Chapter 3

Sketching and Lettering

Objectives

The student will be able to:

- use proper line weights to sketch and letter
- complete a two-dimensional sketch of simple objects
- complete a three-dimensional sketch of simple objects
- file a record of sketched ideas
- select and sharpen sketching and lettering pencils
- keep sketches in proportion
- dimension a sketch
- shade a sketch
- letter clearly on a sketch

Introduction

Highly developed manual drafting skills are not required for the preparation of CAD drawings **(Fig. 3-1)**; however, a competent CAD operator must possess a thorough understanding of the principles of drafting and be skilled in technical sketching.

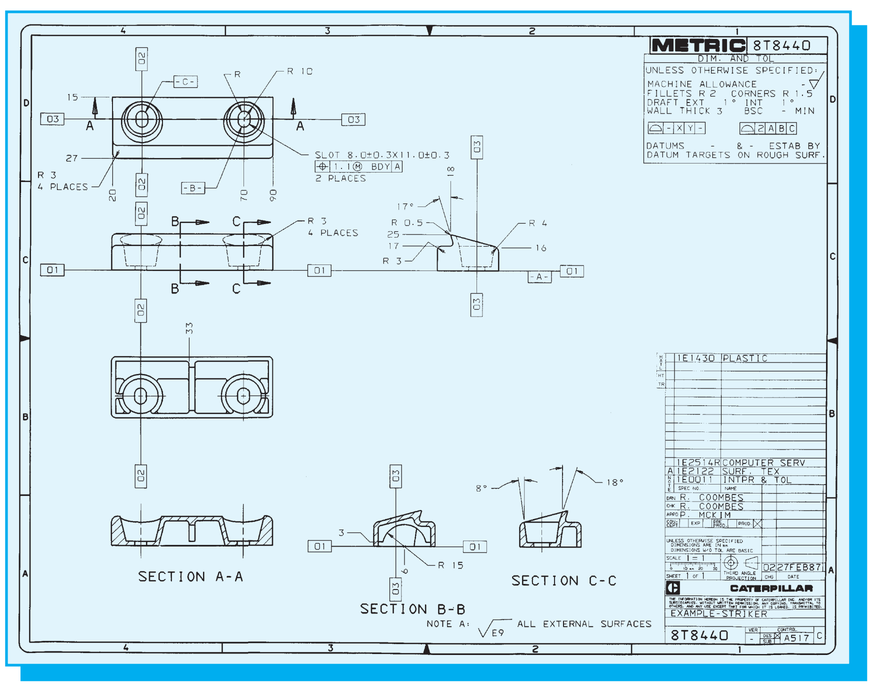


Figure 3-1
No manual drafting was required for this CAD-generated working drawing. *(Courtesy of Caterpillar Inc.)*

Observe how the sketch shown in **Figure 3-2** is used to describe the object shown in **Figure 3-3**. This is another example of the proverb, "A picture is worth a thousand words."

Supplies

Sketching supplies consist of a wide variety of pencils, erasers, and drawing media. Soft pencils in the range shown in **Figure 3-4** are used for sketching. Pencil points **(Fig. 3-5)** are rounded for sketching compared to the sharp points used for instrument drawing. However, sharp points on soft pencils are used for layout and lettering guide line sketching. Chisel points are used for shading. Sketching pencils are sharpened with a mechanical sharpener, or with a knife and file, or sandpaper to shape the point.

Although many types of drawing media are used for technical sketching, **grid paper** is the most practical and easy to use **(Fig. 3-6)**. Grids provide **guide lines** for rough scaling and proper alignment of perpendicular and parallel lines. Use light-colored surfaces if sketches are to be photocopied, and use translucent surfaces if diazo prints are to be made. Translucent surfaces are also helpful if progressive design sketches are to be traced.

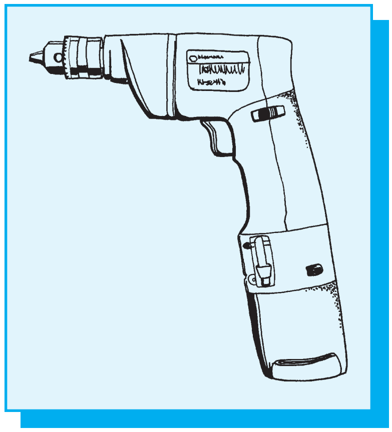


Figure 3-2
A freehand sketch is worth a thousand words.

Figure 3-3
An industrial product
(Courtesy of Black and Decker U.S. Power Tools Group)

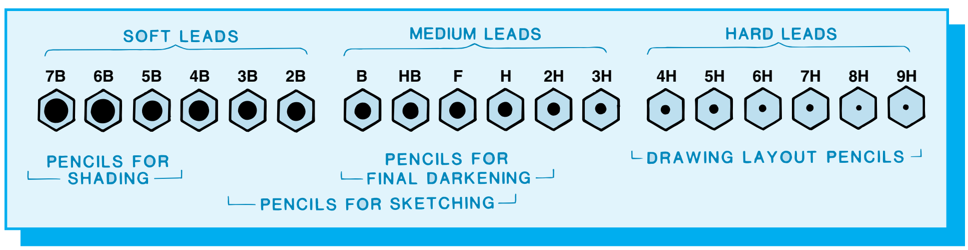


Figure 3-4
Recommended pencil grades for sketching

Figure 3-6
Drawing on grid paper is faster and neater.
(Photo by Ann Ross Wallach)

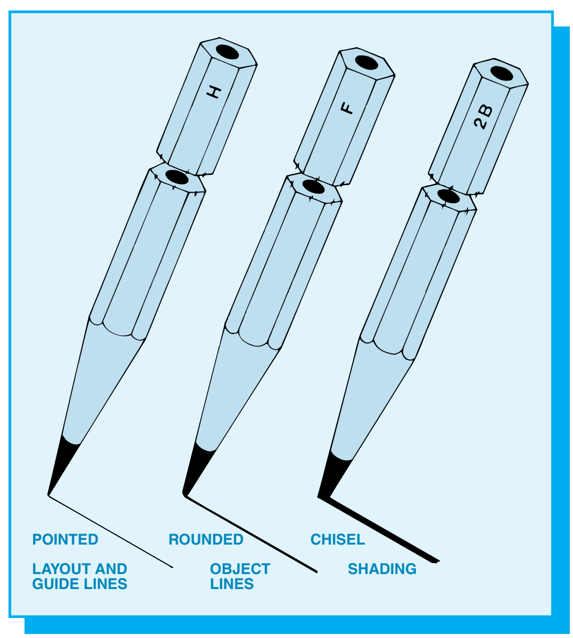


Figure 3-5
Recommended pencil points for sketching

Working Drawing Sketches

Working drawing sketches are used as the major design reference in manufacturing and construction. Sketches are also used as working drawings when time and conditions preclude the preparation of instrument or CAD working drawings. These sketches are usually orthographic multiview drawings, but they are sometimes prepared as pictorial drawings. An **orthographic** drawing shows several views of an object on a drawing surface that is perpendicular to both the view and the lines of projection. A **pictorial** drawing shows an object's depth; three sides of an object can be seen in one view.

Orthographic Multiview Sketches

Multiview sketches provide the greatest amount of detail for manufacturing and construction. **Figure 3-7** shows the steps recommended to complete a multiview sketch. As with instrument drawing (see Chapter 18), blocking in the overall outline before completing the internal details is the key to maintaining correct scales, angles, and proportions.

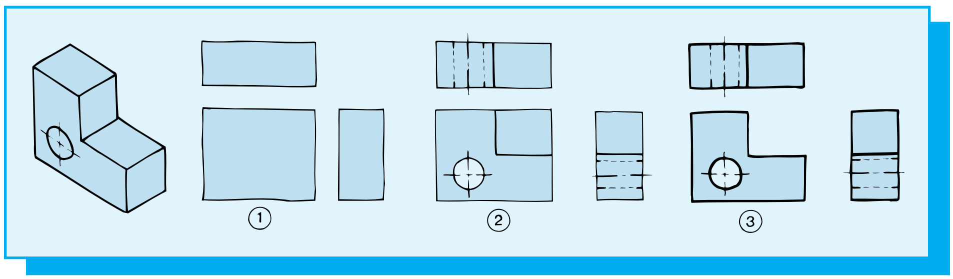


Figure 3-7
Steps to sketch a multiview drawing

Pictorial Sketches

Blocking in the basic outline is also the recommended procedure for pictorial sketches. There are three types of pictorial sketches: isometric, oblique, and perspective.

Isometric sketches are prepared by establishing a vertical corner line and projecting receding lines 30° **(Fig. 3-8)**. As with multiview sketches, always block in the entire outline of the object before cutting corners or adding surface details such as holes and projections.

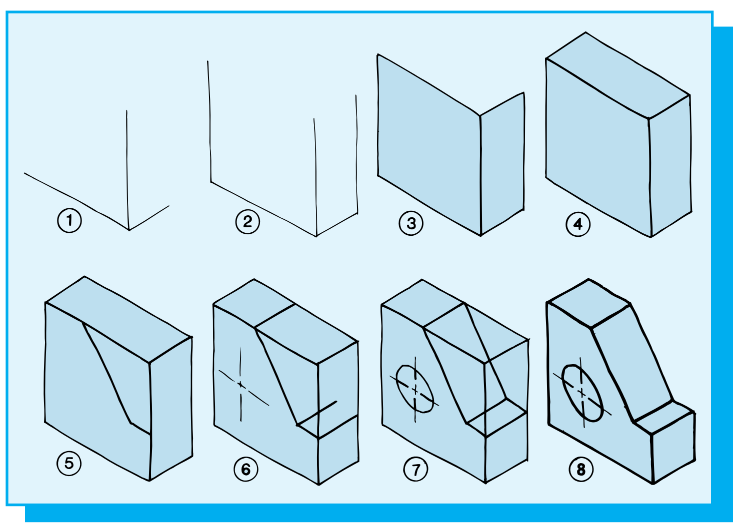


Figure 3-8
Steps to sketch an isometric drawing

Oblique sketches are pictorials that recede on only one side of an orthographic view. In preparing an oblique sketch, first sketch a front view of the object **(Fig. 3-9)**. Then extend lines from each corner upward at 45° or 30°. Connect the ends of these lines with lines that are parallel to the lines of the front view. Oblique sketches are easy to dimension since the width and length of the front view are sketched to actual scale. Only the depth dimension is foreshortened by the receding lines.

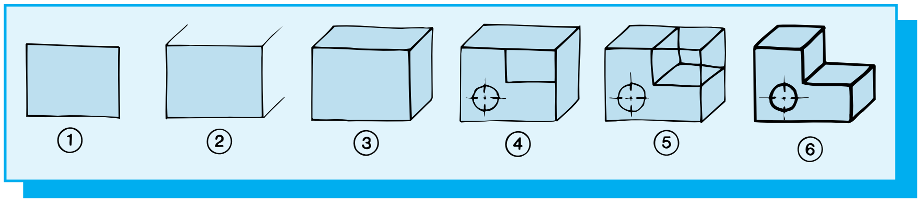


Figure 3-9
Steps to sketch an oblique drawing

Perspective sketches are pictorials that contain receding sides designed to approximate the actual appearance of an object. There are three types of perspectives: one-point, two-point, and three-point.

1. **One-point perspective** sketches are similar to oblique drawings, except the receding lines do not follow a consistent angle. Receding lines are connected to a **vanishing point.** A vanishing point represents the point at which all receding lines appear to come together. It is similar to road or train tracks disappearing on the horizon. In sketching a one-point perspective, first outline the front view, as in oblique sketching. Establish a vanishing point and sketch lines from each corner to this point **(Fig. 3-10)**. Sketch lines representing the back of the object parallel to the lines on the front view. This blocks in the sketch. Now any angular cuts and details can be added.

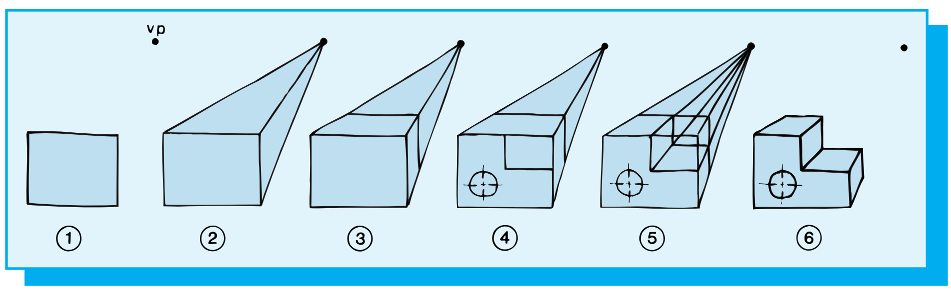


Figure 3-10
Steps to sketch a one-point perspective drawing

2. **Two-point perspective** sketches are similar to isometric sketches, except side lines recede to two vanishing points. First sketch the front vertical corner **(Fig. 3-11)**. Establish two vanishing points above or below the front corner line, and connect the top and bottom of the front corner line to each of these points. Vanishing points on two-point perspective sketches must always be located on a horizontal line representing the horizon. Next, establish the depth of the sides and connect the

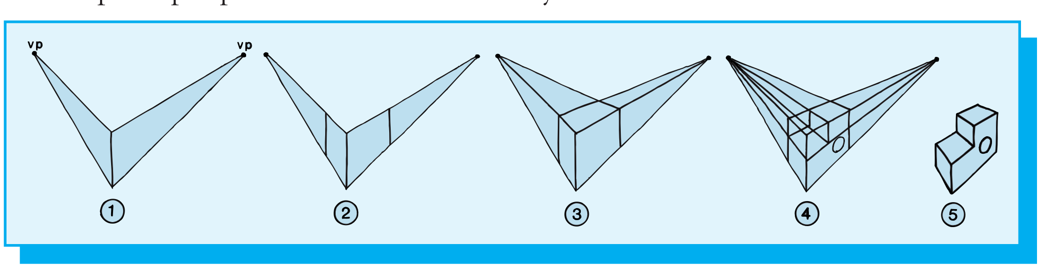


Figure 3-11
Steps to sketch a two-point perspective drawing

back corner lines also to the vanishing points. In two-point perspectives, vertical lines are all parallel.

3. In **three-point perspectives,** vertical lines are projected to a third vanishing point that is aligned with the vertical front corner line. Three-point perspectives are usually used for architectural pictorials, and rarely for technical drawings.

Sketching Guidelines and Procedures

Line conventions and lettering for technical sketches are similar to those used for instrument drawings **(Fig. 3-12)**. Sketching standards differ only in the degree of line raggedness. Lines are dark and wide for object lines, dark and thin for dimension and center lines, and thin and light for layout and guide lines. **Figure 3-13** shows the application of line conventions to a technical sketch.

All sketches are comprised of straight lines, circles and arcs, irregular curves, and letters and numerals **(Fig. 3-14)**. Sketches cannot be prepared with the precision and accuracy of an instrument or CAD drawing. Care must be taken to insure that dimensions are relatively proportional. If dimensional proportions are grossly inaccurate, the sketch will misrepresent the actual appearance of the object **(Fig. 3-15)**.

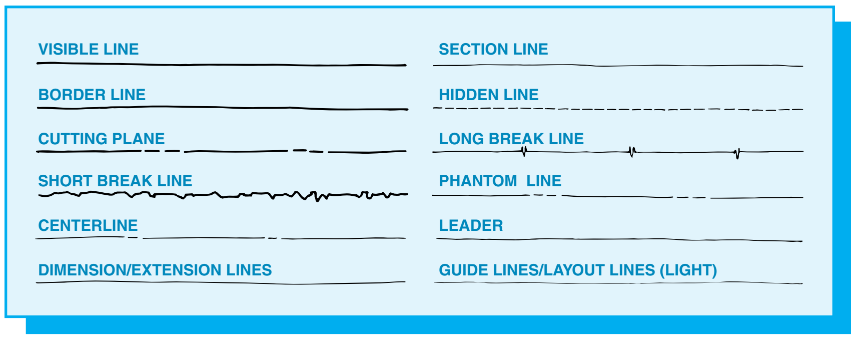


Figure 3-12
Line conventions for sketching working drawings

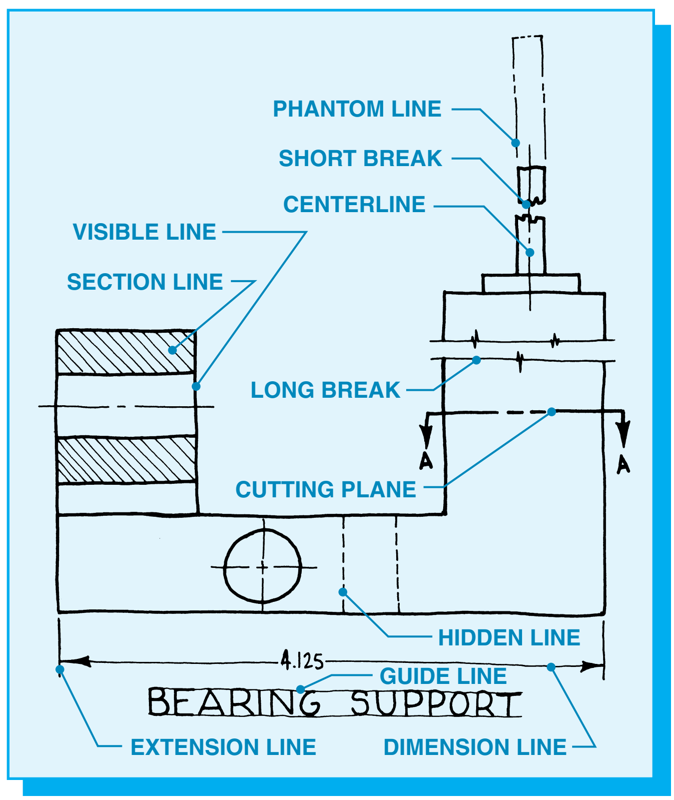


Figure 3-13
Using line conventions on a working drawing

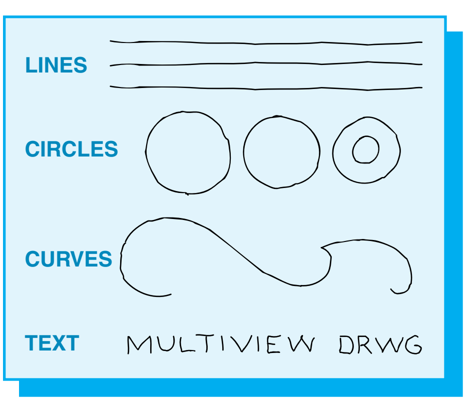


Figure 3-14
Four basic drawing forms make up all drawings.

When sketching straight lines, squares, and rectangles, use short strokes. Do not attempt to draw continuous lines. Right-angle lines, unless sketched on grid paper, should be laid out and sketched **(Fig. 3-16)**.

Circles and arcs can be accurately and symmetrically sketched by following the sequence shown in **Figure 3-17a**. Just as the circle was derived from the square in **Figure 3-17a**, all fillets and rounds should first be blocked in square, as shown in **Figure 3-17b**. By following this procedure, proper proportions and symmetry can be maintained.

The procedure and sequence for sketching ellipses is similar to circle sketching **(Fig. 3-18)**. Sketching accurate angles, other than right angles (90°), can be difficult without using a triangle or protractor; however, by estimating and dividing a right angle into even angles, you can achieve an acceptable level of accuracy **(Fig. 3-19)**.

When sketching, hold the pencil comfortably **(Fig. 3-20)** and pull it **(Fig. 3-21)**, never push it. To maintain a consistently rounded point and avoid wearing a flat chisel point, rotate the pencil frequently **(Fig. 3-22)**. When erasing soft pencil sketches, use a good quality medium-soft eraser.

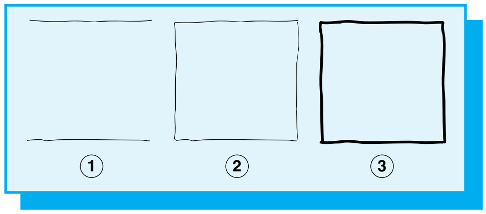


Figure 3-16
Sketching straight lines, squares, and rectangles

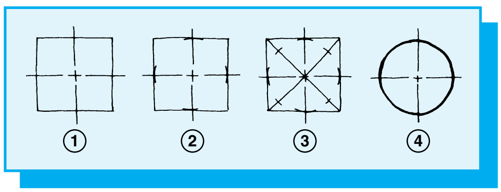


Figure 3-17a
Sketching circles

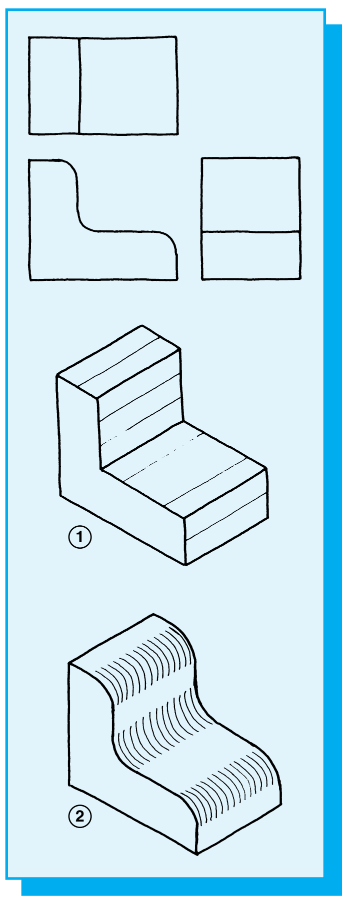


Figure 3-17b
Sketching fillets and rounds

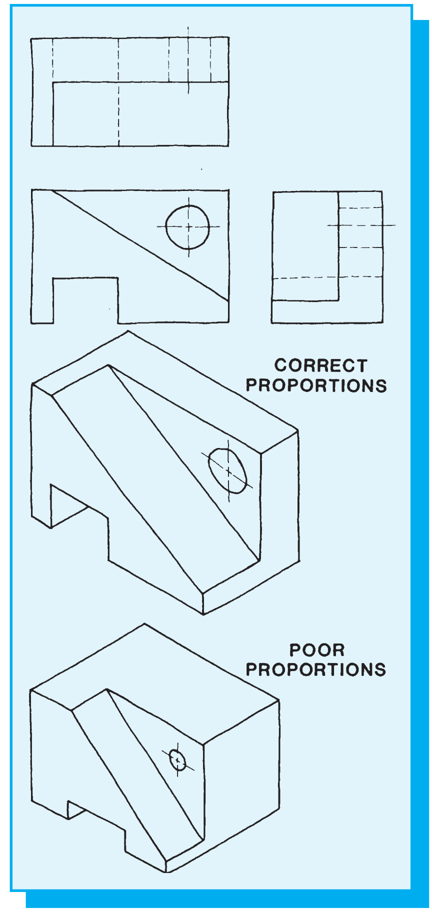


Figure 3-15
Well-proportioned drawings have superior communication.

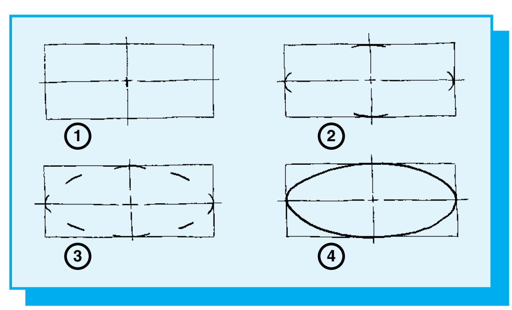


Figure 3-18
Sketching ellipses

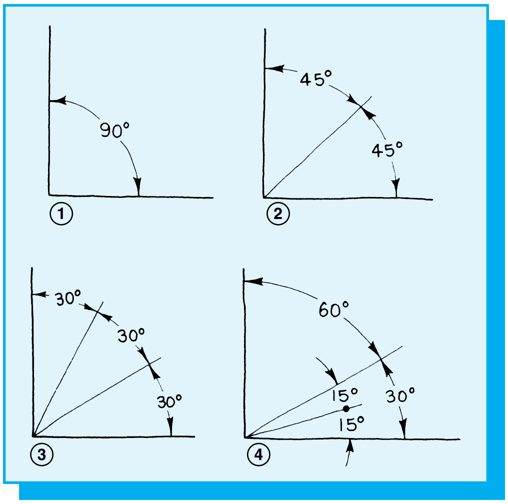


Figure 3-19
Sketching and estimating angles

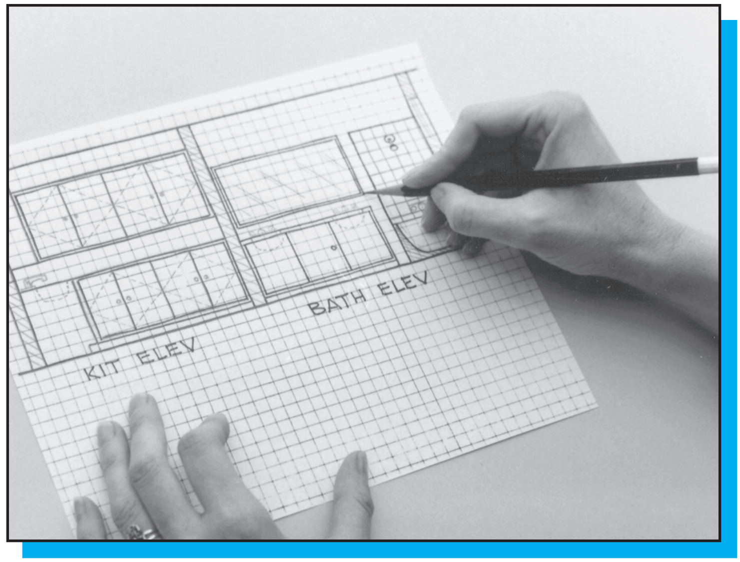


Figure 3-20
Use a comfortable pencil grip for sketching.
(Photo by Ann Ross Wallach)

Shading

Surfaces exposed to a major light source will appear bright. Conversely, surfaces not directly exposed to a light source will be shaded; therefore, adding shading to sketches creates realism **(Fig. 3-23)**. In **Figure 3-23**, the light source is located above and to the left of the object. The opposite areas are shaded because direct light is blocked from these surfaces. **Figure 3-24** shows techniques for shadowing (**shading**) these areas.

Surfaces are rarely totally hidden from a light source. Some surfaces are very light, very dark, or appear in a variety of shadow grades depending on the position, intensity, and number of light sources. **Figure 3-25** shows an object with three light levels: light, medium, and dark. In addition, this figure shows a separate shadow cast by the object.

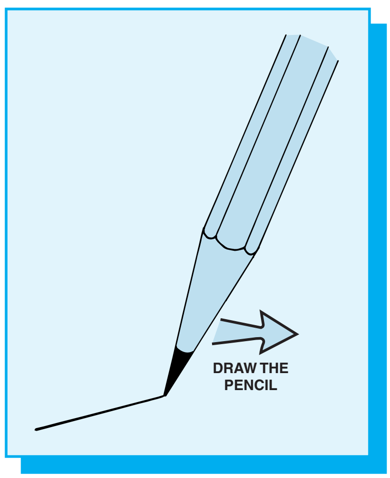


Figure 3-21
Always pull the pencil—never push it.

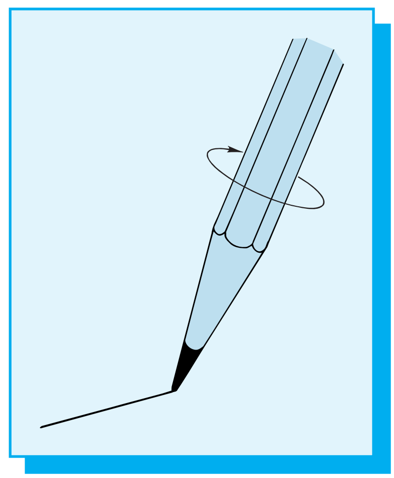


Figure 3-22
Rotate the pencil frequently for rounded points.

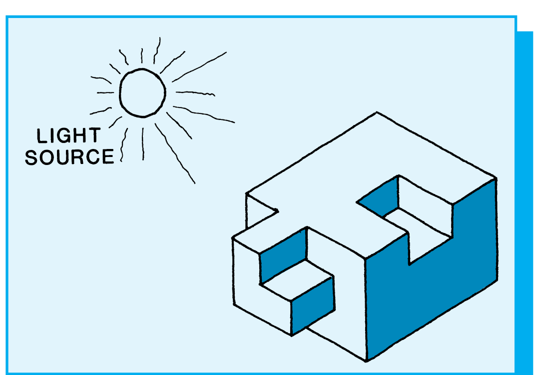


Figure 3-23
Shade (darken) the surfaces opposite the light source.

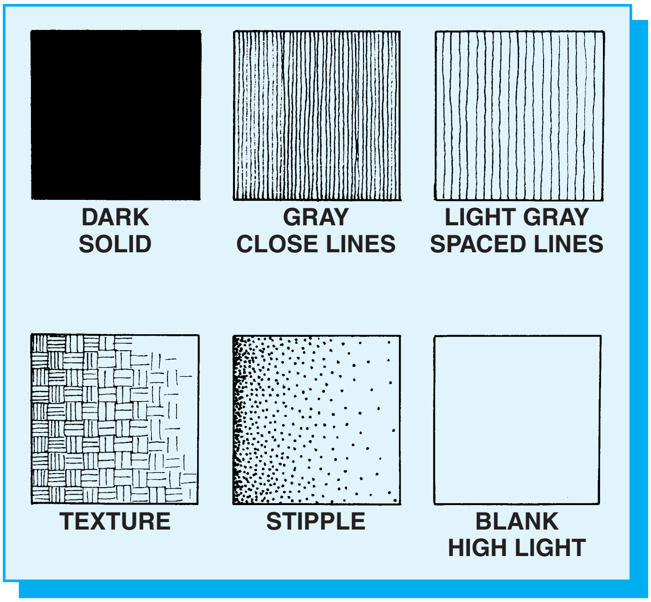


Figure 3-24
Shading techniques

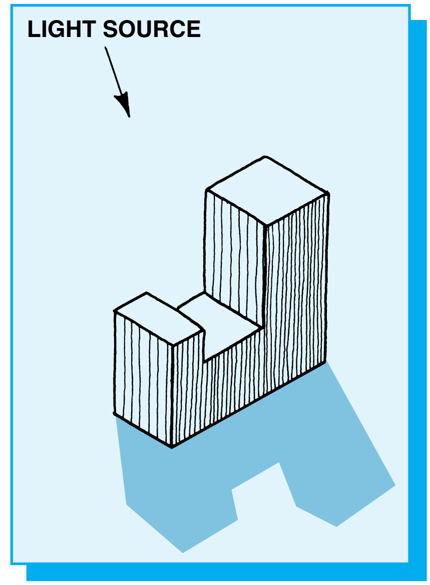


Figure 3-25
The light source dictates the position of the shadows.

Light travels in a straight line and cannot bend around corners unless reflected; therefore, light intensity on surfaces always changes at the corners of objects. **Figure 3-26** shows several methods of sketching these differences to add realism to a sketch. On objects without corners, such as spheres and cylinders, light and dark areas change gradually. **Figure 3-27** shows several methods of shadowing a cylinder sketch to add realism.

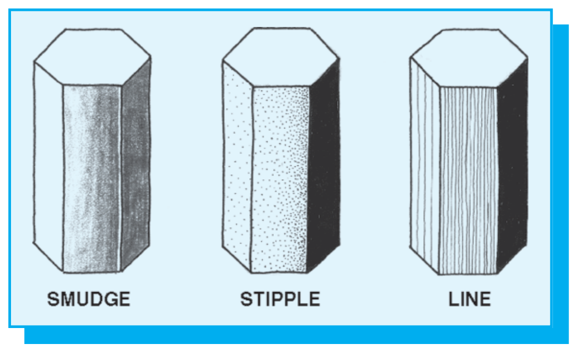


Figure 3-26
Freehand shading of sharp corners

Dimensioning

When sketches are used for instruction, manufacturing, or construction, dimensions are usually necessary to adequately describe the object. When sketches are dimensioned, the overall width, depth, and height dimensions are placed on the outside of the **location dimensions (Fig. 3-28)**. These are known as **overall dimensions**. Dimension lines are sketched parallel to object lines and connected to the object with extension lines and arrows. Location dimensions show the location of parts of an object. **Size dimensions** show the size of any hole or projection on the object and are placed between the object and the overall dimension lines. Dimensions are usually shown on multiview sketches. Pictorial sketches **(Fig. 3-29)** are normally used only to show the general appearance of products and do not require dimensions.

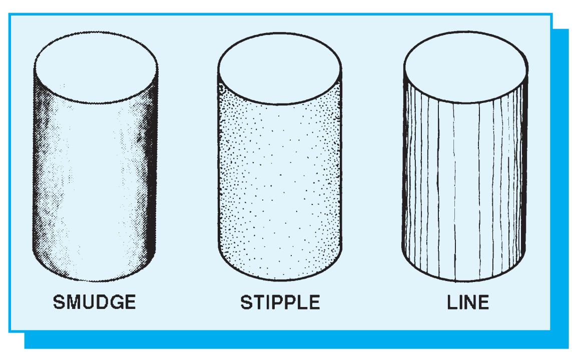


Figure 3-27
Freehand shading of rounded surfaces

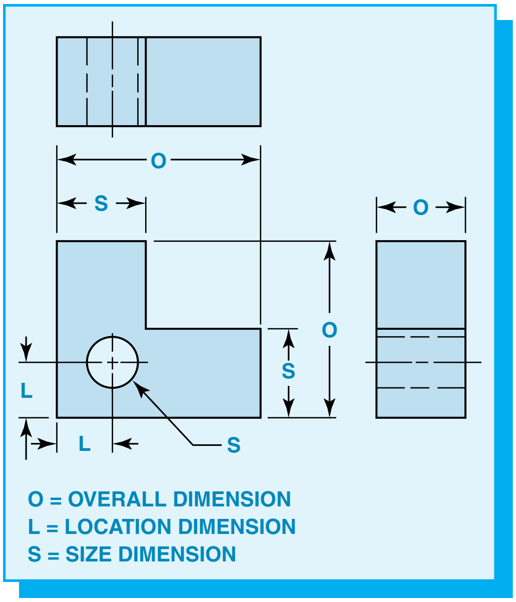


Figure 3-28
Types of dimensions

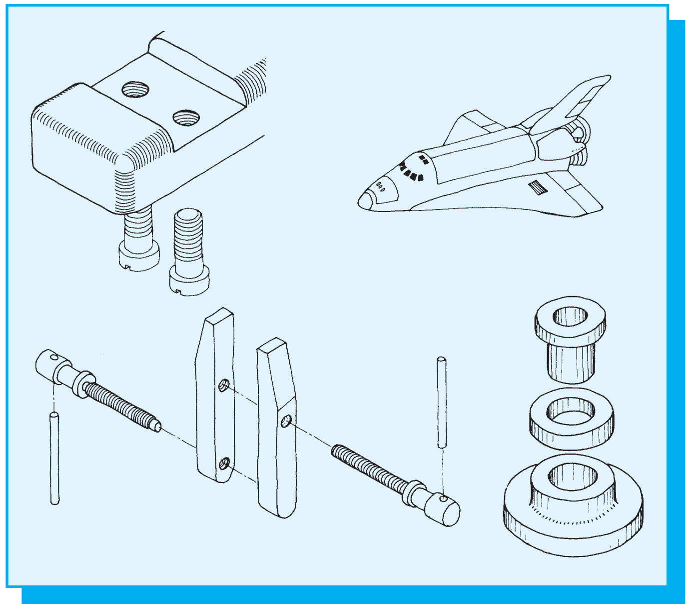


Figure 3-29
Examples of pictorial sketches

Lettering

Some information is best communicated with words or numerals. Almost every sketch or drawing contains notes, labels, and dimensions that must be legible and consistent. In **Figure 3-30**, the title, material, and hole size are described with a lettered notation. Each numeral used for dimensioning must be distinct from all other numerals. The letter *D* which looks like an *O*, or the numeral *3*, which looks like an *8*, can be easily misread and create costly manufacturing or construction mistakes. For this reason, the **American Society of Mechanical Engineers (ASME)** style of letters and numerals **(Fig. 3-31)** is used by most American industries. **Figure 3-32** shows the most efficient and quickest method of making these letters and numerals. A slanted form of this style **(Fig. 3-33)** is acceptable but is rarely used or recommended for engineering drawings.

To letter most efficiently and legibly, always use guide lines **(Fig. 3-34)**. Guide lines keep letters consistent and contained in the area selected. As a general rule, most lettering is 1/8" high with 3/16" high title headings. Drawings to be microfilmed should be 3/16" or 1/4" high, using the **microfont** style shown in **Figure 3-35**.

Correct spacing between letters is also needed to produce lettering that is most readable. **Figure 3-36** shows lettering that has the area between the letters approximately equal. By contrast, **Figure 3-37** shows wide and inconsistent spacing of letters. Notice how difficult it is to quickly read **Figure 3-37** compared to **Figure 3-36**. Spacing between words and sentences is also important for effective reading.

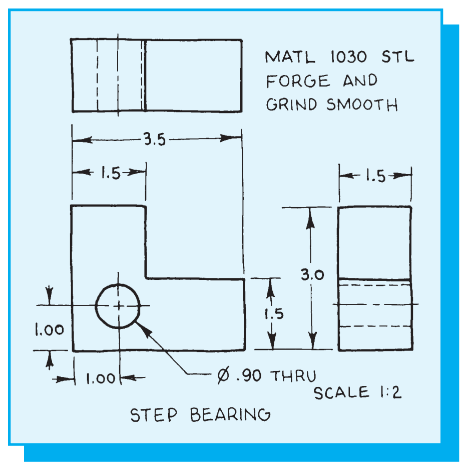


Figure 3-30
Working drawing sketch with dimensions and notations

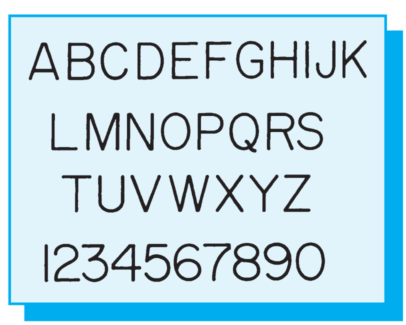


Figure 3-31
Single-stroke vertical Gothic lettering (ASME standards)

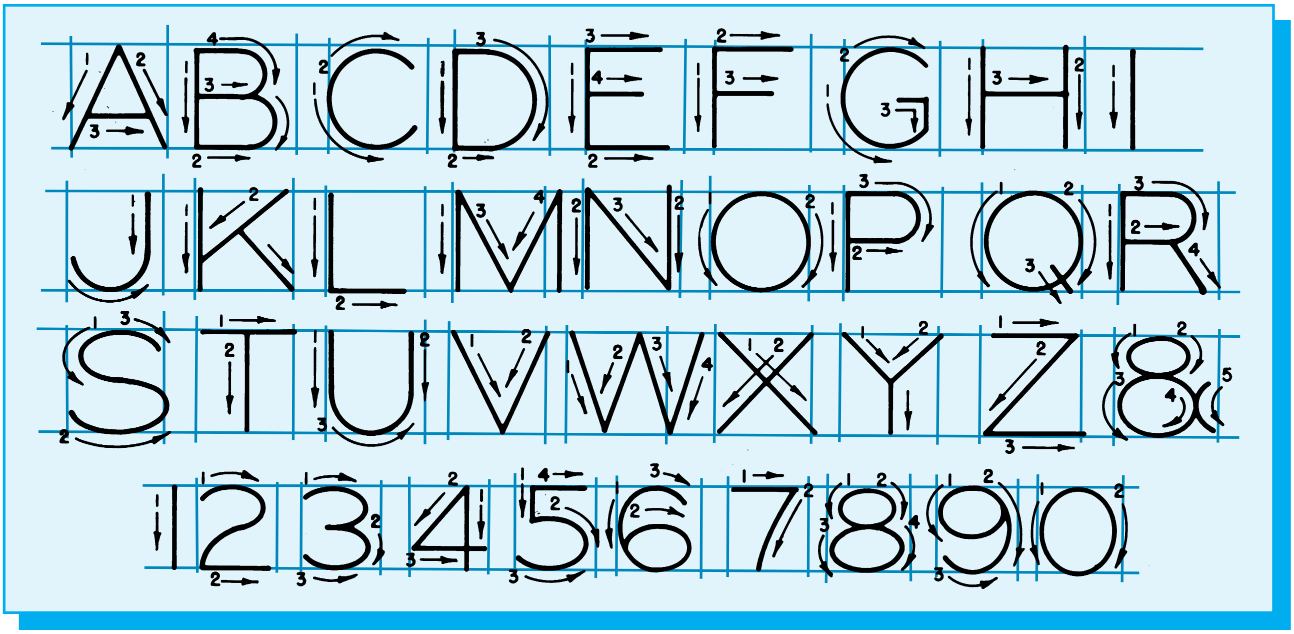


Figure 3-32
Recommended lettering strokes

Figure 3-33
Single-stroke slant (68°) Gothic lettering

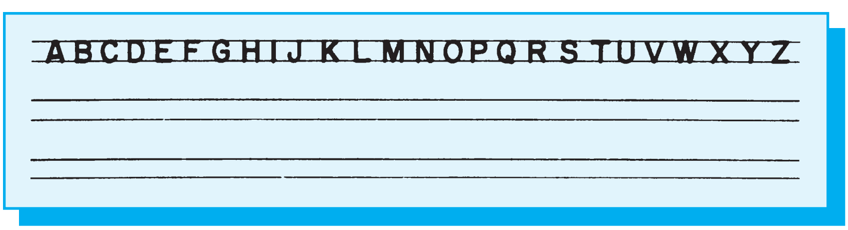


Figure 3-34
Guide lines will aid freehand lettering.

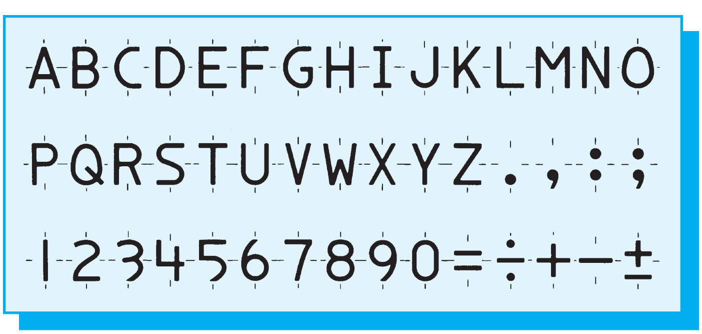


Figure 3-35
Microfont lettering is recommended if drawing is to be microfilmed.

The space between words should be approximately equal to the height of the letters. The space between sentences should be twice the height of the letters **(Fig. 3-38)**.

Fractions are among the most frequent causes of dimensional errors. If a numerator or denominator is misread as a whole number, the result can be disastrous. For this reason, the ASME spacing for fractions **(Fig. 3-39)** should be used to avoid confusion.

When all of the procedures and guidelines for sketching are combined, the result can be a readable and functional technical sketch as shown at the left in **Figure 3-40**. If these guidelines are ignored, the confusing series of lines and letters shown at right in **Figure 3-40** can result.

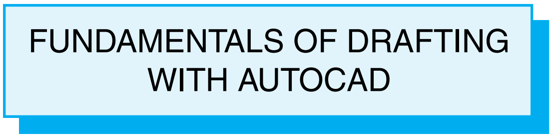


Figure 3-36
The area between letters should be as equal as possible.

Figure 3-37
Inconsistent areas between letters create reading difficulties.

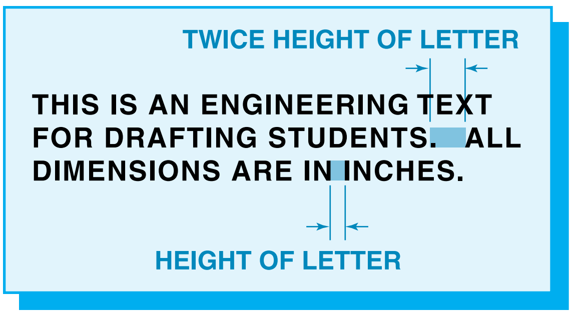


Figure 3-38
Spacing between words and sentences

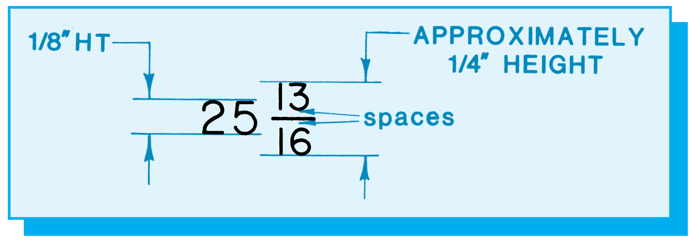


Figure 3-39
Fractions on the working drawing

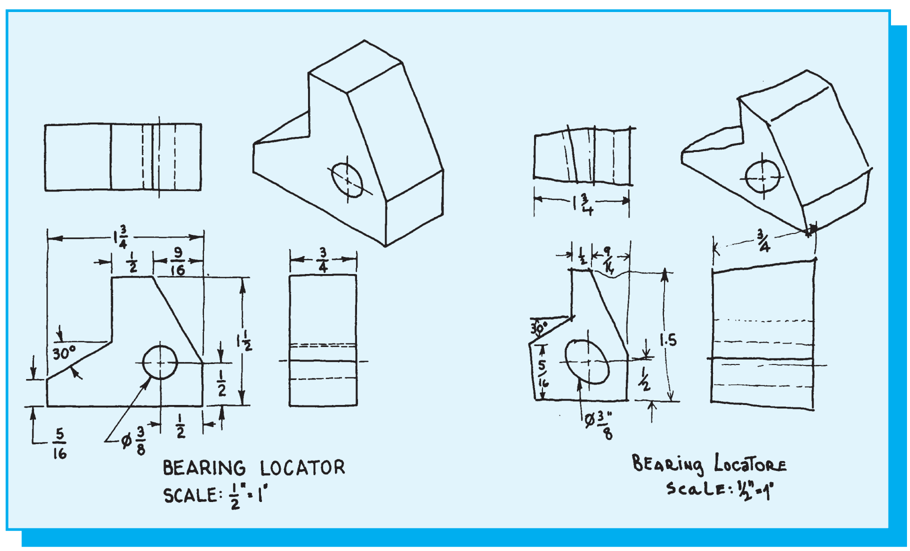


Figure 3-40
Which sketch gives better communication?

1. Sketch the isometric drawings in **Figures 3-41** through **3-47** on isometric grid paper.
2. Sketch the multiview drawings in **Figure 3-48**.
3. Sketch the pickup truck in **Figure 3-49**.
4. Sketch the objects in **Figure 3-50**.
5. Sketch the tool-bit holder in **Figure 3-51**.
6. Practice lettering single-stroke Gothic lettering on 1/8" grid paper.
7. Practice placing various types of fonts in different sizes and angular positions with a CAD system.

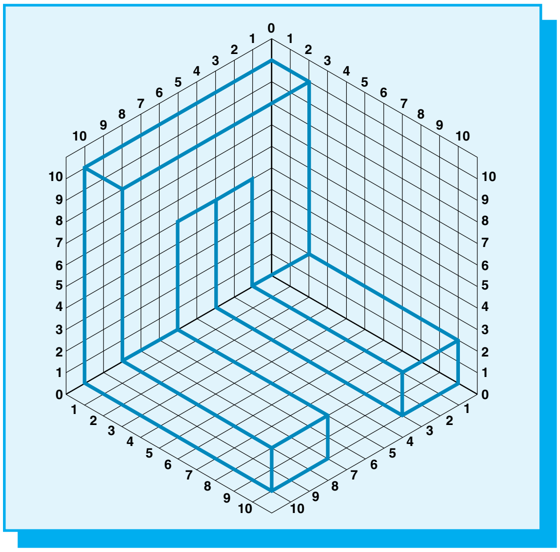


Figure 3-41

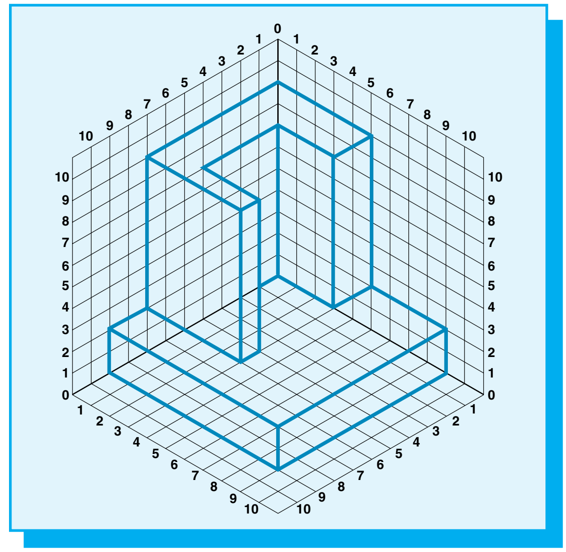


Figure 3-42

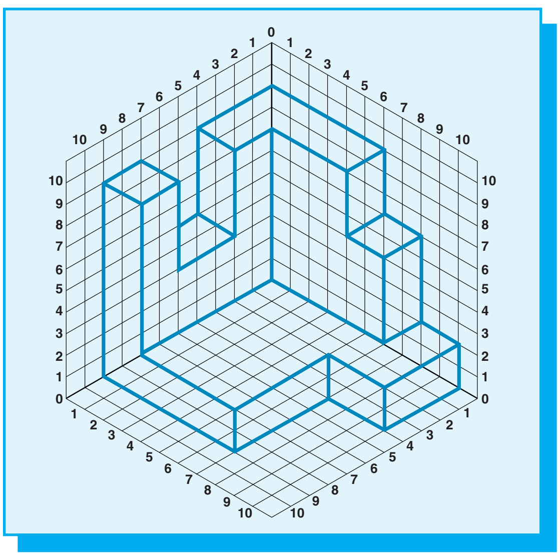


Figure 3-43

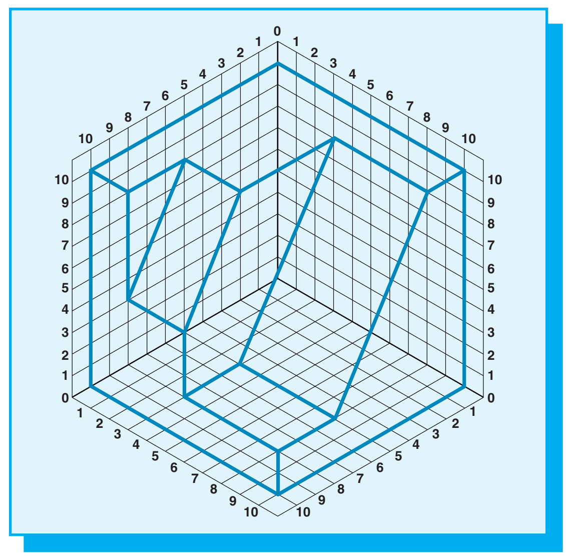


Figure 3-44

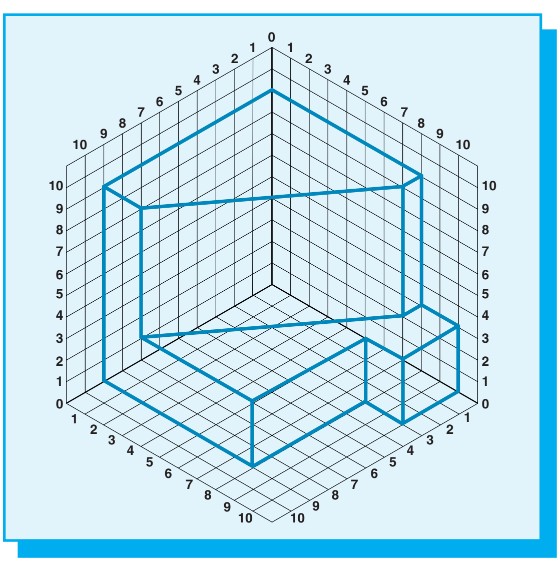


Figure 3-45

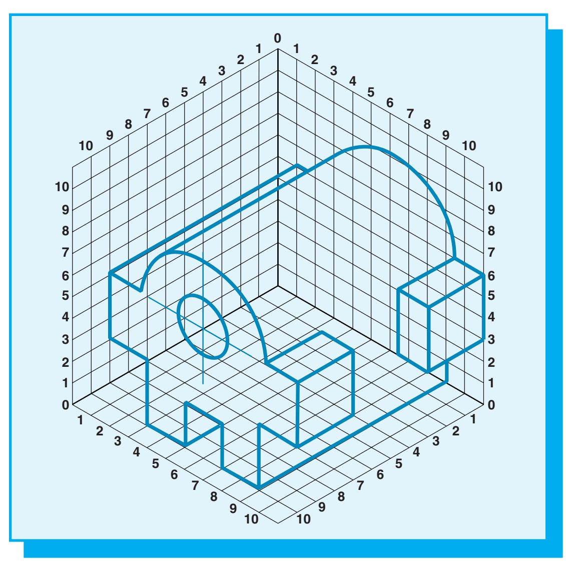


Figure 3-46

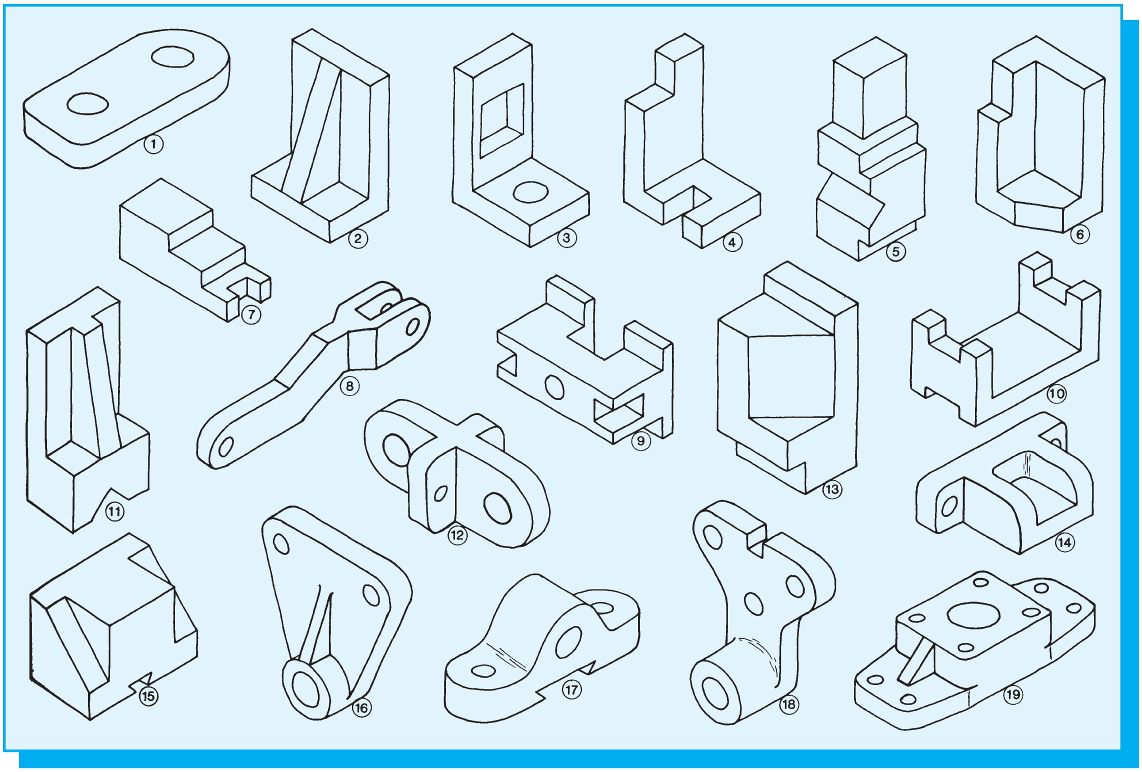


Figure 3-47
Isometric sketching practice

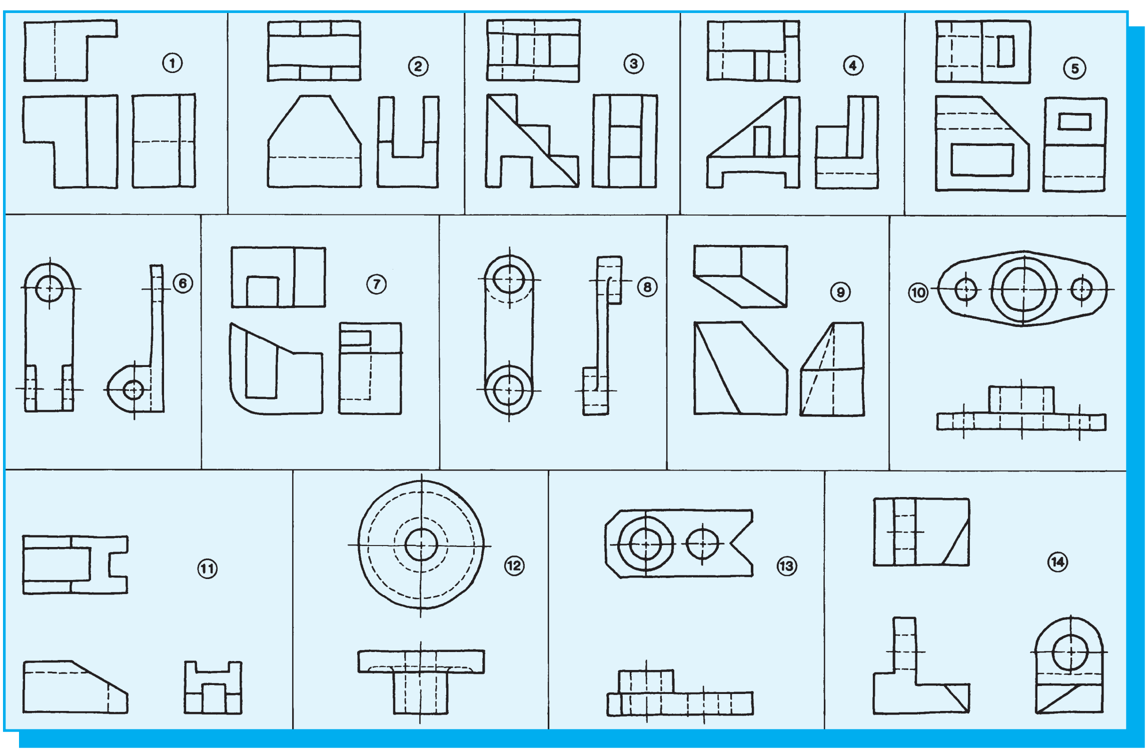


Figure 3-48
Orthographic multiview sketching practice

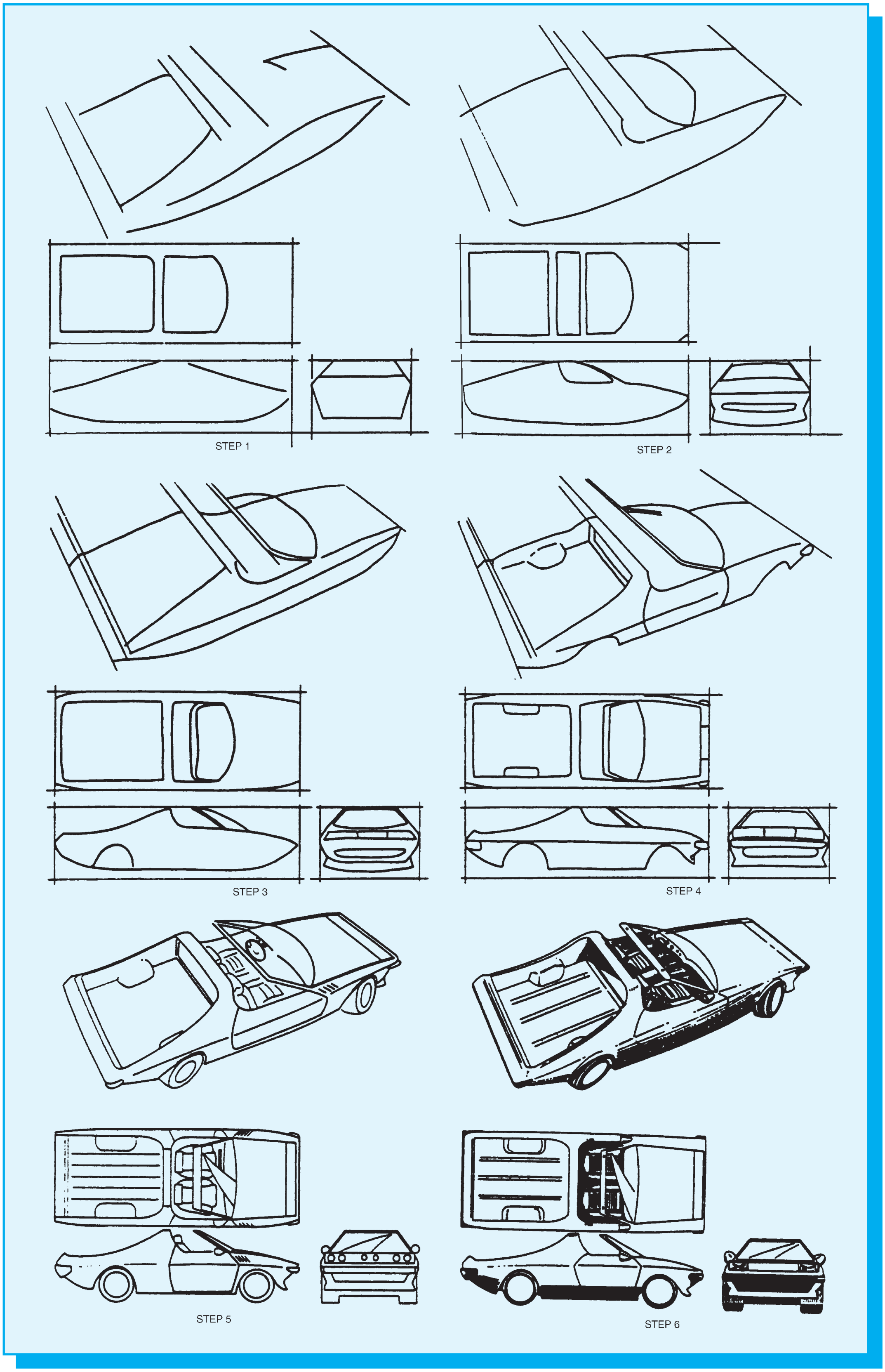


Figure 3-49
Follow the steps to sketch the pickup.

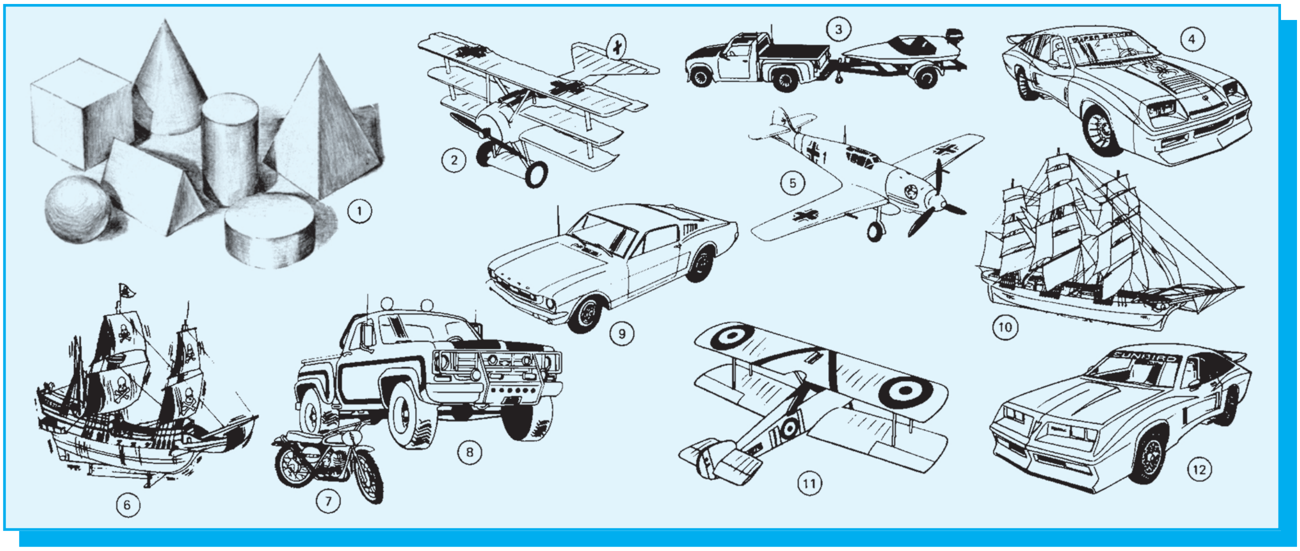


Figure 3-50
Sketching practice with real objects

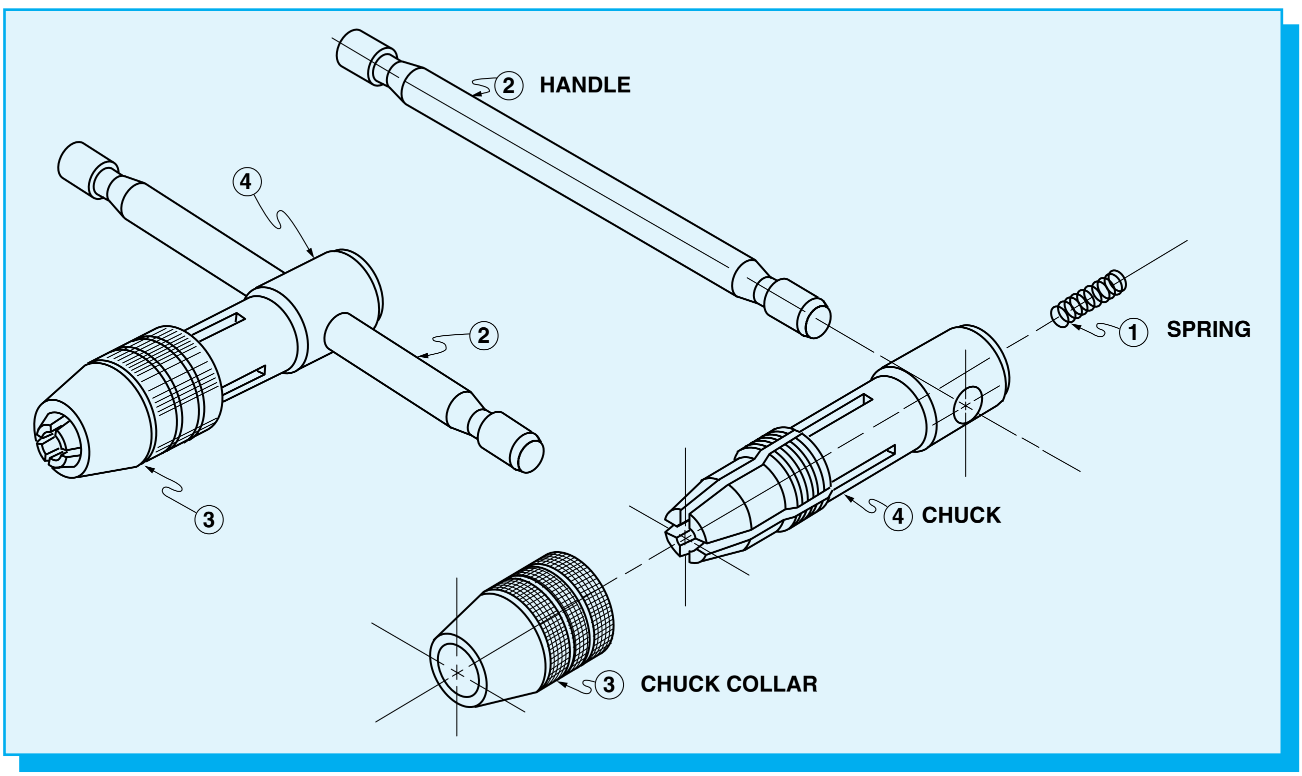


Figure 3-51
Sketch the tool-bit holder.

Design Exercises

1. Redesign and sketch the hexagon wrench in **Figure 3-52**.

2. Sketch the bookend in **Figure 3-53** and design your stylized initials into the surface.

3. Design a new tent stake as specified in **Figure 3-54.**

4. Select one or more of the industrial products in **Figure 3-55** and sketch a new design.

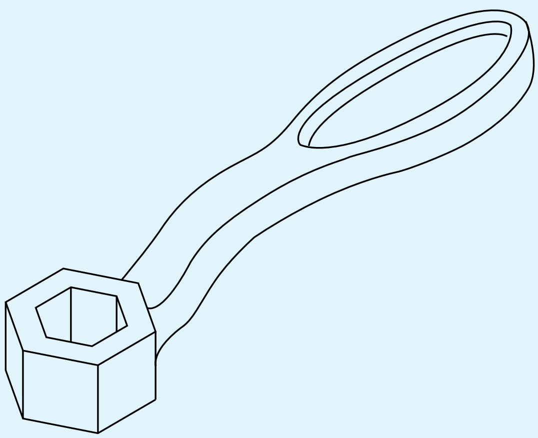


Figure 3-52
Redesign and sketch the hexagon wrench.

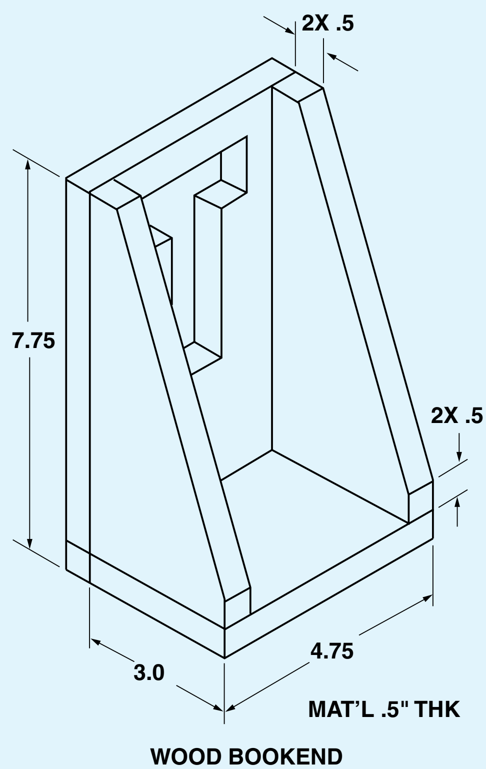
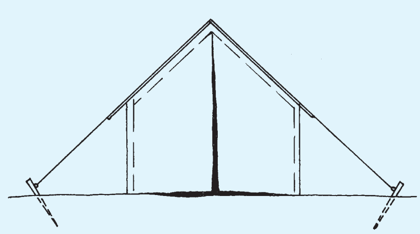


Figure 3-53
Sketch the bookend with your initials.



DESIGN AND DRAW A WORKING DRAWING FOR A TENT STAKE. ITS DESIGN REQUIREMENTS ARE:
1. Easy to store
2. Easy to pound into the ground
3. Easy to attach a rope
4. Will not pull out of the ground in heavy winds
5. Will not injure or cut a person's leg if they stumble over it.

Figure 3-54

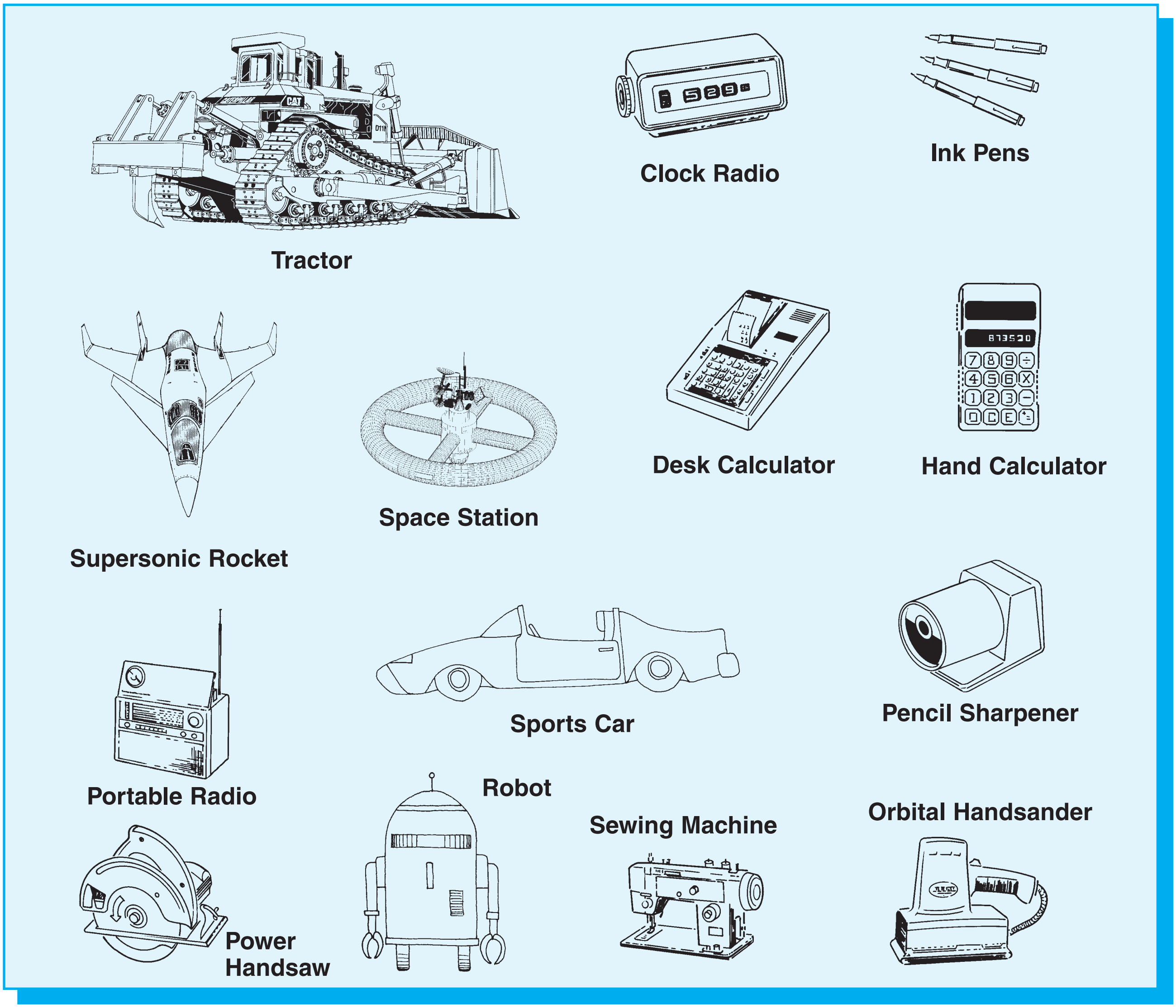


Figure 3-55
Sketch a new design for one or more of these industrial products.

American Society of Mechanical Engineers (ASME)
Grid paper
Guide lines
Isometric
Line conventions
Location dimensions
Microfont
Multiview
Oblique
One-point perspective
Orthographic
Overall dimensions
Perspective
Pictorial
Shading
Size dimensions
Three-point perspective
Two-point perspective
Vanishing point
Working drawing