# IE 111 Computer Aided Engineering Drawing 

## Sectioning

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## Section Views

- Ordinary multiview drawings may not be enough to fully explain the inner details of the objects in some cases.
- Section views are used in such cases.



## (ㄴ) Section Views



## Section Views

$\square$ Sections can be used to reveal interior features of an object that are not easily represented using hidden lines.
$\square$ Aims of sectioning are;

- to improve the visualization of new designs,
- to clarify multiview drawings,
- to facilitate the dimensioning of drawings.


## Section Views



A Typical multiview technical drawing shows the right side view in full section and removed section details.

## Sectioning Basics



## Cutting Planes

Imaginary cutting planes used to create section views are passed through the object to reveal interior features.

## Sectioning Basics

$\square$ Suppose a cutting plane through the top view, then the front view would

l $\begin{aligned} & \text { become a } \\ & \text { section view. }\end{aligned}$


Normal multiview drawing


Normal multiview drawn


## Sectioning Basics

- The cutting plane (section plane) is represented bysection line with arrows denoting the direction of view. The portions cut by the section view arecross-hatched


## Sectioning Examples



Mechanical assembly of a jet aircraft in section showing how parts fit and their spatial relationship

## Sectioning Examples



Bent cap section of a prestressed concreate box girder bridge superstructure (Courtesy of Bentley Systens, Incorporated.)

## Sectioning Examples



Sectioned technical illustration of an internal combustion engine

## Sectioning Steps

Suppose that we want to generate the section view of the object shown below cut by the hatched plane.


## (D) Sectioning Steps

1. Denote the sectioning plane on a suitable view. For this case select the top view. Name the sectioning plane by letters (A-A', or A-A).


Top view of the part

## Sectioning Steps

2. Draw what you see along the cutting plane and beyond on the corresponding view (right side view in this case). Hatch the portions where the cutting plane passes. Label the section view than (Section A-A' or Section A-A).


Section A-A'

Section view

## Sectioning Basics



## Treatment of Hidden Lines

Normally, hidden lines are omitted from section views.


## Sectioning Basics

## Optional Use of Hidden Lines

Hidden lines can be shown in section views to eliminate the need for another view.


Optional use of a hidden line

## Sectioning Basics

## Representing Surfaces and Edges in Section Views



(A) Correct representation

(B) Incorrect representation

(C) Normal multiview

## Some Details

$\square$ Not only the portions where the cutting plane passes are drawn, but also the features beyond the cutting plane are drawn. An illustrative example is on the right.


## Some Details

$\square$ Ribs, webs and other thin features:

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



## Some Details

(A) True orthographic projection sometimes yields a misimpression of objects. Foreshortening of features such as holes, lugs, ribs, spokes, and arms should be avoided.
(B) Recommended practice is to rotate the feature into the plane of projection to yield an aligned view. Here both the hole and the rib have been rotated.

## Some Details

When shown in section views (case A), the web is sectioned to indicate the continuity of the material
 throughout the circumference of the wheel. When shown in section views (case B), spokes are not sectioned to indicate gaps around the circumference.
A.



WEB SECTIONED


SPOKES NOT SECTONED

## Some Details



## CAD Technique



## Defining a Cutting Plane on a CAD Model

A 3-D CAD solid model can be sectioned by positioning a cutting plane relative to the object.


## Sectioned CAD Model

The object is automatically cut along the cutting plane to produce a section view.

## Visualization of Section Views




Normal multiview
drawing


## Visualization of a Section View

A section view is created by drawing the outline of the surfaces cut by the cutting plane. Details then are added to show surfaces behind the cutting plane, such as the back of counterbored hole.

## Visualization of Section Views



## Labeling Features for Visualization

The section view is created by passing an imaginary cutting plane vertically through the object. Corners are labeled to assist in the visualization of the orthographic section view.

## Cutting Plane Lines



No!

## Placement of Cutting Plane Lines

The cutting plane line is placed in the view where the cutting plane appears on edge.


Correct cutting plane line


Incorrect cutting plane line

## Cutting Plane Lines



## Standard Cutting Plane Linestyles

Standard cutting plane linestyles are thick lines terminated with arrows.

## Cutting Plane Lines



## Horizontal Section View

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


Multiview


Section view

## Cutting Plane Lines



## Profile Section View

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


Section view


## Cutting Plane Lines

## Multiple Section Views

Multiple section views can be created on a single multiview drawing. This example shows horizontal and profile section views. Note that each section view is labeled to correspond to its cutting plane line.


SECTION A-A


## Section (Cross-Hatch) Lines

General Purpose Section Line
(A) Cast or malleable iron and general use for all

(D) White metal, zinc, lead, babbitt, and alloys

(G) Cork, felt, leather, and

(J) Titanium and refractory material

(M) Marble, slate, glass, porcelain, etc.

## ANSI Standard Section Lines for Various Materials


(B) Steel

(E) Magnesium, aluminum, and aluminum alloys

(H) Sound insulation

(K) Electric windings, electromagnets, resistance, etc.

(N) Earth

(Q) Water and other liquids

(C) Bronze, brass, copper, and compositions

(F) Rubber, plastic, and electrical insulation

(I) Thermal insulation

(L) Concrete

(O) Rock

(R) Across grain With grain $>$ Wood

## Section (Cross-Hatch) Lines

## Examples of Good and Poor Section Lining Techniques



Correct
(45 ${ }^{\circ}$; Equal spacing)


Incorrect (Linework is inconsistently spaced)


Incorrect
(Linework is too closely spaced)


Incorrect (Linework is not consistent in direction)


Incorrect
(Linework fails to end at boundaries of area)


Incorrect (Linework is too widely spaced)


Incorrect
(Linework intensity is inconsistent)

## Section (Cross-Hatch) Lines


(A) Avoid!

(B) Avoid!

(C) Preferred

## Section Line Placement

Avoid placing section lines parallel or perpendicular to visible lines.

## Section (Cross-Hatch) Lines


(A) Avoid!

(B) Preferred

(C) Preferred

## Notes in Section-Lined Areas

Section lines are omitted around notes and dimensions.

## Section (Cross-Hatch) Lines

## Outline Sectioning

Outline sectioning is used on large areas.


## Section (Cross-Hatch) Lines



## Thin Parts in Section

Thin parts in section are represented without section lines (ASME Y14.2M-1992).

## Section View Types

$\square$ Full section
$\square$ Half section
$\square$ Offset section
$\square$ Aligned section
$\square$ Revolved (Rotated) section
$\square$ Broken-out section
$\square$ Removed section
$\square$ Assembly section

half section

broken-out section

a revolved section
 $\square$ Auxiliary Section

## Full Section

## The object is cut thoroughly.




Normal orthogonal vipur
 (not shown in section view)


Section view

## Full Section



## Creating a Full-Section View



Step 1


Step 3


Step 4
Step 5


## Half Section

Half sections are used with symmetrical parts and with cylinders, in particular as shown in the figures.


## (1) Half Section



## Offset Section



## Offset Section


(A) Offset section view


(B) No!

An offset-section view is created by bending the cutting plane at 90-degree angles to pass through important features.

Offset Section


Multiple Offset Sections
Multiple offset-section views use labels for identification.

## Offset Section



## (2) Offset Section



## Aligned Section

The filter cover has trisymmetric features that are equally spaced around the circular body. For this case, an aligned section technique is appropriate. An angular cutting plane cuts through two of the three slots as shown on the figure.


FILTER COVER

MTL.: ALUMINUM


## Aligned Section



## Aligned Section



(A) True Projection

(B) Preferred

## Aligned Section

Aligned section conversions are used to rotate the holes into position along the vertical center line.

## Aligned Section



Spoke A omitted in the "preferred" section view


True Projection


Preferred

## Aligning Spokes

Aligning spokes in section views is the conventional method of representation.

## Aligned Section



(B)

## Aligning Lugs

Aligning lugs in section views is the conventional method of representation.

## Aligned Section



(A) True projection

(B) Preferred

(C) Section view

## Aligning Ribs

Aligning ribs in section views is the conventional method of representation.

## Rotated (Revolved) Section

Imaginary slices of this chisel are taken perpendicular (at right angles) to the view shown. The slices are then rotated $90^{\circ}$ in place where the "slice" was cut.


If the revolved section does not fit within the edges of the cut surface, break lines are used to show the section, as shown on the far left section of this chisel drawing.

## Rotated (Revolved) Section



## Revolved (Rotated) Section

A revolved-section view is created by passing a cutting plane through the object, then revolving the cross section 90 degrees.

(B) Revolved section; broken view

## Broken-out Section


(A) Broken-out section

(B) Multiview

(C) Broken-out section view

## Broken-Out Section

A broken-out section view is created by breaking off part of the object to reveal interior features.

## Removed Section

- A removed section is the same as a revolved section, except that the perpendicular "slice" is "removed" to another area of the drawing.
- Cutting-plane lines and the corresponding removed sections are labeled with UPPER CASE letters in double alphabetical order: $A A, B B, C C$, etc.

at a different scale
if needed to show detail.
The new scale must be noted.


## Removed Section

## Removed Section

A removed section view is created by making a cross section, then moving it to an area adjacent to the view.


REMOVED SECTION


## Removed Section



## Removed Section



## Scaled-Section View

A scaled removed section view is placed at any convenient location and labeled with the scale.

## Removed Section



## Aligning Removed-Section Views

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

## Assembly Section



Assembly section views are typically full or half sections of multiple assembled parts.

## Assembly Section



## Assembly Section

In addition to thin structural features, parts not sectioned also include standard mechanical elements such as
 shafts, bolts, screws, nuts, rivets, keys, pins, bearings (roller or ball), and gear teeth Here the shaft, bolts, and nuts of the assembly are not sectioned even though they are cut by the cutting plane.


## Assembly Section



## Standard Parts not Section Lined

Standard parts, such as fasteners and shafts, are not section lined in assembly sections, even if they are cut by the cutting plane.

## Assembly Section



## Section Lining Adjacent Parts

Adjacent parts in an assembly section are section lined at different angles so that individual parts can be more easily identified.

## Assembly Section


(Courtesy of Unigraphics Solutions.)

## Translucency of a CAD Model

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

## Auxiliary Section



## A Full Auxiliary Section View

## Auxiliary Section



A Partial Auxiliary Section View


Parts of the object appearing behind the auxiliary section view sometimes are not drawn, to improve the clarity of the drawing.

## Conventional Breaks



(A) Round solid

(B) Round tubular

(C) Round tubular

(D) Rectangular

(E) Rectangular wood

## Sectioning in AutoCAD



## Sectioning in AutoCAD

If we have more than one part in our view, we will need to make sure that it stands out. Here we have the same part, but with another piece placed inside it.


## Drawing Section Views in AutoCAD

Begin by drawing the part below. You do not need to draw the Isometric view, it is just for reference.


## Drawing Section Views in AutoCAD

To draw the "Cutting Plane" that marks the section, draw a line and then use the leader command to make the arrows. Add text for the "A"s.
Copy the related view.
Change the hidden lines.
Remove the lines that lost edge position.
Section view before hatching:


## Hatching in AutoCAD

$\square$ From "draw" pull-down menu choose hatch or click the hatch icon.

- You will get Boundary hatch dialog box.
$\square$ Select a hatching pattern (Hatching pattern should be the same for the same material).
- Use ANSI31 as a pattern for sections. You can choose 0.5,
 0.75 or 1 as a scale depending of your drawing.
- Select the object to hatch.


## Drawing Section Views in AutoCAD

Start the Hatch command and pick in the spots shown below. Pick all the three areas at the same time so that the hatch creates one object instead of three.



## Section Views with 3-D CAD

## A Section View Created of a 3-D CAD Model



## Section View Exercise 8_1.dwg

Generate the section view A-A'

## Section View Exercise 8_1.dwg



Full Section

(Q)Section View Exercise 8_2.dwg

Generate the section view A-A'
Be careful on the direction of viewing.

## Full Section



## (ㄴ) Section View Exercise 8_2.dwg



## 

Full Section


sEcTION A-A

## Section View Exercise 8_3.dwg

Generate the section view A-A'


## (ㅁ) Section View Exercise 8_3.dwg



SECTION AA



Full Section

## Section View Exercise 8_4.dwg



Full Section

## Section View Exercise 8_4.dwg




SECTION B-8


Full Section

## Section View Exercise 8_5.dwg



Full Section

## Section View Exercise 8_5.dwg



SECTIONAA


## Section View Exercise 8_6.dwg



Full Section

## Section View Exercise 8_6.dwg



Full Section


## Section View Exercise 8_7.dwg



Full Section

## Section View Exercise 8_7.dwg



Full Section


## Section View Exercise 8_8.dwg



Full Section

## Section View Exercise 8_8.dwg




## Section View Exercise 8_9.dwg



## Section View Exercise 8_9.dwg



## Section View Exercise 8_10.dwg

## Full Section



## Section View Exercise 8_10.dwg



## Section View Exercise 8_11.dwg

Draw the multi view. Then, generate the section view on the front view.


## Section View Exercise 8_11.dwg



SECTIONAA


Full Section

## Section View Exercise 8_12.dwg

Draw the multi view. Then, generate the section view on the side view.


## Section View Exercise 8_12.dwg



Full Section

## Section View Exercise 8_13.dwg



Section View Exercise 8_13.dwg


## Section View Exercise 8_14.dwg



Aligned Section

Section View Exercise 8_14.dwg


Aligned Section

Section View Exercise 8_15.dwg


Aligned Section

Section View Exercise 8_15.dwg


Aligned Section

## Section View Exercise 8_16.dwg

## Half Section



## Section View Exercise 8_16.dwg



## Section View Exercise 8_17.dwg



## Section View Exercise 8_17.dwg




SECTION A-A

Aligned Section

## Section View Exercise 8_18.dwg



Section View Exercise 8_18.dwg


## Section View Exercise 8_19.dwg



Full Section

## Section View Exercise 8_19.dwg




SECTON A-A

## Section View Exercise 8_20.dwg



## Section View Exercise 8_20.dwg



Full Section

Sketch, or draw with CAD, fullsection views. Each grid is $0.25^{\prime \prime}$ or 10 mm .


## Problem 8.2 (Figure 8.54 (D))

Sketch, or draw with CAD, offset-section views. Each grid is $0.25^{\prime \prime}$ or 10 mm .
(

Sketch, or draw with CAD, half-section views. Each grid is $0.25^{\prime \prime}$ or 10 mm .


Sketch, or draw with CAD, the views with sections as indicated by the cutting plane lines. Each grid is $0.25^{\prime \prime}$ or 10 mm .

(5)

## Problem 8.5 (Figure 8.57 (18))

Sketch, or draw with CAD, the views with sections as indicated by the cutting plane lines. Each grid is $0.25^{\prime \prime}$ or 10 mm .

(18)

## Problem 8.6 (Figure 8.59) Counter Block

Sketch, or draw with CAD, then create the necessary views, including a section view, or create a 3-D model.


## Problem 8.6 (Figure 8.63) Taper Collar

Sketch, or draw with CAD, then create the necessary views, including a section view, or create a 3-D model.


## Problem 8.6 (Figure 8.65) Heavy-Duty V-Pulley

Sketch, or draw with CAD, then create the necessary views, including a section view, or create a 3-D model.


## Classic Problem 1 - End Plate

Select views that will best describe the piece. Draw the multiviews, one of which is sectioned.


## (2) Figure 8.70 - Roller-Model TX

Construct 3-D solid part, then create the necessary views, including a section view.


## English - Turkish Dictionary

| section | kesit | sectioning | Kesit alma | Section view | Kesit görünüş |
| :--- | :--- | :--- | :--- | :--- | :--- |
| Inner details | İç ayrıntılar | Reel | makara | Cutting plane | Kesme düzlemi |
| hatching | tarama | Cross-hatching | Kesit tarama | hatched | taralı |
| web | Bağlantı levhası, ray <br> boğazı | support | destek | lug | Sap, kulp |
| spoke | Cant teli (kolu) | Full section | Tam kesit | Half section | Yarım kesit |
| Offset section | Çıkıntılı kesit | Aligned section | Hizalı kesit | Rotated section | (Ekseni etrafında) |
| döndürülmüş kesit |  |  |  |  |  |
| Revolved <br> section | (bir eksen etrafında) <br> döndürülmüş kesit | Assembly section | Montaj kesiti | nut | somun |
| bolt | civata | rivet | perçin | screw | vida |
| key | kama | pin | pim | bearing | (mil) yatak, burç |
| gear | dişli | Interior features | İç özellikler |  |  |

