Mechanical Engineering Drawing

MECH 211

LECTURE 3

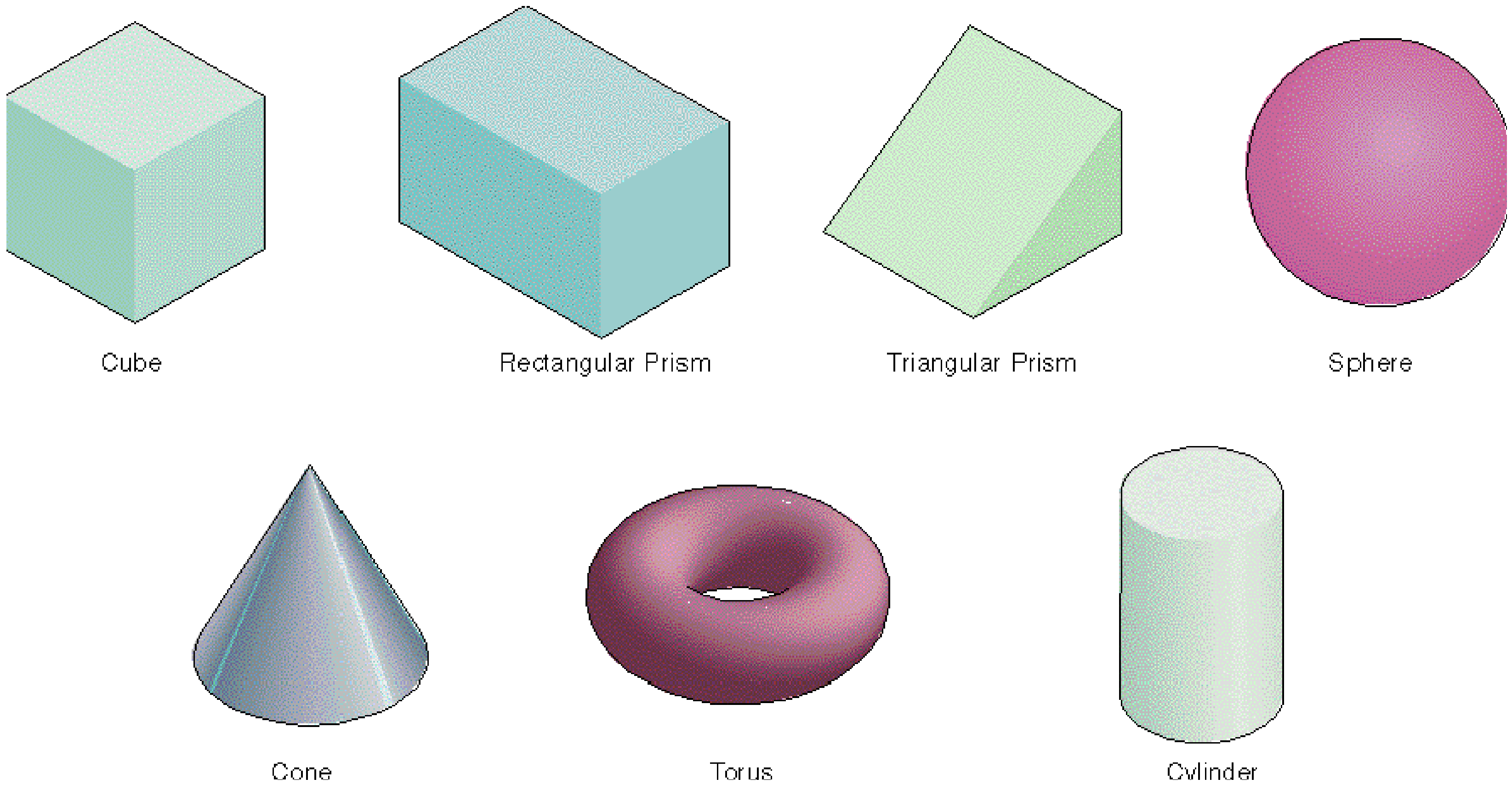
Contents of the lecture

- Shape description
- Shape generation
- Sectional views
- Auxiliary views

Shape description

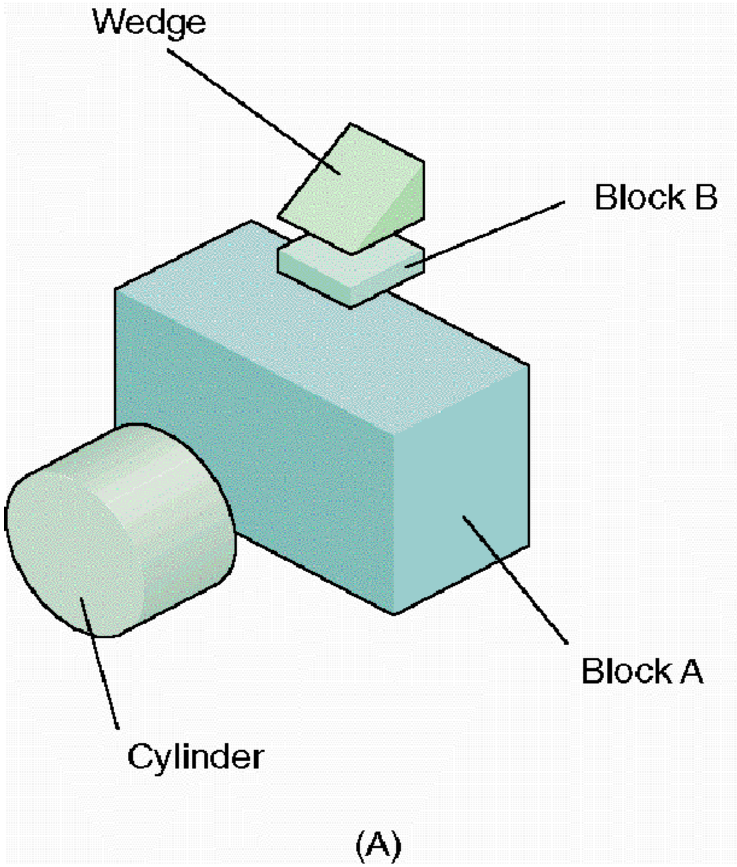
- Geometric shapes are seen according to view they are regarded
- Set of primitives – used to conceptualize the complex shapes by adding/subtracting the primitive shapes
- Primitive shapes:
    - Boxes
    - Prisms
    - Pyramids/truncated pyramids
    - Cylinders
    - Cones
    - Spheres

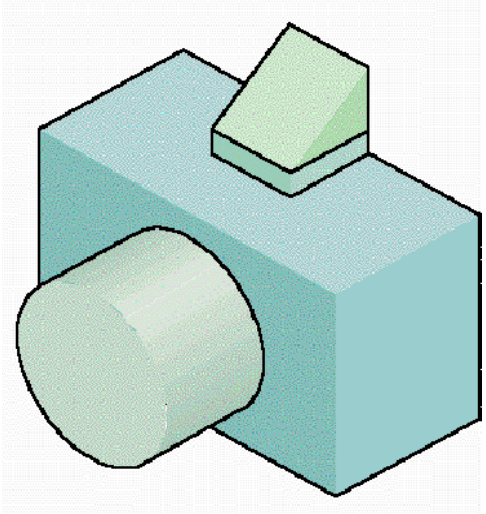
Primitives



Cube
Rectangular Prism
Triangular Prism
Sphere
Cone
Torus
Cylinder

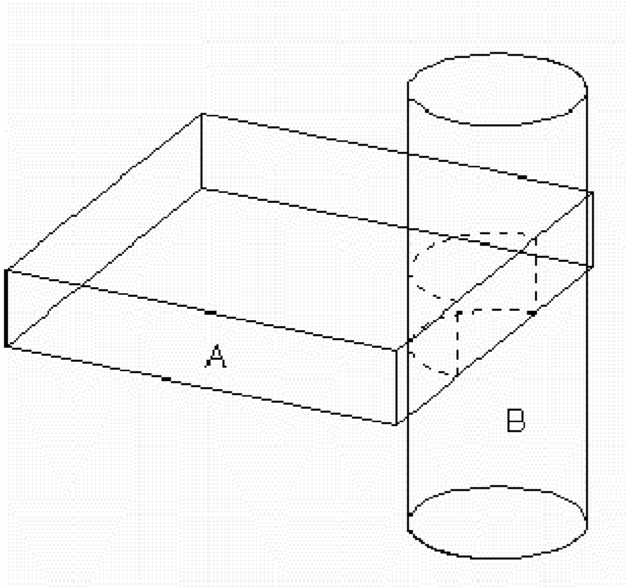
Primitives – shape generation





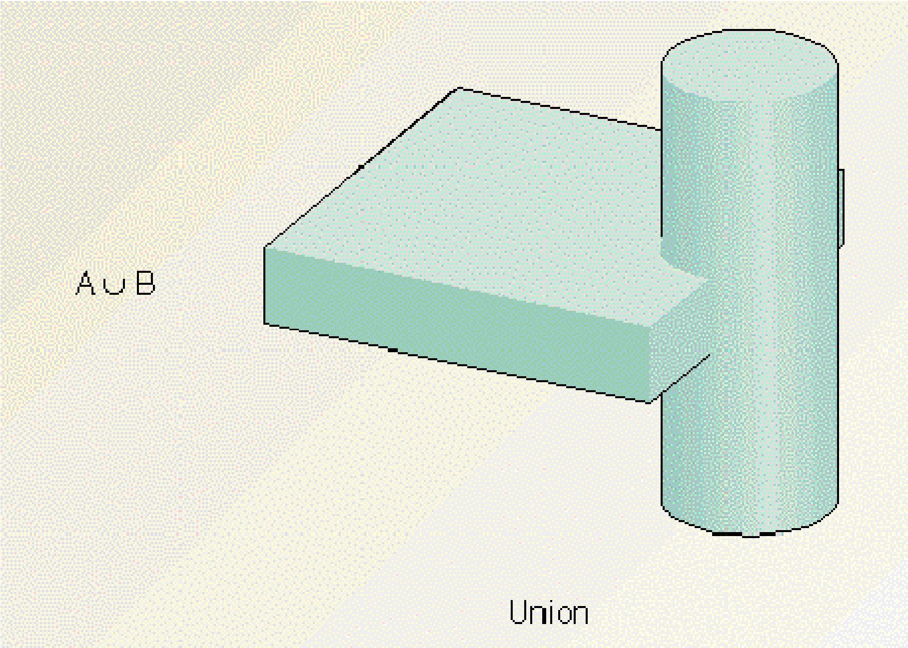
Boolean operations

- Given two shapes, they could be intersected or reunited to obtain a new shape



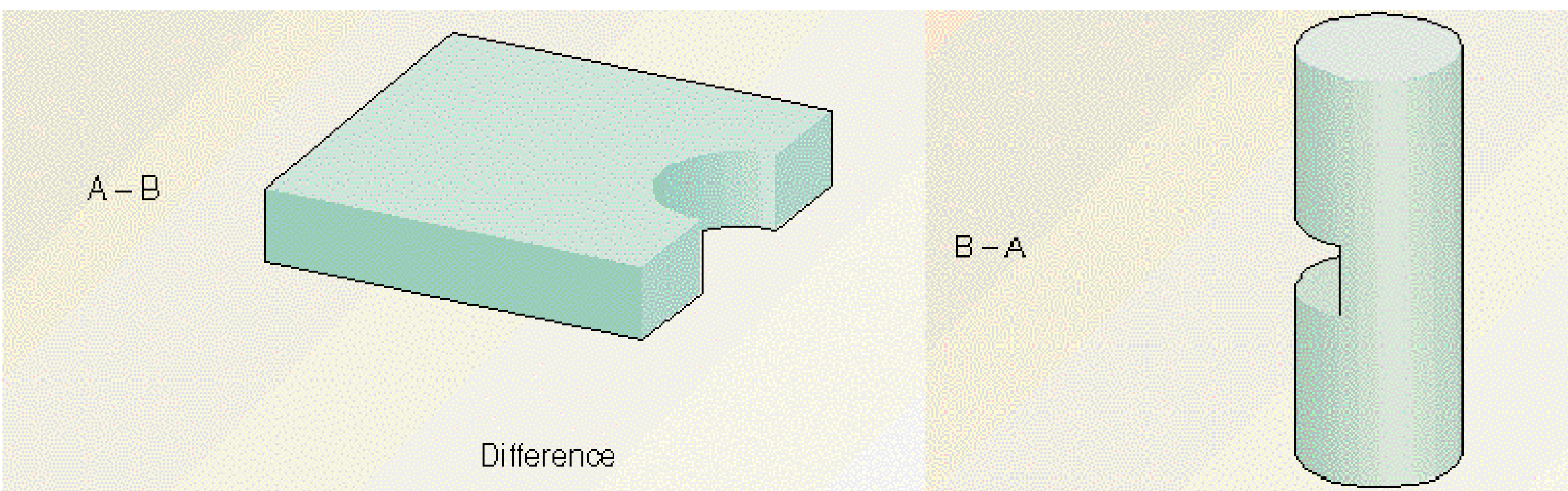
Boolean union

- The common part is removed once



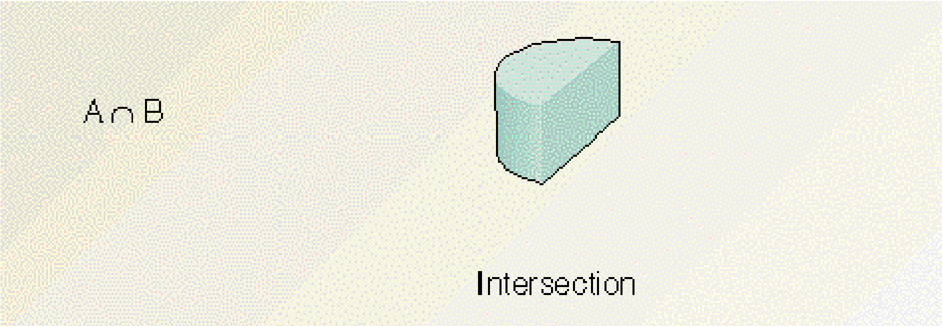
Boolean difference

- The initial shape minus the common portion will be yielded – *notice the difference A-B versus B-A*

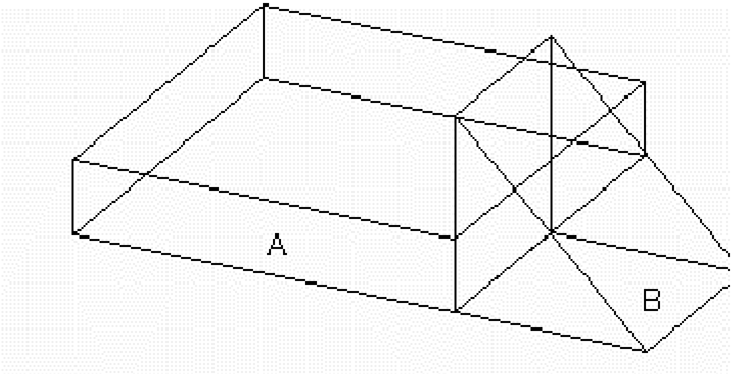


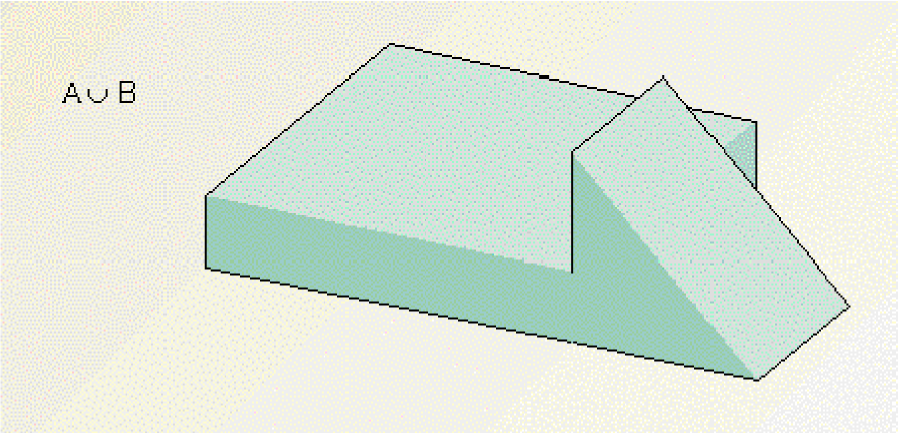
Boolean intersection

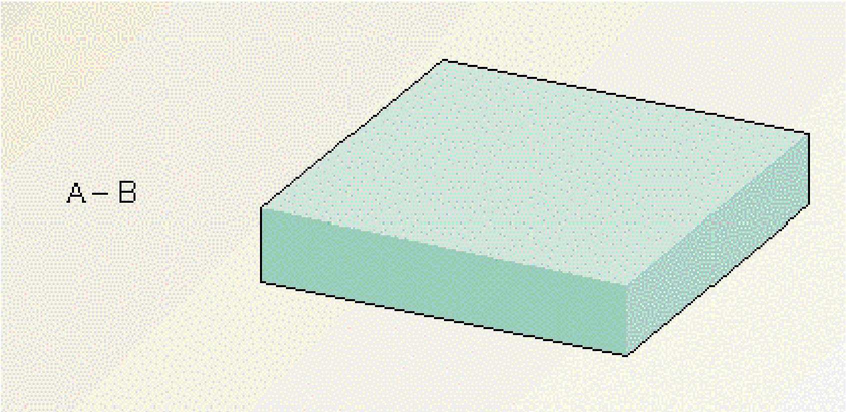
- The intersection means the common portion of the two intersecting bodies



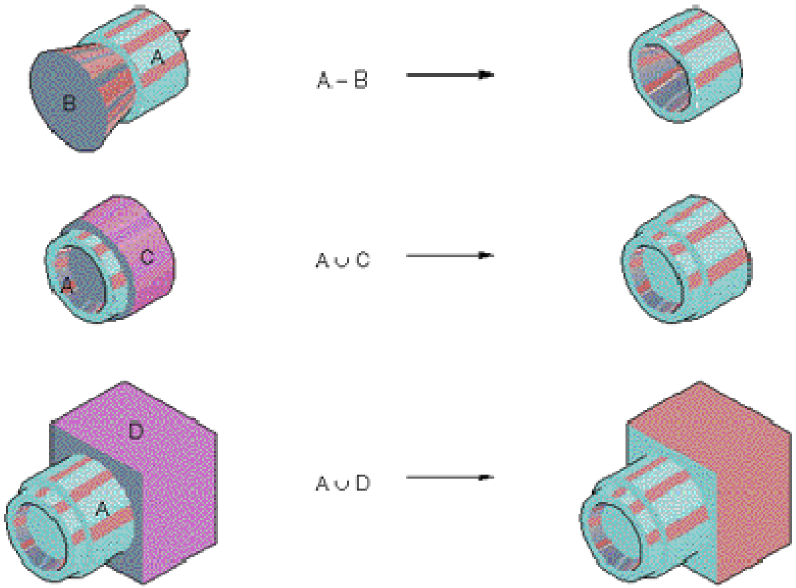
Another example



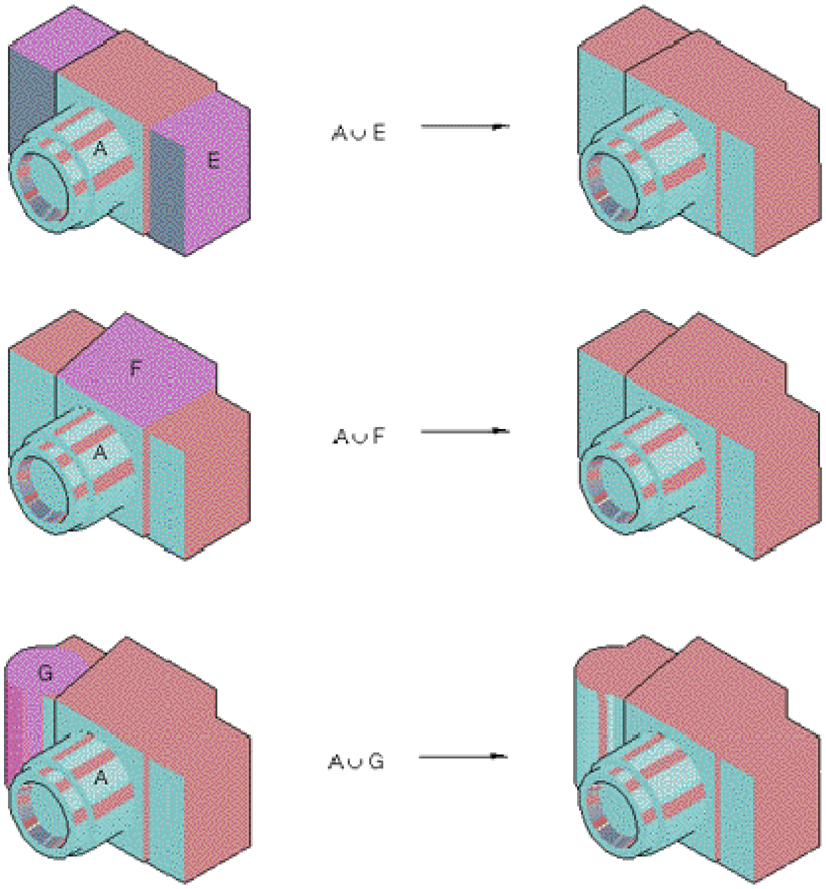




Conceptual generation of a complex shape



Conceptual generation of a complex shape

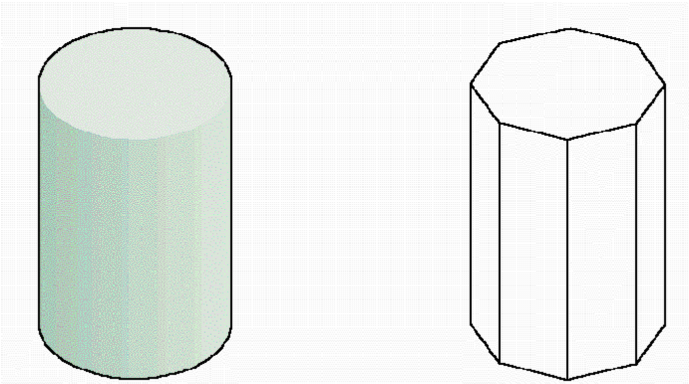


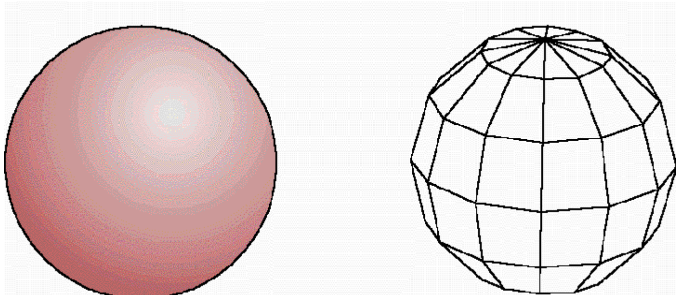
Shape generation

- Two different aspects of shape generation:
  - Conceptual shape generation – when the geometry does not exist and when a functional do-able shape is created
  - Physical shape generation – when the geometric object is physically created/generated by machining
- Physical generation involves material selection, machine tool and tools selections

Conceptual shape generation

- The concept is created by the human judgment
- The concept can be translated in codes – create models





Physical shape generation

- Planes: flat surfaces
- Polyhedrons: inclined flat surfaces
- Cylindrical/conical surfaces: round surfaces, holes
- Ruled surfaces/non-ruled surfaces: complex kinematics cutting or forming in complex shape dies

Physical shape generation

- Two basic principle methods are used to generate surfaces:
  - **Forming** – create shape form a shapeable material: ex
    - » Casting
    - » Deformation (forging, bending, squeezing, etc.)
    - » Growing (nature's way ex: stereo-lithography)
  - **Cutting** – create shape through removal out of a larger piece of material
    - » Turning, milling, drilling, grinding, lapping, etc.
- Multiple types of operations are used to generate the same class of shapes – various surface qualities are obtained for various materials

Shape generation of primitives

- Boxes – flat surface
- Cylinders – round surfaces
- Prisms – flat surface
- Cones – round surfaces
- Spherical – double curved
  - As a general principle, the cutting tool and work piece move one with respect to the other; the cutting tool will remove the undesired volume of material from the work

Machining procedures

- Shaping and planing
- Turning
- Milling
- Drilling
- Sawing
- Broaching
- Grinding

FORMING PROCESS

Hot working

Cold working

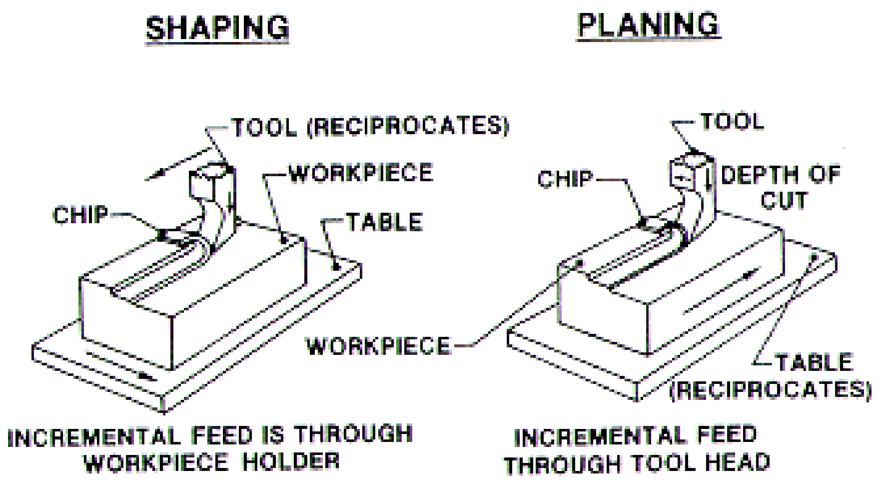
CASTING PROCESS

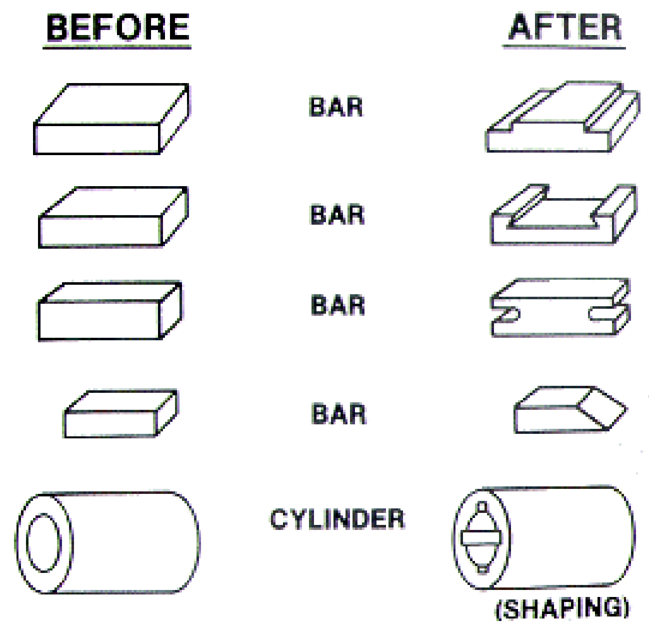
JOINING PROCESS

NON-CONVENTIONAL

PROCESSES

Shaping and planing

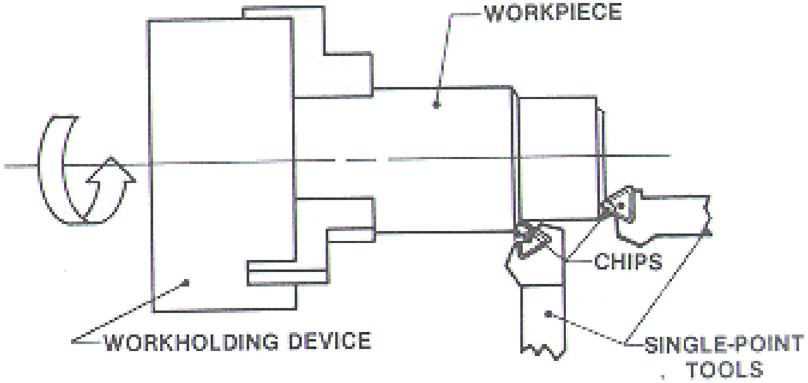


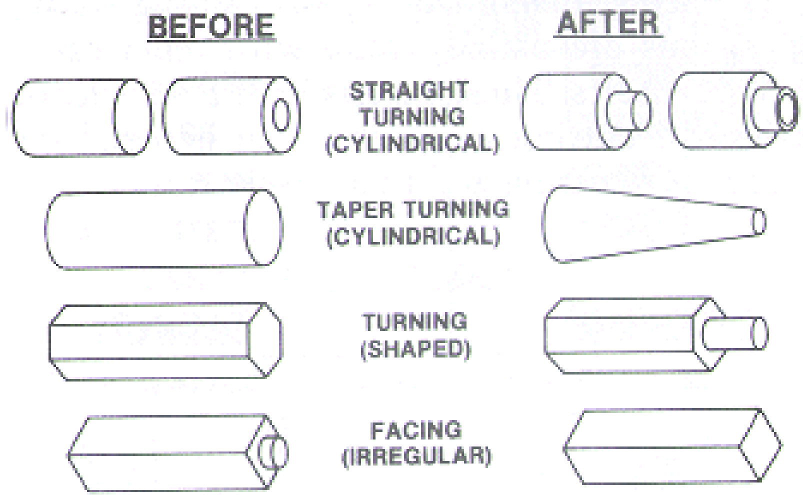


Generation of
Flat surfaces

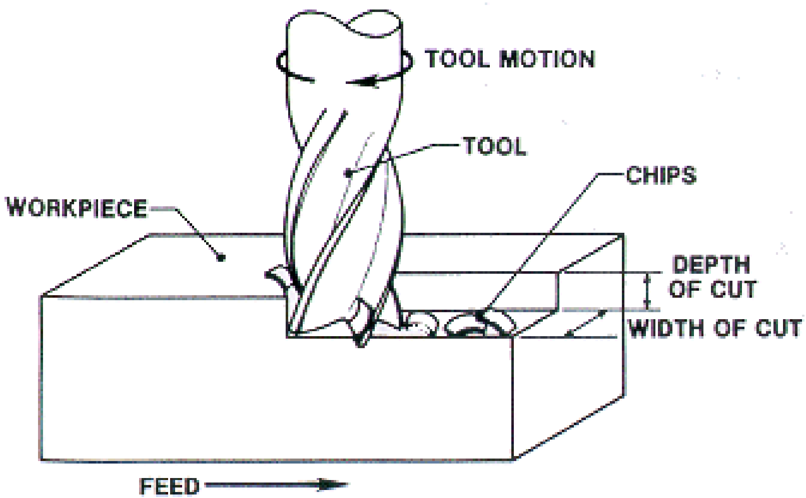
Turning

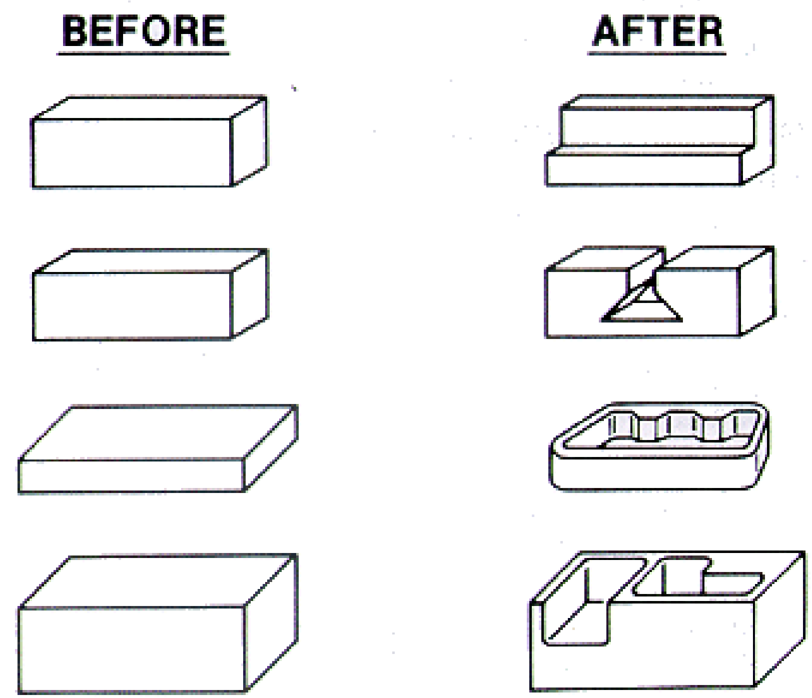
Turning


WORKPIECE
CHIPS
WORKHOLDING DEVICE
SINGLE-POINT TOOLS

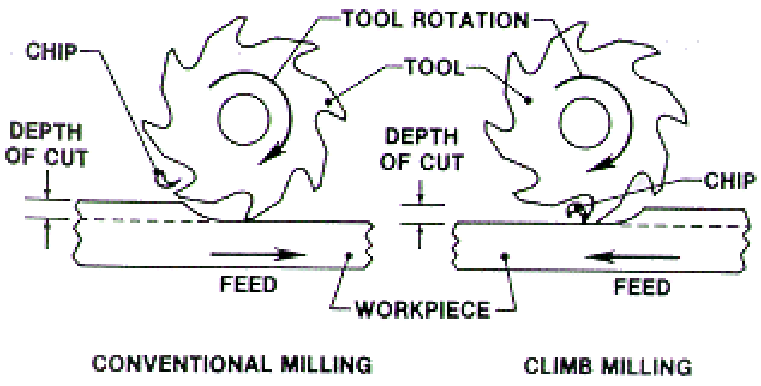

BEFORE
AFTER
STRAIGHT TURNING (CYLINDRICAL)
TAPER TURNING (CYLINDRICAL)
TURNING (SHAPED)
FACING (IRREGULAR)

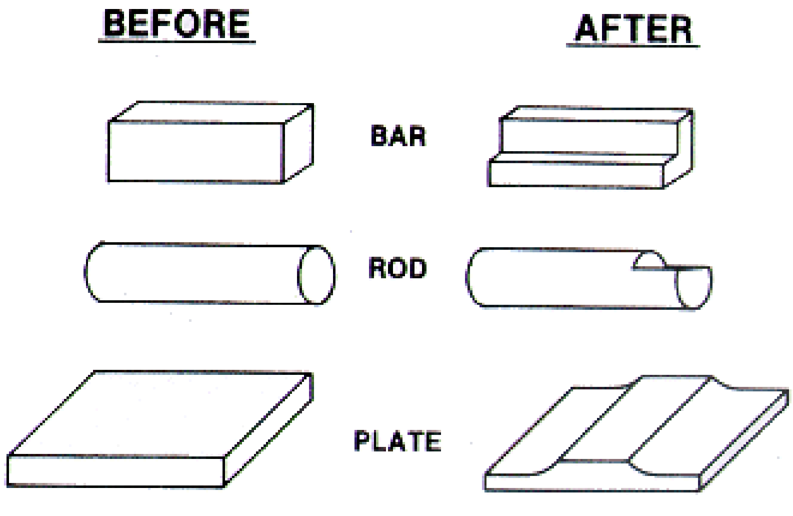
Milling


TOOL MOTION
TOOL
CHIPS
WORKPIECE
DEPTH OF CUT
WIDTH OF CUT
FEED

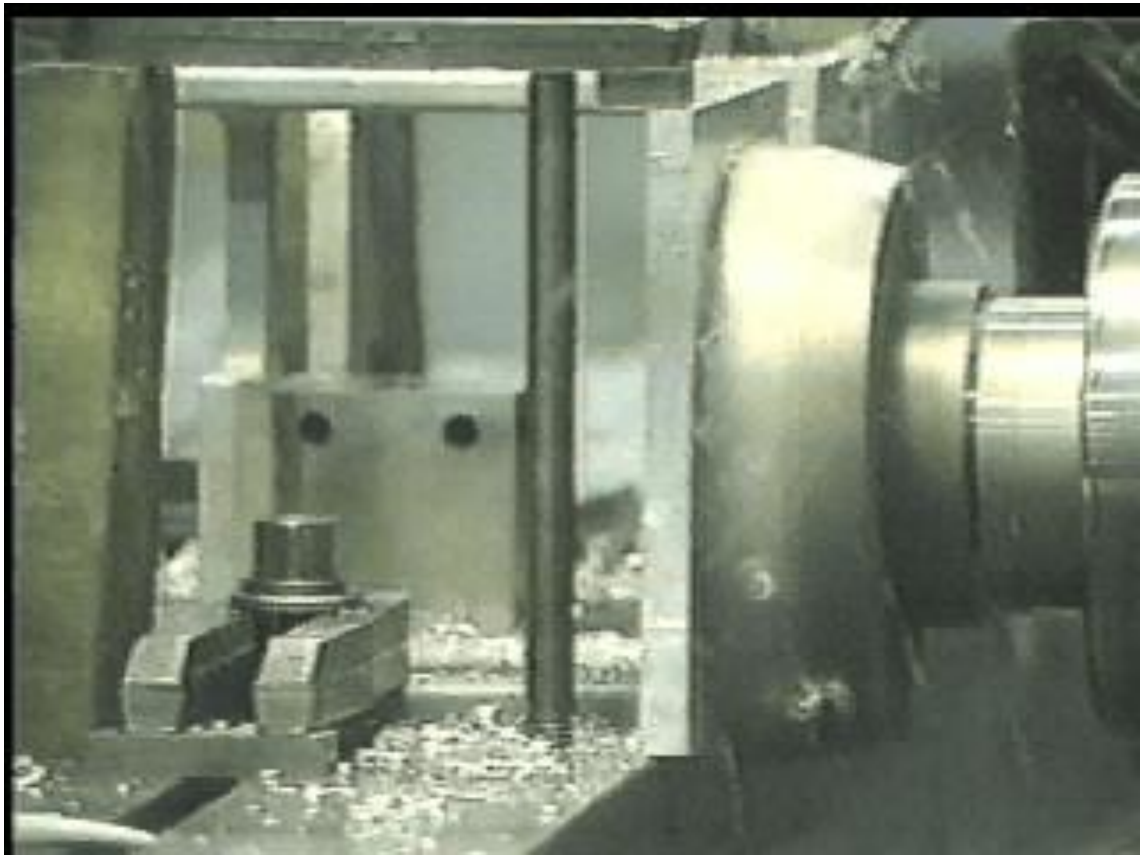

BEFORE
AFTER

Milling

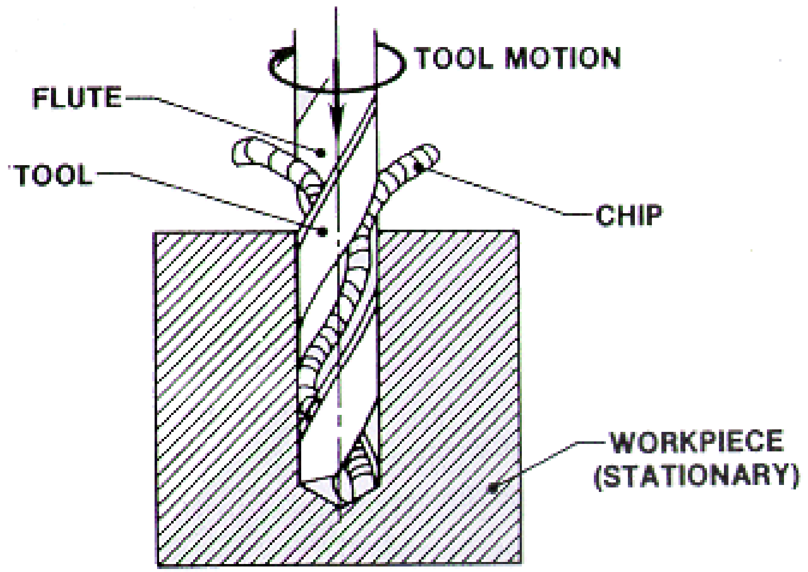

TOOL ROTATION
CHIP
TOOL
DEPTH OF CUT
DEPTH OF CUT
CHIP
FEED
WORKPIECE
FEED
CONVENTIONAL MILLING
CLIMB MILLING

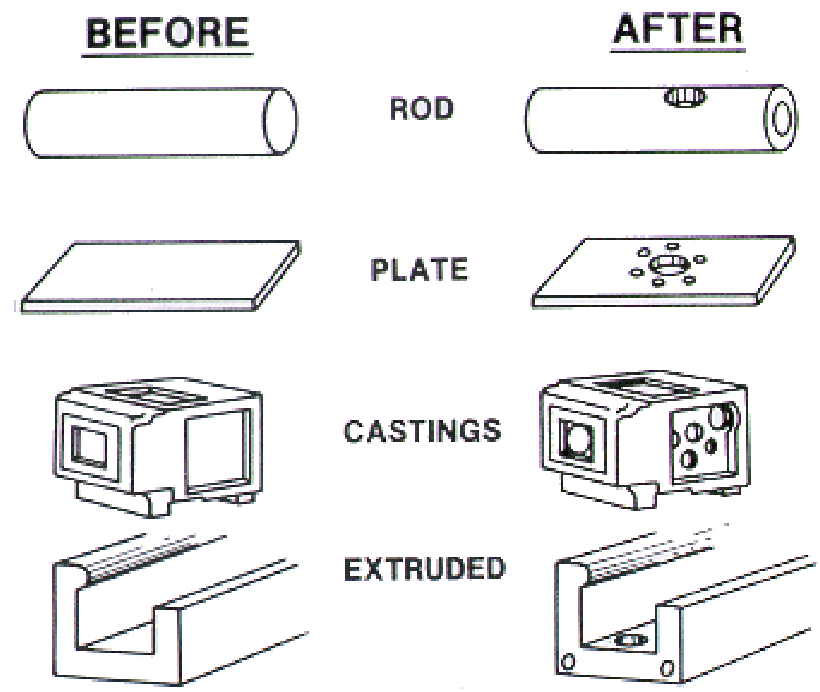

BEFORE
AFTER
BAR
ROD
PLATE

Milling

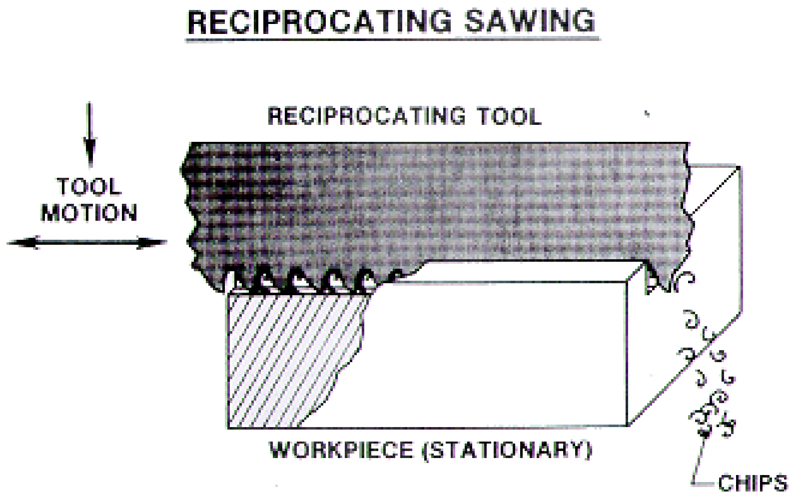


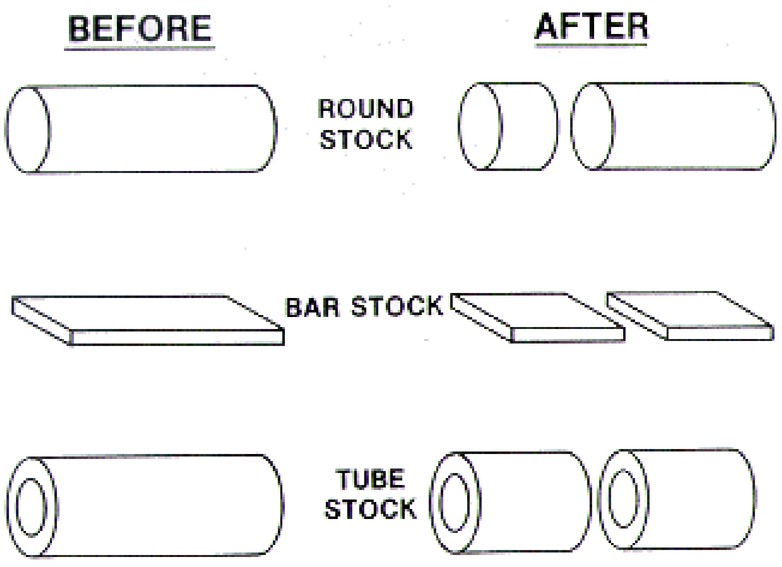
Drilling


TOOL MOTION
FLUTE
TOOL
CHIP
WORKPIECE
(STATIONARY)

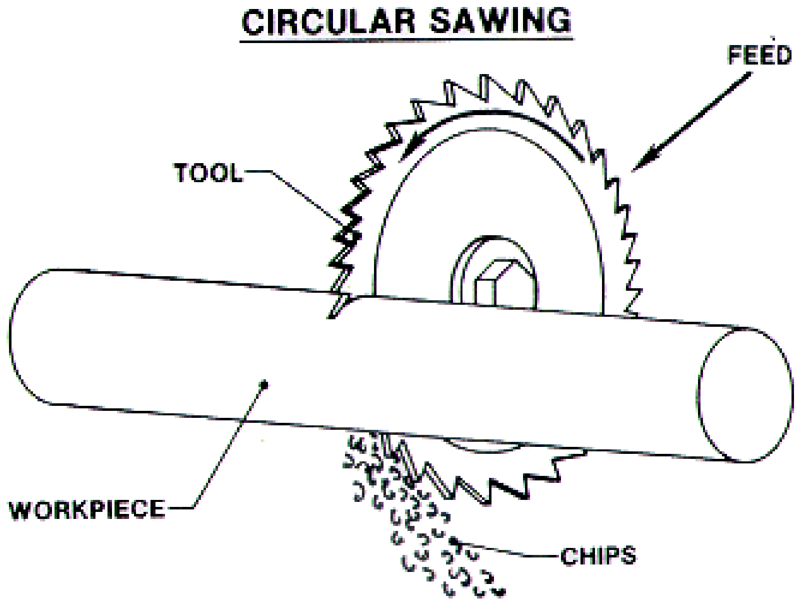

BEFORE
AFTER
ROD
PLATE
CASTINGS
EXTRUDED

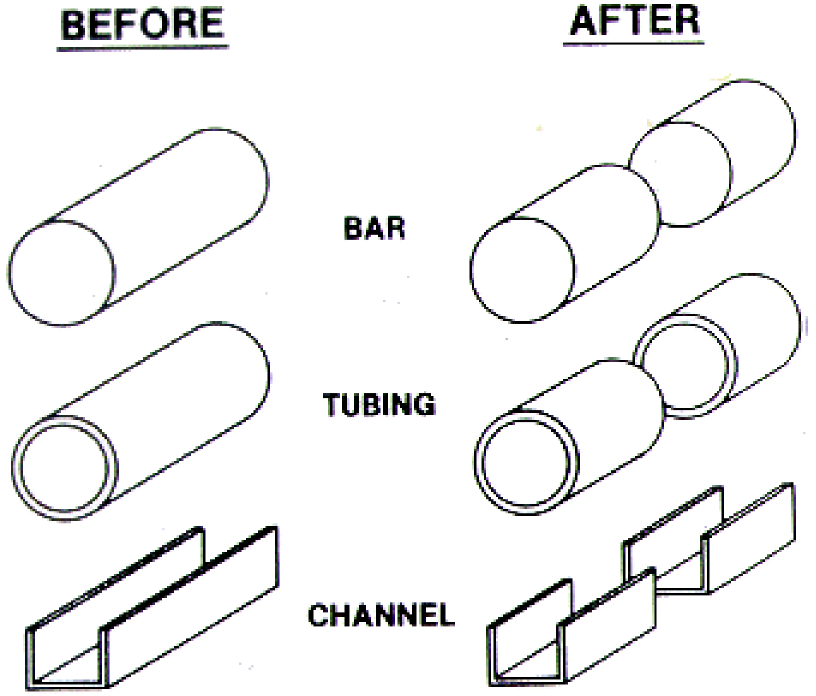
Sawing


RECIPROCATING SAWING
RECIPROCATING TOOL
TOOL
MOTION
WORKPIECE (STATIONARY)
CHIPS

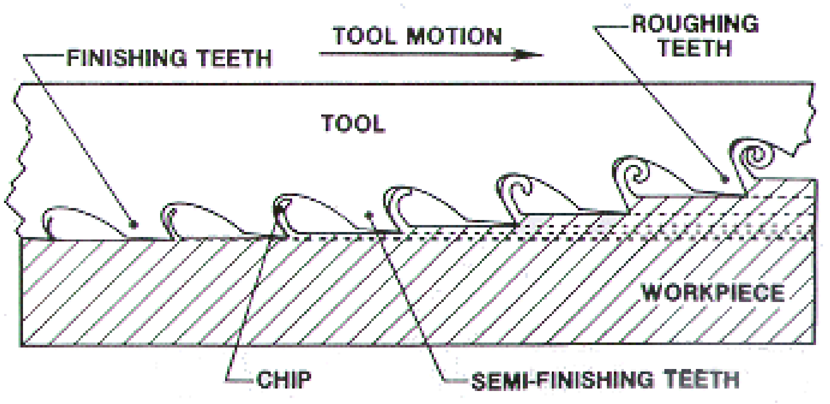

BEFORE
AFTER
ROUND
STOCK
BAR STOCK
TUBE
STOCK

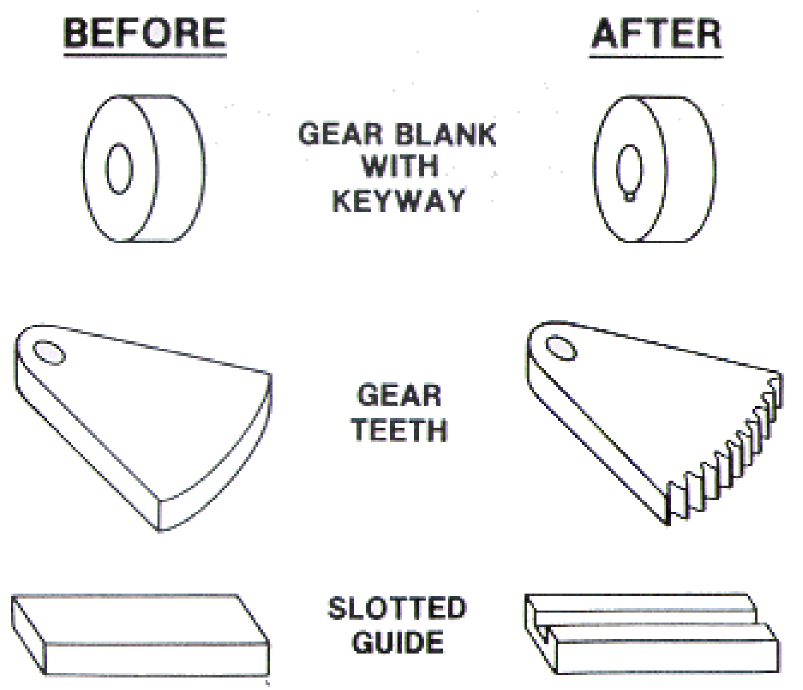
Sawing


CIRCULAR SAWING
FEED
TOOL
WORKPIECE
CHIPS

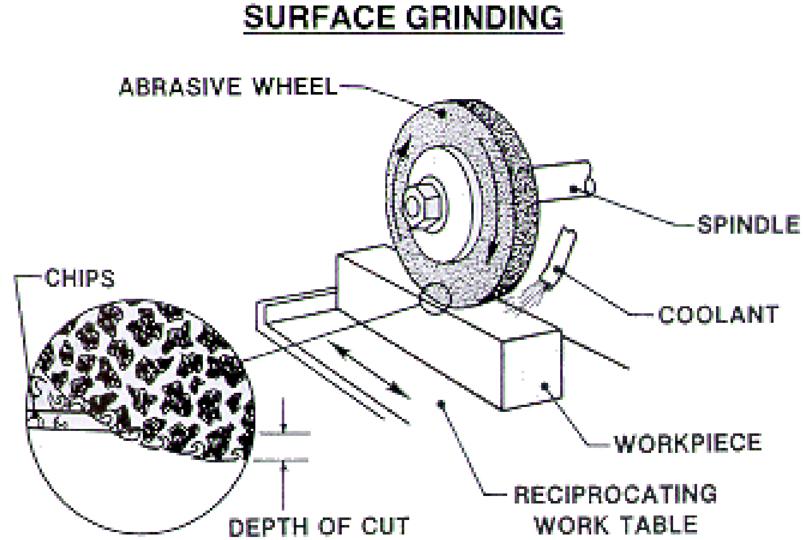

BEFORE
AFTER
BAR
TUBING
CHANNEL

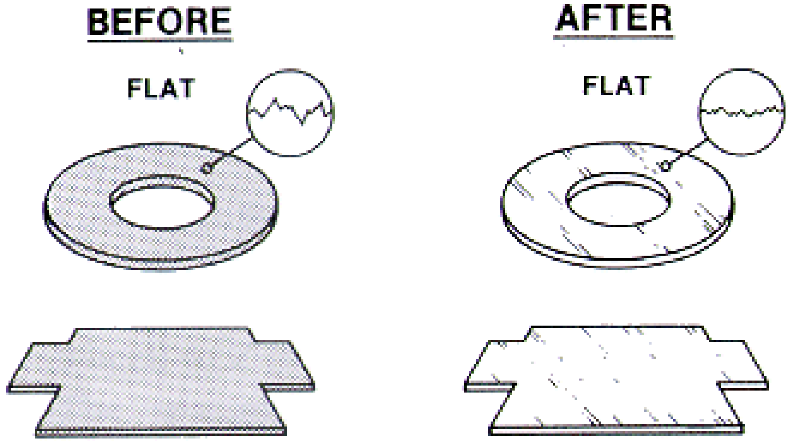
Broaching


FINISHING TEETH
TOOL MOTION
ROUGHING TEETH
TOOL
WORKPIECE
CHIP
SEMI-FINISHING TEETH


BEFORE
AFTER
GEAR BLANK WITH KEYWAY
GEAR TEETH
SLOTTED GUIDE

Grinding

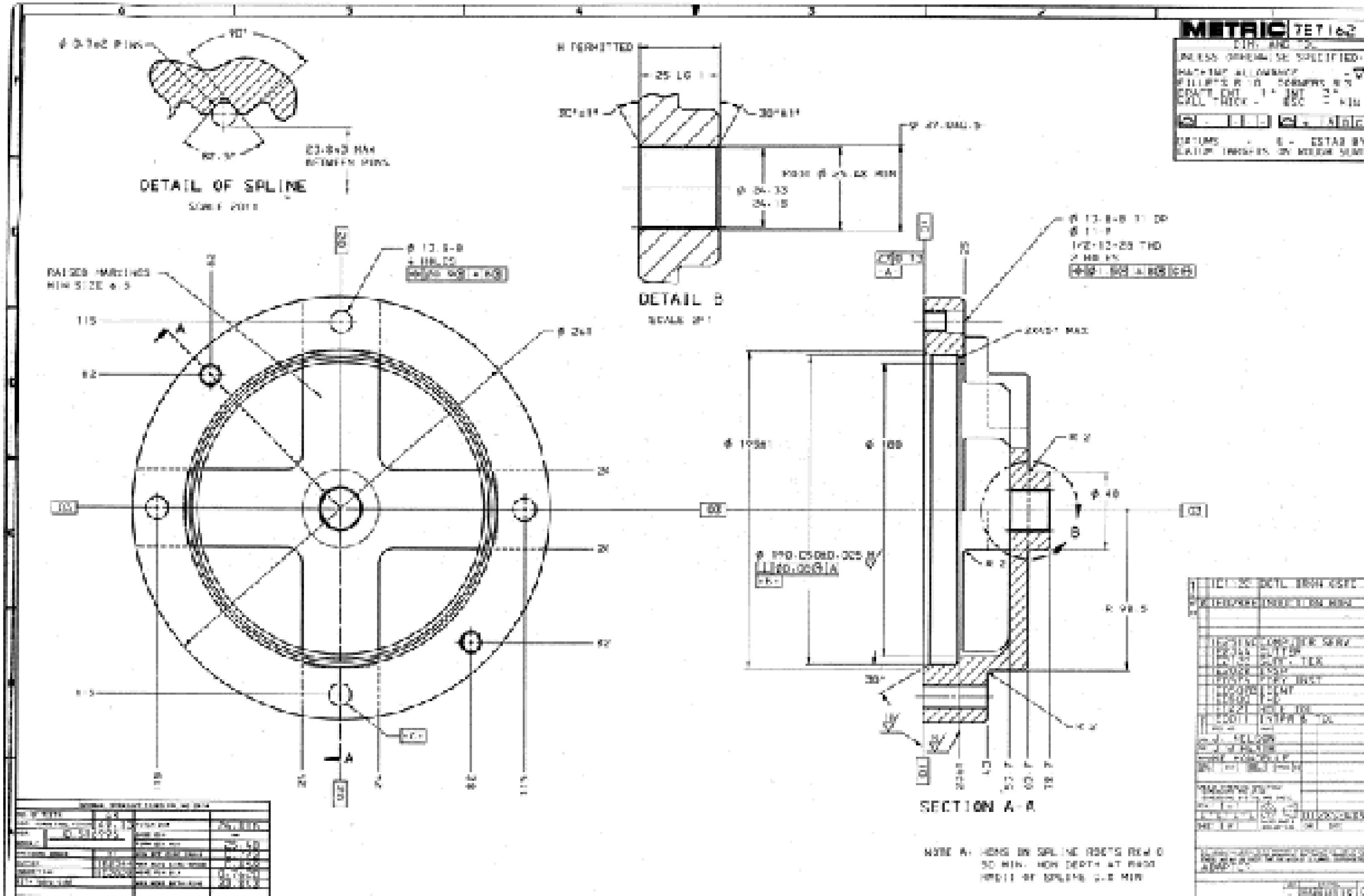

SURFACE GRINDING
ABRASIVE WHEEL
SPINDLE
CHIPS
COOLANT
WORKPIECE
RECIPROCATING
WORK TABLE
DEPTH OF CUT


BEFORE
FLAT
AFTER
FLAT

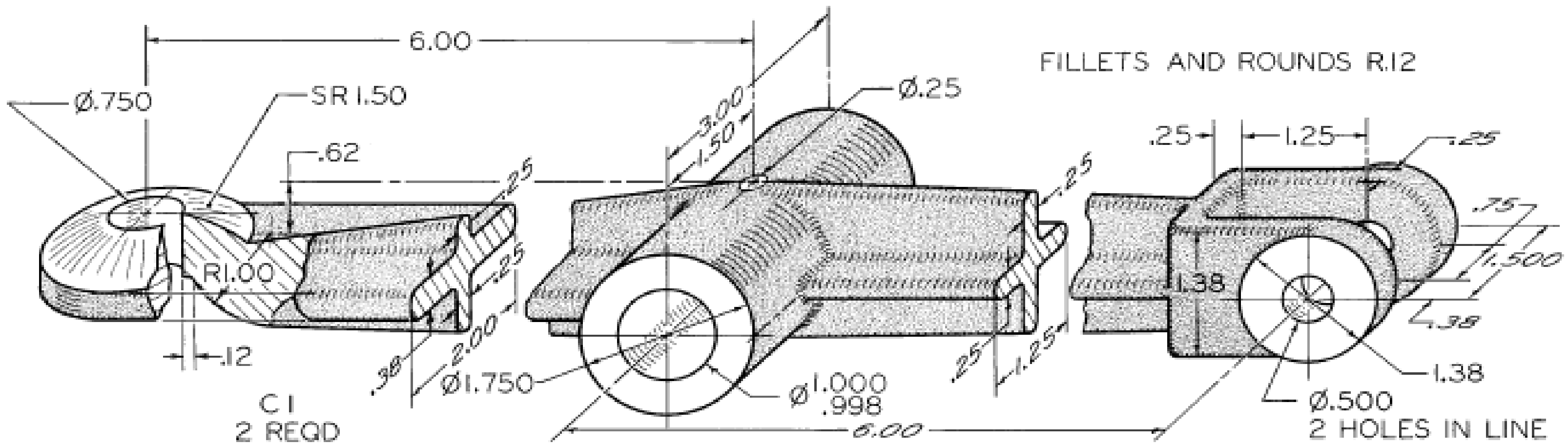
SECTION VIEWS

Purpose of sectioning

- Provide the details of the features that are invisible in a normal view
- A cutting plane is assumed to pass through the conveniently selected features
- If the plane passes through the object, the view is called a FULL SECTION
- Cutting plane is indicated on the adjacent view


METRIC
DETAIL OF SPLINE
DETAIL B
SECTION A-A
90°
Ø 180
Ø 40
R 98.5
30°

SECTIONAL VIEW



Why do we use sectional views?

SECTIONAL VIEW TYPES

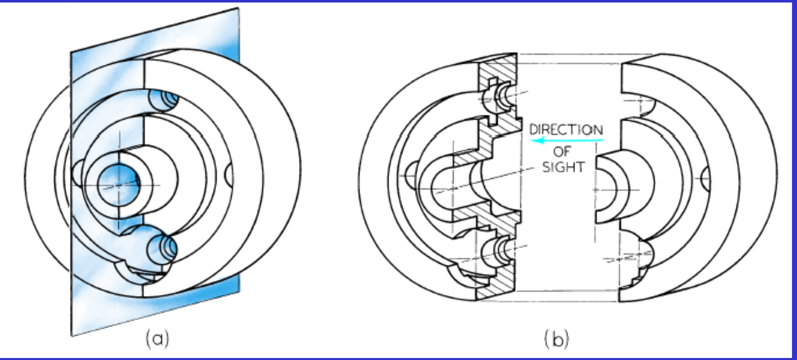
- Full Sections
- Half Sections
- Offset Sections
- Broken Sections
- Revolved Sections
- Conventional Breaks
- Partial Views

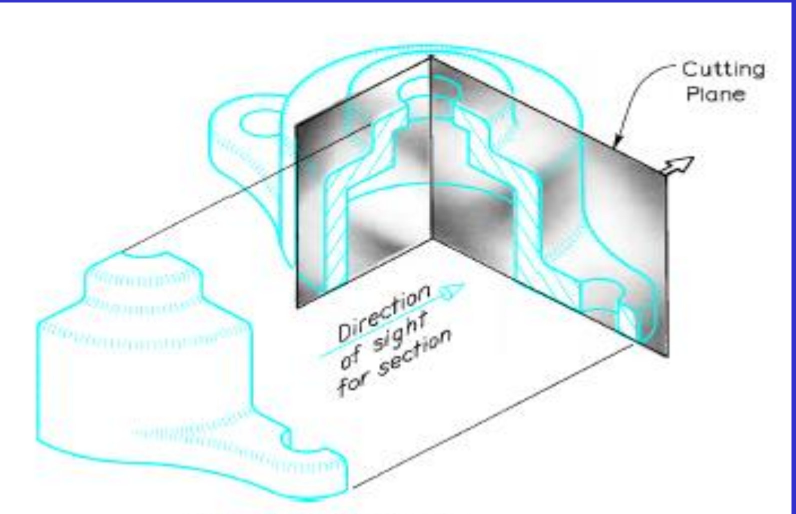
ELEMENTS IN SECTIONAL VIEWS

- Cutting Plane

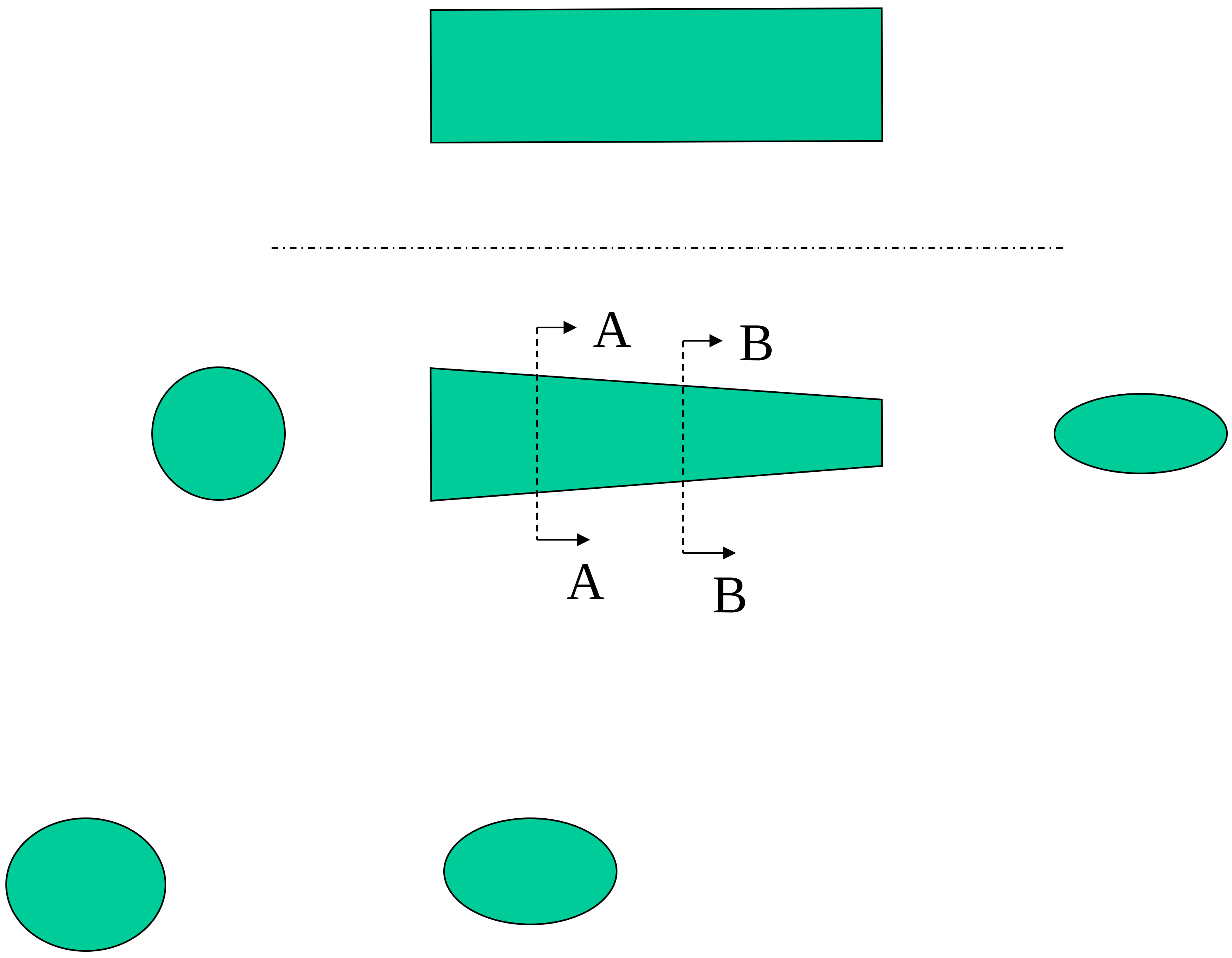
  An assumed plane passes through the part to expose the interior construction.

  Different cutting planes make different types of sectional views

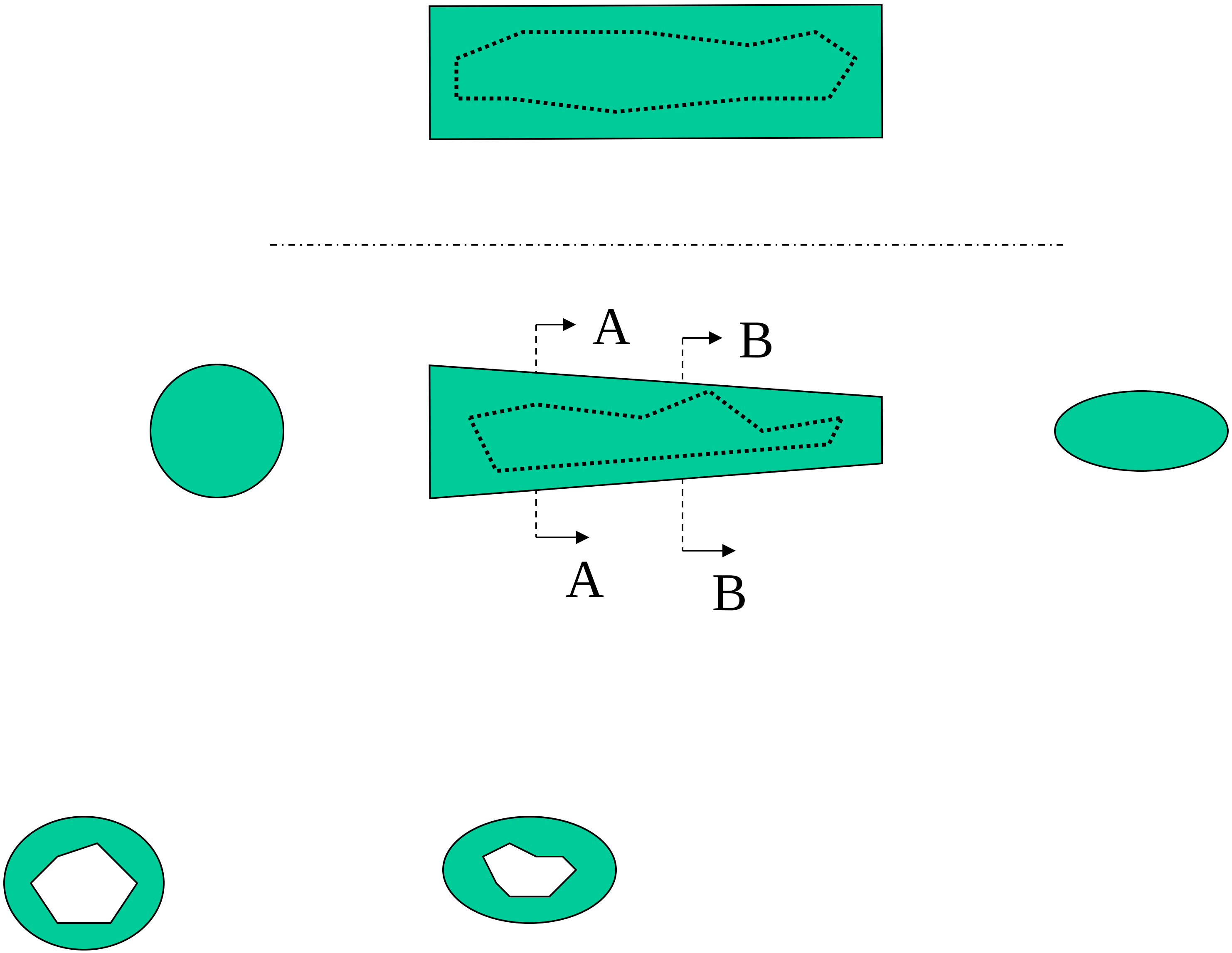




(a) CUTTING PLANE

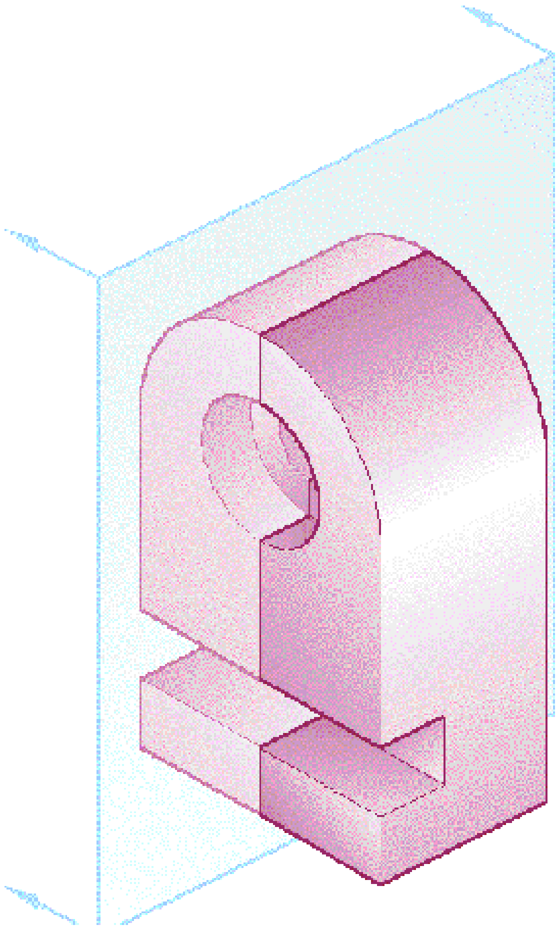


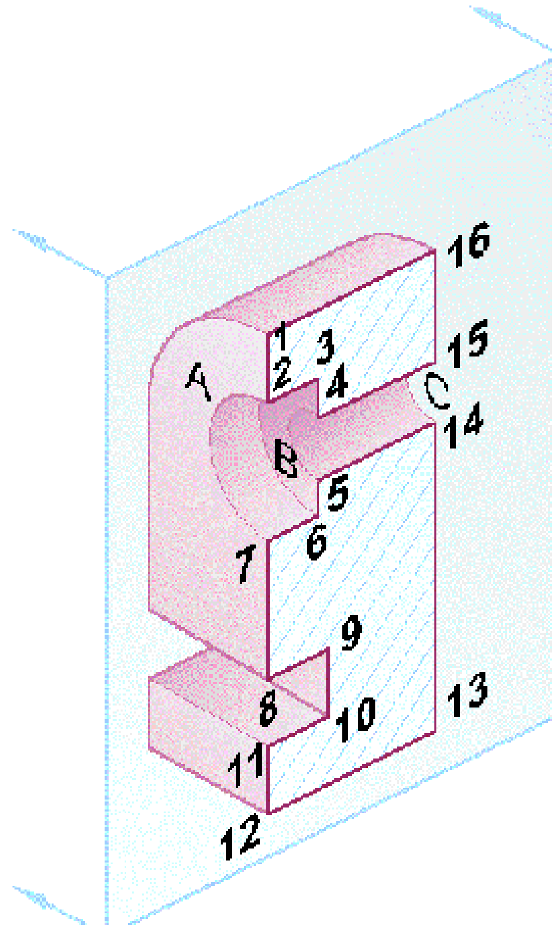
Section AA Section BB



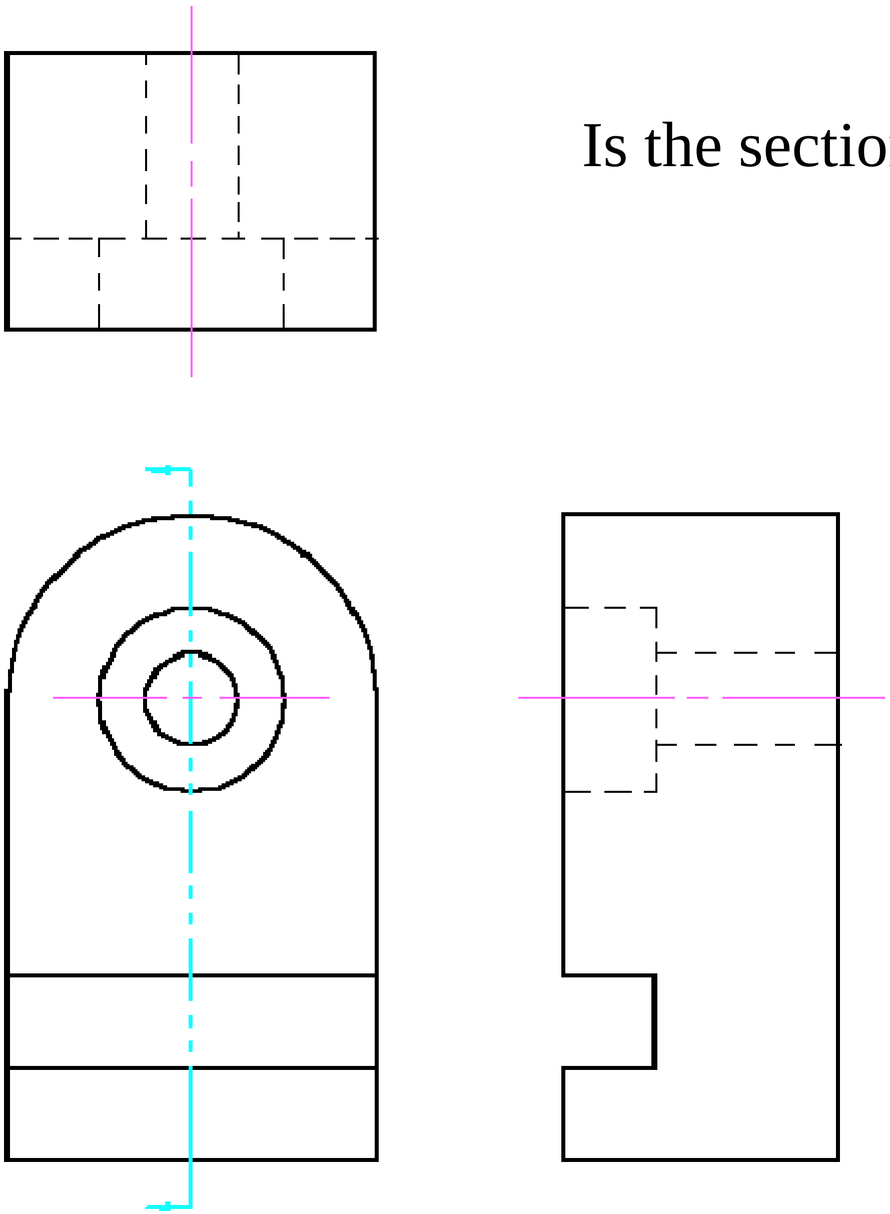
Section AA Section BB

The cutting plane

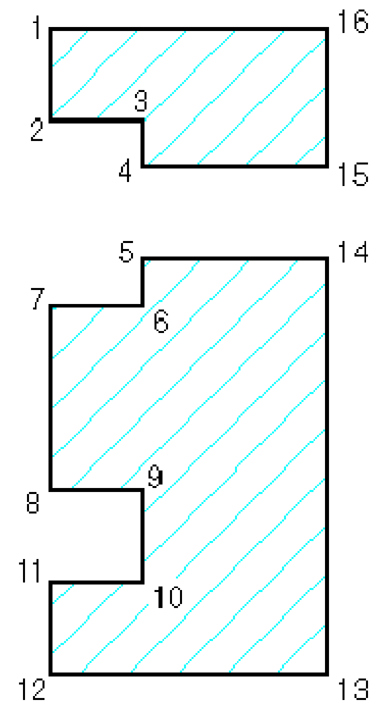




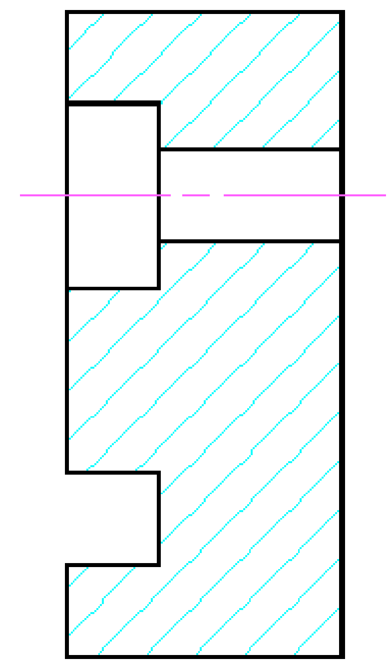
Is the section view really needed?



Normal multiview drawing



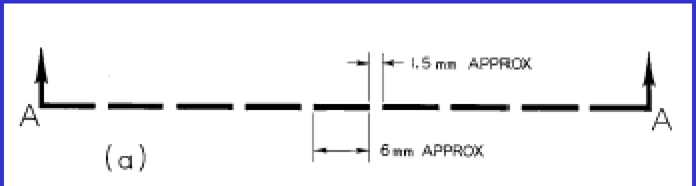
(A)

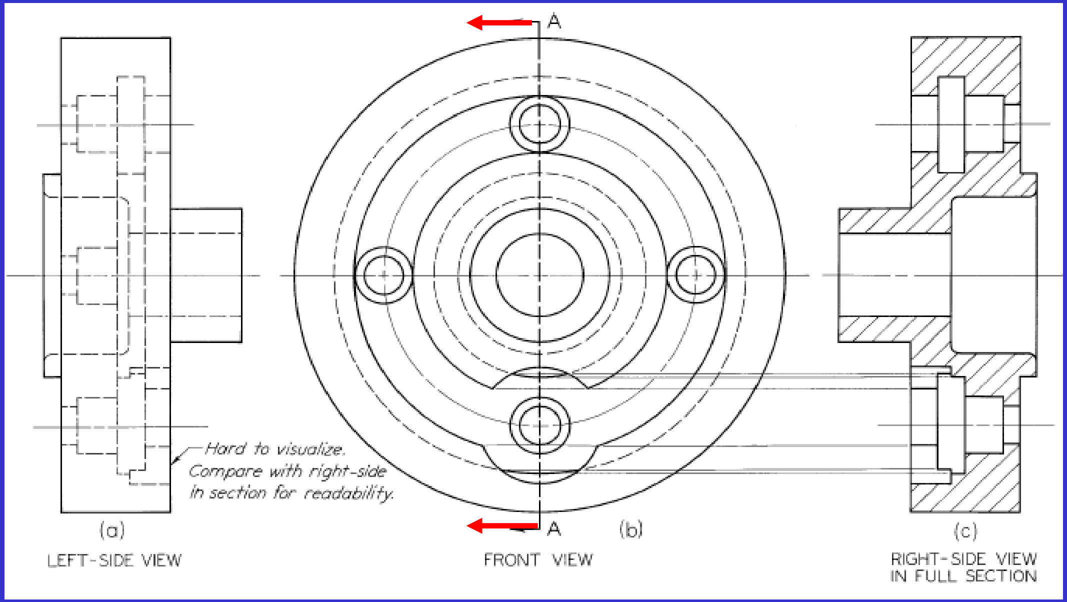


(B)

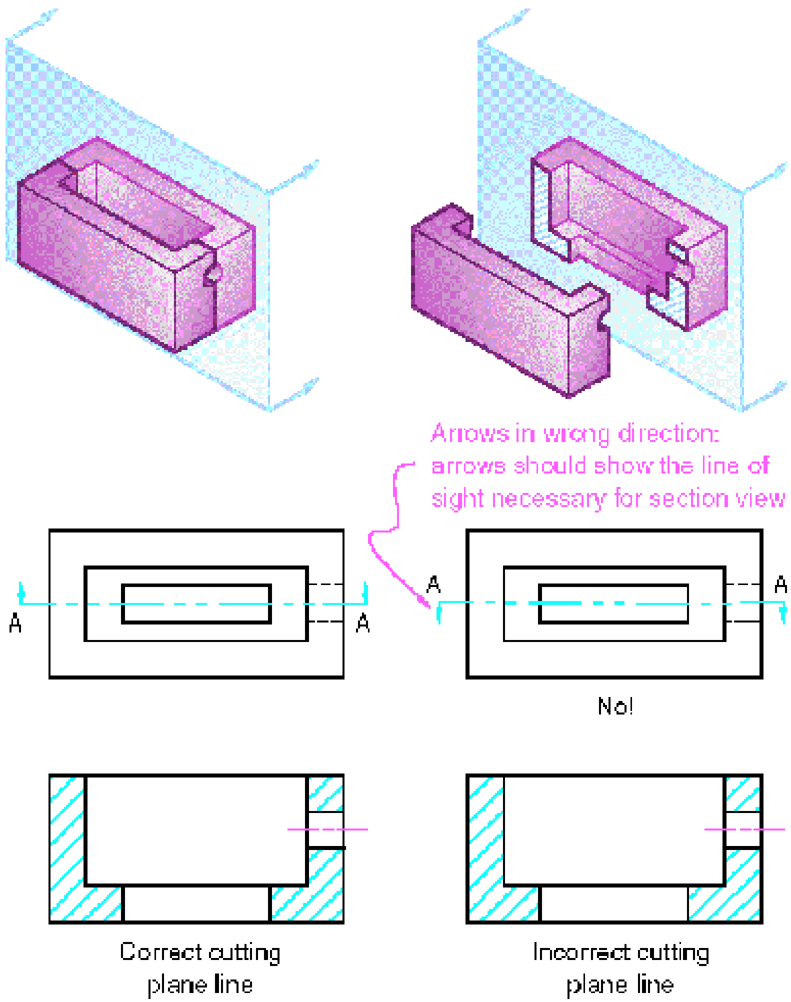
ELEMENTS IN SECTIONAL VIEWS

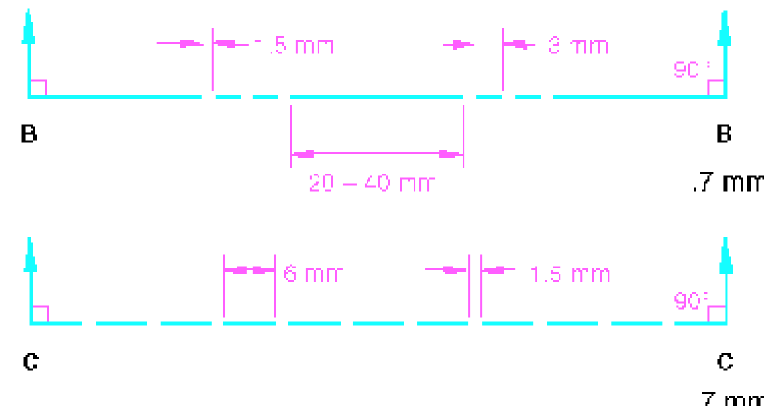
- Cutting-Plane Line
  - ✓Location
  - ✓Line Type
  - ✓Arrowheads
  - ✓Capital Letters



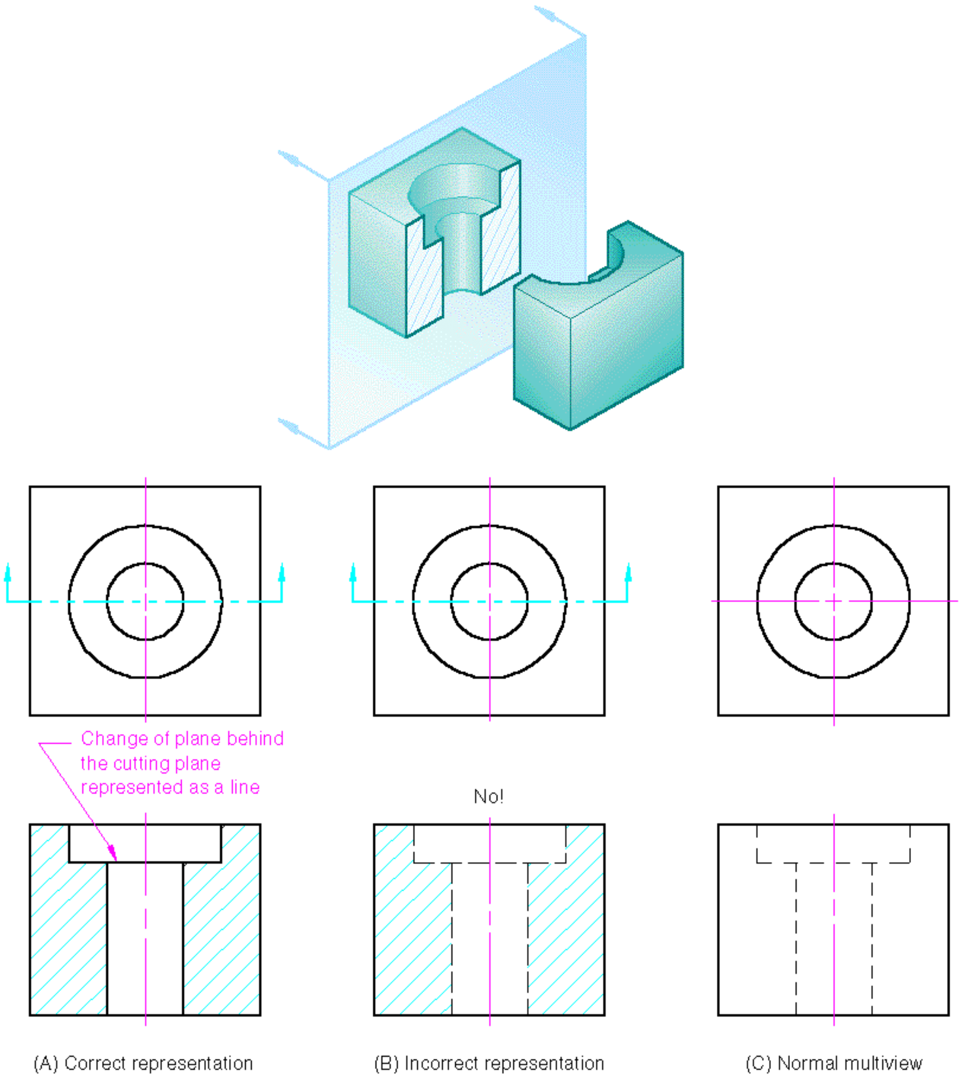


Indicate the cutting plane

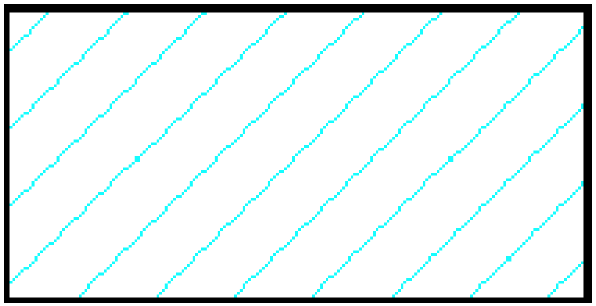




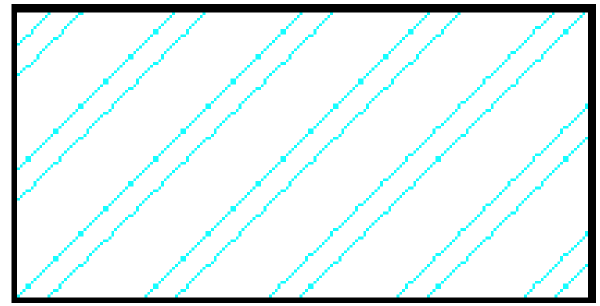
Basic representation rules



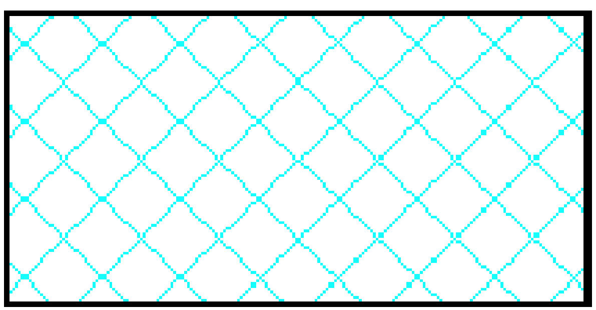
Section lines (lining)



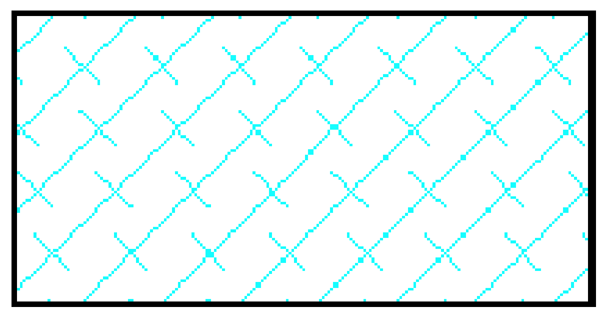
(A) Cast or malleable iron and general use for all materials



(B) Steel

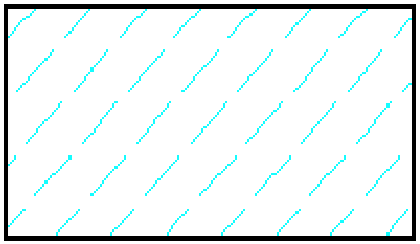


(D) White metal, zinc, lead, babbitt, and alloys

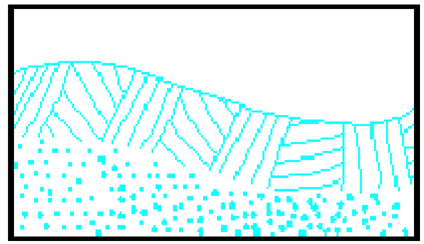


(E) Magnesium, aluminum, and aluminum alloys

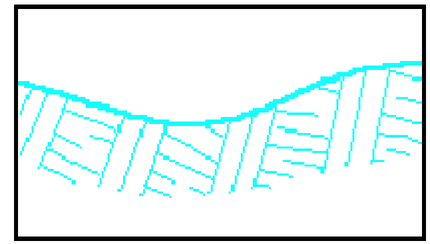
Section lines



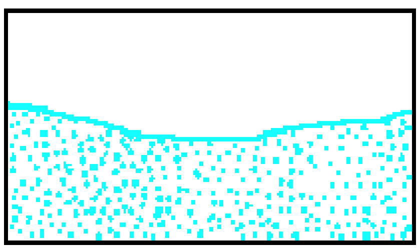
(M) Marble, slate, glass, porcelain, etc.



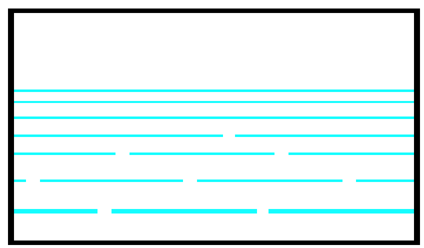
(N) Earth



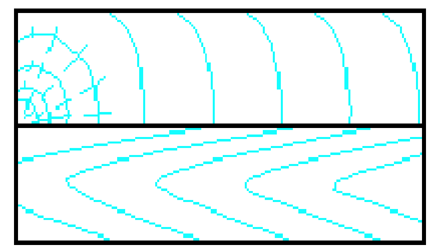
(O) Rock



(P) Sand

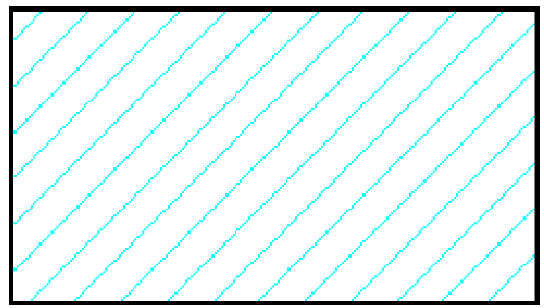


(Q) Water and other liquids

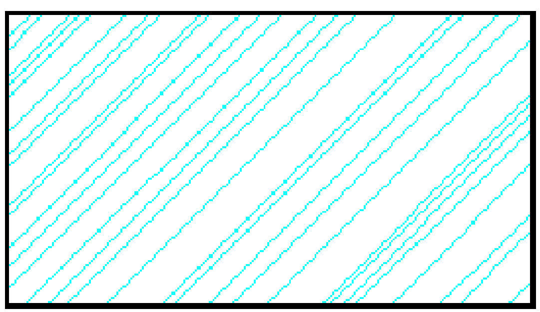


(R) Across grain
With grain > Wood

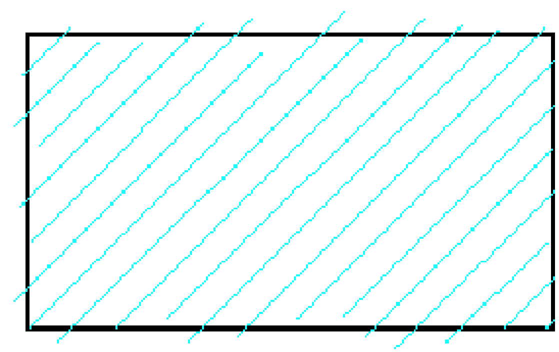
Common mistakes



Correct
(45°; Equal spacing)

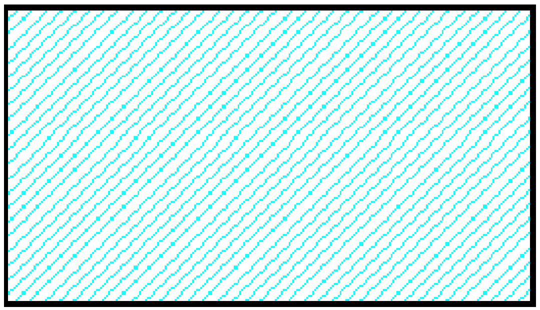


Incorrect
(Linework is inconsistently spaced)

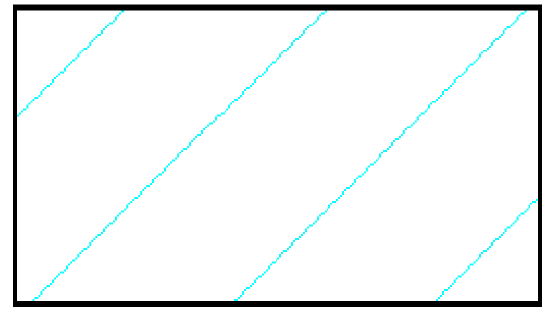


Incorrect
(Linework fails to end at boundaries of area)

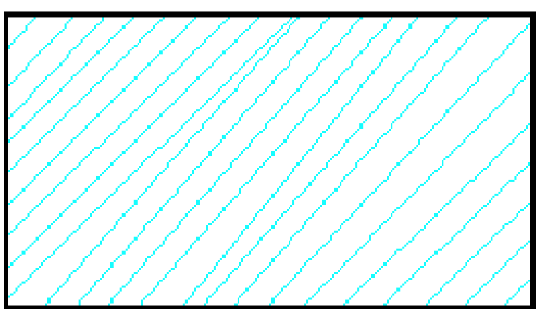
Common mistakes



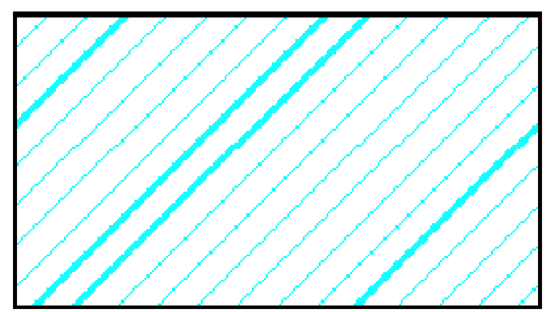
Incorrect
(Linework is too closely spaced)



Incorrect
(Linework is too widely spaced)

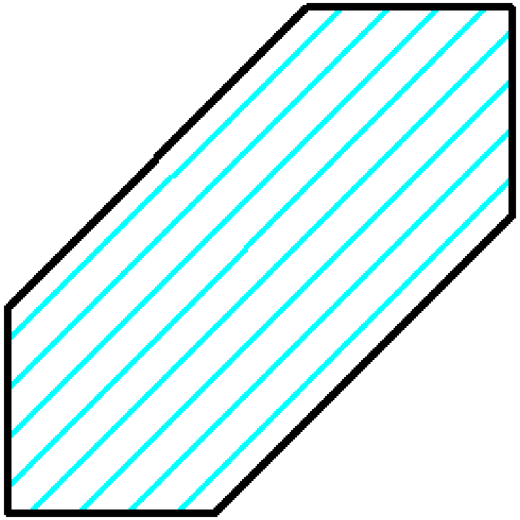


Incorrect
(Linework is not consistent in direction)

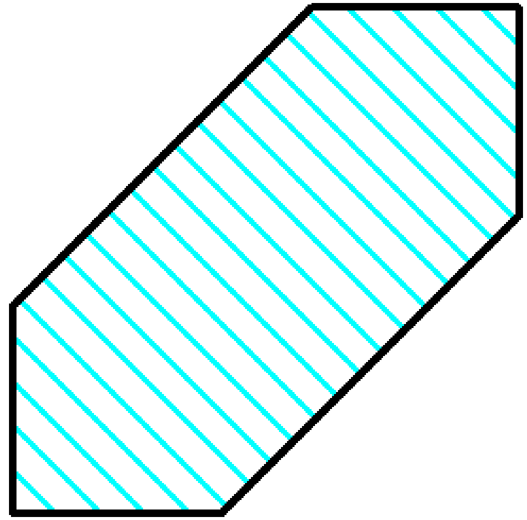


Incorrect
(Linework intensity is inconsistent)

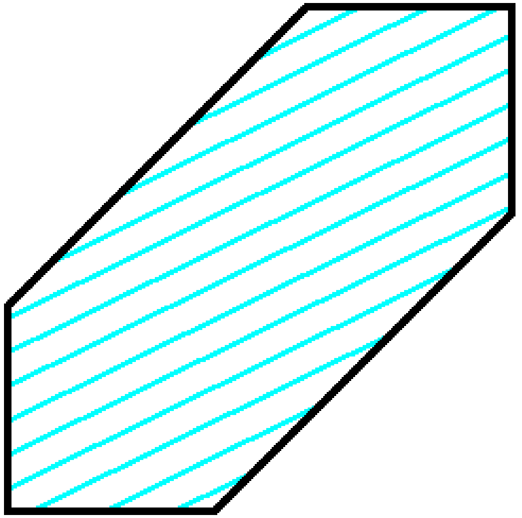
Difficult cases



(A) Avoid!



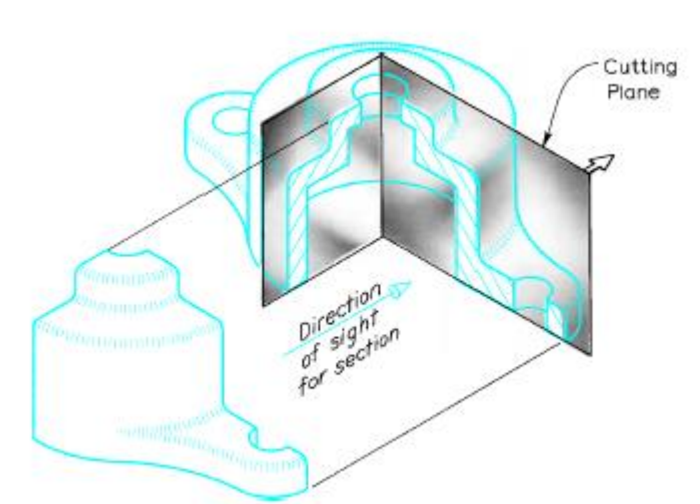
(B) Avoid!



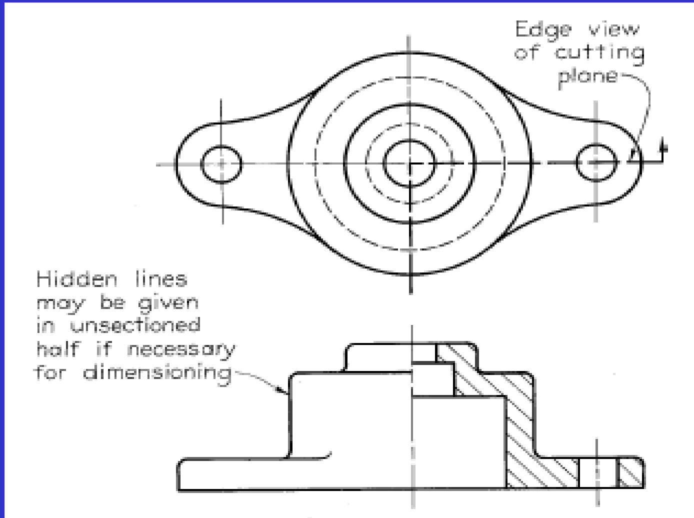
(C) Preferred

HALF SECTIONS

- If a cutting plane passes halfway through an object, the result is a half section.
- Expose the interior and retain the exterior.
- It is often used for symmetrical objects, not for detail drawings.

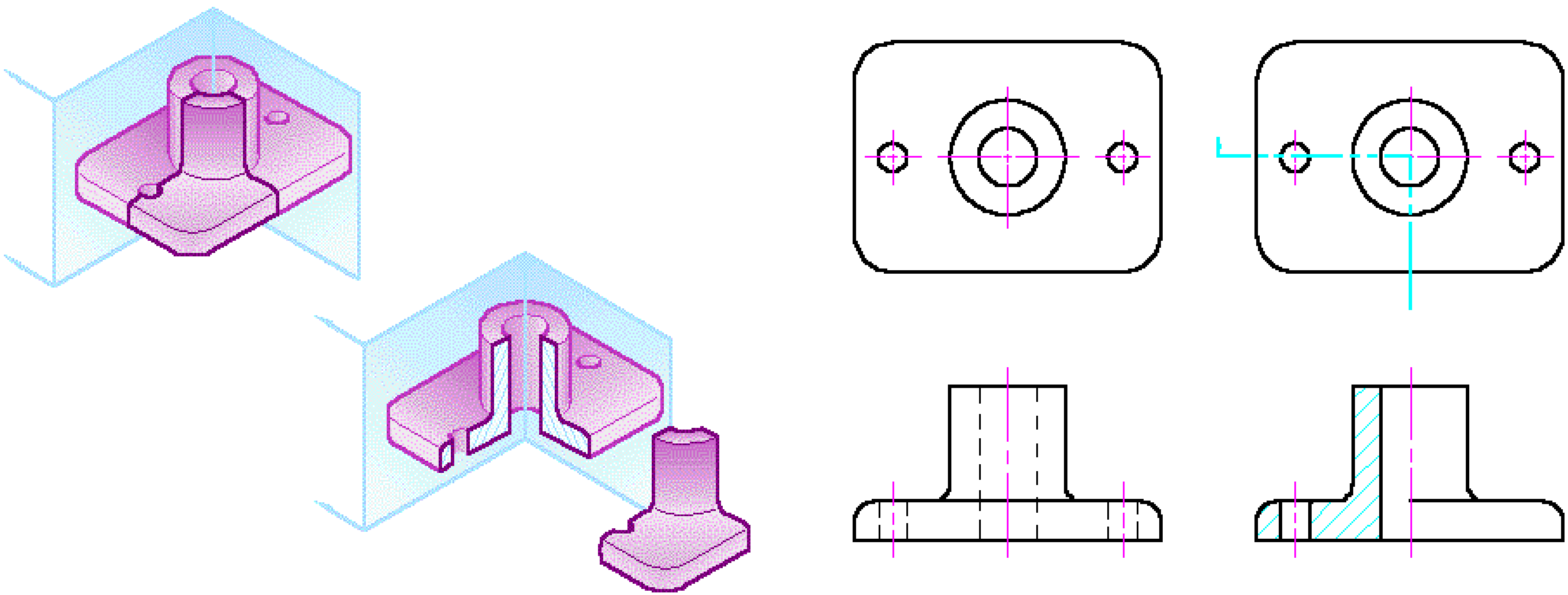


(a) CUTTING PLANE



(b) HALF SECTION

Half sections

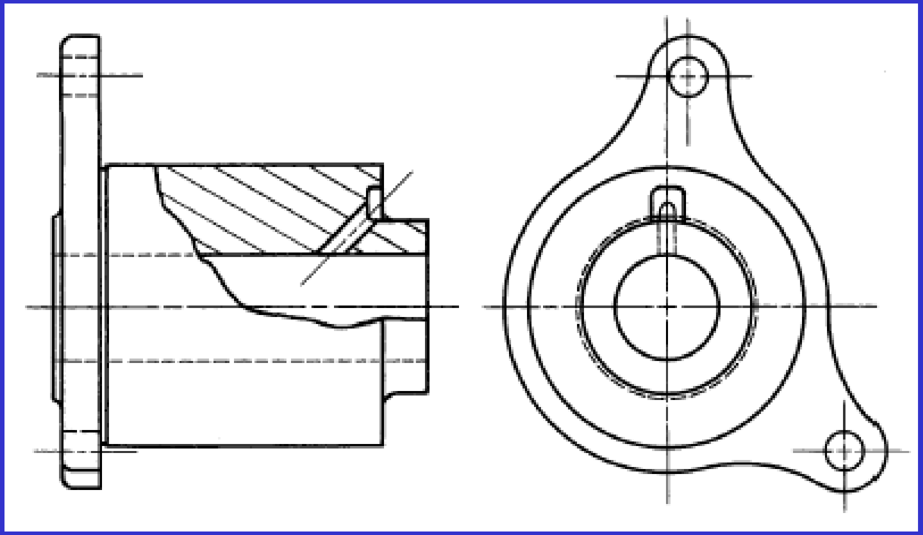


(A) Half section (B) Multiview (C) Half section view

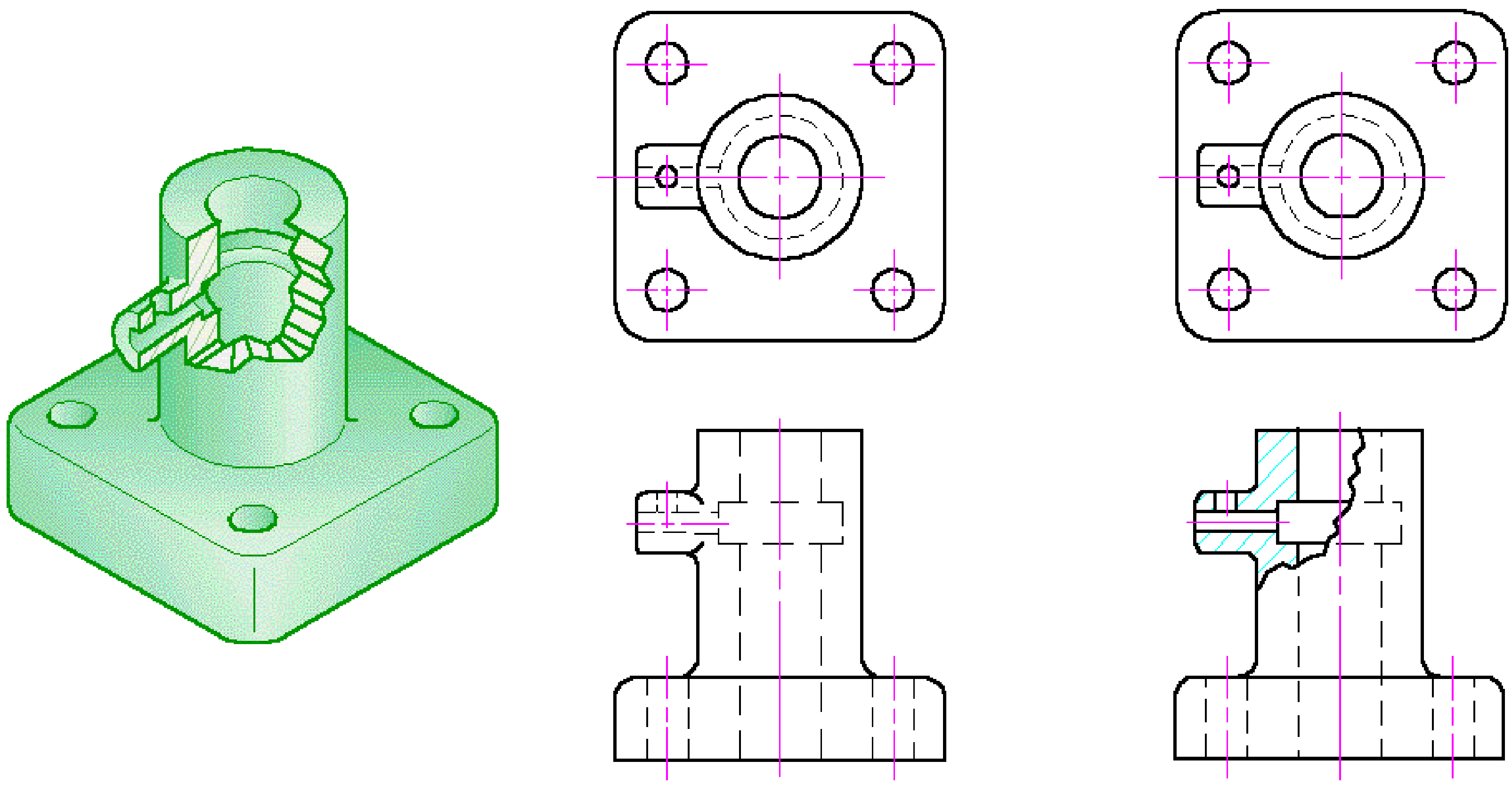
Convenient way to show the view and section in symmetric parts

BROKEN-OUT SECTIONS

- If only a partial section of a view is needed to expose interior shapes, a break line is used for the section.
- The section is limited.



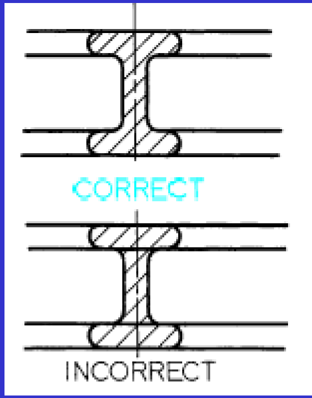
Broken out sections

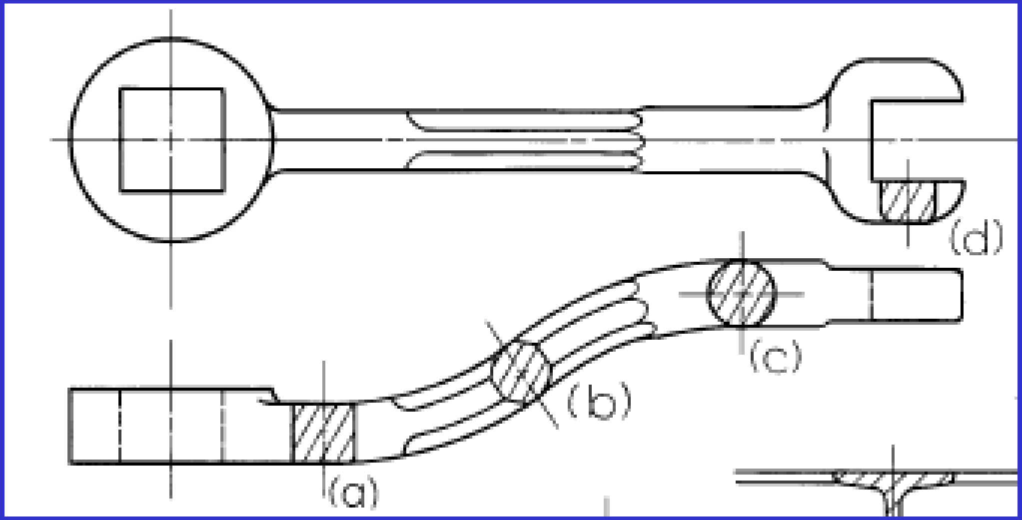


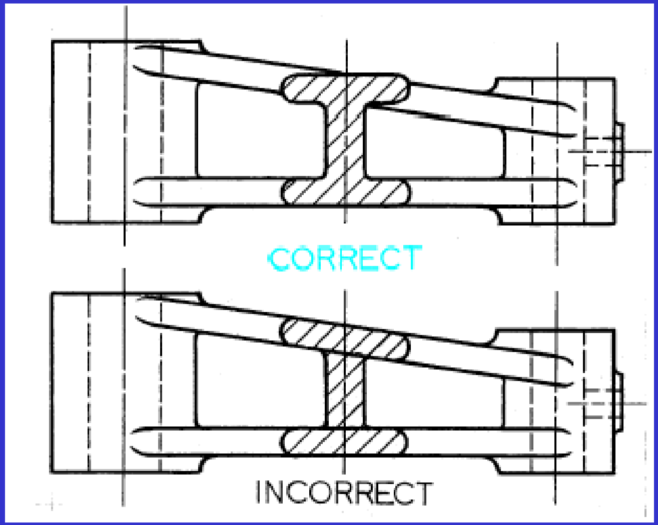
(A) Broken-out section (B) Multiview (C) Broken-out section view

REVOLVED SECTIONS

To show the shape of cross section of bars, arms, spokes, a plane perpendicular to the center line of the part cuts through. Then rotate the plane by 90° around a line at right angle to the center line.

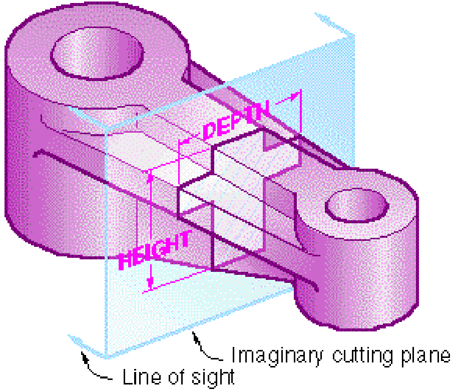


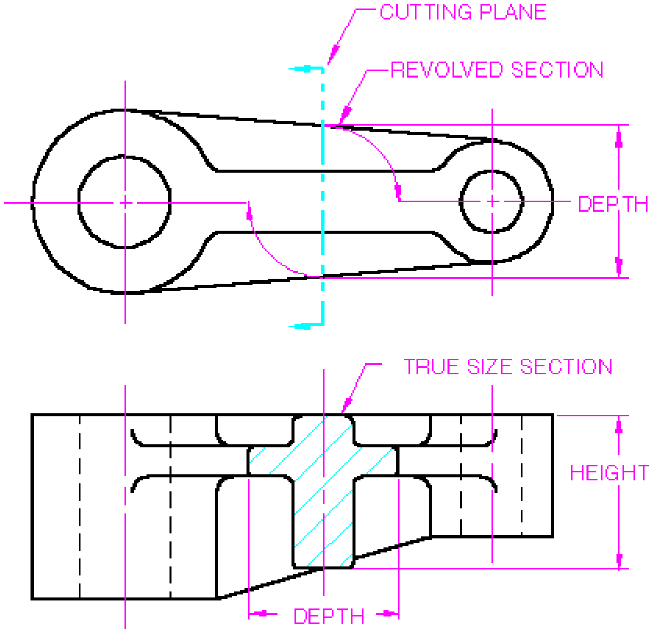




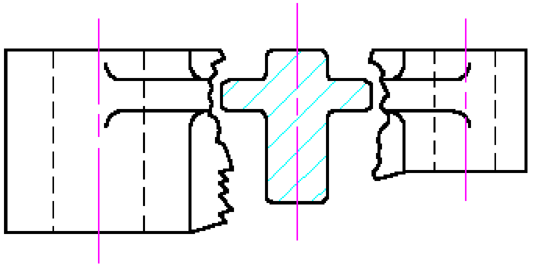
Revolved sections

Assume a section plane perpendicular to the front axis of the component; revolve the plane to see the section as a true shape



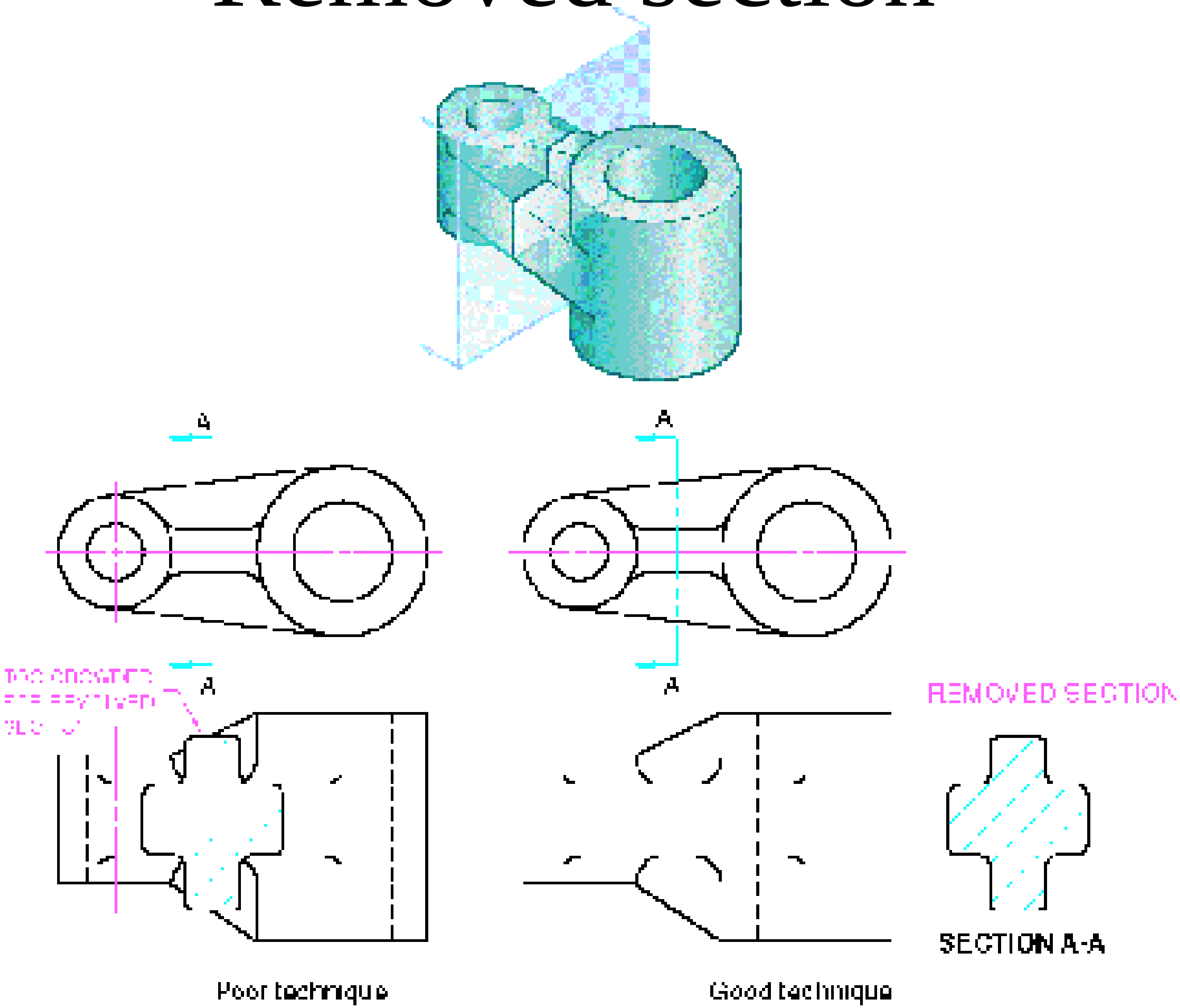


(A) Revolved section

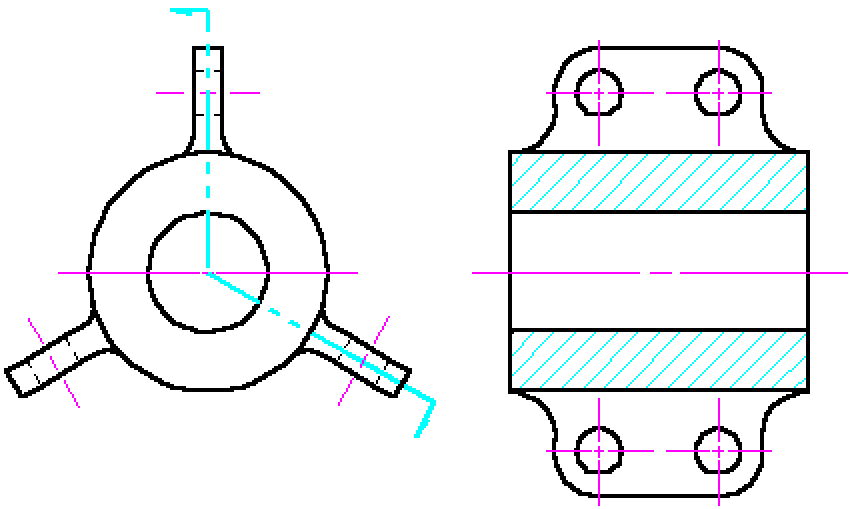


(B) Revolved section; broken view

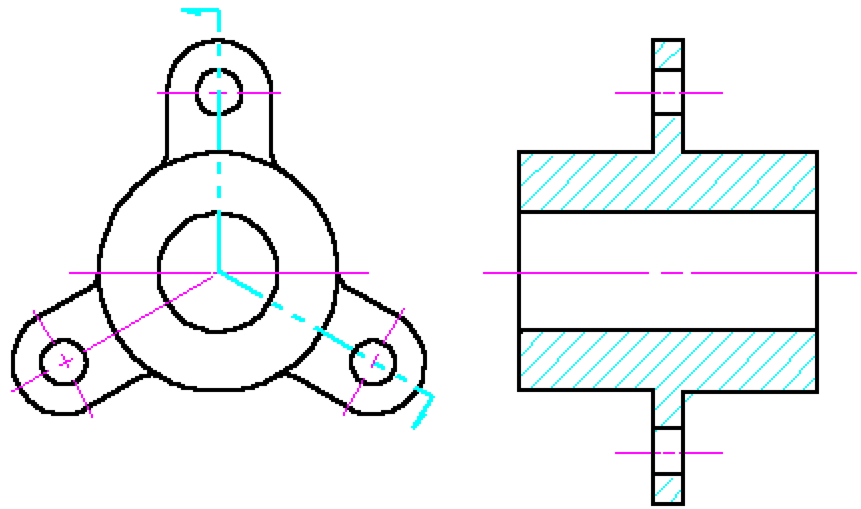
Removed section



Aligned sections

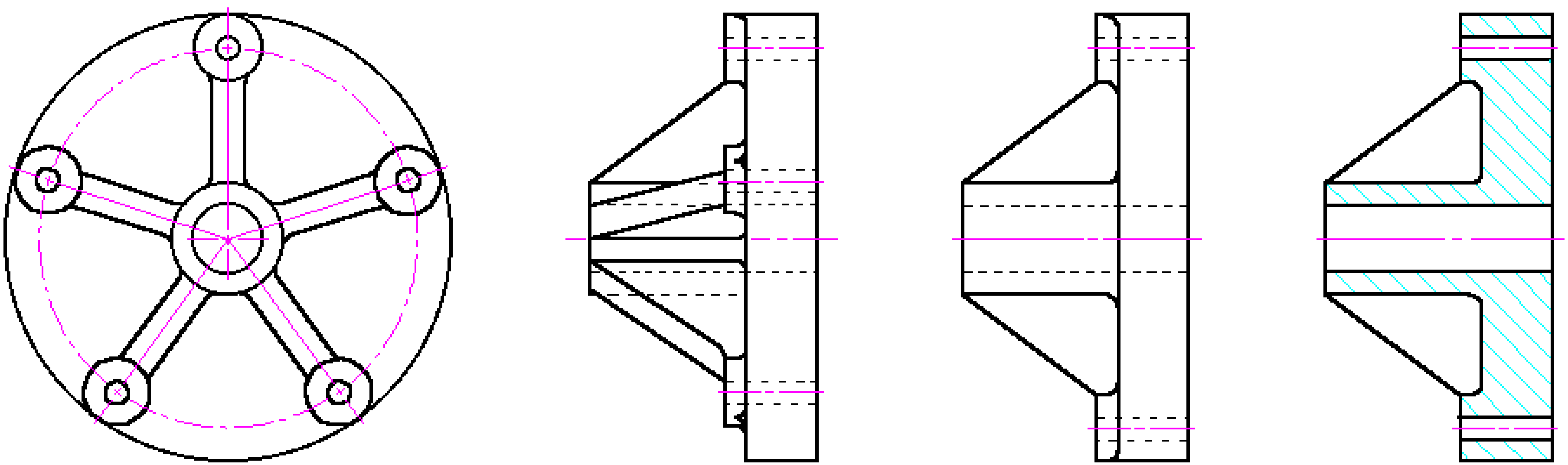


(A)



(B)

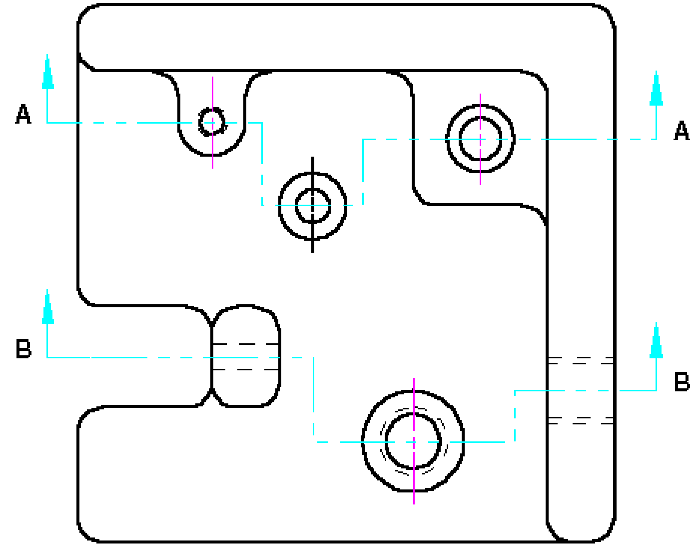
Aligned sections

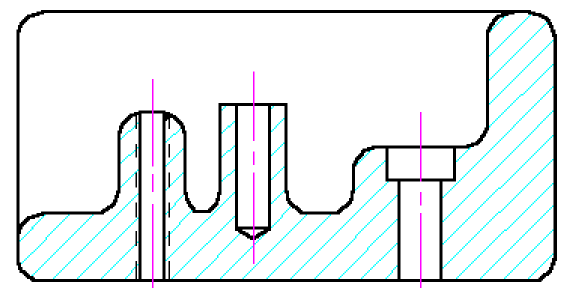


(A) True projection (B) Preferred (C) Section view

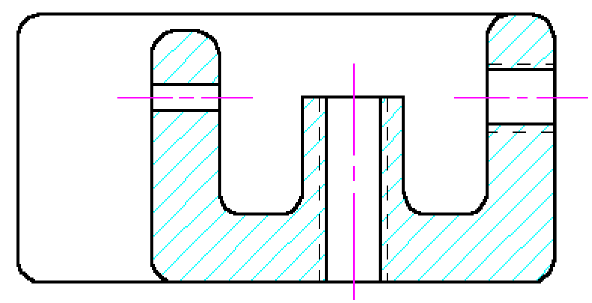
Offset section

Necessary when features to show are located in different planes



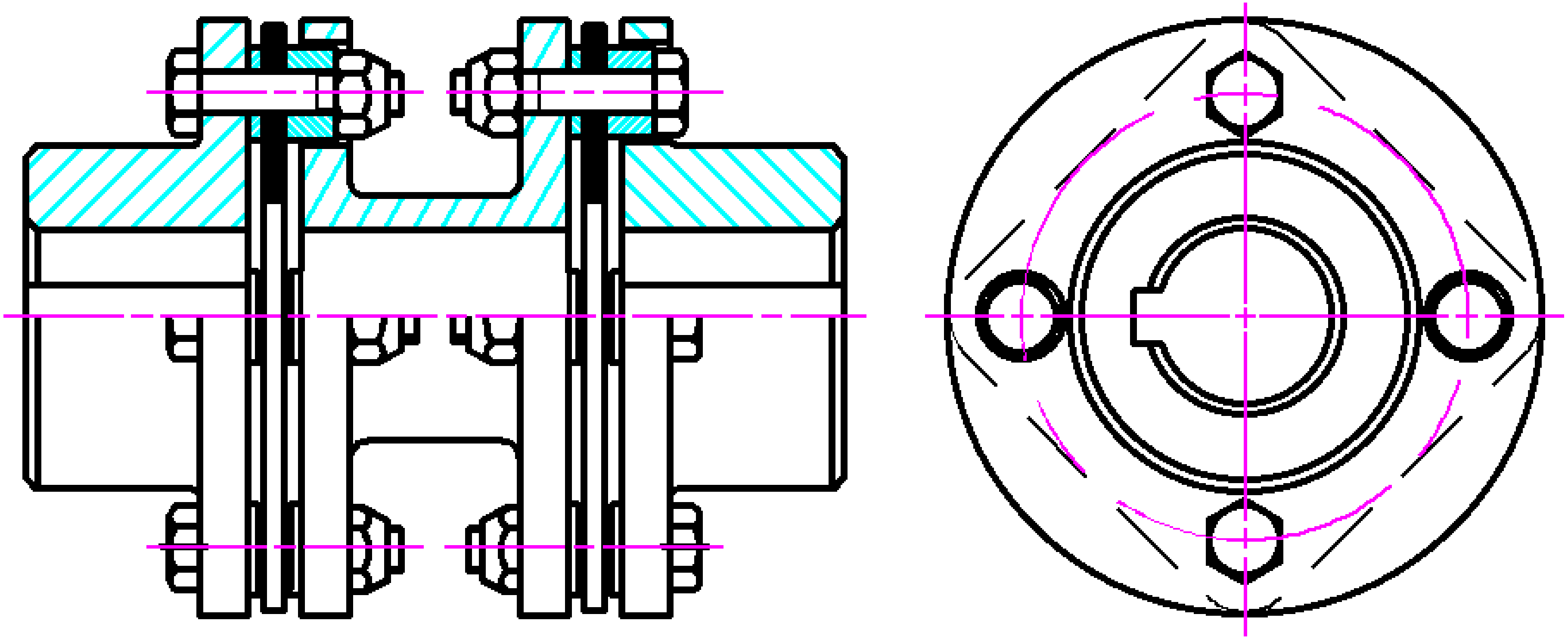


SECTION A-A

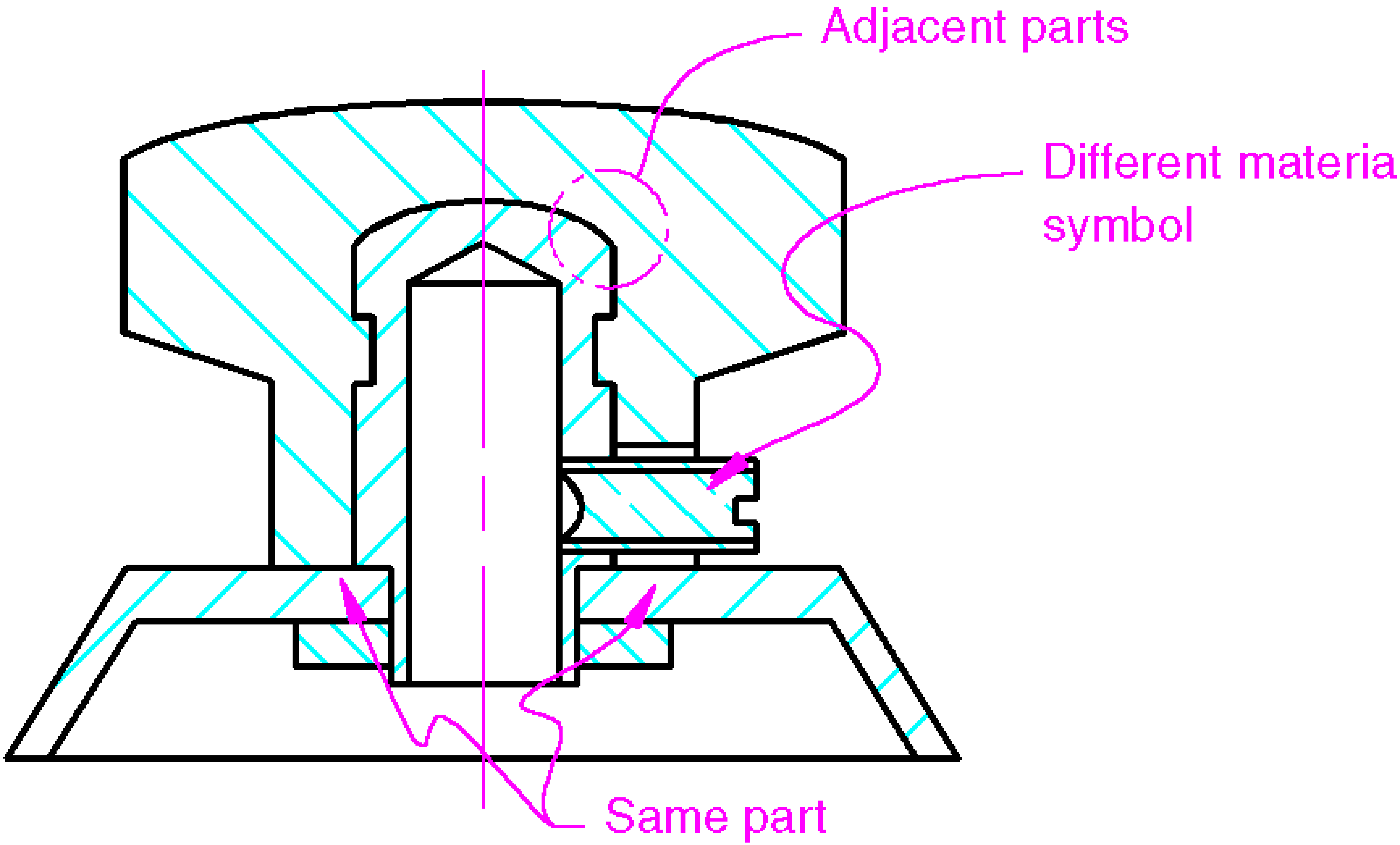


SECTION B-B

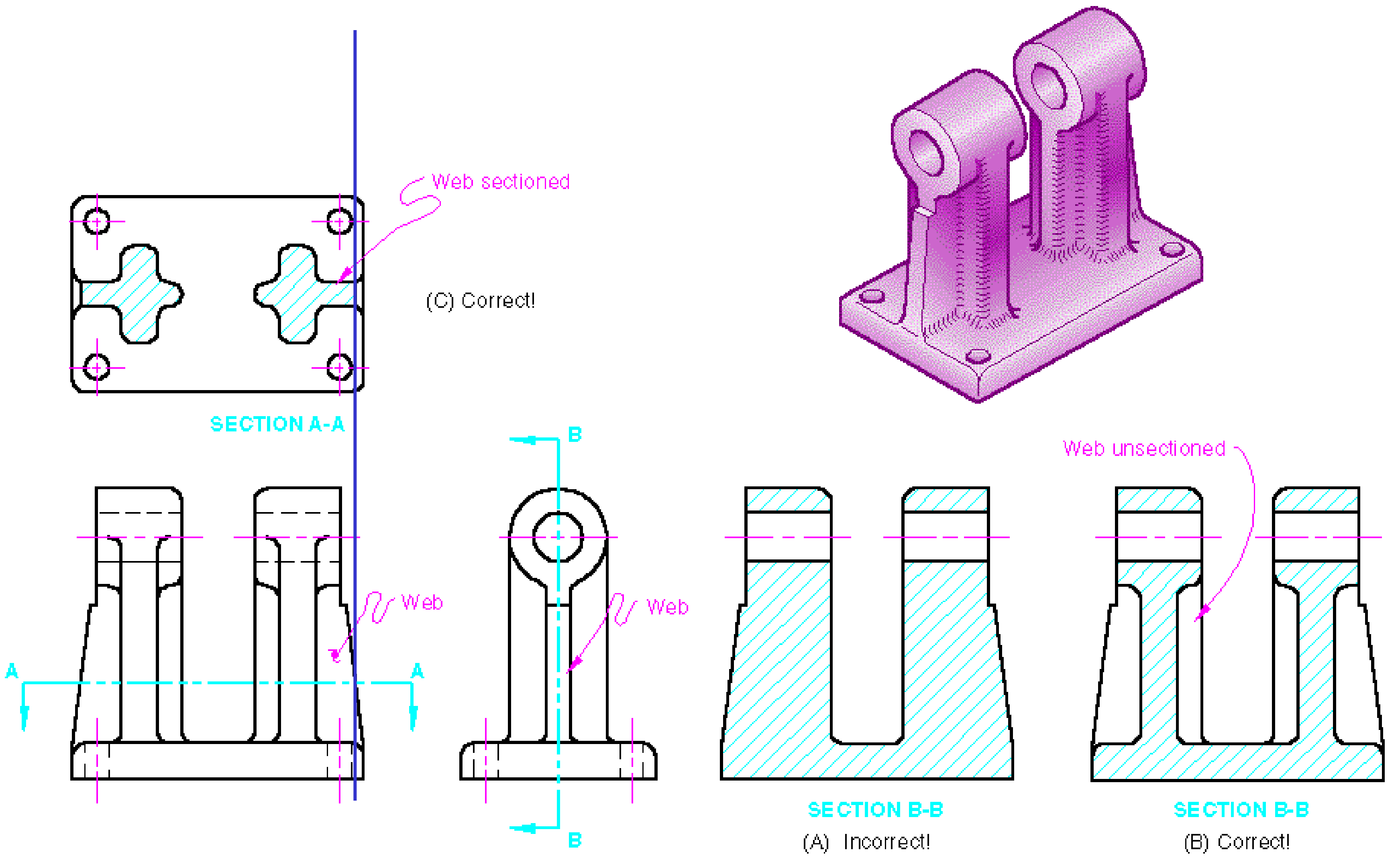
Sections through assemblies



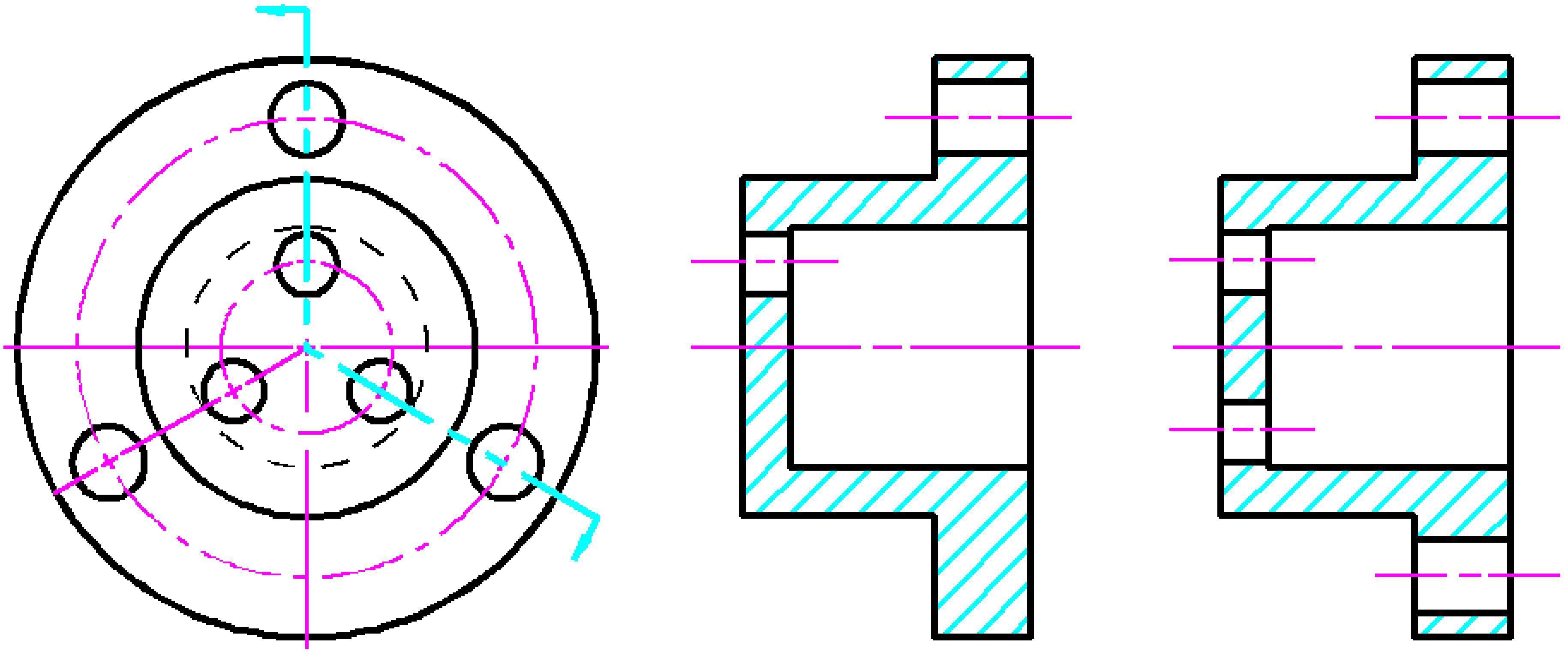
Pay attention to lining



Pay attention to representation



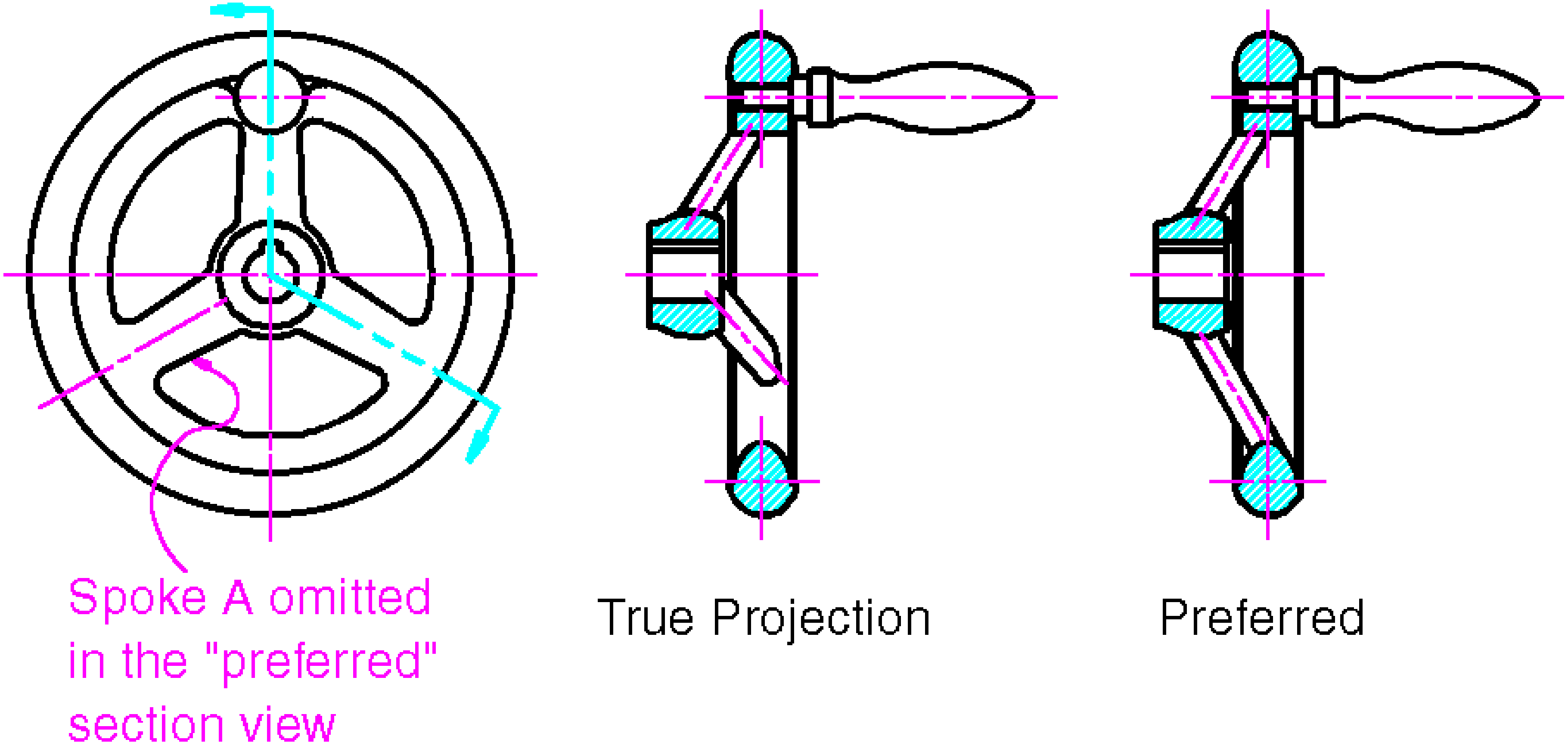
Pay attention to representation



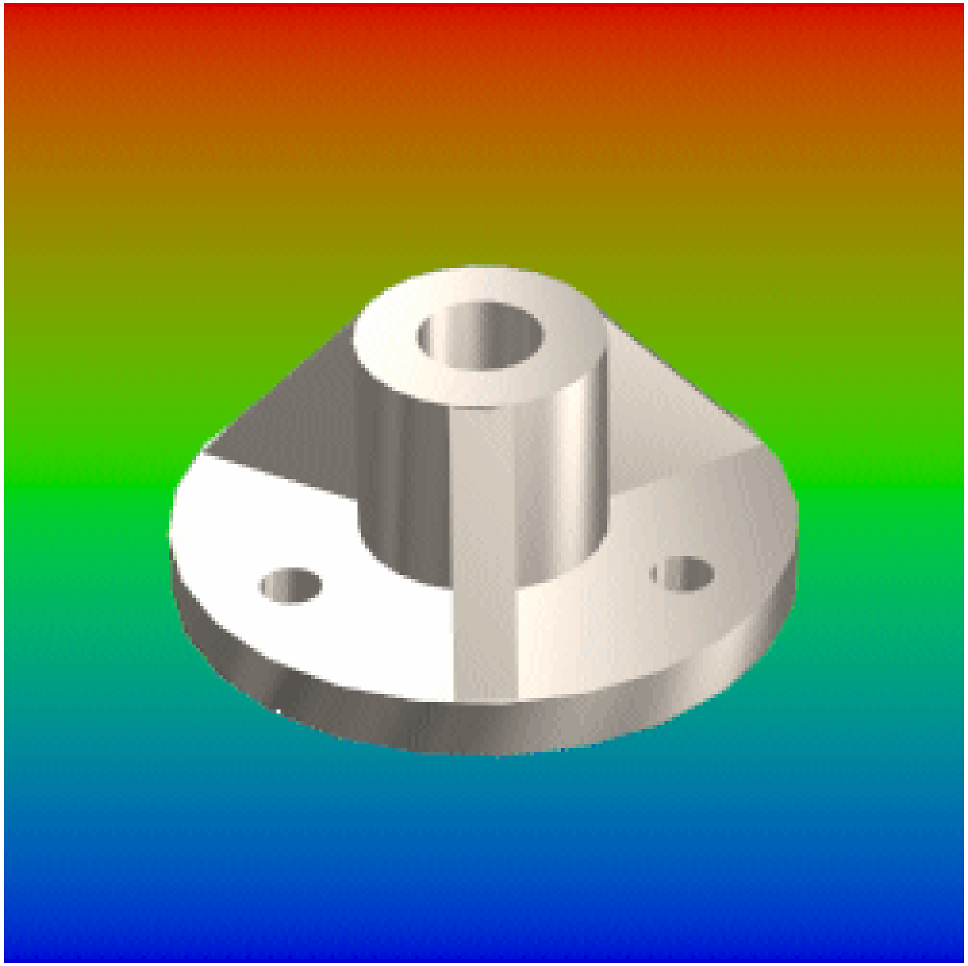
(A) True projection

(B) Preferred

Pay attention to representation



Section in a flange

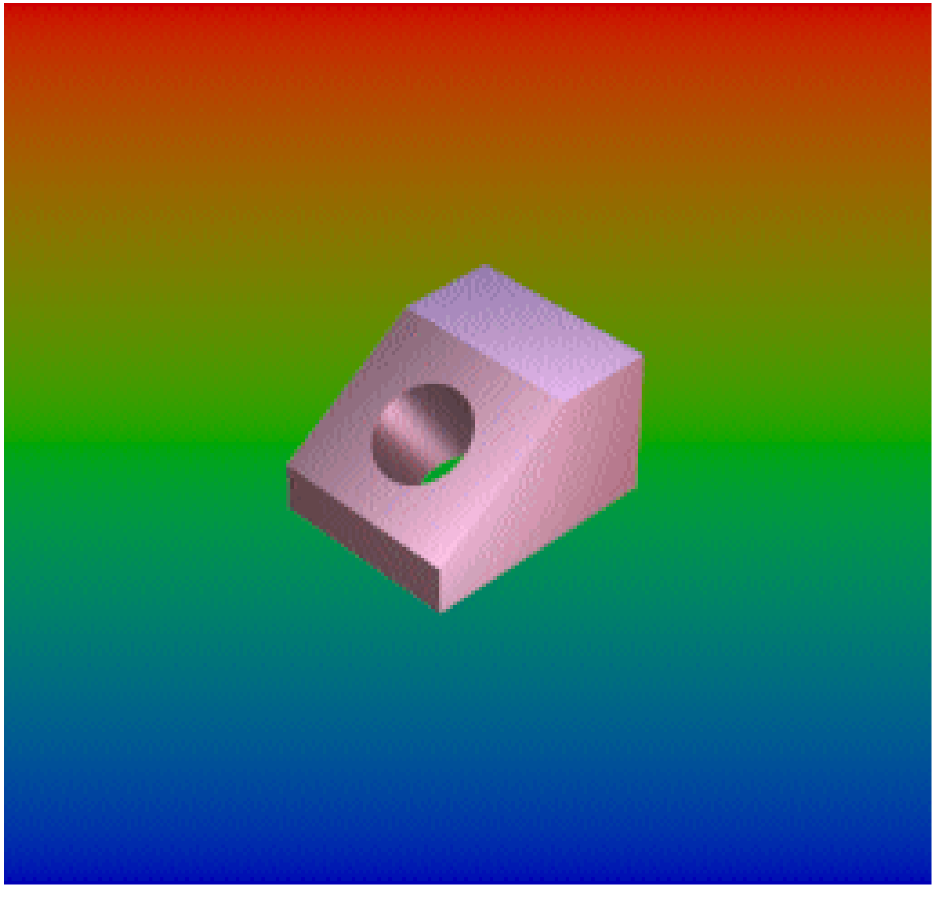


AUXILIARY VIEWS

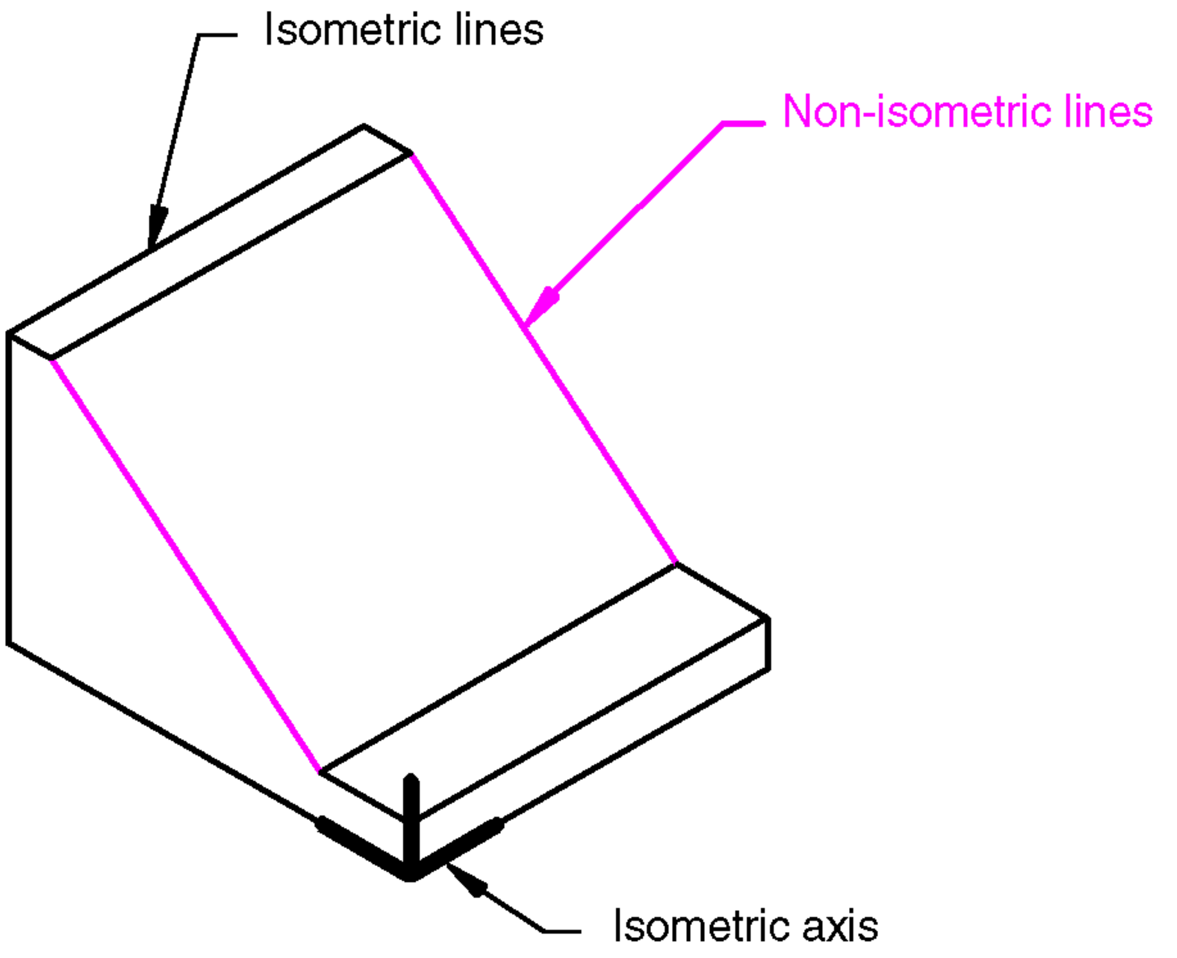
Definitions

- Any view obtained by a projection on a plane other than the horizontal (H), frontal (F) and profile (P) is an auxiliary view.
- Primary auxiliary is projected to a plane that is perpendicular to one of the principal planes
- Secondary auxiliary is projected from a primary auxiliary to a plane that is inclined to all three principal views

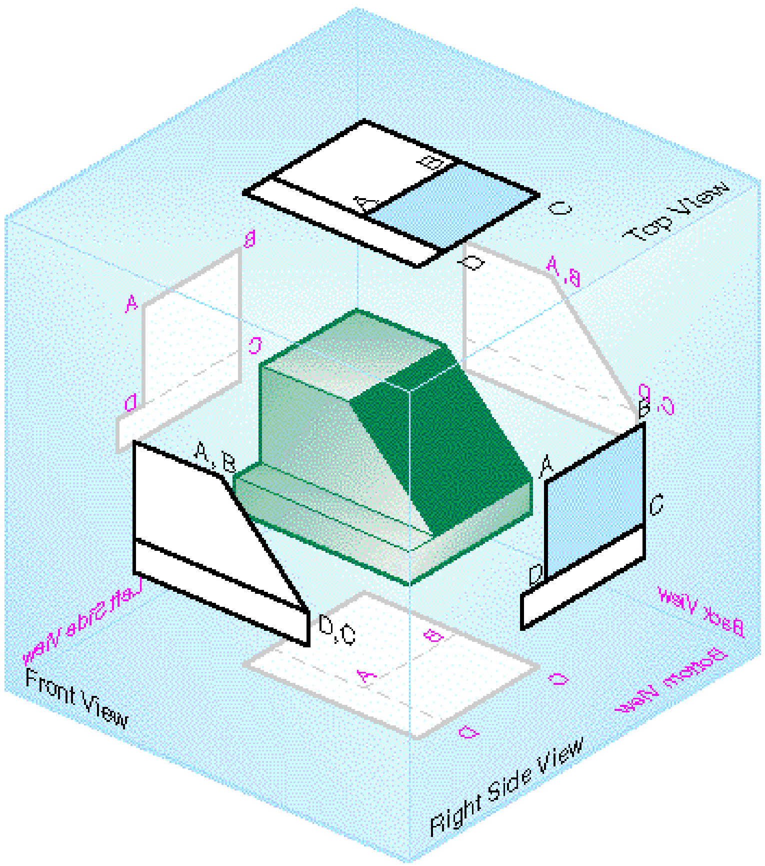
Auxiliary view

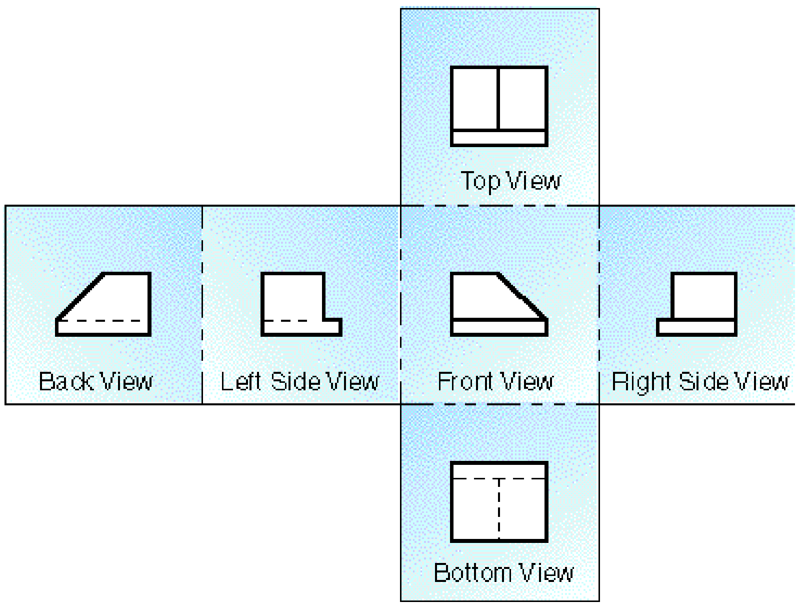


Candidates for auxiliary views

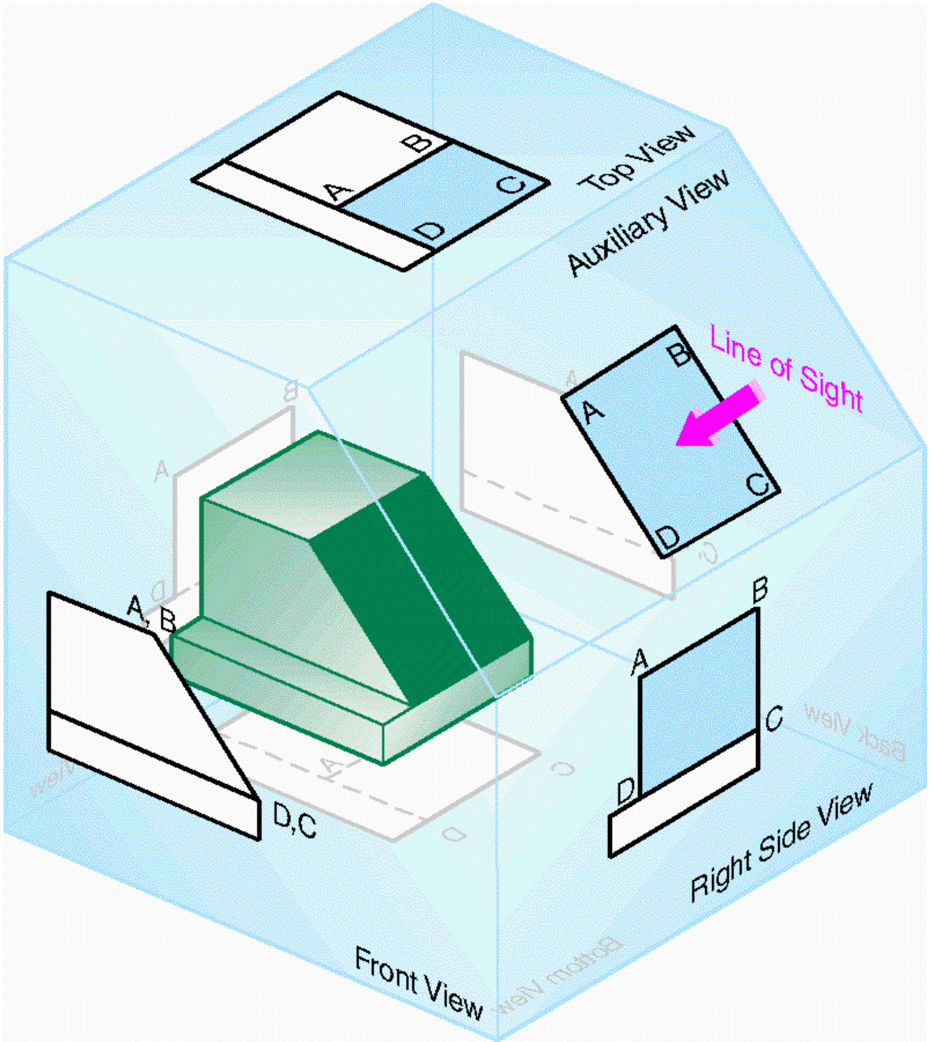


Principal planes

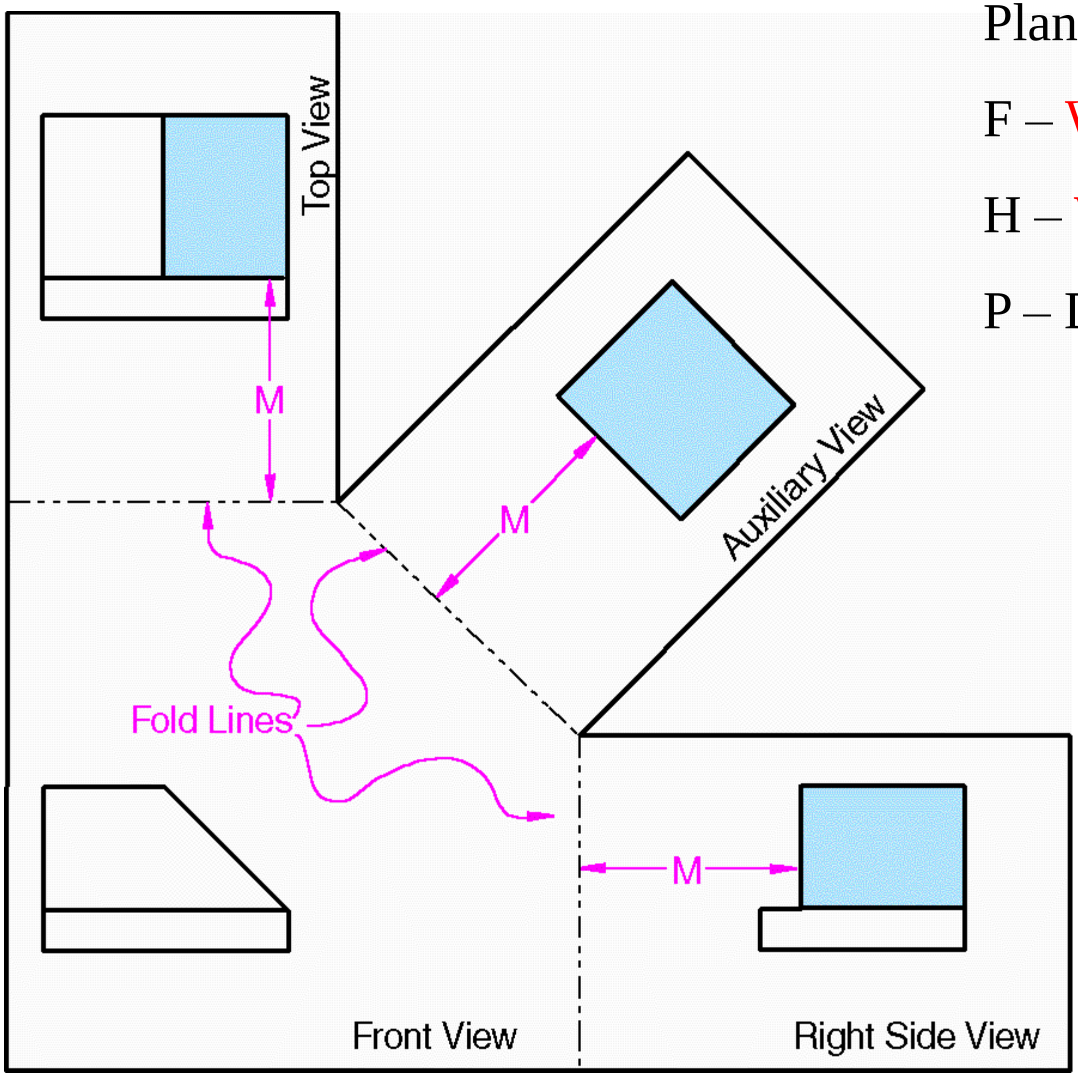




Auxiliary plane



Primary auxiliary view



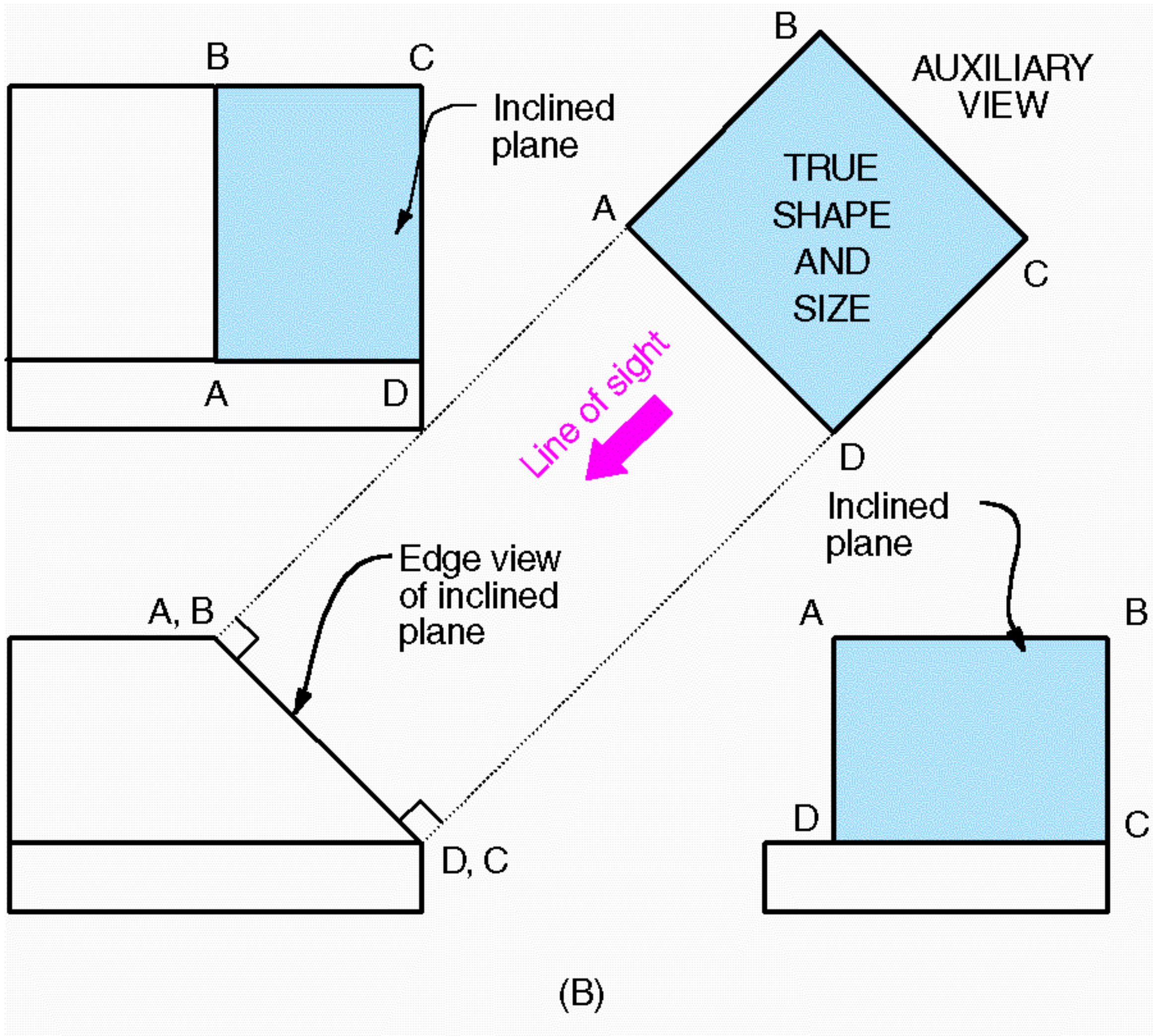
Plane True Dim.

F – Width, Height

H – Width, Depth

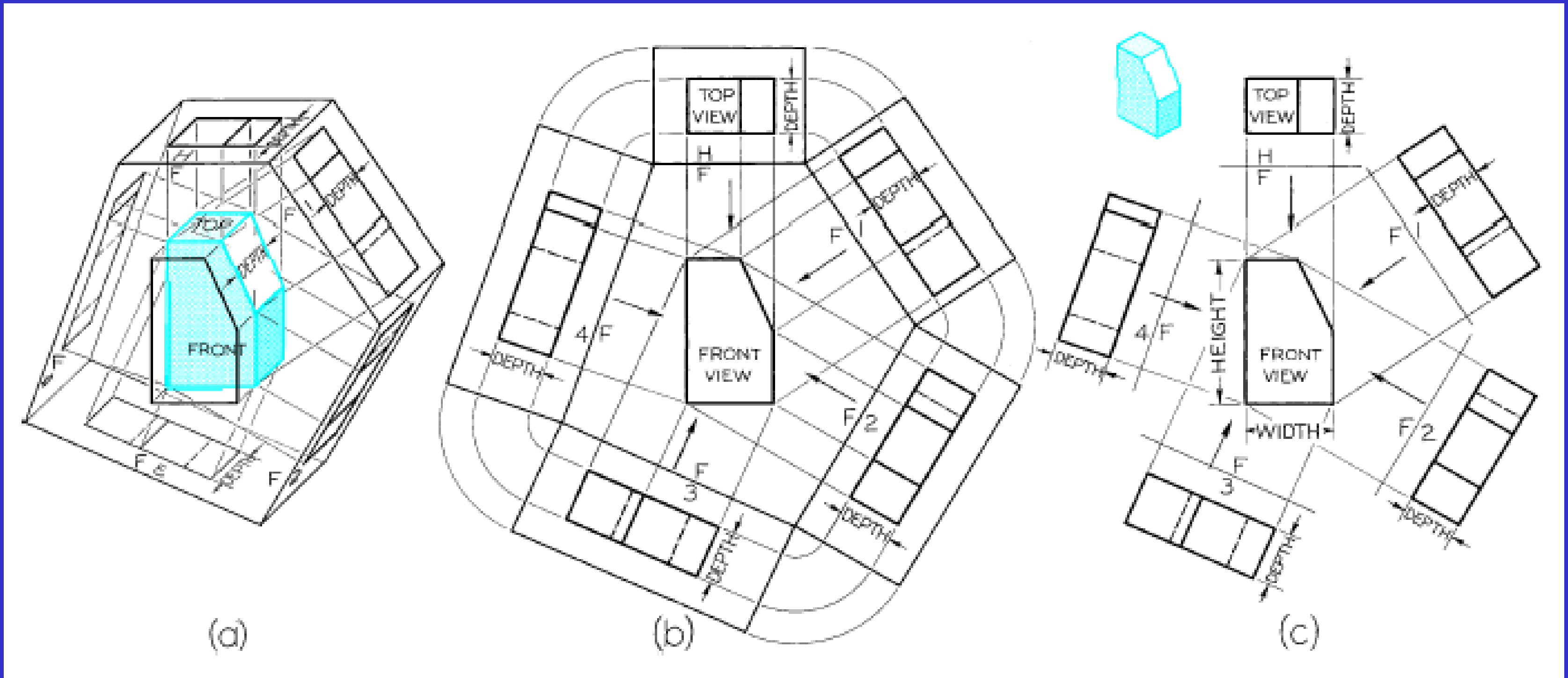
P – Depth, Height

Primary auxiliary view



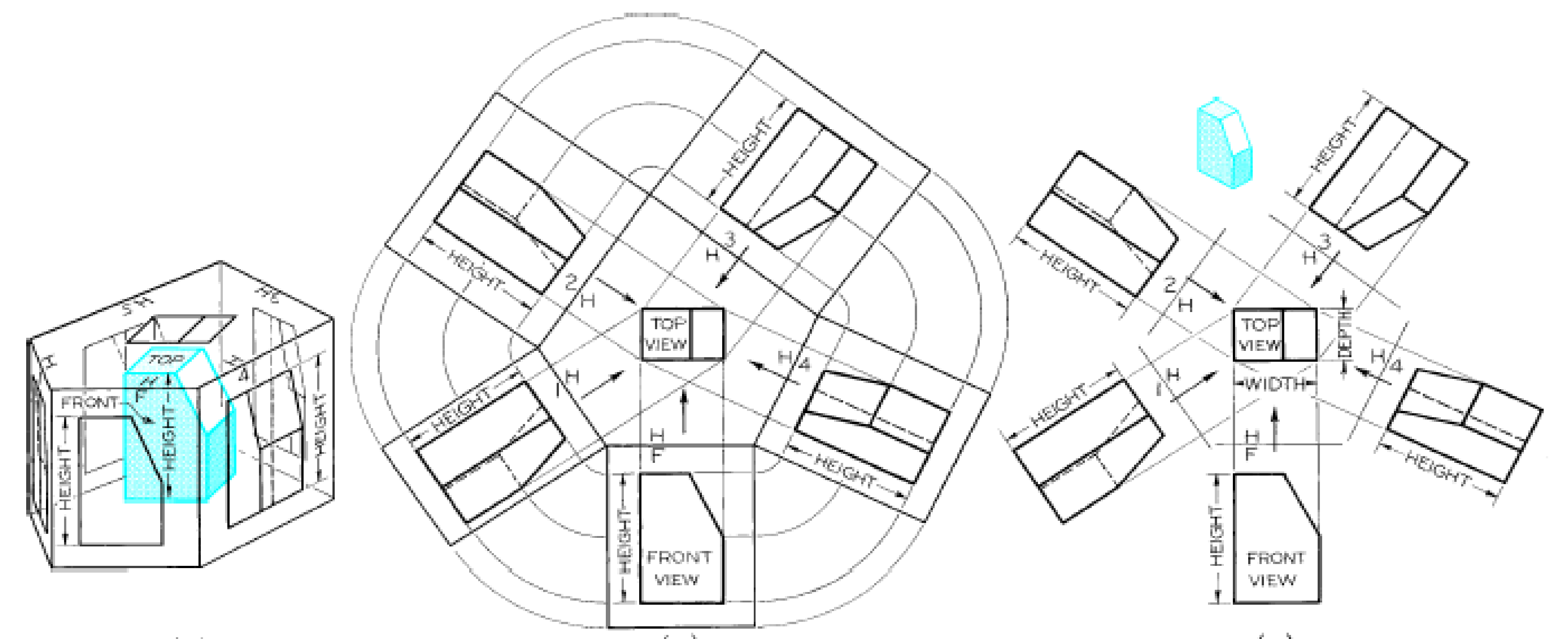
DEPTH AUXILIARY VIEWS

- A projection plane is perpendicular to the frontal view, and oblique to the top (or side) view. The auxiliary view is based on the frontal view.
- Depth in Auxiliary View = Depth in Top (Side) View



HEIGHT AUXILIARY VIEWS

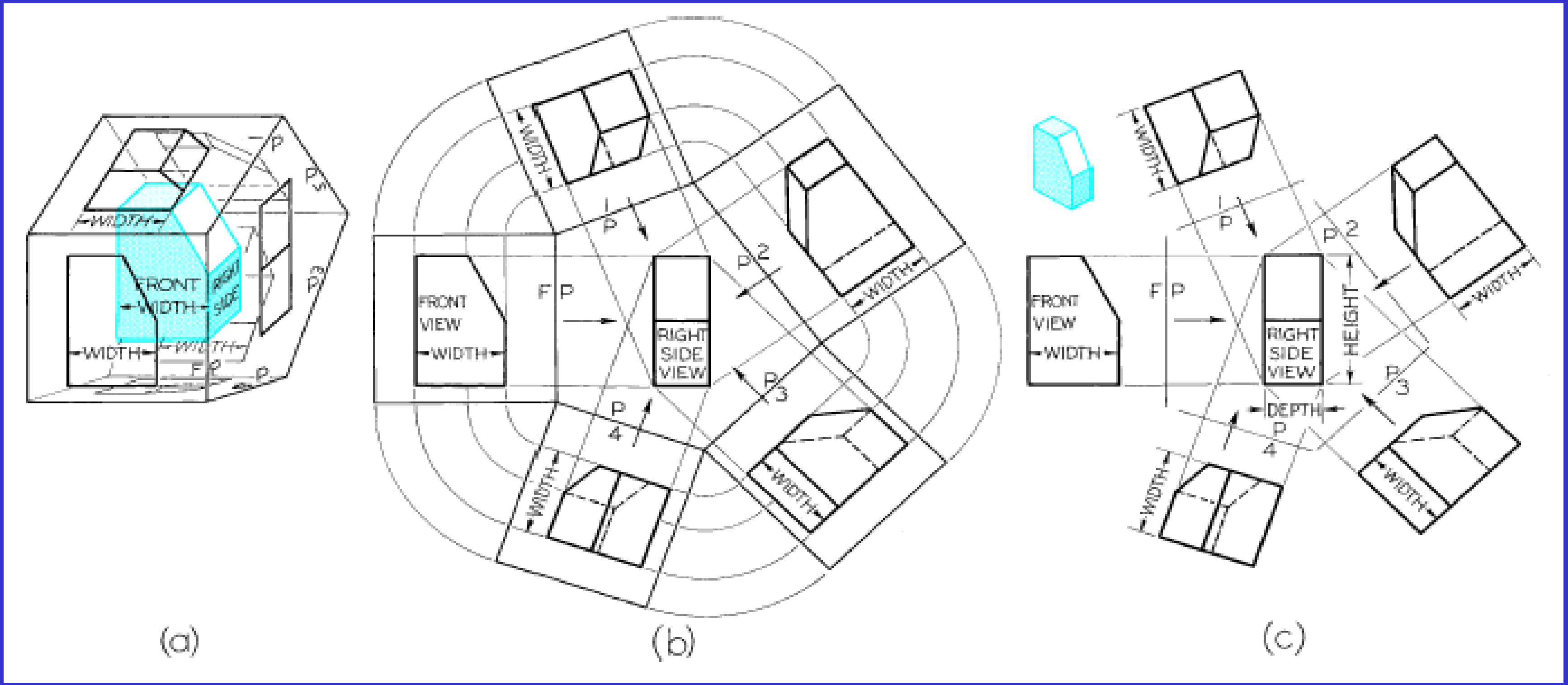
- A projection plane is perpendicular to the top view, and oblique to the frontal (side) view. The auxiliary view is based on the top view.
- Height in Auxiliary View = Height in Frontal (Side) View



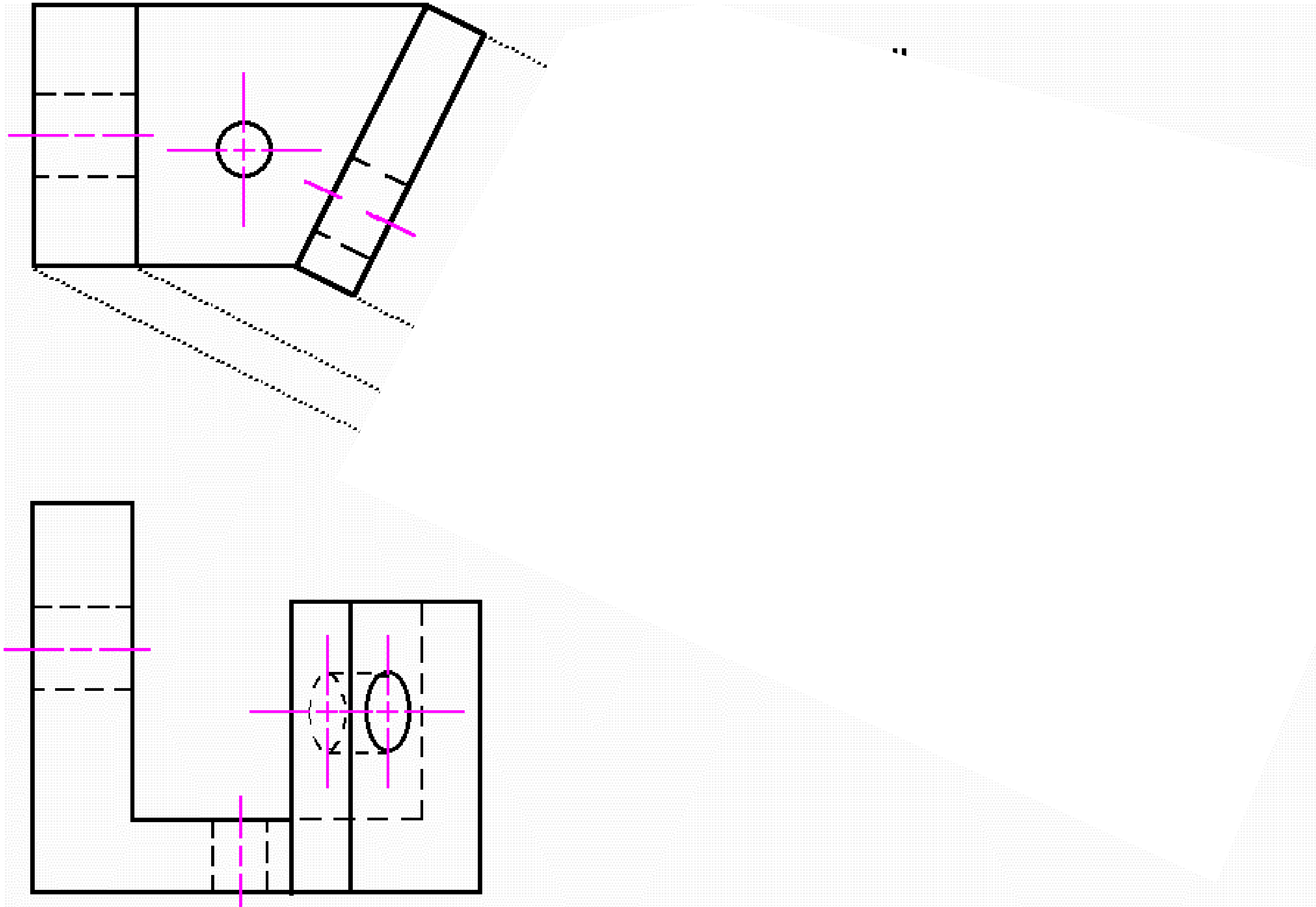
(a) (b) (c)

WIDTH AUXILIARY VIEWS

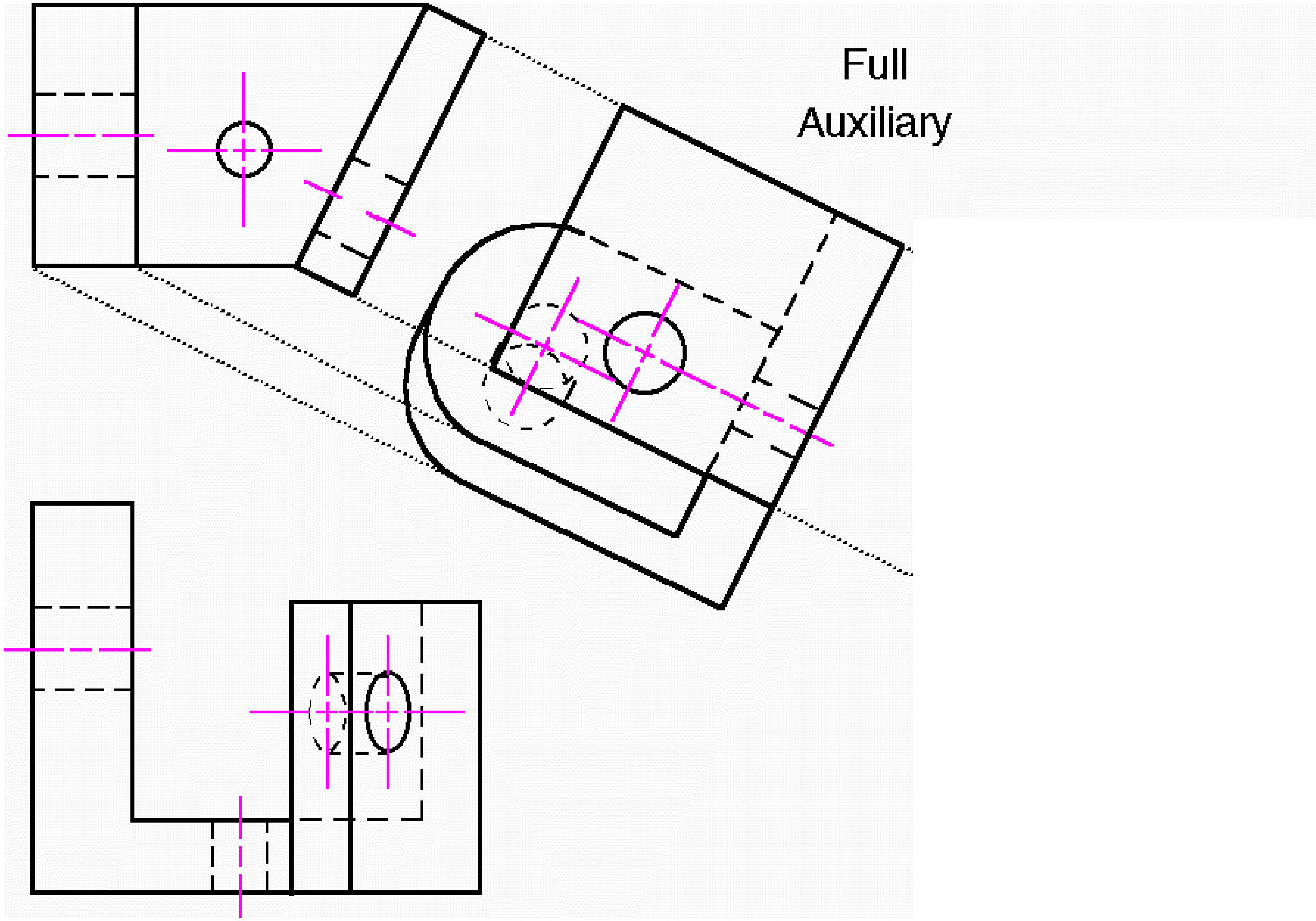
- A projection plane is perpendicular to the side view, and oblique to the frontal (or top) view. The auxiliary view is based on the side view.
- Width in Auxiliary View = Width in Frontal (Top) View



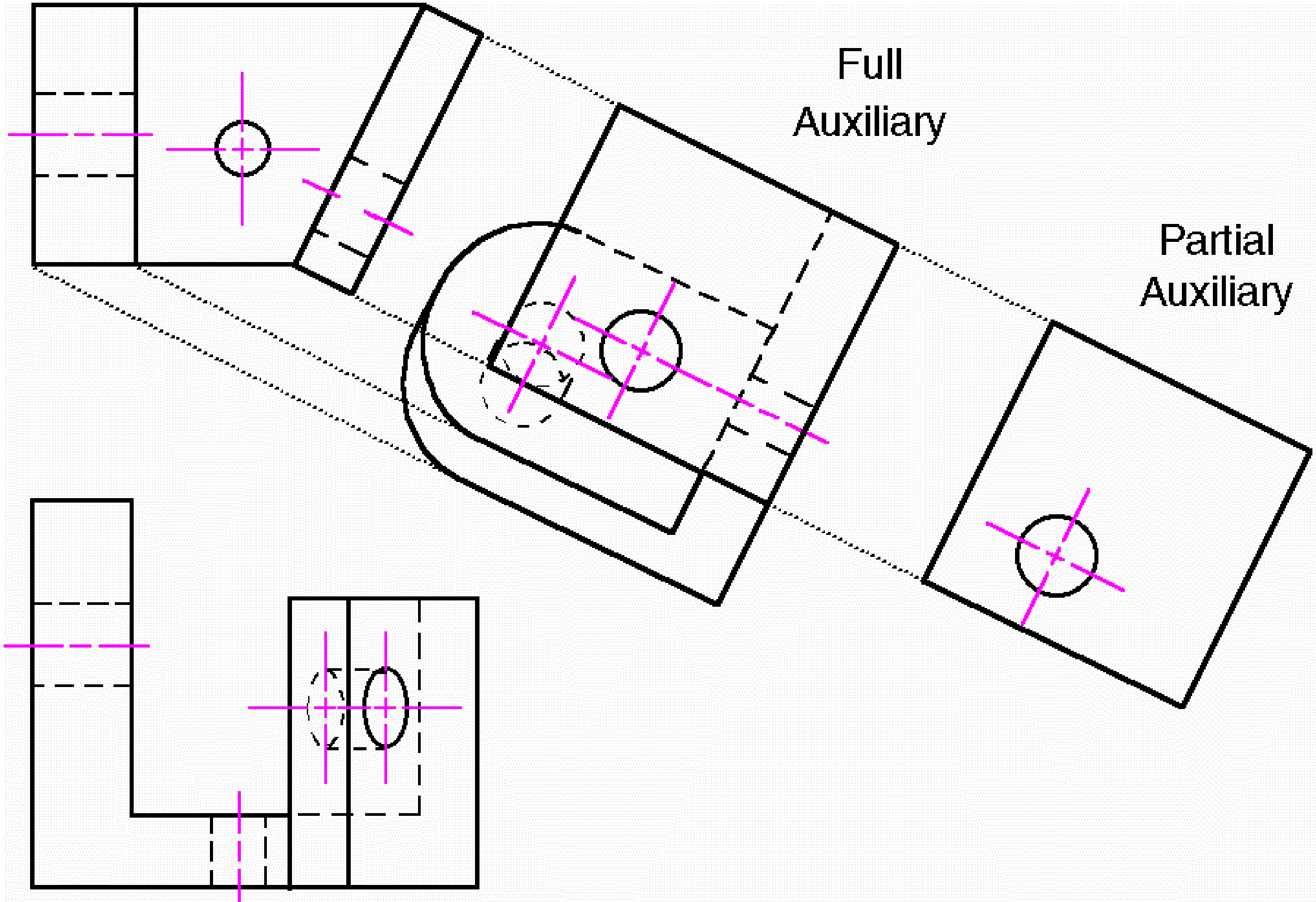
The features in auxiliary planes are seen deformed in the principal views



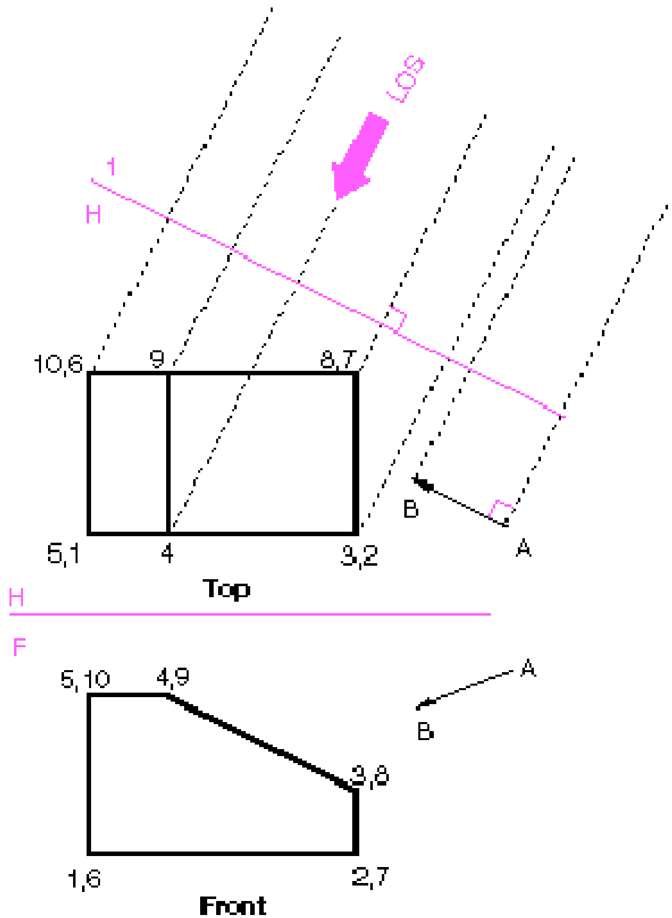
The features in auxiliary planes are seen deformed in the principal views



The features in auxiliary planes are seen deformed in the principal views

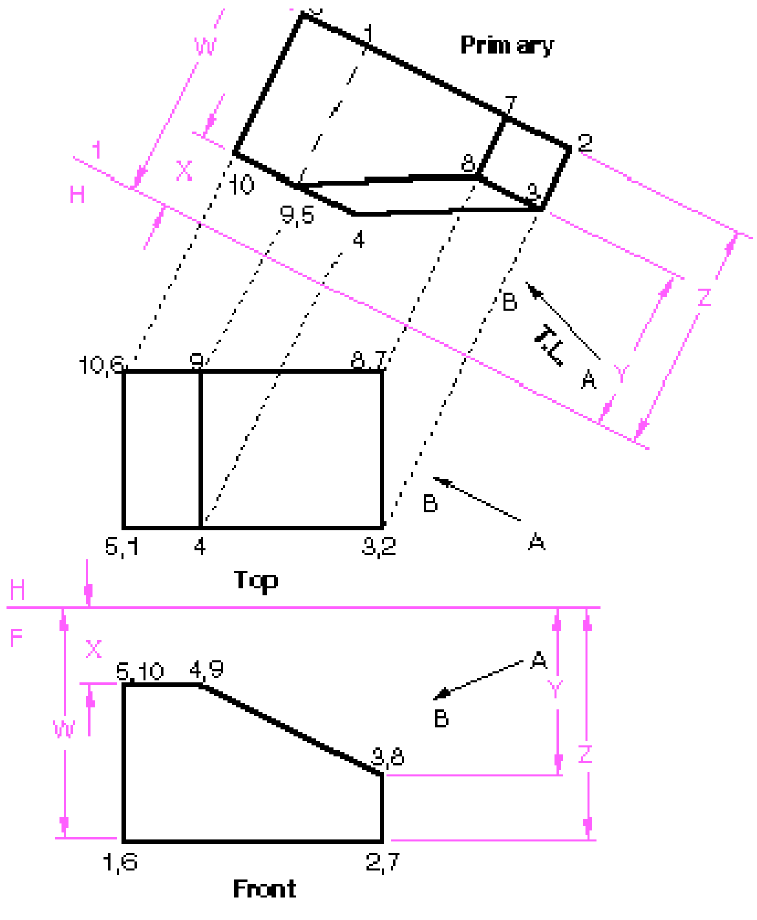


How to represent a full auxiliary view? Folding-Line Method



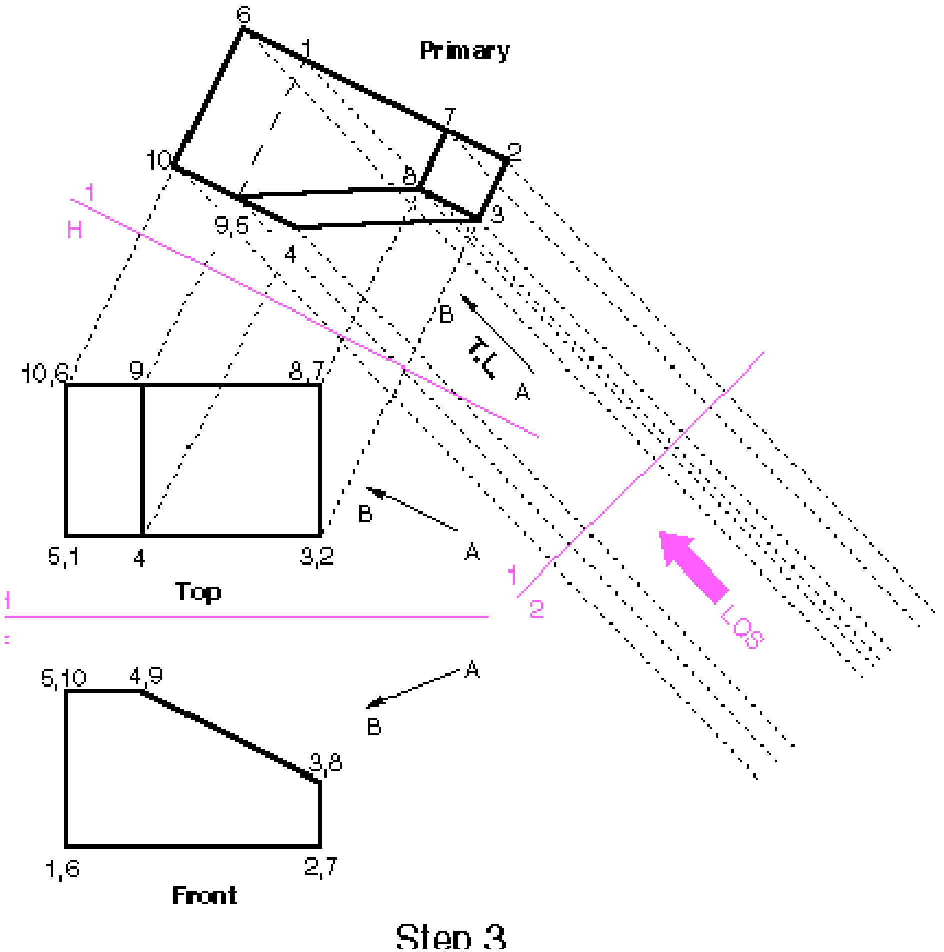
Step 1

How to represent a full auxiliary view?

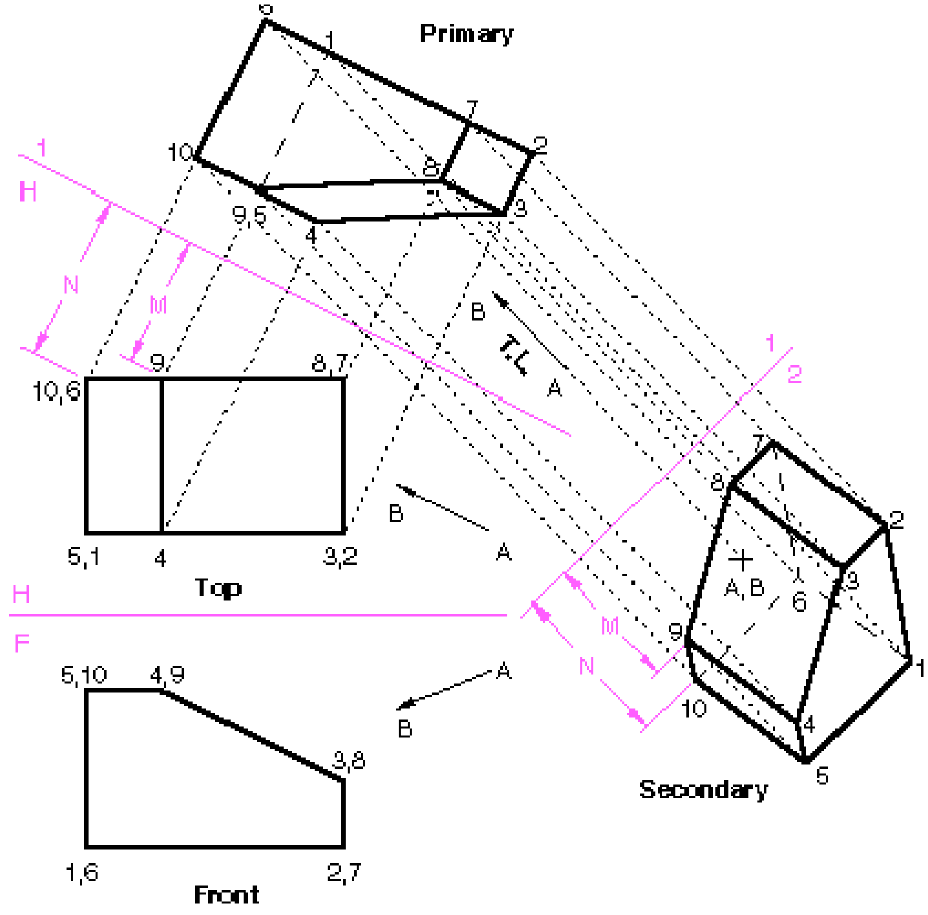


Step 2

How to represent a full auxiliary view?



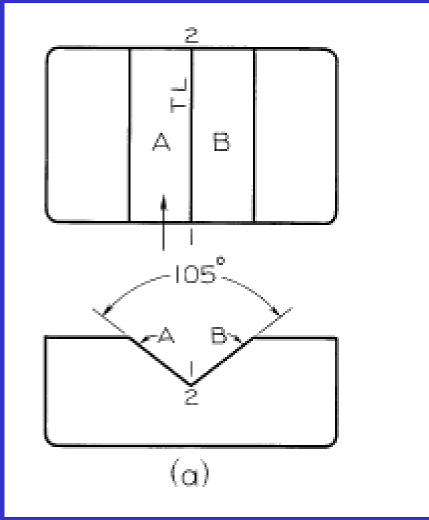
How to represent a full auxiliary view?



Step 4

DIHEDRAL ANGLES

Definition: An angle between two intersection planes



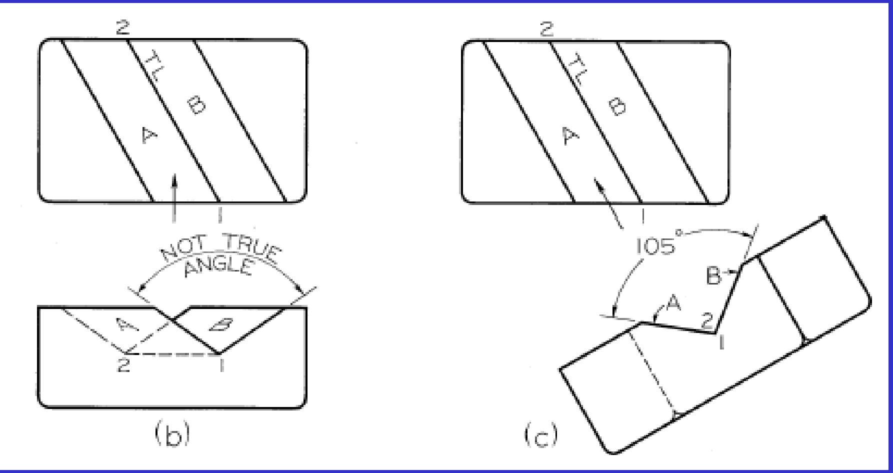
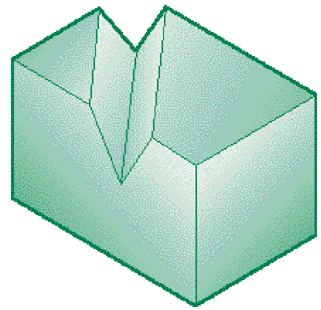
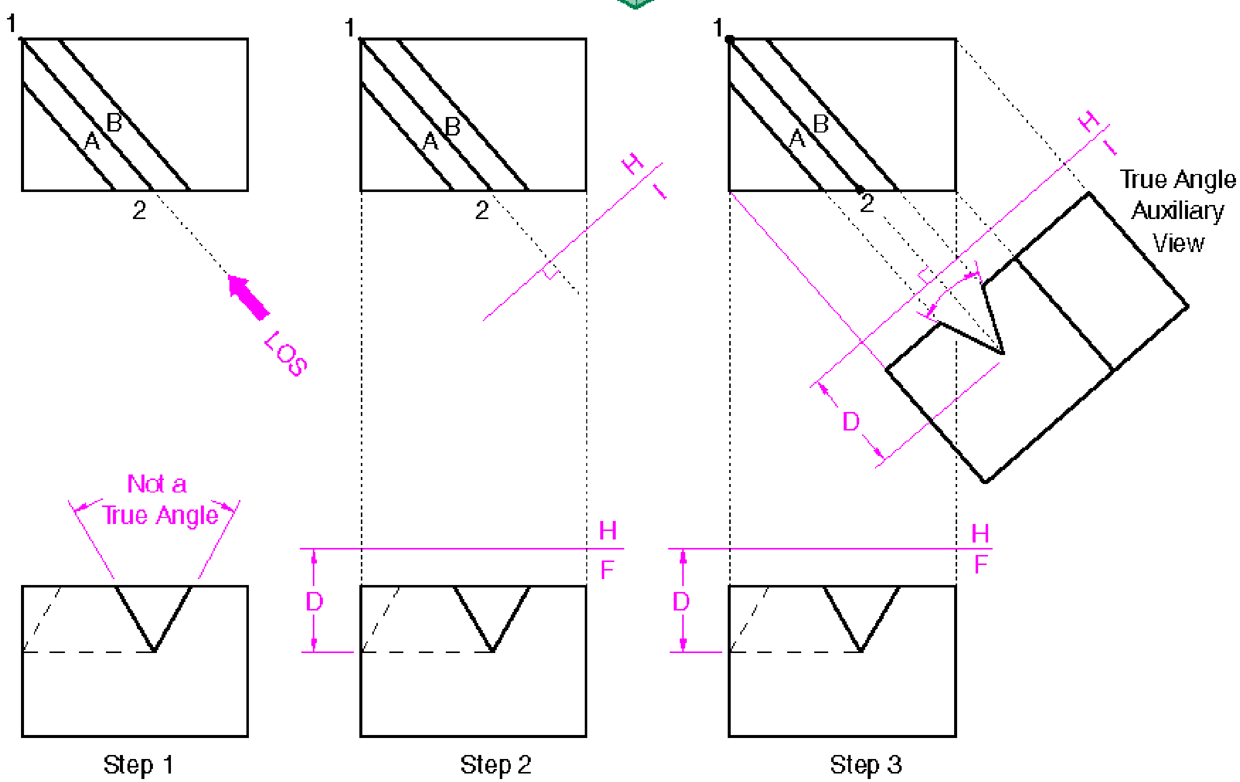


Figure (a) shows a dihedral angle between surface A and B. To find the angle for the case in Figure (b), auxiliary view is used.

A practical problem

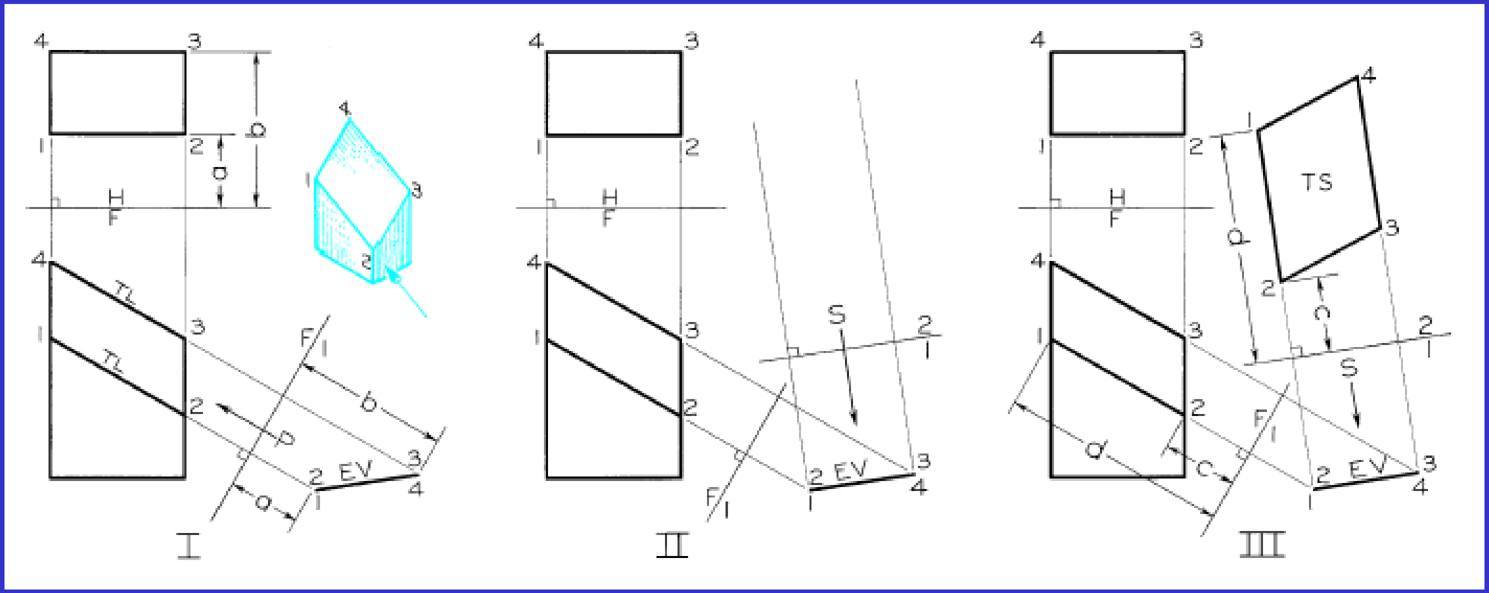


Find the angle of the V-cut



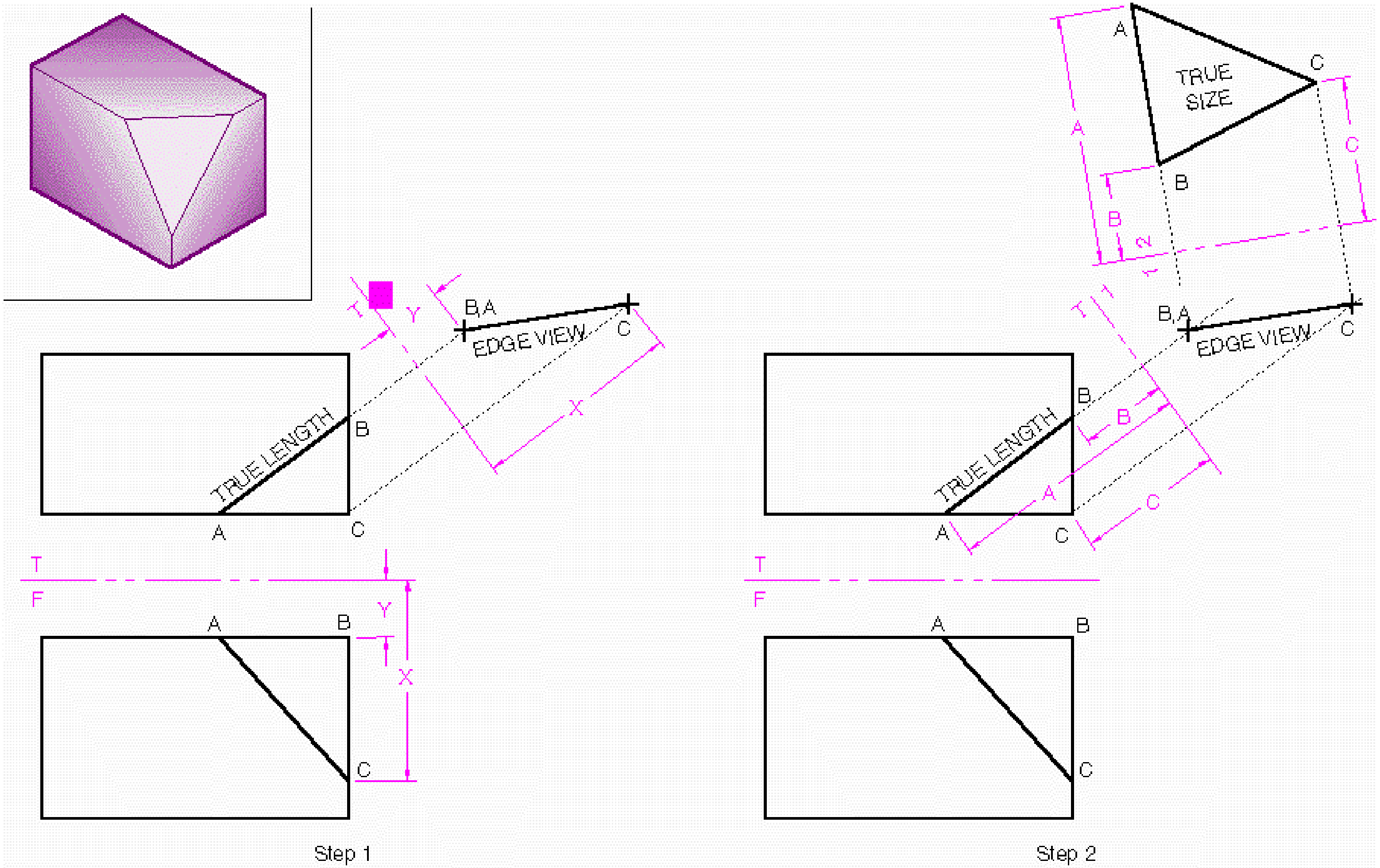
SOLUTION: TURE SIZE OF AN OBLIQUE SURFACE

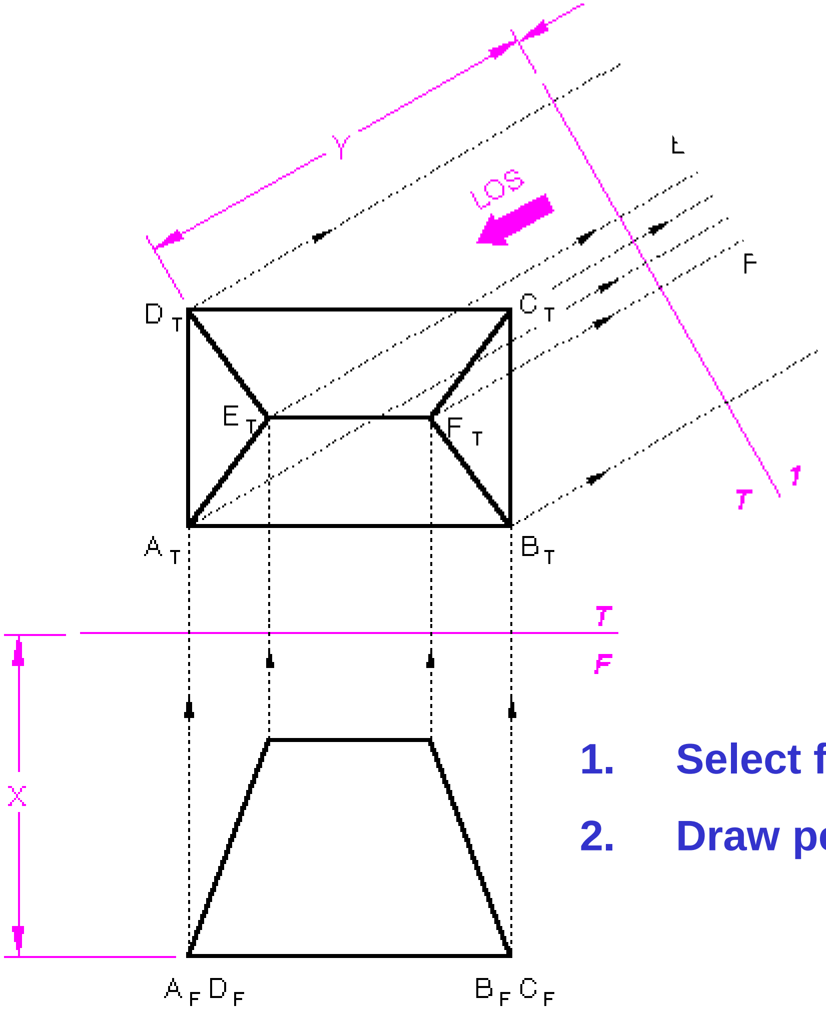
1. Find the edge view of the plane in a primary auxiliary view
2. Find the true size of the plane in a secondary auxiliary view



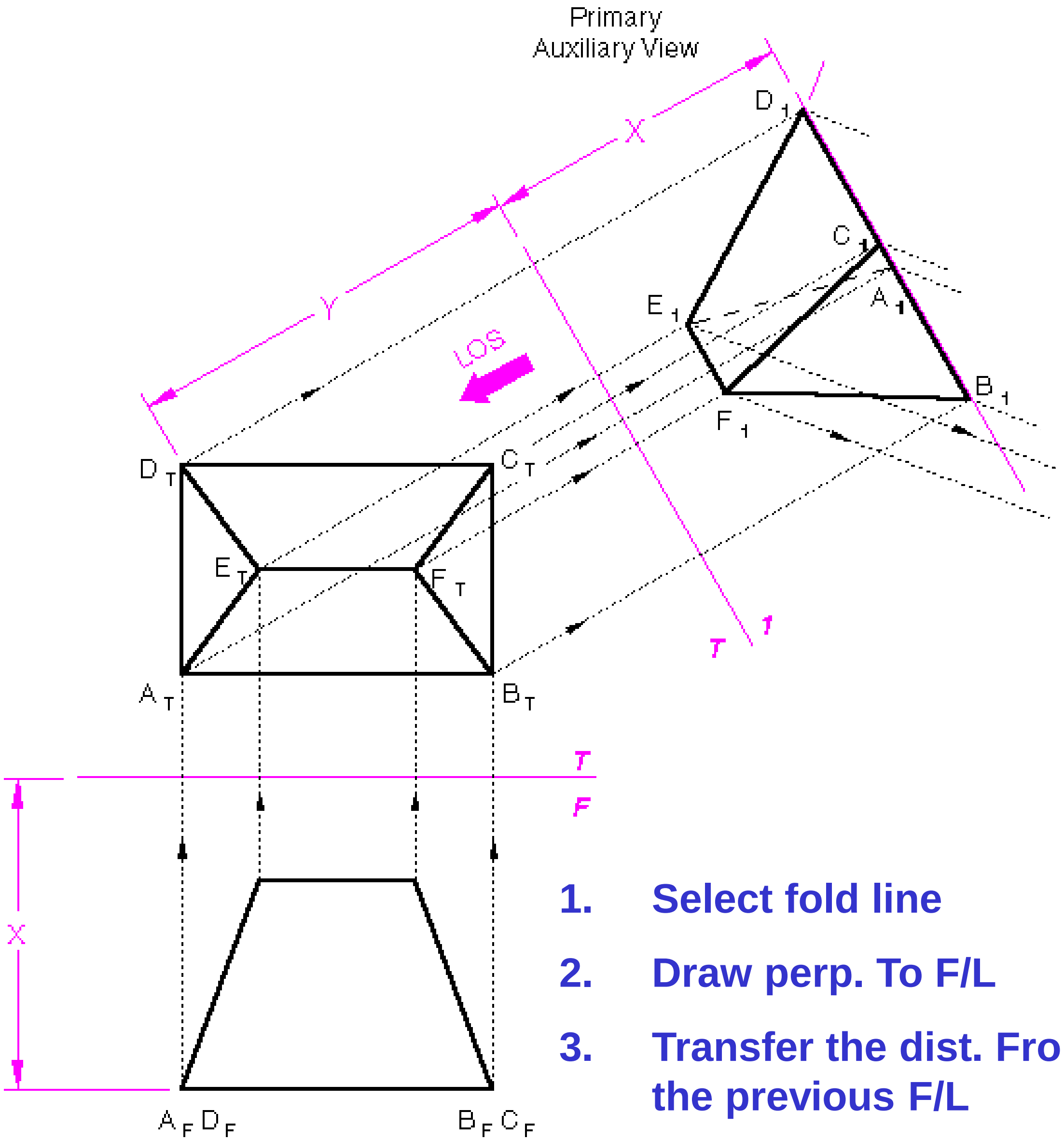
Another practical problem

Find the true shape of the section (triangle)

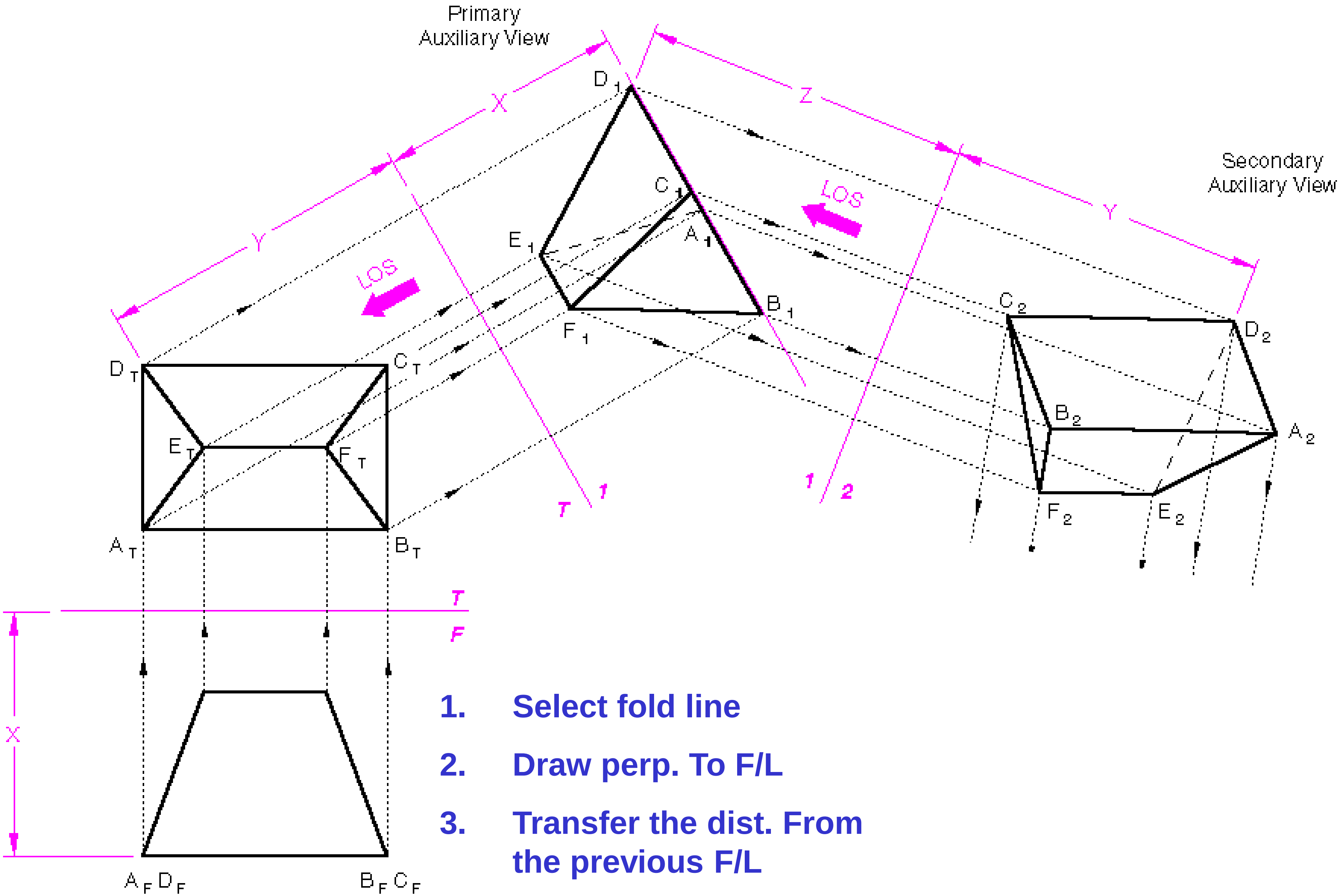




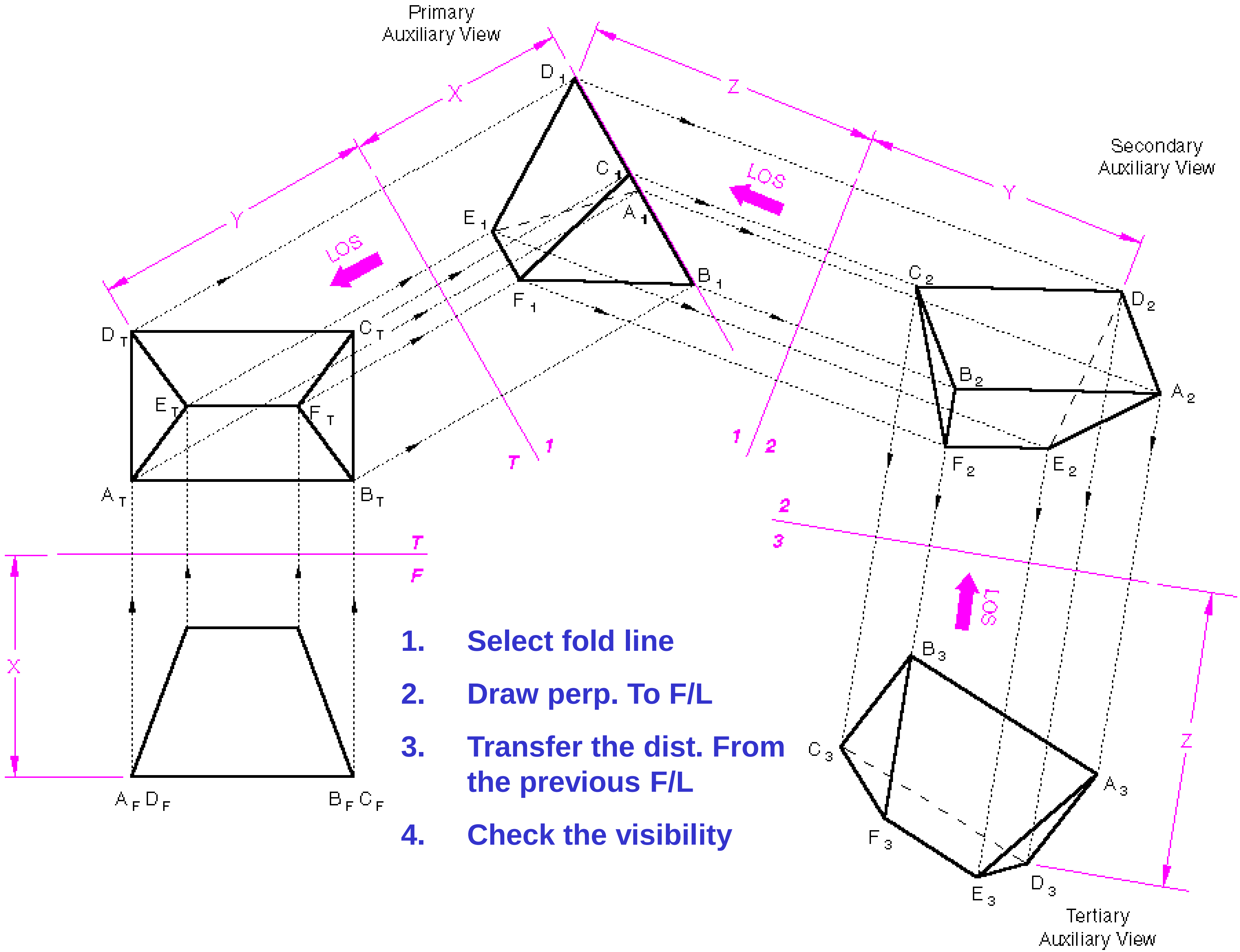
1. **Select fold line**
2. **Draw perp. To F/L**



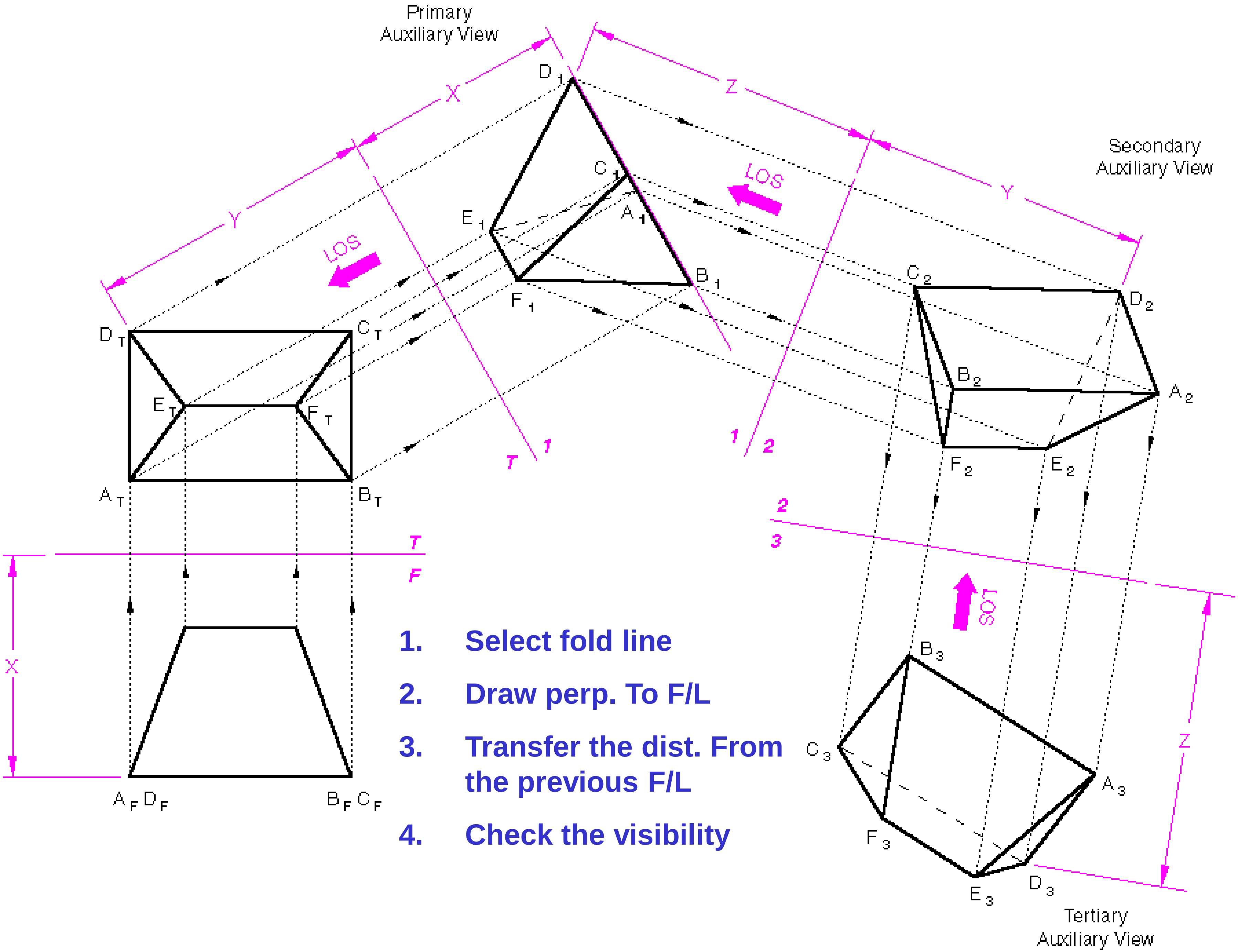
1. **Select fold line**
2. **Draw perp. To F/L**
3. **Transfer the dist. From the previous F/L**
4. **Check the visibility**



1. Select fold line
2. Draw perp. To F/L
3. Transfer the dist. From the previous F/L
4. Check the visibility



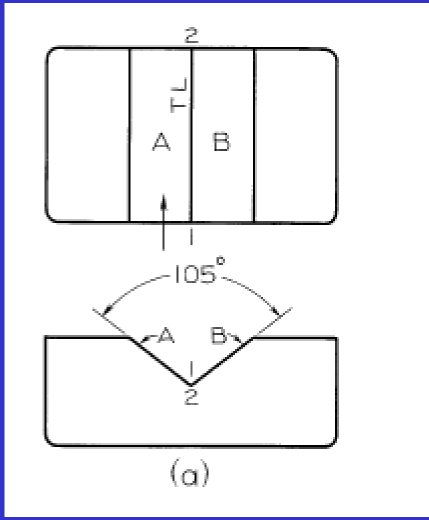
1. **Select fold line**
2. **Draw perp. To F/L**
3. **Transfer the dist. From the previous F/L**
4. **Check the visibility**



1. **Select fold line**
2. **Draw perp. To F/L**
3. **Transfer the dist. From the previous F/L**
4. **Check the visibility**

DIHEDRAL ANGLES

Definition: An angle between two intersection planes



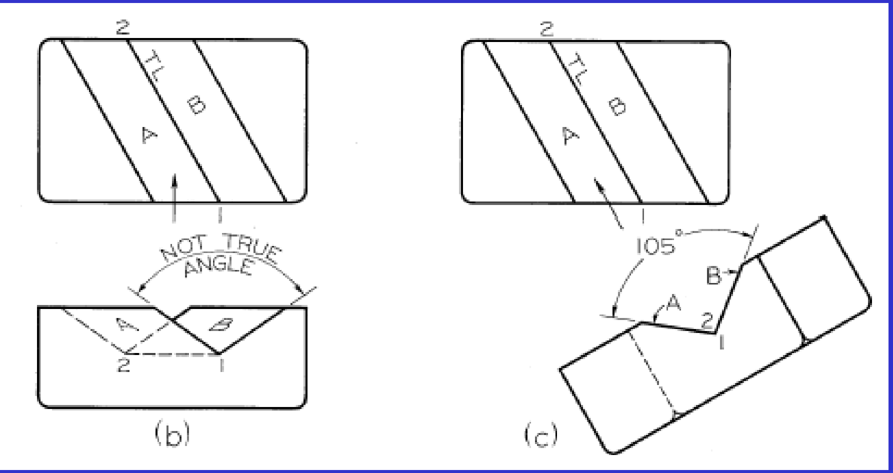
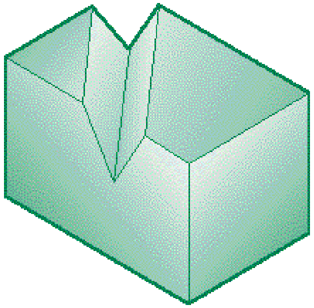
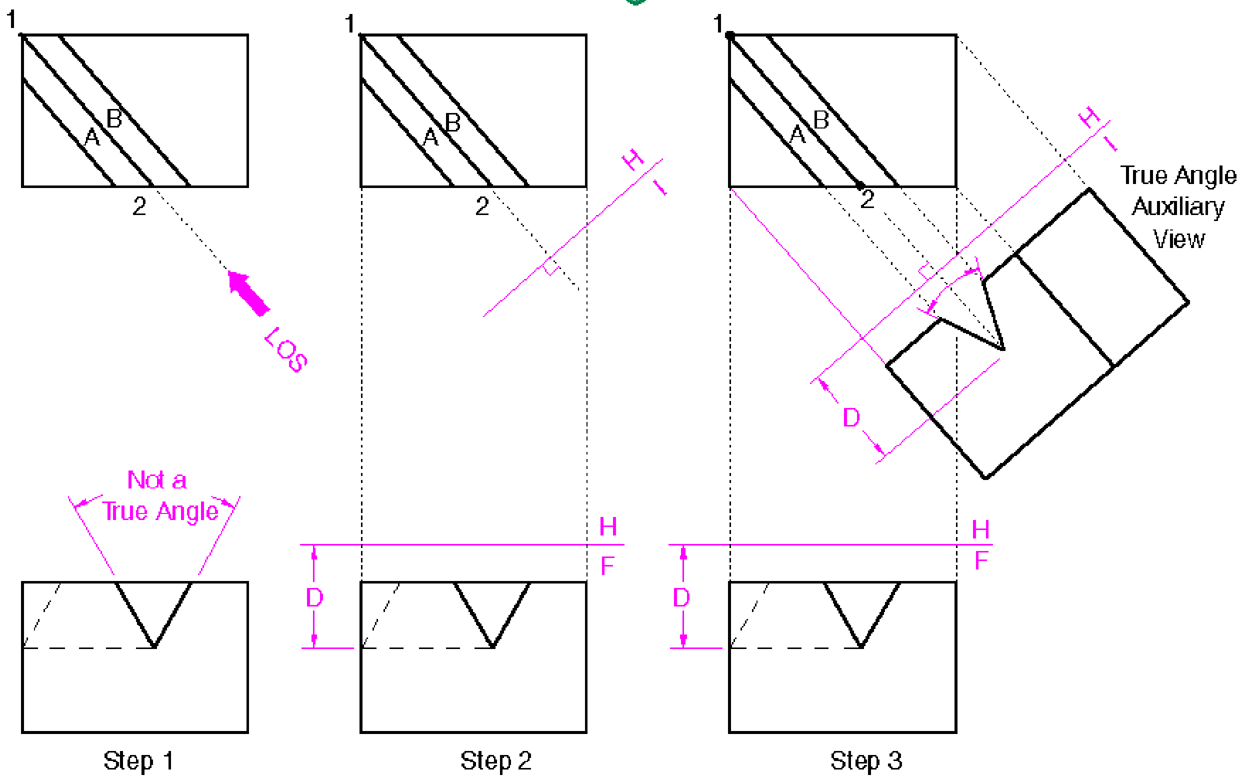


Figure (a) shows a dihedral angle between surface A and B. To find the angle for the case in Figure (b), auxiliary view is used.

A practical problem

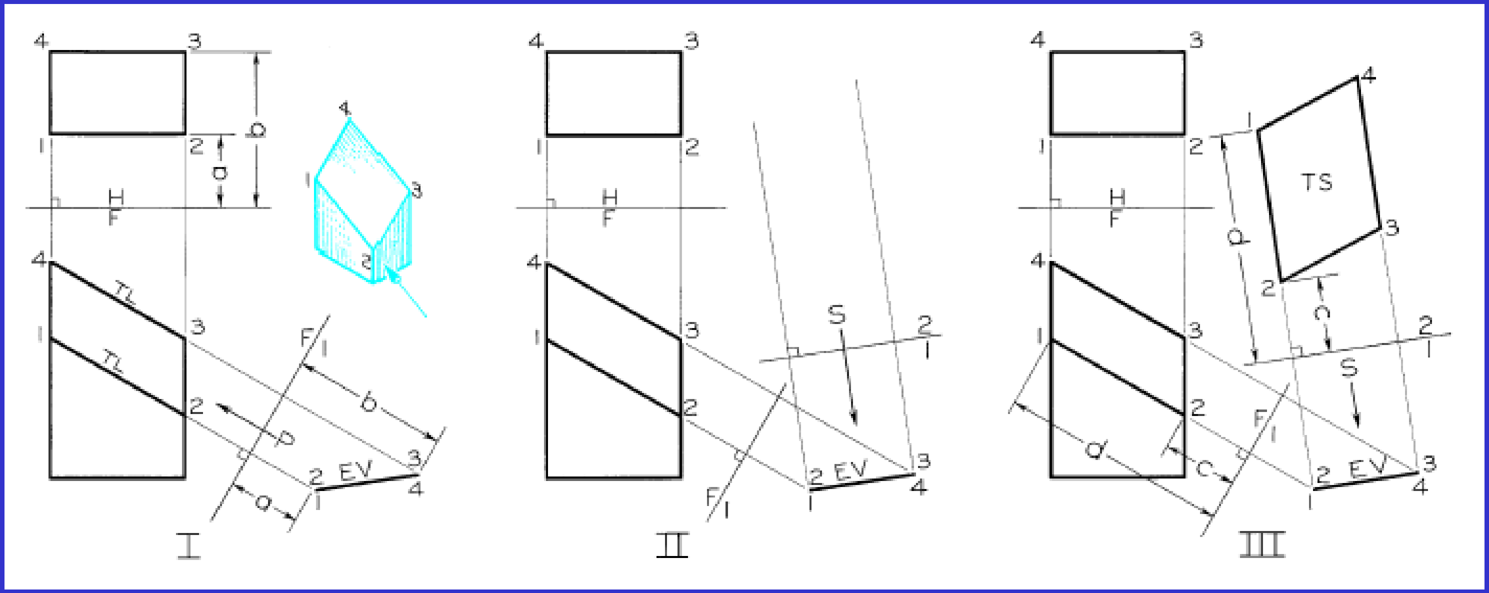


Find the angle of the V-cut



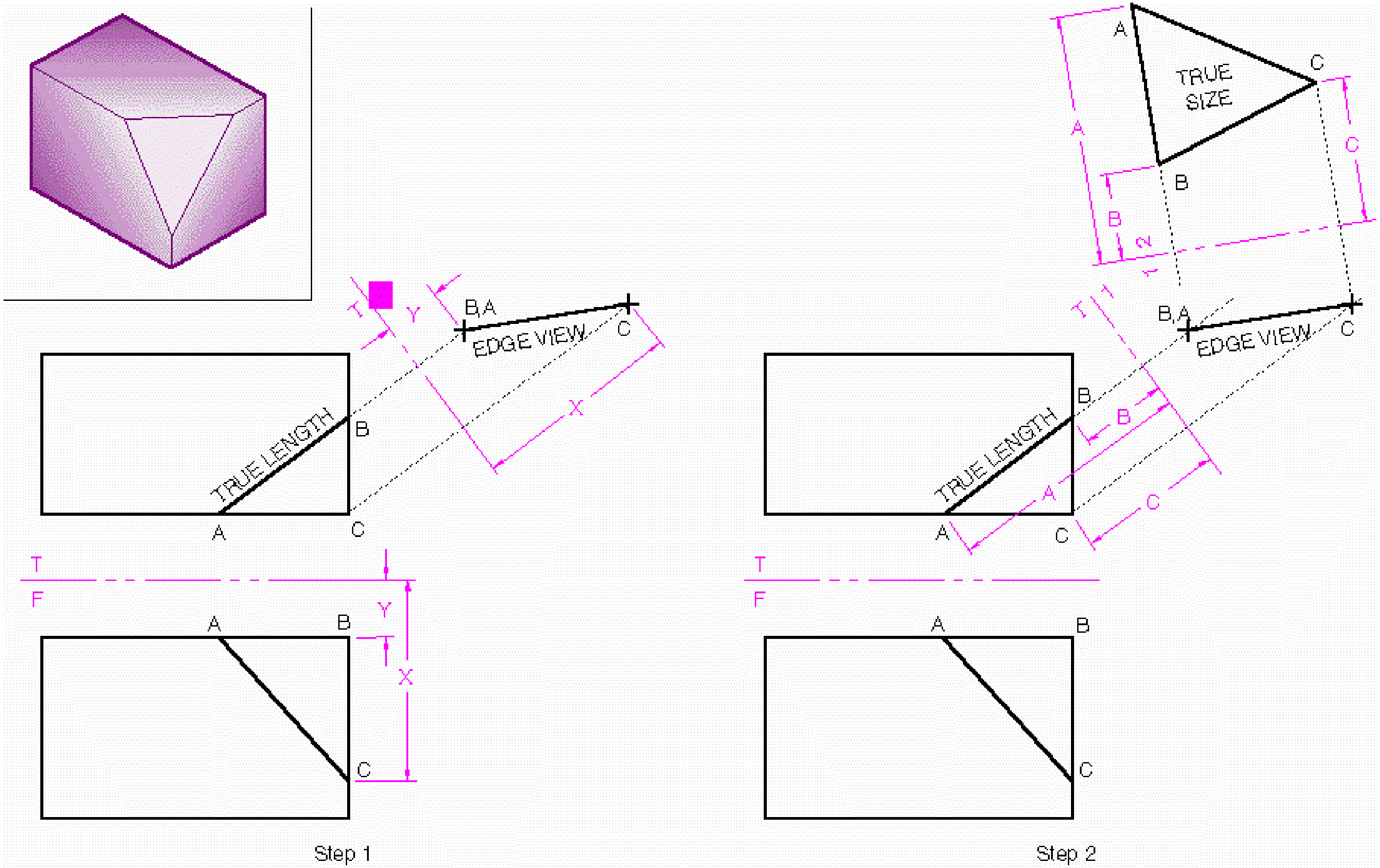
SOLUTION: TURE SIZE OF AN OBLIQUE SURFACE

1. Find the edge view of the plane in a primary auxiliary view
2. Find the true size of the plane in a secondary auxiliary view



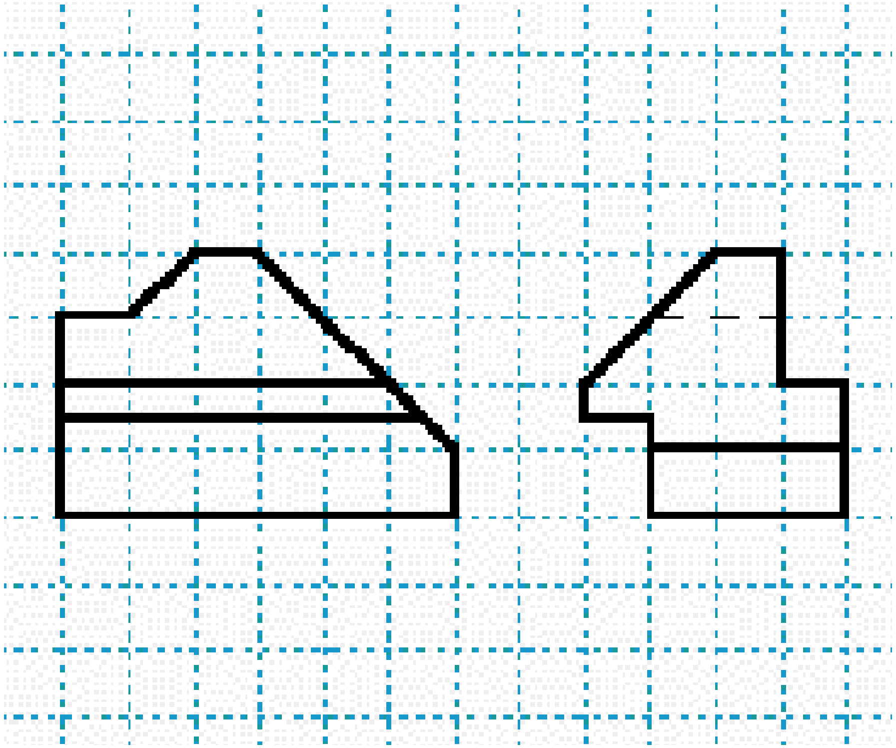
Another practical problem

Find the true shape of the section (triangle)



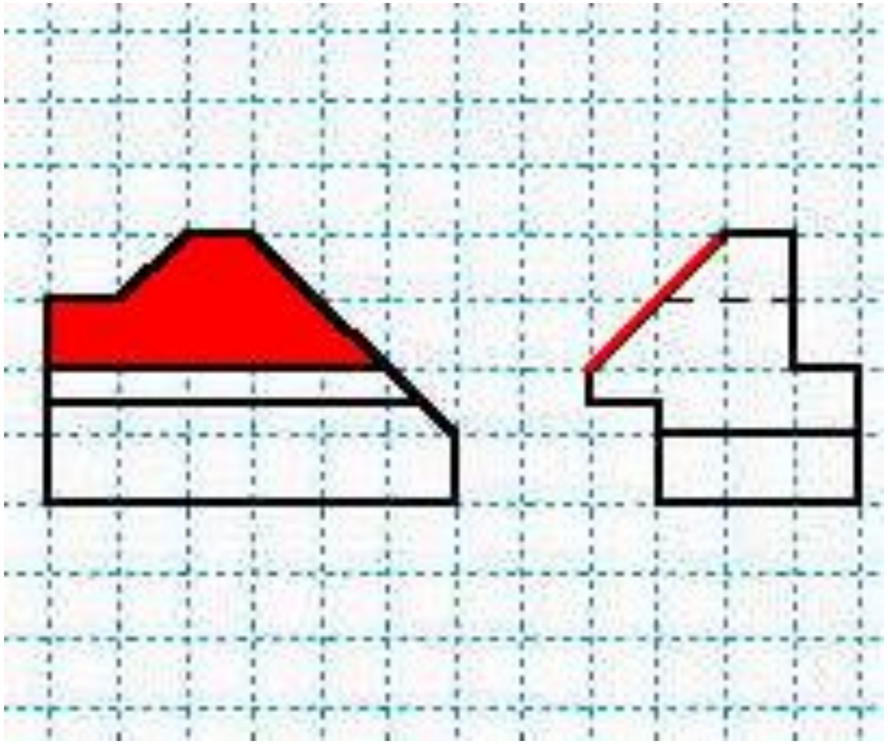
Example of auxiliary view problem

Find the true shape of the distorted features



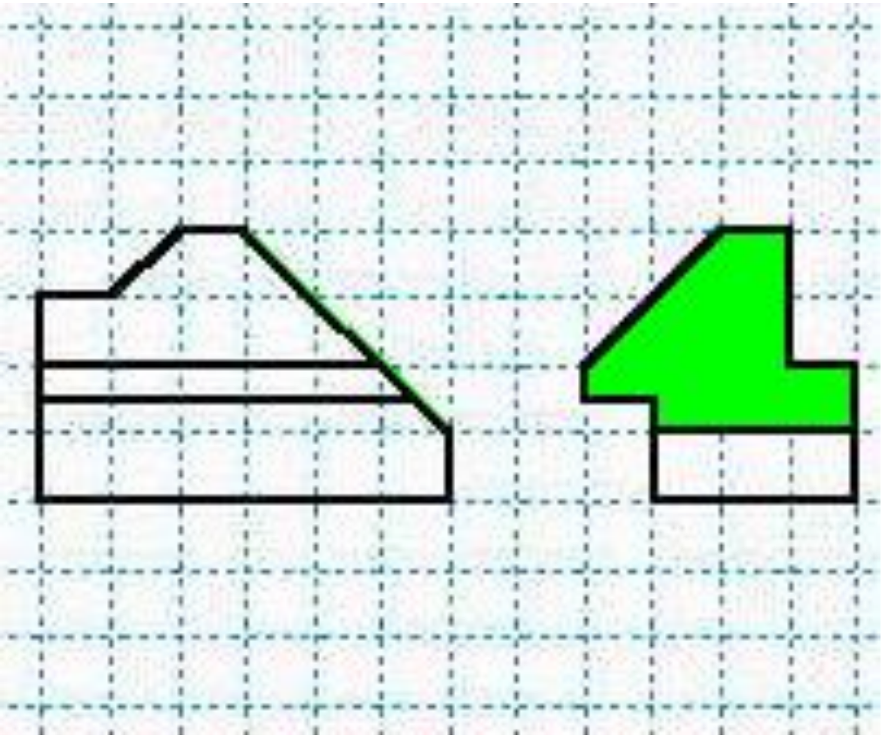
Example of auxiliary view problem

One feature is seen in P view as a line
– one auxiliary view needed



Example of auxiliary view problem

Another feature is seen in F view as a line
– one auxiliary view needed



Auxiliary Views:

To draw

TL of line, point view of line, Edge view of the plane and true size of plane.

To View TL : Draw Aux.View parallel to any view

To view point view: Draw Aux.View perp. To TL

To view Edge View : Draw Aux.View perp. To TL of any edge/line

To view full surface : Draw Aux.View perp. Edge view