

the advantages of freehand sketching is that it requires only paper and pencil—items that anyone has for ready use. However, the type of sketch you make, and your personal preference will determine the materials you use.

A soft-lead pencil is best for sketching, somewhere in the grade range from F to 3H, with H being a good grade for most sketching. The pencil should be long enough to permit a relaxed, but stable, grip. As you gain experience, you may prefer to use fine-tip felt pens. (Dark or bright colored pens work best.) A felt-tip pen works very well on overlay sketches, described in the next paragraph.

You will draw most of your sketches on scratch paper, which can be any type or use. A 3 in. × in. or 5 in. × 8 in. scratch pad is handy to carry in a toolbox. Tracing paper is convenient to carry, too, for planning the layout of a drawing. The advantage of sketching on tracing paper is that you can change or redevelop sketches easily, simply by placing transparent paper over (overlying) your previous sketches or existing drawings. Sketches prepared in this manner are called *overlay sketches*. You can also use cross section or graph paper (see Fig. 8-1) to save time if you must draw sketches to scale. Isometric sketches are easily made on specially ruled isometric paper, as shown in Fig. 8-2. You may want to carry a pink rubber eraser too, although you will probably do very little erasing of final lines. You can usually redraw sketches faster than you can erase them. To make dimensioned sketches, you will want to carry some sort of measuring instrument, such as a rule or metal tape.

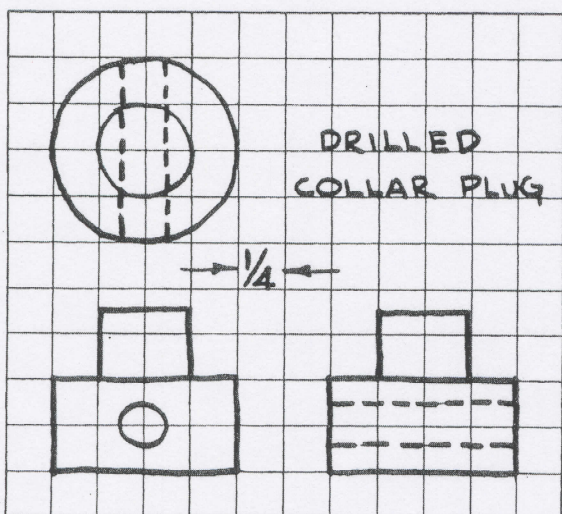


Figure 8-1 Cross section paper.

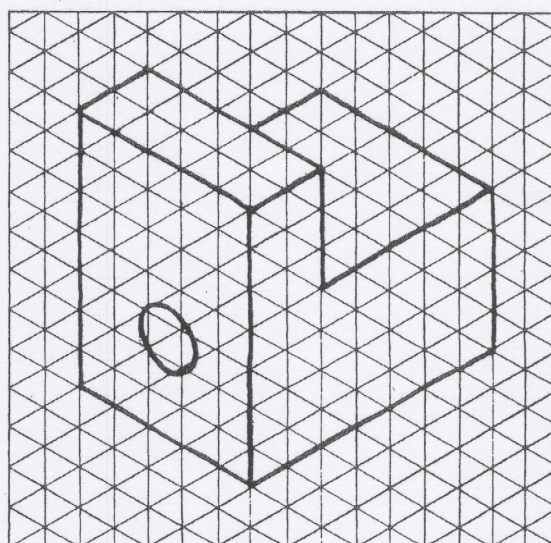


Figure 8-2 Ruled isometric paper.

### SKETCHING LINES AND CURVES

All sketches consist of straight and curved lines. The main difference between freehand sketches and mechanical drawing is in the techniques used to make the lines and curves on the paper.

#### Straight Lines

No one can draw a perfectly straight long line, but anyone can draw a straight short one—about 1 1/2 in. long. To draw a long line, place a dot at the beginning and end, and several in between. Then, simply connect the dots using a series of short pencil strokes, instead of one long one. By using short strokes, you can better control the direction of the line and the pressure of



the pencil on the paper. Hold the pencil about  $\frac{3}{4}$  in. to 1 in. from its point so that you can see what you are doing. Try to make free and easy back-and-forth movements, rather than tightening up your finger and wrist muscles into a cramped position. In other words, *relax*.

To keep your sketch neat, draw your lines lightly first. Lines not essential to the drawing can be sketched so lightly that you need not erase them. Later, when you have drawn what you wanted to, darken the essential lines by running the pencil over them using more pressure.

Drawing horizontal lines is easier for many people than drawing vertical or diagonal lines. If this is the case with you, draw all horizontal lines first, then rotate the paper 90 degrees or less, as required, and draw the vertical and diagonal lines as if they were horizontal.

#### Dividing Lines and Areas Equally

You must be able to divide (bisect) lines and areas into equal parts to arrive at many of the common geometric figures that make up parts. The easiest way to bisect lines is by visual comparison, as shown in Fig. 8-3. Simply "eyeball" the entire line, and determine its center by optically comparing the two halves. You can repeat this procedure any number of times to divide a line into any number of equal parts, merely by dividing and redividing the line segments.

You can easily determine the centers of rectangular areas by first drawing their diagonals. If necessary, you can also divide the halves with diagonals to obtain smaller divisions, as shown in Fig. 8-4.

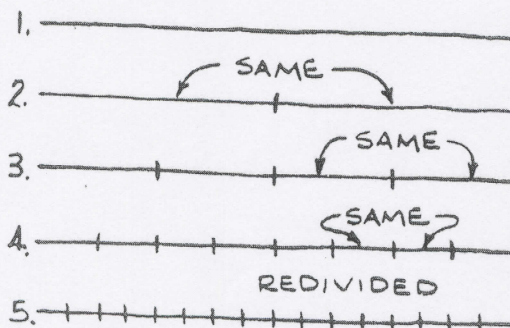


Figure 8-3 Bisecting a line by visual comparison.

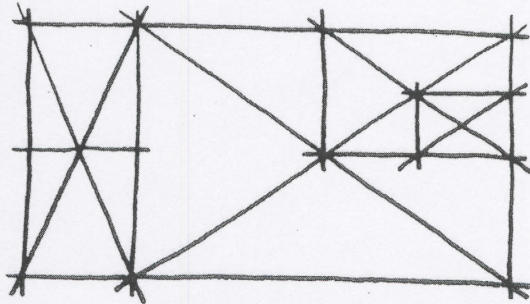


Figure 8-4 Finding the centers of rectangles by drawing diagonals.

#### Sketching Angles

You will require the 90 degree angle in many of your sketches. Use the perpendicular edges of your paper to serve as a visual guide when drawing them. Check their accuracy by turning your sketch upside down. This makes evident any non-perpendicular tendencies of horizontal and vertical lines. Check your 90 degree angles with a triangle occasionally to make sure you are drawing them correctly.

You can make a 45 degree angle by dividing a right angle using visual comparison, and you can make a 30 degree or 60 degree angle by dividing the right angle into equal parts in the same way (see Fig. 8-5). By starting with a right angle, you can make the most accurate estimate of the shape of any angle that divides into 90 degrees equally.

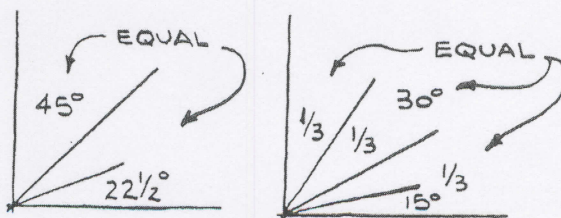


Figure 8-5 Sketching angles by visual comparison.



### Sketching Circles and Arcs

Perfectly round circles are the most difficult to draw freehand. However, Fig. 8-6 shows how to draw both circles and arcs, using straight lines as construction lines. First, draw two straight lines crossing each other at right angles as in Fig. 8-6A. Their intersection is the center of the circle. Mark a piece of scrap paper to measure the radius of the circle from the center on each axis. Next, sketch a square with the center of each side passing through the marks on the axes, as shown in Fig. 8-6B. Now sketch in the circle, using the angles of the square as a guide for each arc.

When larger circles are required, you can add 45 degree angles to the square to form an octagon. This will give you four more points of tangency for the inscribed circle. Or, to draw very large circles, you can make a substitute compass with a pencil, a length of string and a thumb-tack. Tie one end of the string to the pencil near the tip. Measure the radius of the circle you are drawing on the string, and insert the tack through the string at this point and into a pad of paper. Now, swing the pencil in a circle, marking the paper at the same time, and keeping the pencil perpendicular to the paper.

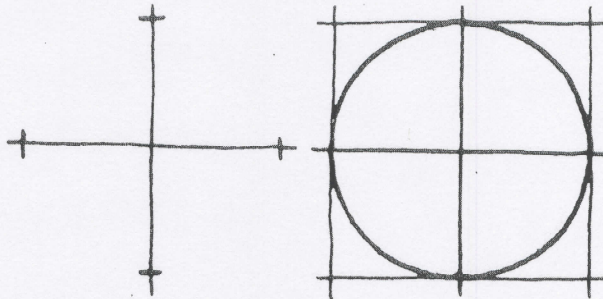


Figure 8-6 Sketching circles using construction lines.

### Sketching Curves

You can sketch curves by blocking them with straight lines, as shown in Fig. 8-7. This method is simply a variation of Fig. 8-6, which shows how to sketch circles. One of the best ways to sketch curves connected to straight lines is the six-step method illustrated in Fig. 8-8:

- (1) Intersect a vertical and a horizontal line lightly, as shown in Fig. 8-8A.
- (2) From the intersection, mark off the same distance on the vertical and horizontal lines, as in Fig. 8-8B.
- (3) Draw the hypotenuse of the triangle lightly through the two points marked, as in Fig. 8-8C.
- (4) Place an x or a dot in the exact center of the triangle formed, as in Fig. 8-8D). (Use visual comparison to find the center.)
- (5) Start the curve from one point of the triangle (the intersection of the hypotenuse and the vertical line is best), as in Fig. 8-8E, touching the center point and ending at the other point of the triangle.
- (6) Erase all unnecessary guidelines, and darken the curve and any adjoining straight lines as shown in Fig. 8-8F.



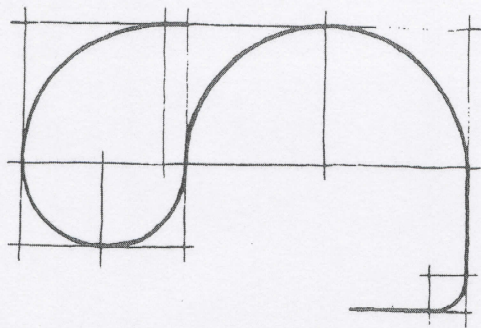


Figure 8-7 Sketching curves.

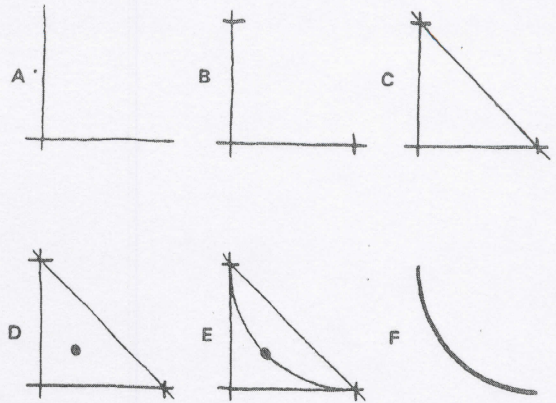


Figure 8-8 Sketching curves connected to straight lines.

Using Construction Lines

To sketch a part, such as the one shown in Fig. 8-9, you can't simply start at one corner and draw it, detail by detail, and have it come out with the various elements in correct proportion. You should first block in the rectangular outline of the object, as shown in Fig. 8-9A. Then draw light guidelines at the correct angles to obtain the shape of the object, as in Figs. 8-9B and C. Finish the sketch by drawing in the details, and then darken the outlines, as shown in Fig. 8-9D.

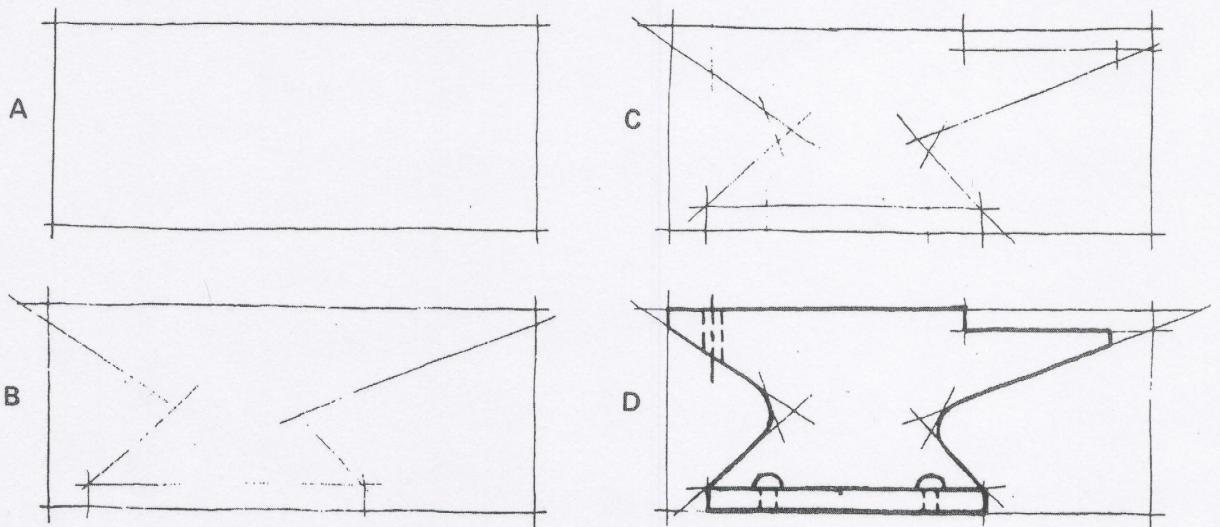


Figure 8-9 Using construction lines to sketch an object.

Line Widths

So that anyone can read your sketches easily and accurately, use the same relative width of lines to represent the same standard meanings as those described in Chapter II. To obtain the widths required, first sharpen a pencil to a conical point with a pencil sharpener. Then round it the varying degrees of dullness required with a piece of sandpaper. Draftsmen use small pads



of sandpaper made for that purpose. All final lines should be very dark, except construction lines, which should remain very light.

### MAKING A WORKING SKETCH

To make a working sketch (a sketch that is dimensioned), start with a clean piece of paper, either plain, cross-sectioned, or isometric. Estimate the size that the sketch should be, and select the view or views that will best represent the object—usually the front view. Then draw the orthographic projections or pictorial drawings, leaving enough space for dimensions. Follow this sequence of steps to make orthographic projections:

- (1) Draw the centerlines as shown in Fig. 8-10A.
- (2) Block in the views.
- (3) Draw the outlines, aligning them as in Fig. 8-10B.
- (4) Add the details to the surface of the views.
- (5) Darken the lines of the finished sketch.

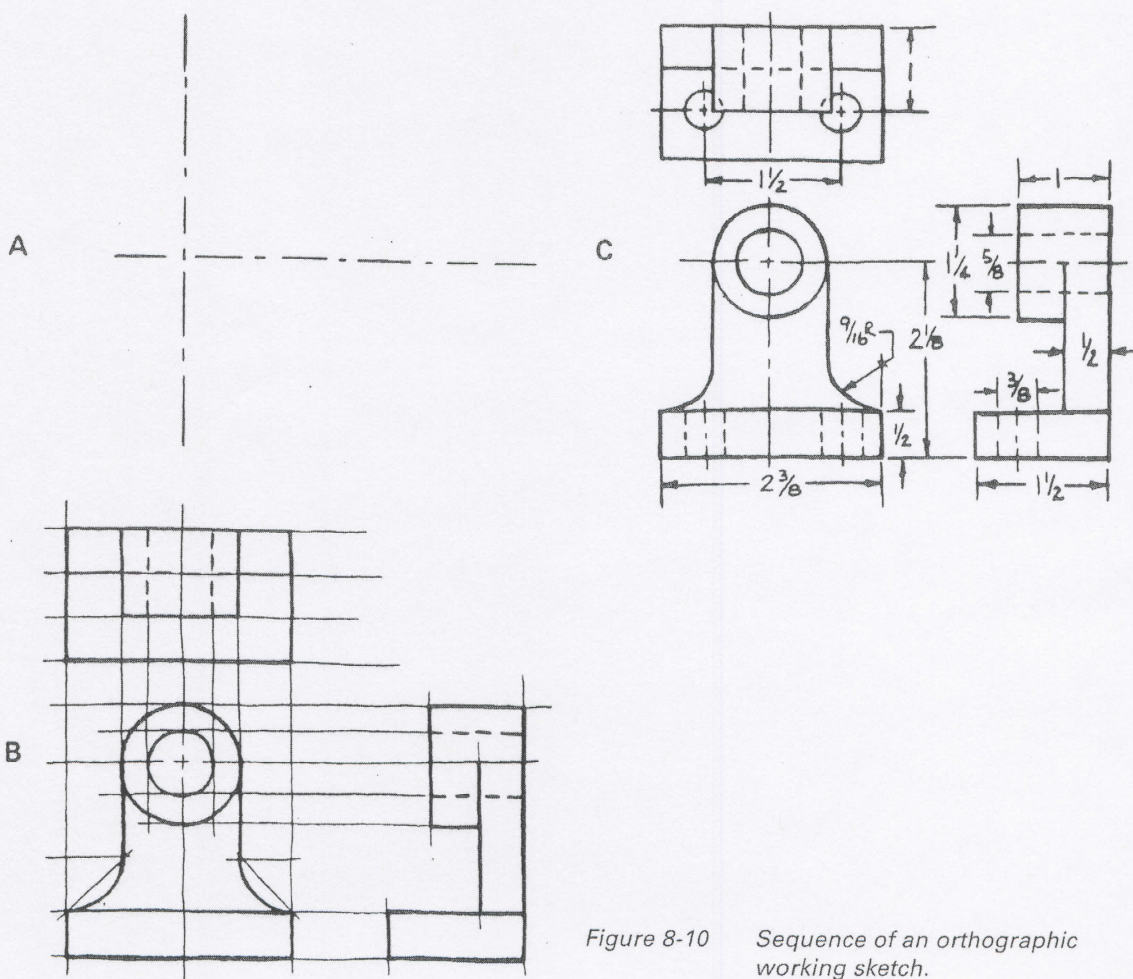


Figure 8-10 Sequence of an orthographic working sketch.