# Sectional Views and Conventions 

## Sacramento City College Engineering Design Technology

## Objectives

- Describe the purpose of a sectional view.
- Select the appropriate type of sectional view to show the hidden feature.


## Objectives

- Show ribs, webs, and fasteners when the cutting plane passes through them.
- Rotate certain features into the cutting plane.
- Describe and use conventional breaks and symbols


## Vocabulary

- Auxiliary section
- Broken-out section
- Conventional break
- Crosshatching
- Cutting plane
- Cutting-plane line
- Full section
- Half section
- Offset section
- Phantom section
- Removed Section
- Revolved Section
- Ribs
- Section lining
- Webs


## Sectional Views

## Sectional Views

- Technical drawings must show all parts of an object, including
- Insides and

Other parts not easily seen.
-Hidden lines could be used to show hidden features.

## Sectional Views

- If hidden lines are used, the part must be simple.
$\rightarrow$ If the shape is complicated, dashed lines may show it poorly.


## Sectional Views

- Instead of hidden lines a special view called a section or sectional view should be drawn instead.
- A sectional view shows an object as if part of it were cut away to expose the insides.


## Drawing Sectional Views

- To draw a sectional view, imagine that a wide-blade knife has cut through the object.
-Call this knife a cutting plane.


## Cutting-Plane "Knife"



Fig. 9-9 The cutting-plane line represents the edge view of the cutting plane.

## The Cutting-Plane Line

-The cutting-plane line represents the cutting plane as viewed from an edge. Refer to Figure 9-9, 9-10

- Remove everything in front of the plane.
- The cut surface and interior parts can be seen.


## Drawing Sectional Views

- On a normal view, show where the cutting plane passes through the object by drawing a special line called a cutting-plane line.


## Section Views/Cutting Plane Lines

- Cutting Plane lines have two forms: A thick hidden (evenly spaced dashed) line.
A phantom line in accordance with ASME Y14.2M.


Sectional Views and Conventions

## Section Views/Cutting Plane Lines

- The arrows on the cutting-plane line indicate the direction of sight when looking at the section view.



## Section Line



NOTE: ALL SIZES ARE ESTIMATED, NOT MEASURED.

## Section Views/Cutting Plane Lines

- The cutting-plane lines are labeled with letters that relate to the proper section view.
- The section name, SECTION A-A, is placed under the view.


## Normal Views



## Isometric Pictorial View

## Top View



A Front View
Right Side View

## Cutting-Plane



B


Section View C

## Section Views/Cutting Plane Lines

- The arrows on the cutting-plane line indicate the line of sight when looking at the section view.


B


Section A-A C

## 栄 <br> Section Views/Cutting Plane Lines

- The cutting-plane lines are labeled with letters that relate to the proper section view.
- SECTION A-A, is placed under the view.


B


Section A-A C

## Section Views/Cutting Plane Lines

- When more than one section view is drawn, labels continue with B-B through Z-Z.


## Section Lines and Material Types

## Drawing Sectional Views

- On the sectional view, show the cut surface by marking it with evenly spaced thin lines.
-This is called section lining or crosshatching.


## Section Line Rules

- Section lines may be drawn using different patterns to represent the specific type of material.


## Cross-Hatching

-The American National Standards Institute (ANSI) provides many standard symbols to indicate different types of materials.

- Refer to Figure 9-2.


## Cross-Hatching/Section Lines



CAST IRON AND MALLEABLE IRON. ALSO FOR GENERAL USE FOR ALL MATERIALS


MAGNESIUM, ALUMINUM, AND ALUMINUM ALLOYS


STEEL


RUBBER, PLASTIC ELECTRICAL INSULATION

## Cross-Hatching/Section Lines



BRONZE, BRASS,
COPPER, AND
COMPOSITIONS


CORK, FELT, FABRIC,


WHITE METAL, ZINC, LEAD, BABBITT, AND ALLOYS


SOUND INSULATION

## Cross-Hatching/Section Lines



THERMAL INSULATION


FIREBRICK AND REFRACTORY MATERIAL


MARBLE, SLATE, GLASS, PORCELAIN, ETC.

## Cross-Hatching/Section Lines



ELECTRIC WINDINGS, ELECTROMAGNETS, RESISTANCE, ETC.



CONCRETE


ROCK

## Cross-Hatching/Section Lines



CAST IRON AND MALLEABLE IRON. ALSO FOR GENERAL USE FOR ALL MATERIALS


MAGNESIUM, ALUMINUM, AND ALUMINUM ALLOYS


STEEL


RUBBER, PLASTIC ELECTRICAL INSULATION

## Cross-Hatching/Section Lines



SAND


WATER AND OTHER LIQUIDS

## Cross-Hatching/Section Lines



WOOD ACROSS GRAIN WOOD WITH GRAIN


## Cross-Hatching

- Cross-hatching lines usually are spaced about 0.03 inches to 0.12 inches. (Think 1/8").
- Space lines by eye, not by measuring Refer to Figures 9-3, 9-4.


## Cross-Hatching

- Evenly space cross-hatching lines, usually at a $45^{\circ}$ angle.
- Graying or shading may also be used Refer to Figures 9-6, 9-7


## Edge Shading



Fig. 9-7 A cut surface may have a grayed outline.

## Section Lining Rules

## Section Line Rules

$\bullet 1$. Section lines are placed at $45^{\circ}$ unless another angle is required to satisfy the next two rules.

- Avoid section lines placed at angles greater than $75^{\circ}$ or less than $15^{\circ}$ degrees from horizontal.


## Section Line Rules

$\bullet$ 2. Section lines should not be drawn parallel or perpendicular to any other adjacent lines on the drawing.

- Section lines are NEVER drawn parallel to or at right angles to visible lines. Refer to Figure 9-8


## * Section Lines/Object Lines

Figure 9-8
POOR PRACTICE

## Section Lines/Object Lines

Figure 9-8
CORRECT

## Section Line Rules

-3. Section lines should not cross object lines.

## Centerline as Cutting Plane Line

- A cutting plane line is not needed when it is clear that the section is taken along an object's main centerline.
- Refer to Figure 9-11.
* Figure 9-11
-Sectiona



## Sections Through Assemblies

- If the drawing shows more than one piece in section, draw the section lines at different angles.
- Refer to Figures 9-12, 9-13.


Fig. 9-12 Because this sectional view contains two different pieces in section, each piece is sectioned using lines at a different angle.


Fig. 9-13 This sectional view contains three assembled pieces in section, so the section lines are drawn in three different directions.

## Outline Sectioning and Graying

## Outline Sectioning

- When the area is large, you can use outline sectioning.
Refer to Figure 9-5


Fig. 9-3 Space section lines by eye.
The distance between section lines varies according to the size of the space to be sectioned.

## Outline Sectioning



Fig. 9-4 You may blacken in the entire sectioned area instead of using section lines when areas are very small.

## Outline Sectioning



Fig. 9-5 Outline sectioning.

## Graying



## Fig. 9-6 A cut surface may be grayed.

## Types of Sectional Views

## Types of Sectional Views

- Types of Sections:

Full Sections.
Offset Sections.
Half Sections.
Broken-Out Sections.
Revolved Sections.
Removed Sections.
Auxiliary Sections.
< Phantom (Hidden) Sections.

## Full Sections

## Full Sections

- A full section is a sectional view that shows an object as if it were cut completely apart from one end or side to the other.
Refer to Figure 9-16
- These views are sometimes just called sections.


## Front View



## Full Section



TOP VIEW


## Full Sections

- The two most common types of full sections are
vertical and profile sections.
$\checkmark$ Refer to Figures 9-17 and 9-18.


Fig. 9-17 Vertical section.


## Section Views/Cutting Plane Lines



## Full Sections

- Full sections remove half the object.
- In a full section, the cutting-plane line passes completely through the object along a center plane.


## Direction of



## Section lines

SECTION $\underbrace{A-A}_{\text {Section-view label }}$

## Full Sectioning

- Sectioning is also used in other drafting fields, such as architectural and structural drafting.
- Cross sections through buildings show the construction methods and materials.




## Offset Sections

## Offset Sections

- In full sections, the cutting plane is usually taken straight through the object.
- Offset sections are almost the same as full sections, Difference: the cutting-plane line is staggered.
- The line cuts through features that are not in a straight line.


## Offset Sections

- The cutting plane can also be offset or shifted at one or more places to show a detail or to miss a part.

Refer to Figure 9-19.
The cutting plane is offset to pass through the two bolt holes.

## Offset Section - Figure 9-19



OFFSET-SECTIONAL VIEW


## Half Sections

## Half Sections

- A half section is one half of a full section.
- A full section makes an object look as if half if it has been cut away. Refer to Figure 9-20.
- A half section looks as if one quarter of the original object has been cut away.


## Half Sections

- The term half section is used because

Half of the view appears in section. The other half is shown as an exterior view.

## Half Section - Figure 9-20



## Half Sections

-The half section shows one half of the front view in section. Refer to 9-20 E.

## Half Sections

- Half sections are commonly used on symmetrical objects.
- Both the inside and outside can be shown in one view.


## Half Sections

- A centerline is used to separate the sectioned part of the view from the unsectioned part.
- Hidden lines are normally omitted from the un-sectioned side.
Half Sections - Figure 9-20
- Use a centerline where the exterior and half-sectional views meet since the object is not actually cut.



## Half Sections

- In the top view, show the complete object, since no part is actually removed.
- Use one arrow for the direction of viewing.
* 


## Half Sections - Figure 9-20



## Half Sections

- Half sections show one-quarter of the object removed.
- The term half section is used because

Half of the view appears in section. The other half is shown as an exterior view.

## Broken Sections

## Broken Sections

- A broken-out section shows an object as it would look if a portion of it were cut partly away from the rest by a cutting-plane and then "broken off" to reveal the cut surface and insides.

Refer to Figure 9-21

## Broken Sections - Figure 9-21



## Broken Sections - Figure 9-21



B

## Broken Sections - Figure 9-21

## Broken Sections

- A broken-out section show some inside detail without drawing a full or halfsection.


## Broken Sections

-The broken-out section is bounded by a short-break line drawn freehand the same thickness as visible lines. Refer to Figure 9-22

## Broken-out Sections

- Broken-out sections show only a small portion of the object removed.
- Broken-out sections clarify hidden features.


## Broken-out Sections



FRONT VIEW

## Broken-out Sections



FRONT VIEW WITH BROKEN-OUT SECTION

## Broken-out Sections



# Fig. 9-22 Two additional examples of broken-out sections. 

## Broken-out Sections



## Aligned Sections

## Aligned Sections

- Aligned sections are used when a feature is out of alignment with the center plane.
- An offset section would distort the image.


## Aligned Sections

- The cutting-plane line cuts through the feature to be sectioned.
- The feature is then rotated to align with the center plane before projecting into the section view.



## Revolved Sections

## Revolved Sections

- Revolved sections clarify the contour of objects that have the same shape throughout their length.
- The section is revolved in place within the object, or part of the view may be broken away.


## Revolved Sections

- A revolved section has a cutting plane passing through a part, and then revolved $90^{\circ}$ so that its shape can be seen clearly.


## Revolved Sections

- Use a revolved section:

When the part is long and thin.
When its shape in cross section is the same throughout.
Refer to Figure 9-25

## Revolved Section - Figure 9-23



Fig. 9-23 Cutting plane in position for revolved section.
*- Revolved Section - Figure 9-24

## Revolved Section - Figure 9-24



OTHER ACCEPTABLE METHODS
Fig. 9-24 Revolved section.

## Revolved Sections

## -The view may be shortened.

$\checkmark$ Give the full-length of the part by a dimension.
-This lets you draw a large part with a revolved section in a short space.

## Revolved Sections Figure 9-24



## Revolved Sections Figure 9-24



Fig. 9-25 Revolved sections in long parts.


## Removed Sections

## Removed Sections

- Removed sections serve much the same function as revolved sections.
- The section view is removed from the regular view.


## Removed Sections

- A removed section is taken from its normal place on the view and moved somewhere else on the drawing sheet.
- A cutting-plane line shows where the section was taken.


## Removed Sections

- The removed section must be positioned to look as if it were in its normal place on the view.
-The removed section cannot be rotated in just any direction !
- Refer to Figure 9-26 for examples


## Removed Sections

- When multiple removed sections are taken, the cutting planes and related views are labeled.
- Drawing only the ends of the cuttingplane lines simplifies the views.




## Section C-C



## Removed Sections Figure 9-26



## Removed Sections Figure 9-26



## WRONG



SECTION A-A

## Removed Sections Figure 9-26



SECTION C-C


SECTION D-D



SECTION E-E

## Removed Sections

- Use bold letters to identify a removed section and its corresponding cutting plane.


## Removed Section

- A removed section can be a sliced section or it can show additional detail visible beyond the cutting lane.


## Removed Sections

- When multiple removed sections are taken, the cutting planes and related views are labeled.
- Drawing only the ends of the cuttingplane lines simplifies the views.


## Special Cases

## Special Cases

- Certain exceptions are made to the general sectioning rules for:

Ribs and Webs in Section.
Hidden and Visible Lines.
Alternate Section Lining.

- Certain Parts usually not sectioned. Rotated Features in Section.


## Special Cases - Ribs in Section

## Ribs and Webs in Section

- Show ribs as if the cutting plane passed in front of the rib.

Refer to Figure 9-29.

## Ribs and Webs in Section



## Ribs and Webs in Section

- If a cutting plane passes through a rib, a web or other thin, flat part, at right angles to the flat side,
- Show the section lines for that part.
- Refer to Figure 9-30.


## Ribs and Webs in Section



CORRECT


INCORRECT

Fig. 9-30 Web in section.

## Sections

 and
## Hidden and Visible Lines

## Hidden and Visible Lines

- Do not draw hidden lines on sectional views unless they are needed for dimensioning or for clearly describing the shape.
Refer to Figure 9-31A
$\bullet$ A hub is described clearly using no hidden lines.


## Hidden and Visible Lines



PREFERRED
HIDDEN LINES NOT SHOWN
Fig. 9-31 Omit hidden lines when not needed for clarity.

## Hidden and Visible Lines

- On sectional assembly drawing hidden lines are generally omitted.

Refer to Figure 9-32.

- Include all lines that would be visible on or beyond the plane of the section.


Fig. 9-32 Omit hidden lines to keep the drawing from becoming confusing.

## Hidden and Visible Lines

- In a section view, include all lines that would be visible on or beyond the plane of the section.
- Refer to Figure 9-33 and 9-34.


## * <br> Hidden/Visible Lines Fig 9-33



## Hidden/Visible Lines Fig 9-33



CORRECT
A
-Sectional Views and Conventions

## Hidden/Visible Lines Fig 9-33



Fig. 9-33 Show all visible lines beyond the sectioned surface.

## Hidden/Visible Lines Fig 9-34



## Hidden/Visible Lines Fig 9-34



## INCORRECT

## Alternate Section Lining

## Alternate Section Lining

- Alternate section lining is a pattern made by leaving out every other section line.

Refer to Figure 9-35A \& B.

- Alternate section lines are useful to show ribs and other thin, flat pieces in one-view drawings.


Fig. 9-35 Alternate, or wide, section lining.

## Other Parts NOT Sectioned

## Other Parts NOT Sectioned

- Do not draw section lines on spokes and gear teeth when the cutting plane passes through them.
- Refer to Figure 9-36.


## Fig. 9-36 Spokes and gear teeth

 should not be sectioned.
## Other Parts Not Sectioned

- Do not draw section lines on these objects when the cutting plane passes lengthwise through the object.

Spokes
Gears teeth
Shafts
Bolts
Pins
Rivets

- Draw section lines when cut across the axis


BALL BEARING




Fig. 9-38 Section bolts, screws, rivets, and similar parts when the cutting plane cuts the across the axis.

## Other Parts Not Sectioned

- Figure 9-39 shows items that should not be sectioned.


Fig. 9-39 Examples of features not sectioned.

## Rotated Features in Section

## Rotated Features in Section

- A section or an elevation can be hard to read if drawn in true projection.
- It can also be hard to draw. Refer to Figure 9-40.
- Compare the true projection to the good practice drawings.



## Rotated Features in Section

- Note that only the parts that extend all the way around the vertical axis are drawn with section lining.
Refer to Figure 9-41.
Lugs are rotated to show true shape.


Fig. 9-41 Do not section lugs.

## Rotated Features in Section

- When a section passes through spokes, do not draw section lines on the spokes.

Refer to Figure 9-42 A and B



Fig. 9-42 A section through spokes.

## Rotated Features in Section

- When drawing a section or elevation of a part with holes arranged in a circle, follow example shown in Figure 9-43.


## Rotated Features in Section

- The holes have been rotated until two of them lie squarely on the cutting plane.
- This shows the true distance of the holes from the center.




## Conventional Breaks and Symbols

## Conventional Breaks/Symbols

- Conventional breaks and symbols are used to show that a uniform part of a very long object has been cut out of the drawing.
- This makes drawing easier to draw and easier to understand
$\checkmark$ Refer to Figure 9-45


Fig. 9-45 Conventional breaks and symbols.


Fig. 9-46 Drawing the break symbols for cylinders and pipes.

## Conventional Breaks/Symbols

- Using breaks lets you draw a view to a larger scale.
- Give the length by dimension.
- Symbols for breaks are usually drawn freehand.


## Section Lines

- Section line symbols are placed in the section view to show where material has been cut away.

