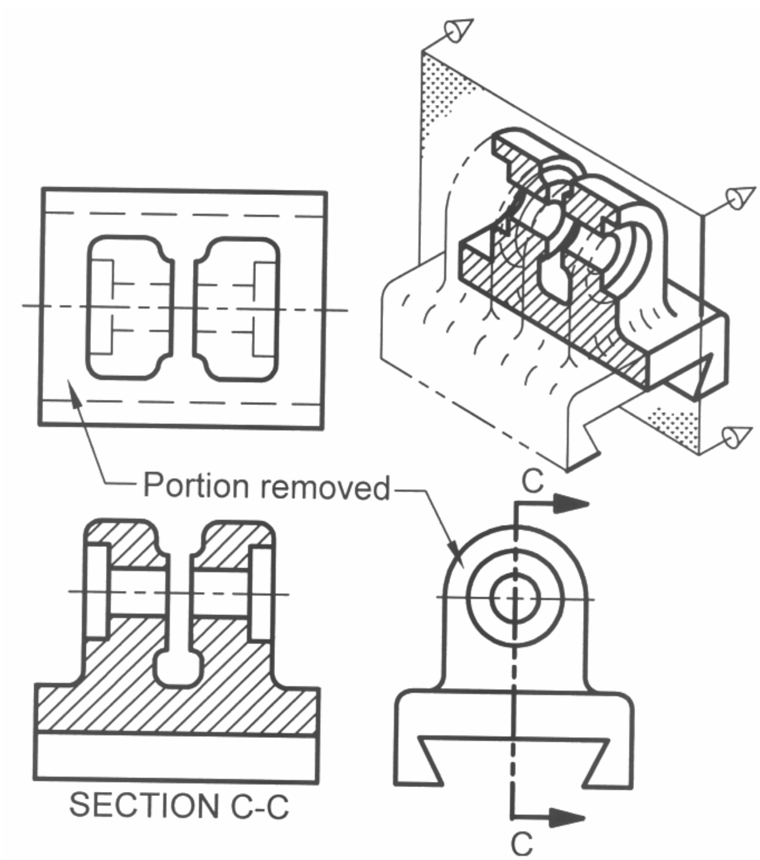
A Concise Introduction to Engineering Graphics

and Supplemental Workbook

Third Edition



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Chapter 4

Multiview Drawing

The Engine of Industry:

Multiview drawings are the most common type of technical drawings for both the machine and architectural industries. As the name implies, a multiview drawing is "multiple" views of a single object. For example Figure MVD 1 is a multiview sketch of a table lamp showing the lamps front, top, and right side views. A single view of the lamp would not describe its exact shape. You need at least these three views to envision its shape.

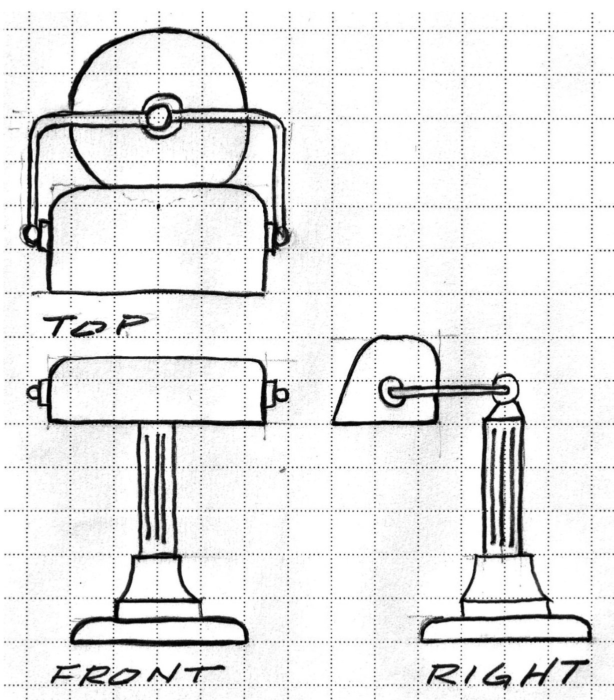

Figure MVD 1: Sketch showing the front, top, and right views of a table lamp

Normally when people refer to "blue prints" they are not referring to traditional drawing that have white lines on a blue background. They are referring to any technical drawing. These technical drawings are multiview drawings and they are the engine that runs industry because nothing is manufactured or constructed without first making multiview drawings.

Orthographic Projection:

Orthographic projection is the projection theory used to make multiview drawings. The easiest way to understand orthographic projection is to envision an object placed inside a rectangular box made of sheets of plastic as illustrated in Figure MVD2. The arrows illustrate viewing positions of the six principle orthographic views.

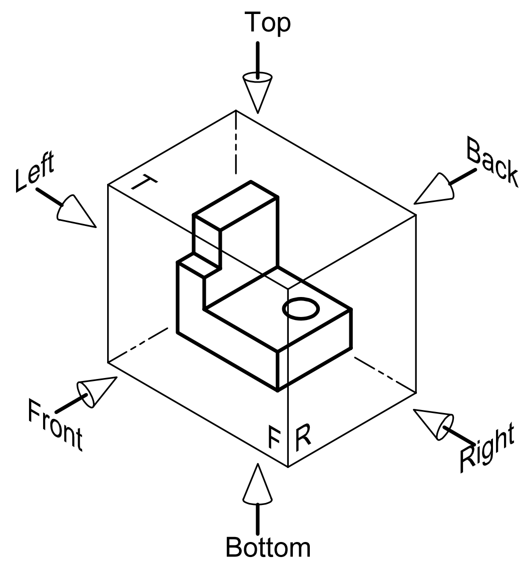

Figure MVD 2: Object encased in a clear plastic box with arrows locating the viewing position of the six principle orthographic views

Each of its six clear plastic sides is called a plane of projection. Each side of the object is projected onto one of the six planes of projection. For example in Figure MVD 3, the front view of the object is projected onto the front plane of projection with lines called projection rays.

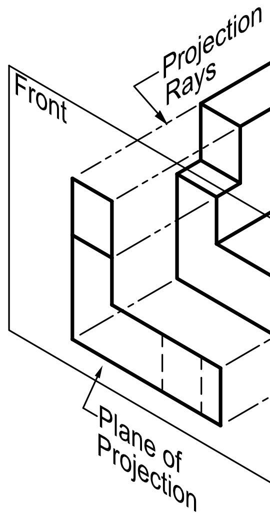

Figure MVD 3: Projection rays projecting the front view of the object onto the front plane of projection

Projection rays are parallel to each other and perpendicular to the plane of projection. The resulting front orthographic view is illustrated in Figure MVD 4.

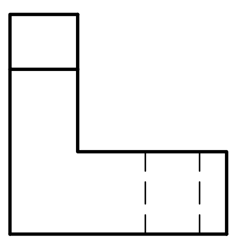

Figure MVD 4: Resulting front orthographic view as projected onto the front plane of projection

To obtain another view of the object, the viewer must either change their viewing position or rotate the object until their line of sight is perpendicular to one of the six sheets of plastic.

The Six Plastic Planes of Projection:

The top, front, right, left, bottom, and back make up the six principal orthographic views of an object. In order to describe a 3-D object on a 2-D piece of paper, the six principle orthographic views must be unfolded into a single plane. Figure MVD 5 illustrates the plastic box unfolding with the views being hinged about the front view. Figure MVD 6 illustrates the six principle projection planes completely unfolded into a single plane. The result is the correct layout of the six principle orthographic views. Note that the projectability of views is maintained. This means the top, front, and bottom views line up and the front, right, left, and back views line up. Projectability of views must ALWAYS be maintained when sketching, drafting, or laying out views in CAD.

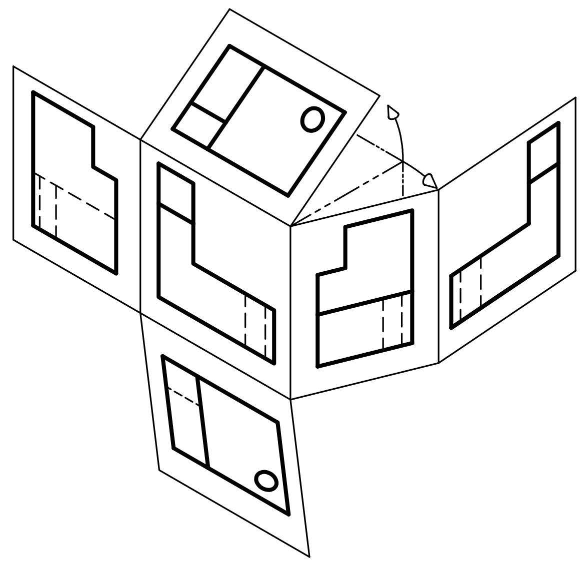

Figure MVD 5: All six planes of projection being unfolded about the front plane

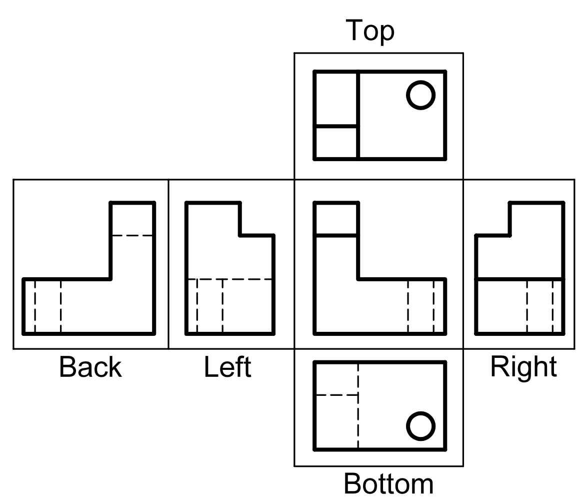

Figure MVD 6: All six sides of the plastic box unfolded into the 2-D plane of a piece of paper.

Figure MVD 7 illustrates the relationship of height, width, and depth between the views. Note that each individual view only has two of the three dimensions height, width, and depth (thus 2-D drawing).

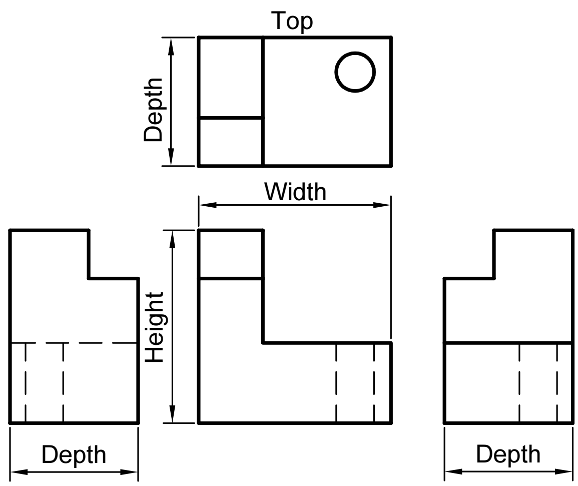

Figure MVD 7: Relationship between height, width, and depth

Figure MVD 8 provides a look of how a 45° miter line is used to transfer depth between the top and right views. The 45° miter line starts at the intersection of lines 1 and 2. Lines 1 and 2 radiate from the edge views (EV) of the frontal planes in the top and right views. Line 3 helps transfer the small notch from the right to the top view. Line 4, 5, and 6 help transfer the hole from the top to the right view. Using the 45 ° miter line makes it both faster to construct a multiview drawing and allows you to check yourself with respect to the right/top and left/top relationships.

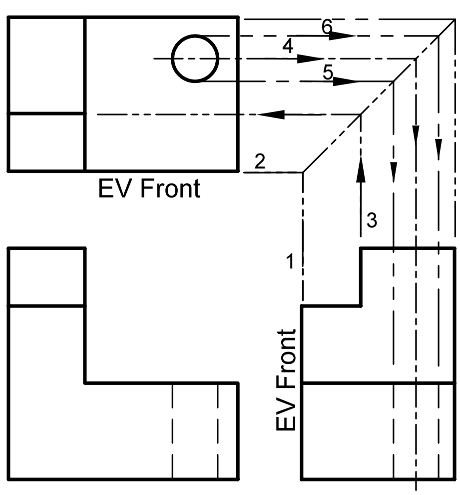

Figure MVD 8: The 45° miter line is used to transfer details between the top and right views

Even though each orthographic view in a multiview is only 2-D, it is helpful to envision each view as it if it were 3-D. Figure MVD 9 illustrates the six principle views of the 3-D letter "L". Planes in or parallel to a principle plane of projection are shaded while planes perpendicular to a principle plane of projection are labeled EV for edge view. Note that the planes labeled EV appear as lines in their respective planes of projection.

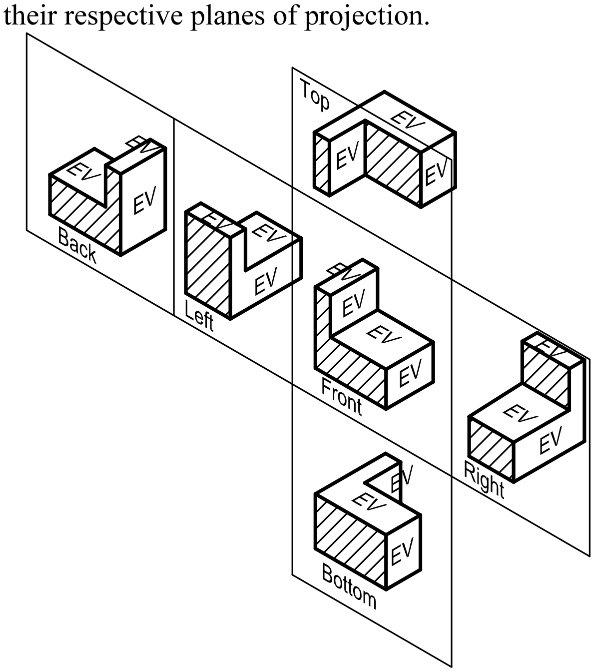

Figure MVD 9: The 3-D letter "L" with planes in or parallel to a principle plane shaded and planes perpendicular to a principle plane labeled EV

2-D Planes:

Each orthographic view of a multiview drawing is two dimensional. For example, if you look at just the front view of Figure MVD 10 you cannot tell that plane A is the front most plane while B and C are further back. Similarly, if you look at the top view of Figure MVD 10 you cannot tell that plane D is higher than E and if you look at the right view you cannot tell that plane F is closer than plane G.

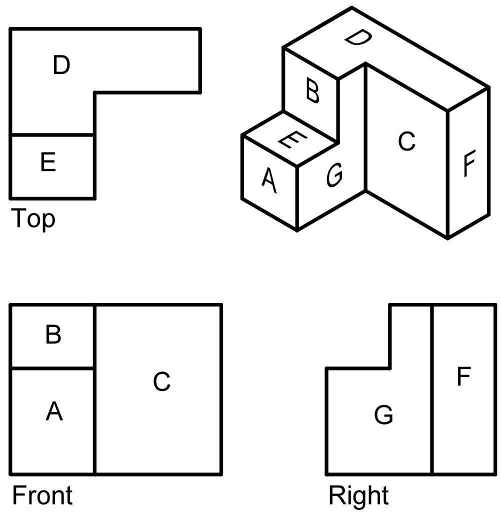

Figure MVD10: No way of telling which plane is closer

Types of Planes:

The examples and exercises in this text are limited to: normal, inclined, oblique, and single curved surfaces. Each of these four will be discussed and illustrated in this text. Double curved and warped surfaces are considered too advanced for this text.

Normal Planes:

A normal plane is parallel to two principle planes and projects as an edge view in the other four. When a plane is parallel to a principle plane, it projects its true size and shape (TSS). For example, the normal surface "A" in Figure MVD 11 projects its TSS in the front view and projects as an edge view (line) in both the top and the right views.

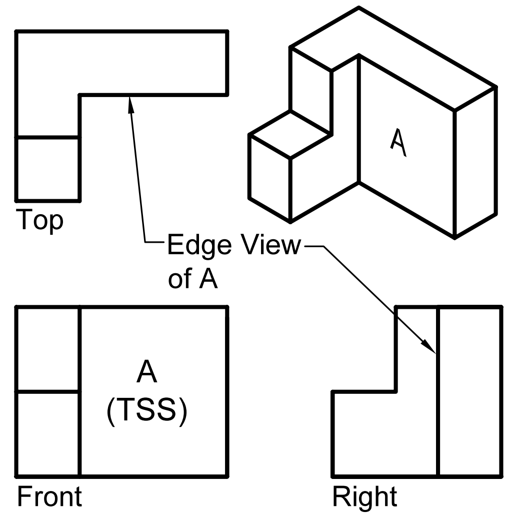

Figure MVD11: Normal plane "A" is true size and shape in the front view and is in edge view in the top and right views

Inclined Planes:

An inclined plane is not parallel to any of the principle planes. Therefore, it does not show its true size and shape in any of the principle views. An inclined plane will be perpendicular to the six principle planes and display as a similar shape in the others four. For example, plane B in Figure MVD 12 displays as an edge view in the front view because plane B is perpendicular to the front plane of projection and as similar foreshortened rectilinear shapes in both the top and right views.

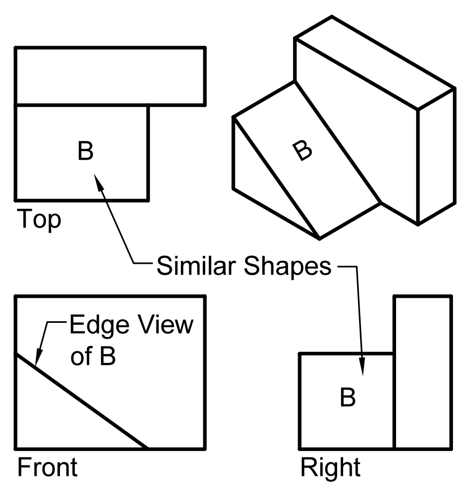

Figure MVD 12: Inclined plane "B" is in edge view in the front view and similar though foreshortened shapes in the top and right views

Oblique Planes:

An oblique plane is not parallel nor is it perpendicular to any of the six principle projection planes. Therefore, it does not display its true size and shape or as an edge view in any view. An oblique plane does show the same number of sides and the same number of corners in all six principle views as plane "C" illustrates in Figure MVD 13.

Oblique planes can be difficult to draw unless the following rules are understood and applied:

1. parallel lines are ALWAYS parallel; and
2. when parallel planes are sliced at an angle by another plane, the resulting lines of intersection are parallel.

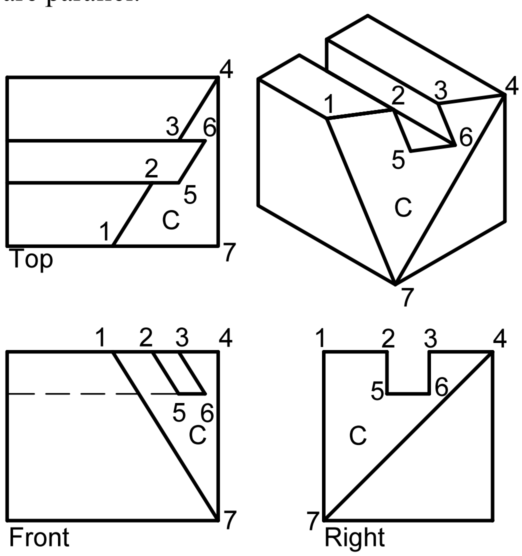

Figure MVD 13: Oblique plane "C" with the same number of sides and corners in all views

Single Curved Surfaces:

A single curved surface is formed by extruding (stretching out) a circle, an arc, or an irregular curve. Figure MVD 14 illustrates an extruded circle and two extruded arcs. An extruded circle forms either a hole, or a solid cylinder like a coffee can. An extruded arc forms a smooth curved surface such as the rolled front edge of many kitchen counters. An extruded irregular curve forms a rolling curved surface like a child's slide found at a playground. The front view in Figure MVD 14 displays the EV of two arcs and one circle. The top and right views display the edge lines of the hole and the right view displays the edge line of the two arcs and one cylinder.

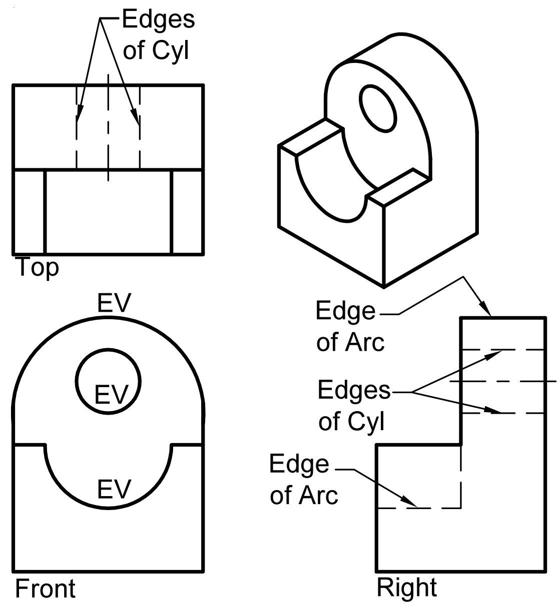

Figure MVD 14: Single curved surfaces display as edge views in the front view and as lines in the top and right views

Line and Surfaces:

This text concentrates on flat and single curved surfaces. It is easier to visualize an object from multiview drawings if you know how lines, arcs and circles are formed. Refer to Figure MVD 15 when visualizing the ways geometry is formed.

A straight line is formed when:

1. viewing the EV of a flat plane
2. two flat planes intersect
3. viewing the edge lines of a cylinder, cone, torus (doughnut), or extruded arc

An arc or circle is formed when:

1. viewing the edge view of a curved surface
2. looking down into a hole
3. viewing the end of a cylinder

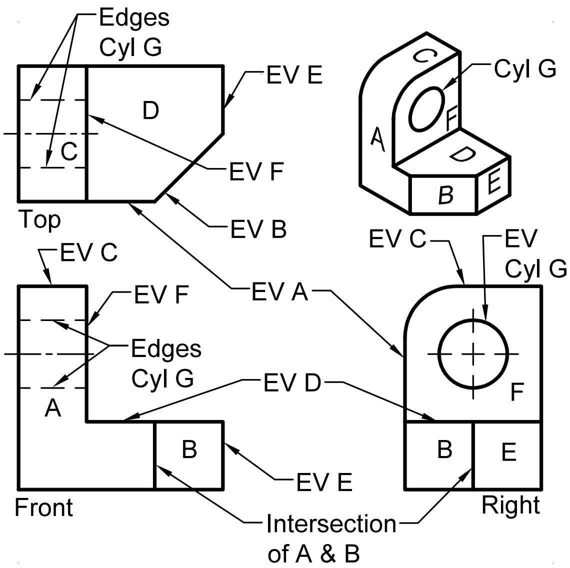

Figure MVD 15: Lines formed by the intersection of planes, EV of planes, and edges of arcs or cylinders

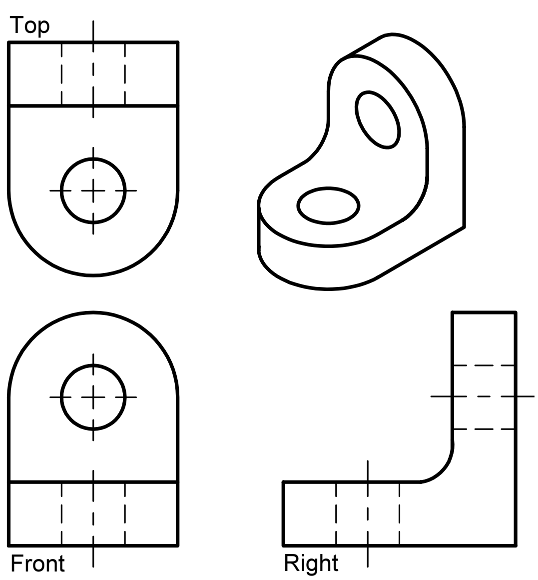

Figure MVD 16: Circles and arcs in normal planes

Circles vs. Ellipses:

Holes and solid cylinders appear as circles when they are on normal surfaces as illustrated in Figure MVD 16. But when they lie on an inclined plane they appear as ellipses as illustrated in Figure MVD 17.

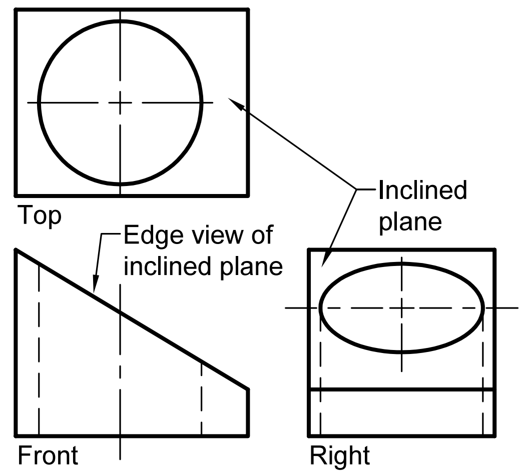

Figure MVD 17: A hole appears as an ellipse when in an inclined plane

When a circle is rotated about an axis it changes into an ellipse. The shape of the ellipse depends on how much the ellipse is rotated. Figure MVD 18 shows a circle being rotated about an axis. When the circle is in the 0° position it appears as an edge view (line) in the front view. A full 90° rotation produces a true circle in the front view. A 30° or 60° rotation of the circle produces an ellipse. The flatness of the ellipse depends on how much it is rotated. A 30° rotation produces an ellipse that is flatter than the ellipse produced by rotating the circle 60°. Note that the length of the ellipses major axis AB in the front view of Figure MVD 18 does not change. It remains equal to the circle's original diameter. But the minor axis CD of the 30° rotated circle is shorter than the minor axis EF of the 60° rotated circle.

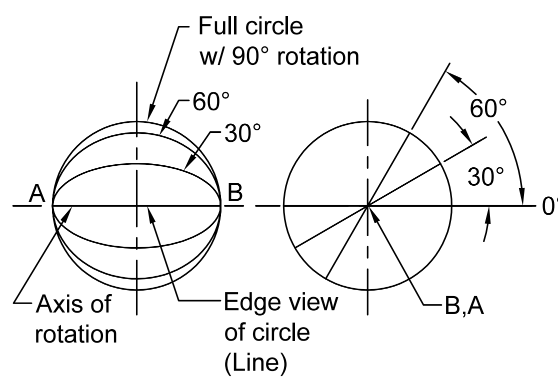

Figure MVD 18: The rotating circle starts as a line then forms two different ellipses and finally a full circle

3rd Angle vs. 1st Angle Projection:

To this point, and for the remainder of the text, multiview drawing has been discussed and illustrated using 3rd angle projection. This is the projection system used in the United States. However, most countries use 1st angle projection to create multiview drawings. In 1st angle projection the object is positioned in front of the plastic planes as illustrated in Figure MVD 19. Views are still hinged off the front view and result in the view placement illustrated in Figure MVD 20. Note how the positions of the views differ from 3rd angle projection. To ensure that those reading the drawing know whether it is 3rd or 1st angle projection, use one of the two symbols illustrated in Figure MVD 21.

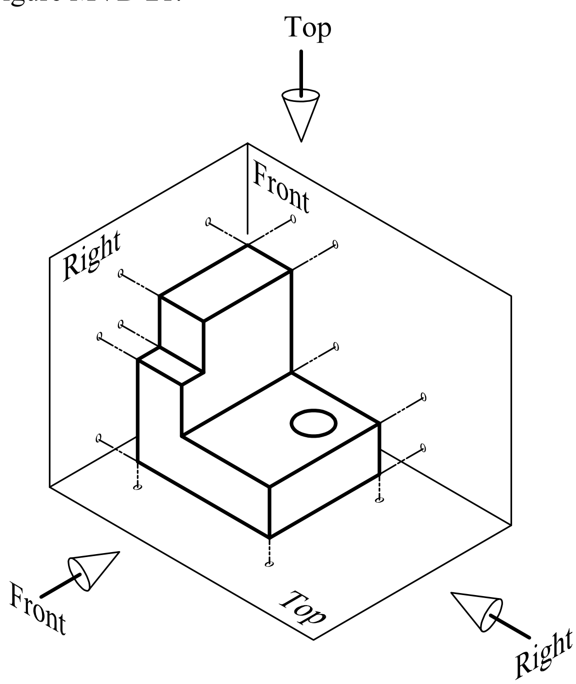

Figure MVD 19: the object is placed in front of the plastic planes in 1st angle projection

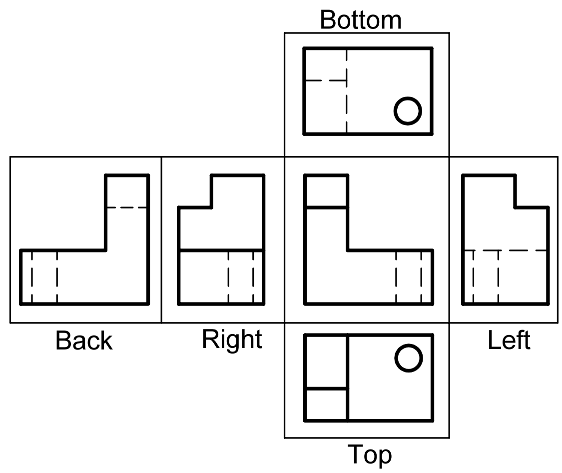

Figure MVD 20: Positioning of the six principle views in 1st angle projection

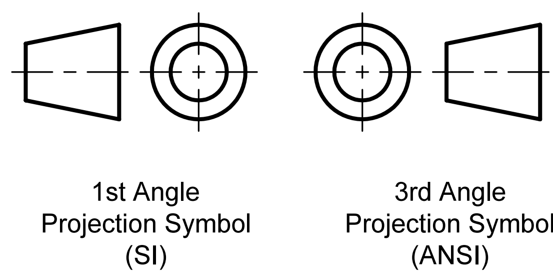

Figure MVD 21: 1st and 3rd angle projection symbols placed in or near the title block