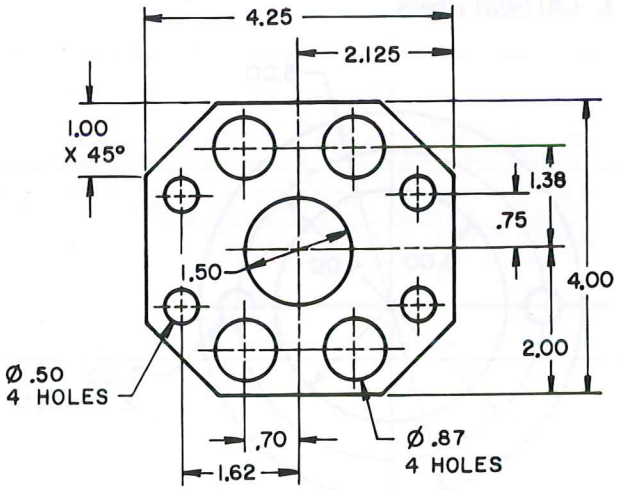
6. Lock Washer



7. Plate Clamp

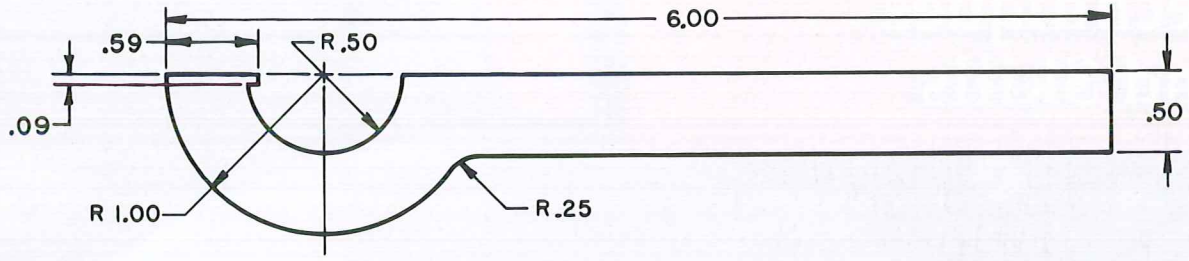


8. Adapter

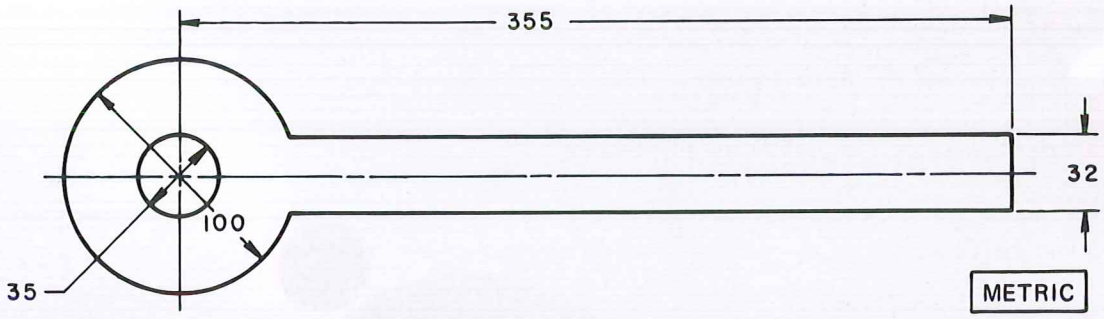


Intermediate

9. Spanner Wrench

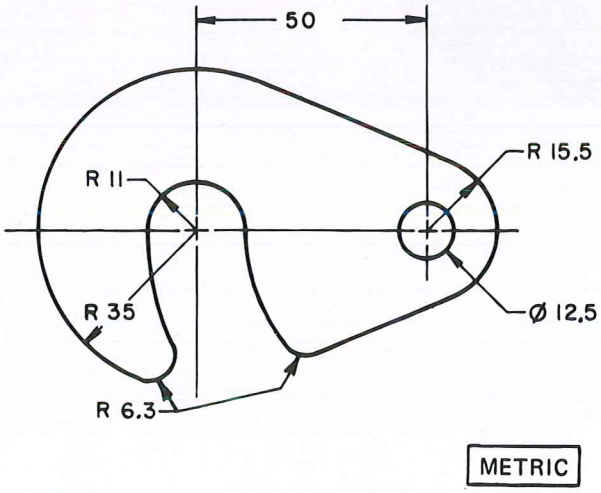


10. Eye Rod



Advanced

11. Swing C-Washer



12. Drill Jig