

8.1 SECTIONING BASICS

Section views are a very important aspect of design and documentation and are used to improve clarity and reveal interior features of parts.

Sectional drawings are multiview technical drawings that contain special views of a part or parts, a view that *reveal interior features*. In the figure a regular multiview drawing and a sectioned multiview drawing of the same part in the front view, the hidden features can be seen after sectioning.

Traditional sections views are based on the use of an imaginary **cutting plane** that cuts through the object to reveal interior features.

Mechanical assemblies are sectioned to assist in the assembly of components and for visualization.

The use of sectioned technical illustrations is a common practice to describe interior features of complicated assemblies.

Normally, hidden lines are omitted from section views. Adding hidden lines to a section view complicates the drawing, defeating the purpose of clarifying with a section.

A minimum number of hidden lines are sometimes needed to represent features other than the primary one shown by the section. This is done if it eliminates the need for another view.

Visible surfaces and edges representing changes of planes that are behind the cutting plane are drawn in a section view. Section lined areas are bounded by visible lines and never by hidden lines, because the bounding lines are visible in the section view.

A 3-D CAD model can be sectioned by positioning a reference plane relative to the object and partitioning the object to produce a section view.

The direction the cutting plane arrows points represents the direction of sight for producing a section view. The direction of the arrow can also be thought of as pointing toward the half of the object being kept. Half of the object is "removed" to reveal the interior features of the part. The line of sight for the section view is perpendicular to the cut surfaces, which means they are drawn true size and shape in the section view.

Note that only those surfaces touched by the cutting plane are shown hatched with cutting plane lines.

Conventional practice requires that features behind the cutting plane and visible in the cut section be represented. In Figure 8.12, the change of planes between the two holes in the counterbored are shown. All the surfaces touched by the cutting plane are marked with section lines, while those which are not cut are shown as they would be in a normal view.

Because all the sectioned surfaces are the same part, the section lines are identical and are drawn in the same direction. The center line is added to the counterbored hole to complete the section view.

If the cutting plane line is in the same position as a center line, the cutting plane line has precedence. Cutting plane lines are only added to a drawing for clarity. If the position of the cutting plane is obvious, it does not have to be drawn.

Edges and corners which intersect the cutting plane can be labeled to assist in the visualization of an orthographic section view.

8.2 CUTTING PLANE LINES

Cutting plane lines which show where the cutting plane passes through the object, represent the edge view of the cutting plane and are drawn in the view(s) adjacent to the section view.

Two types of lines are acceptable for cutting plane lines in multiview drawings. It is important to use only one type of cutting plane line on a single drawing.

Cutting plane lines are thick (.7mm) dashed lines, that extend past the edge of the object 1/4" or 6mm and have line segments at each end drawn at 90 degrees and terminated with arrows.

The arrows represent the direction of the line of sight for the section view and they point away from the sectioned view. The long dash can be lengthened for very large section drawings to save drawing time and create a more readable drawing.

It is customary to have a short dash centered over a perpendicular center line such as at the center of a hole.

A horizontal section view is one where the cutting plane is on edge in the front view and the top view is sectioned.

A profile section view is one where the cutting plane is on edge in the front and top views and the profile view is sectioned.

Multiple sections can be done on a single object.

8.3 SECTION LINE PRACTICES

Section lines or **cross-hatch lines** are added to a section view to indicate surfaces that are cut by the imaginary cutting plane. Different section line symbols can be used to represent various types of materials. However, the general purpose (cast iron) section line symbol used in most section view drawings is that of cast iron.

The general purpose or cast iron section line is drawn at a 45 degree angle and spaced 1/16" (1.5mm) to 1/8" (3mm) or more depending on the size of the drawing, but can be changed when adjacent parts are in section. The spacing of section lines is equal or uniform on a section view. Section lines should be thinner than visible lines. Do not run section lines beyond the visible outlines or stop them too short.

Section lines should not run parallel or perpendicular to the visible outline. If the visible outline to be sectioned is drawn at a 45 degree angle, the section lines are drawn at a different angle, such as 30 degrees.

Avoid placing dimensions or notes within the section lined areas. If the dimension or note must be placed within the sectioned area, the section lines are omitted in the area of the note.

When section lining large parts, outline sectioning may be used to save time.

Very thin parts, such as washers and gaskets, are not easily represented with section lines, so conventional practice calls for representing the thin part in solid black.

8.4 SECTION VIEW TYPES

There are many different types of section views that can be used to clarify technical drawings. Up to this point only full sections have been represented in the figures. There are times when it may be more appropriate to use a section view that is not a full section. For example, symmetrical objects can be sectioned using a half section. Or objects with only small areas that need to be clarified with the use of a section view can be represented with a broken-out section.

A **full section** view is made by passing an imaginary cutting plane fully through an object. The figure shows an imaginary cutting plane passing fully through an object and half of it being removed. In a multiview drawing, a full section view is placed in the same position that an unsectioned view would normally occupy; that is, a front section view would replace the traditional front view.

Half sections are created by passing an imaginary cutting plane halfway through an object and one quarter of it is removed. Hidden lines are omitted on both halves of the section view. External features of the part are drawn on the unsectioned half of the view. A center line, not an object line, is used to separate the sectioned half from the unsectioned half of the view. Half section views are most often used on parts that are symmetrical, such as cylinders.

A **broken-out section** is used to show interior features of a part by breaking away some of the object. A broken-out section is used instead of a half or full section view to save time. A break line separates the sectioned from un-sectioned half of the view. A break line is drawn free-hand to represent the jagged edge of the break. No cutting plane line is drawn with a broken-out section view.

A **revolved section** is made by revolving the cross-section view of the part about an axis of revolution and placing the section view on the part. The cross section created at the position that the cutting plane passed is then revolved 90 degrees and drawn on the view. Visible lines adjacent to the revolved view can either be drawn or broken out using conventional breaks. When the revolved view is drawn or superimposed on the part, the original lines of the part are replaced with the outline of the revolved section view. The cross section is drawn true shape and not distorted to fit the view. The axis of revolution is drawn on the revolved view in the form of a center line.

Removed section views do not follow standard view alignments as practiced in multiview drawings. Removed sections are made in a manner similar to revolved sections, by passing an imaginary cutting plane perpendicular to a part then revolving the cross section 90 degrees. However, the cross section is then drawn adjacent to the orthographic view, not on it. Removed sections are used when there is not enough room on the orthographic view for a revolved section. If a number of removed sections are done on a part, cutting plane lines may be drawn with labels to clarify the position from which each section is taken. Whenever possible, a removed section should be on the same sheet as the part it represents, and it should be clearly labeled. If the removed section view must be drawn on another sheet, it must be properly labeled, such as SECTION A-A ON SHEET 2.

Multiple removed section views of an object identified with labels.

Removed sections can also be drawn to any scale, for better representation of the details of the cross section, and for dimensioning.

In one technique, the removed section view is aligned along center lines adjacent to the regular view.

An **offset section** has its cutting plane bent at 90 degree angles to pass through important features. Offset sections are used for complex parts that have a number of important features that cannot be sectioned using a straight cutting plane. The cutting plane is bent at 90 degrees to pass through the hole, then bent 90 degrees again to pass through the slot. Note that the

change of plane which occurs when the cutting plane is bent 90 degrees is not represented with lines in the section view.

Multiple offset section views use labels for identification. The same letter is placed at either end of the section and used to label the removed sections (e.g., SECTION A-A, SECTION B-B).

8.4.7 ASSEMBLY SECTIONS

Assembly sections are typically orthographic, pictorial full or half section views of parts in assembly.

Section assembly drawings have some special conventions. Standard parts such as fasteners, dowels, pins, washers, springs, bearings, gears, and non-standard parts such as shafts are *not* sectioned; instead, they are drawn showing all of their exterior features.

Adjacent parts in assembly sections are cross hatched at different angles so that they are more easily identified. Different material symbols can also be used for this purpose.

With a 3-D CAD model, translucency can be used instead of cutting planes to reveal interior features.

8.4.8 AUXILIARY SECTIONS

Auxiliary views can be drawn in section. An **auxiliary section** can be a full or partial section. Auxiliary sections follow the same conventions as other types of sections.

8.5 SPECIAL SECTIONING CONVENTIONS

Conventional practices have been established to handle section views of special situations, such as the alignment of holes, ribs, and spokes.

Ribs, webs, spokes, lugs and other thin features are not section lined when the cutting plane passes parallel to the feature. A **rib** or **web** is a thin flat piece that acts as a support.

Adding sections lines to these figures would give the false impression that the part is thicker than it really is.

Occasionally, section lines are added to thin a thin feature, so that it is not mistaken or read as an open area. In Figure 8.43, the webs could be interpreted as being round and without webs. To section line a thin feature, use alternate lines on the feature.

If the feature is not lost, then the section lines should not be added.

Aligned sections are special types of orthographic drawings used to revolve or align special features of parts to clarify or make them easier to represent in section. Normally the alignment is along a horizontal or vertical center line and always less than 90 degrees.

Conventional breaks are used in revolved section views or to shorten a view of an elongated part, such as the handle of a shovel or an axle of a vehicle.

Some examples of conventional breaks used for different materials and cross sections.

8.6 3-D CAD TECHNIQUES

CAD can create section views for 2-D orthographic drawings in a manner similar to that of using hand tools. However, 3-D CAD solid modeling programs can create section views using

nontraditional techniques. In using CAD to create a solid model of a part, the user can assign material properties and can view the model from any position.

After the model is defined, section views of the part can be created by defining a cutting plane in 3-D space.

8.7 SUMMARY

The use of section views are powerful aids in the design and documentation of products and construction. There are many different types of section views that can be used to describe parts. Standards and conventions must be closely followed when creating section views.