Concordia University
Engineering and Computer Science

MECH 211 – Mechanical Engineering Drawing

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Credits: 3.5

Lecture 3

Contents of the lecture

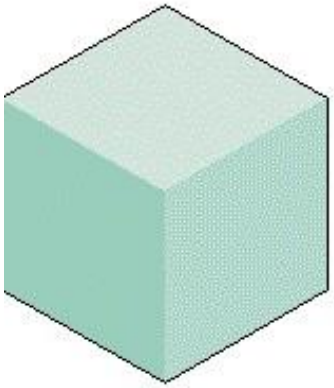
- Shape description and 3D modeling
- Shape generation
  - Conceptual
  - Physical
- Sectional views
- Auxiliary views – much more to discuss in the following 5 lectures

Shape description

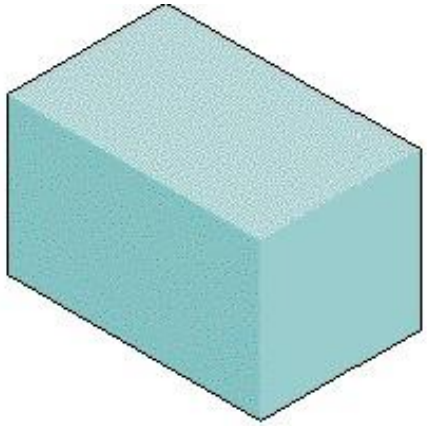
- Geometric shapes are seen according to view they are regarded
- Set of primitives – used to conceptualize the complex shapes by adding/subtracting the primitive shapes

- Primitive shapes:
  - Boxes
  - Prisms
  - Pyramids/truncated pyramids
  - Cylinders
  - Cones
  - Spheres

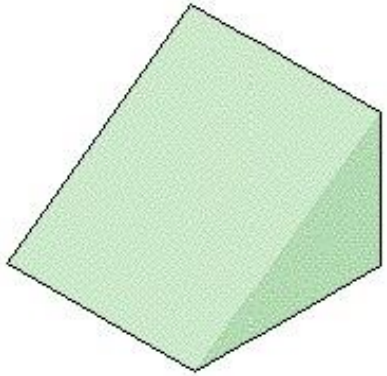
Primitives



Cube



Rectangular Prism



Triangular Prism

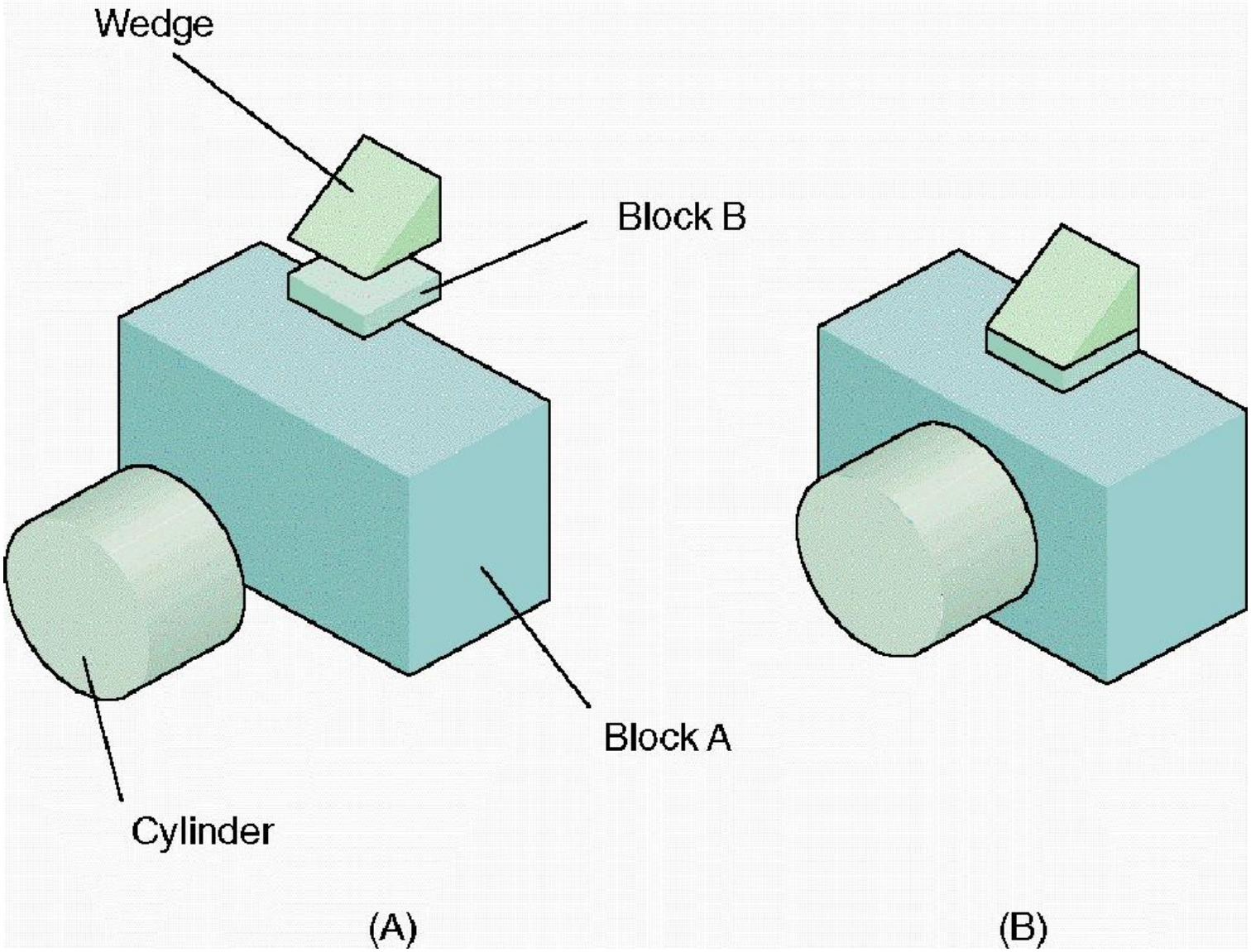
Sphere

Cone

Torus

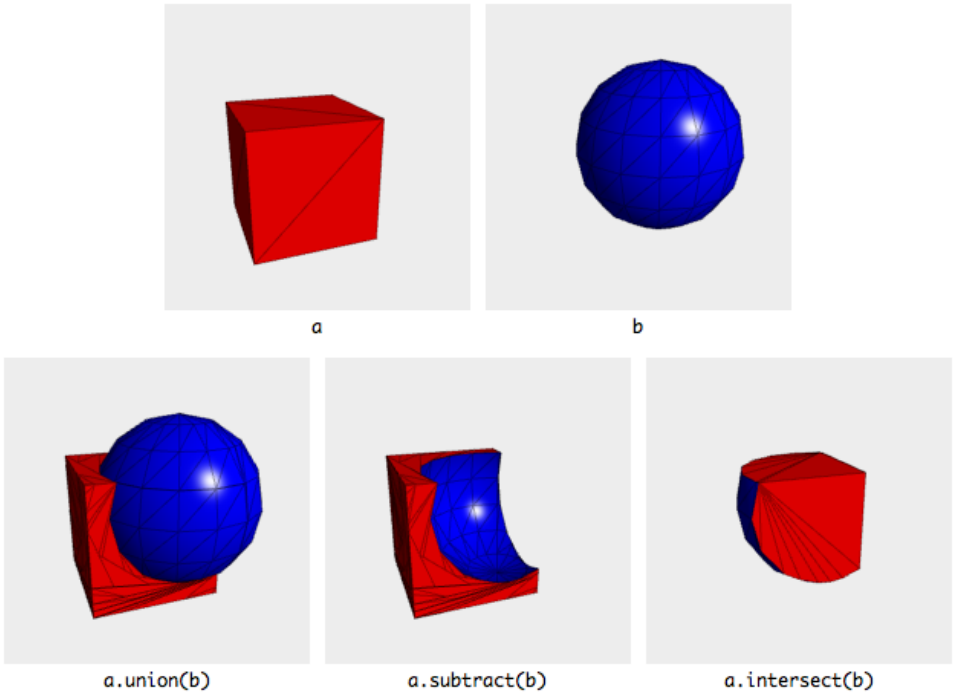
Cylinder

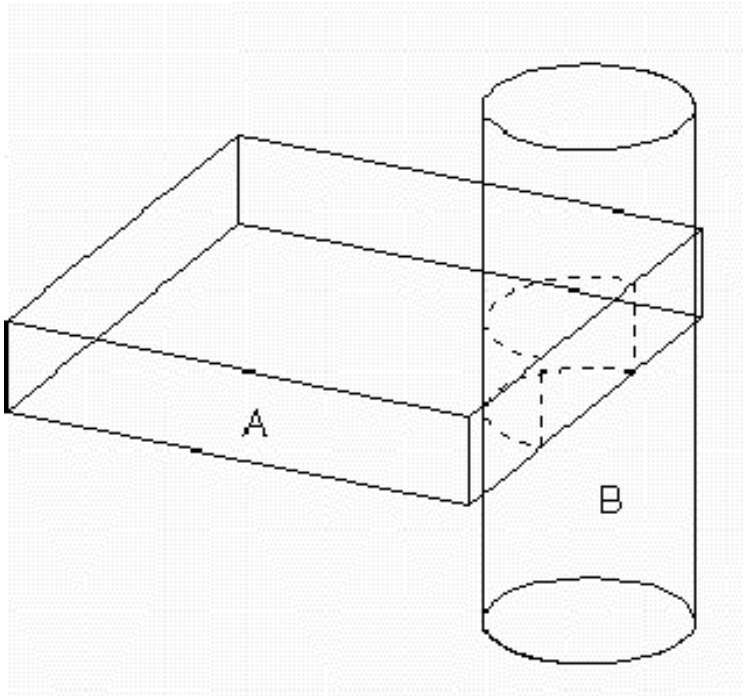
Primitives – Shape Generation



Boolean Operations

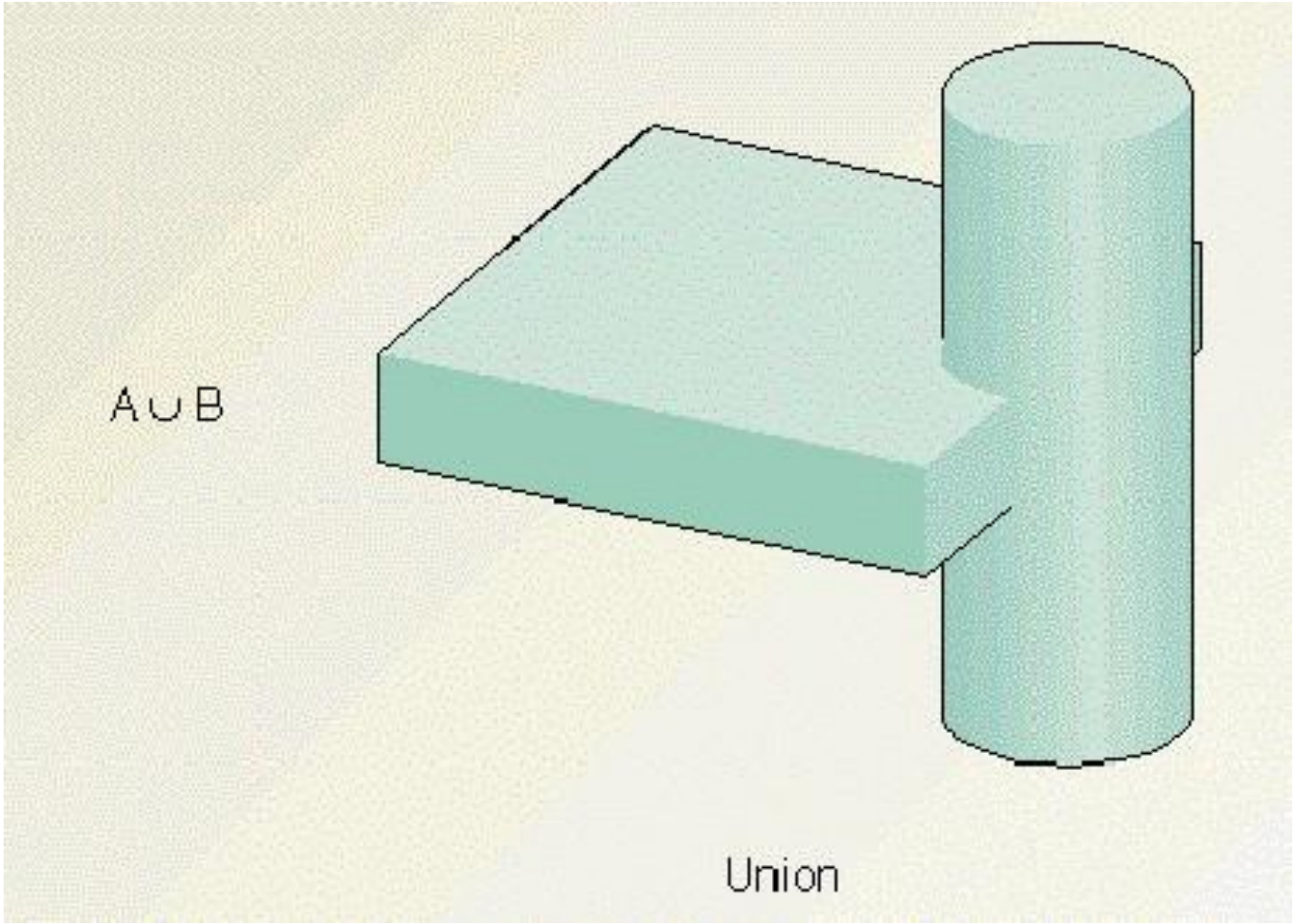
Given two shapes, they could be intersected or reunited to obtain a new shape.





Boolean Union

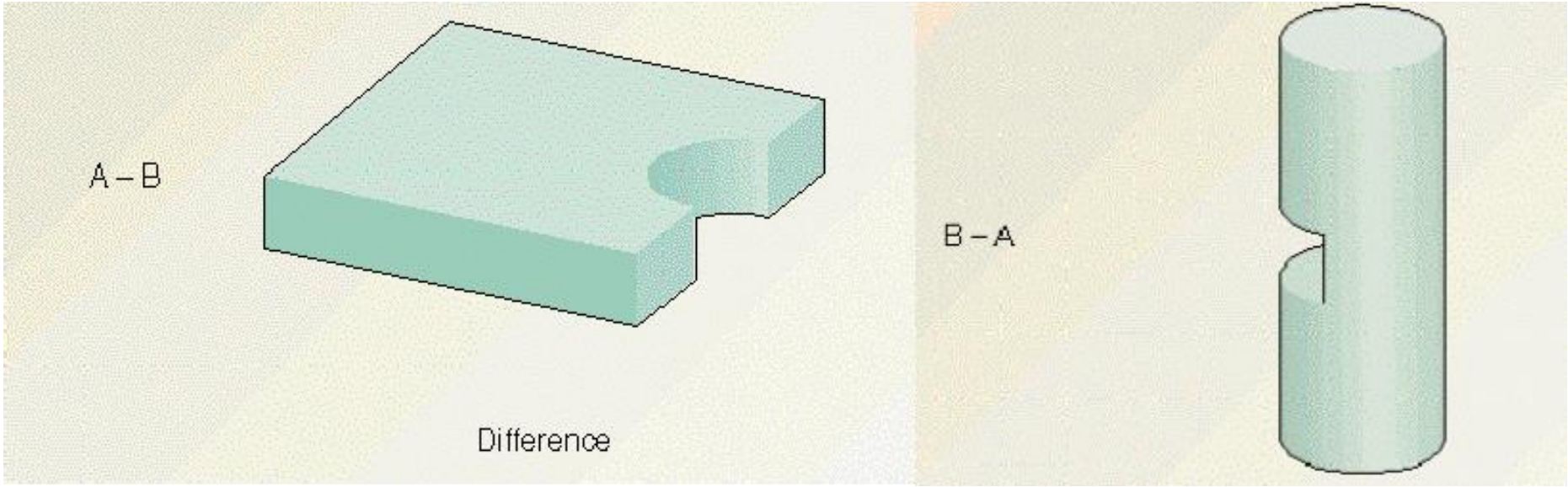
The common part is removed once.



Boolean Difference

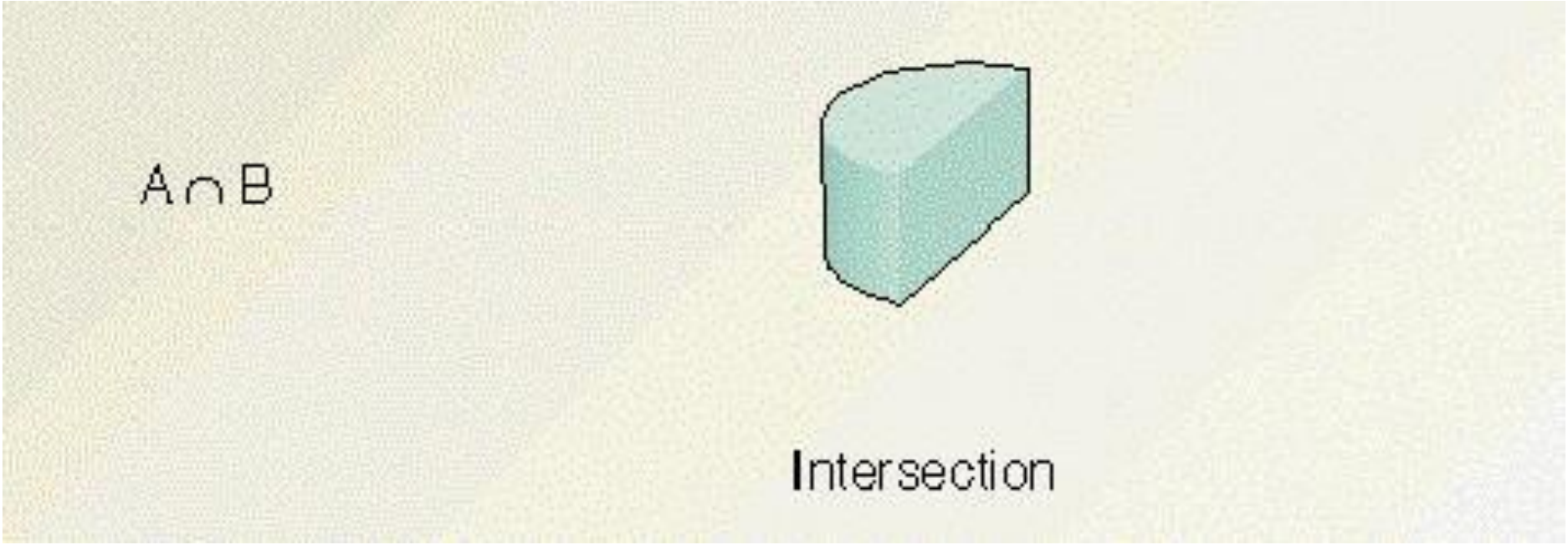
The initial shape minus the common portion will be yielded.

notice the difference between A-B and B-A

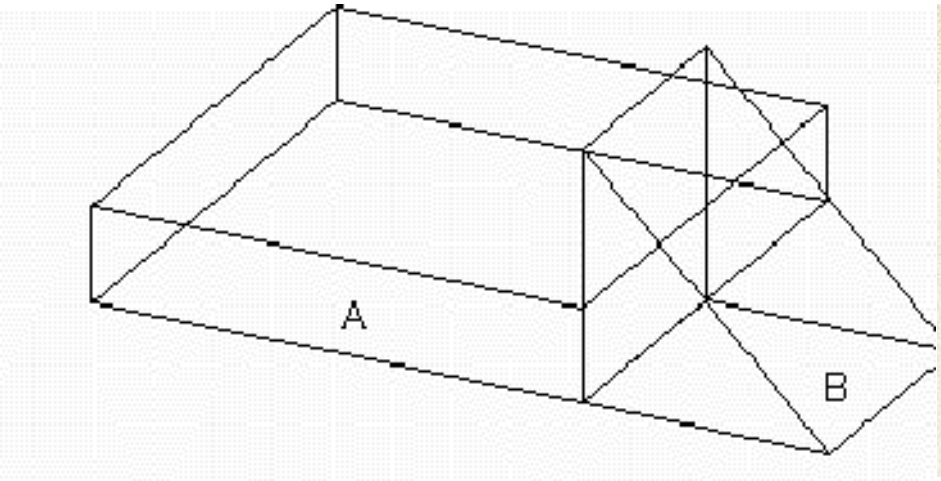


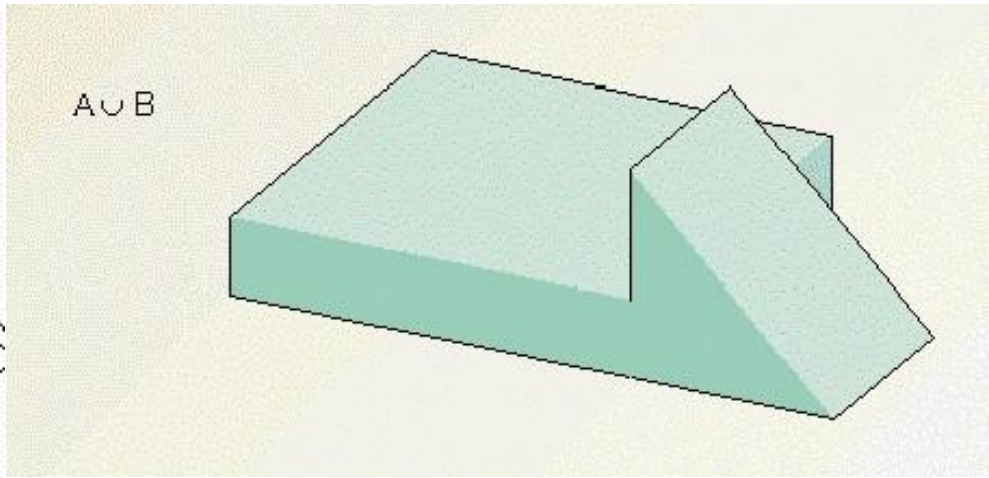
Boolean Intersection

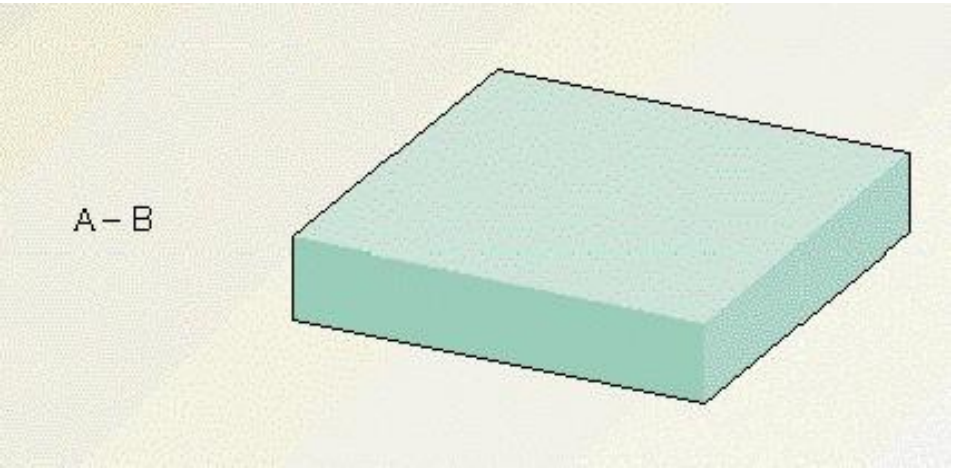
The intersection means the common portion of the two intersecting bodies.



Another Example



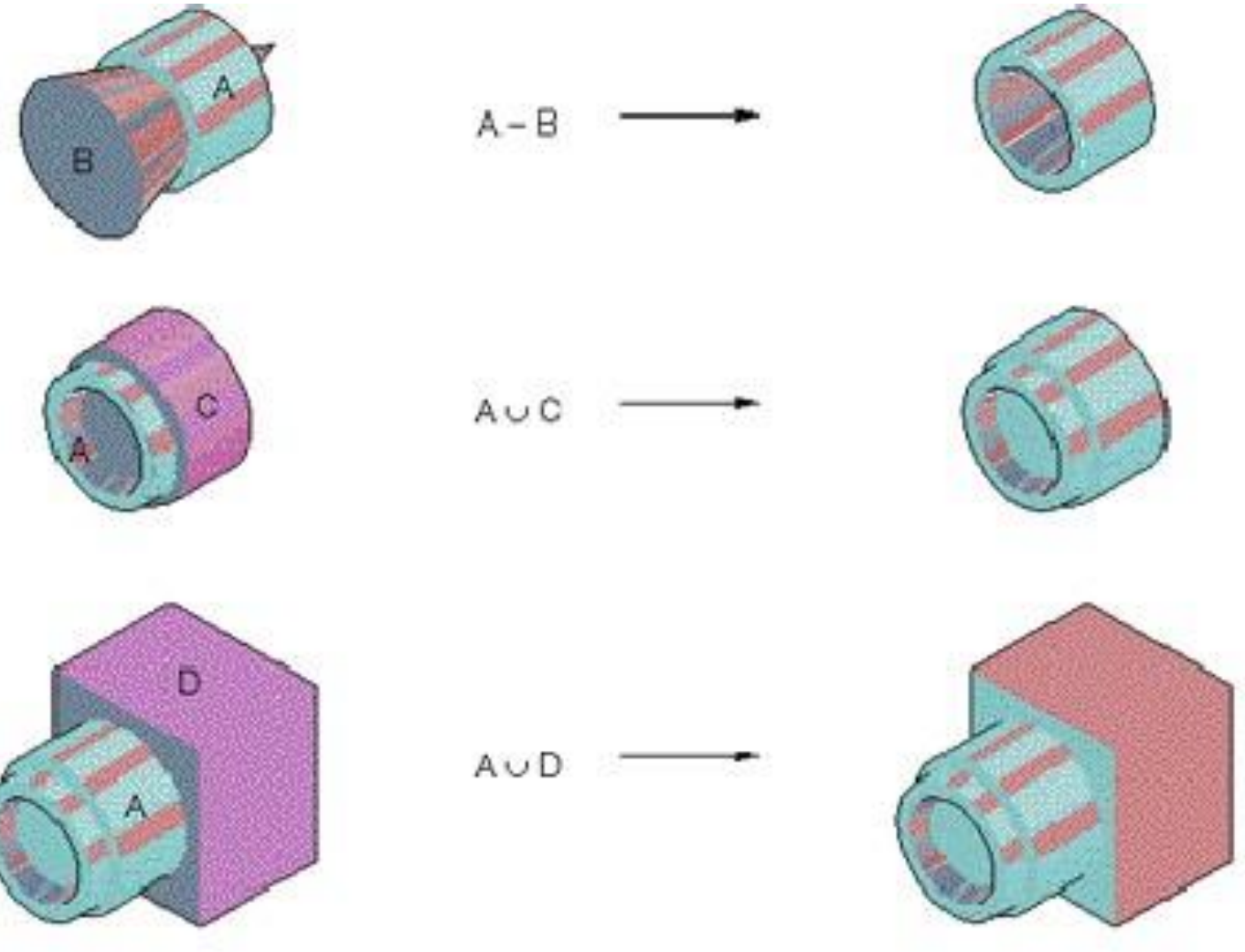




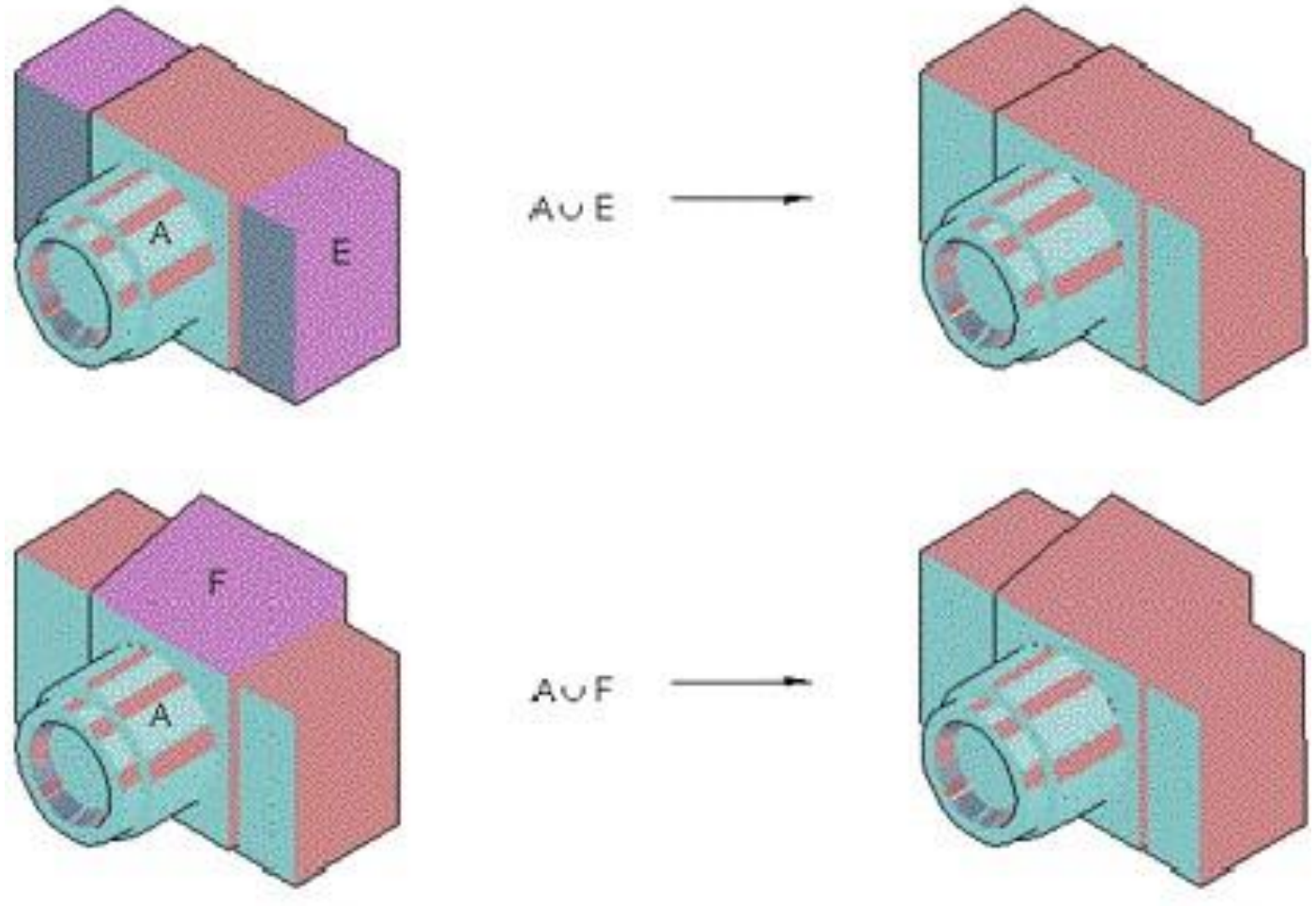
$A \cap B$ $\varnothing$

Null object

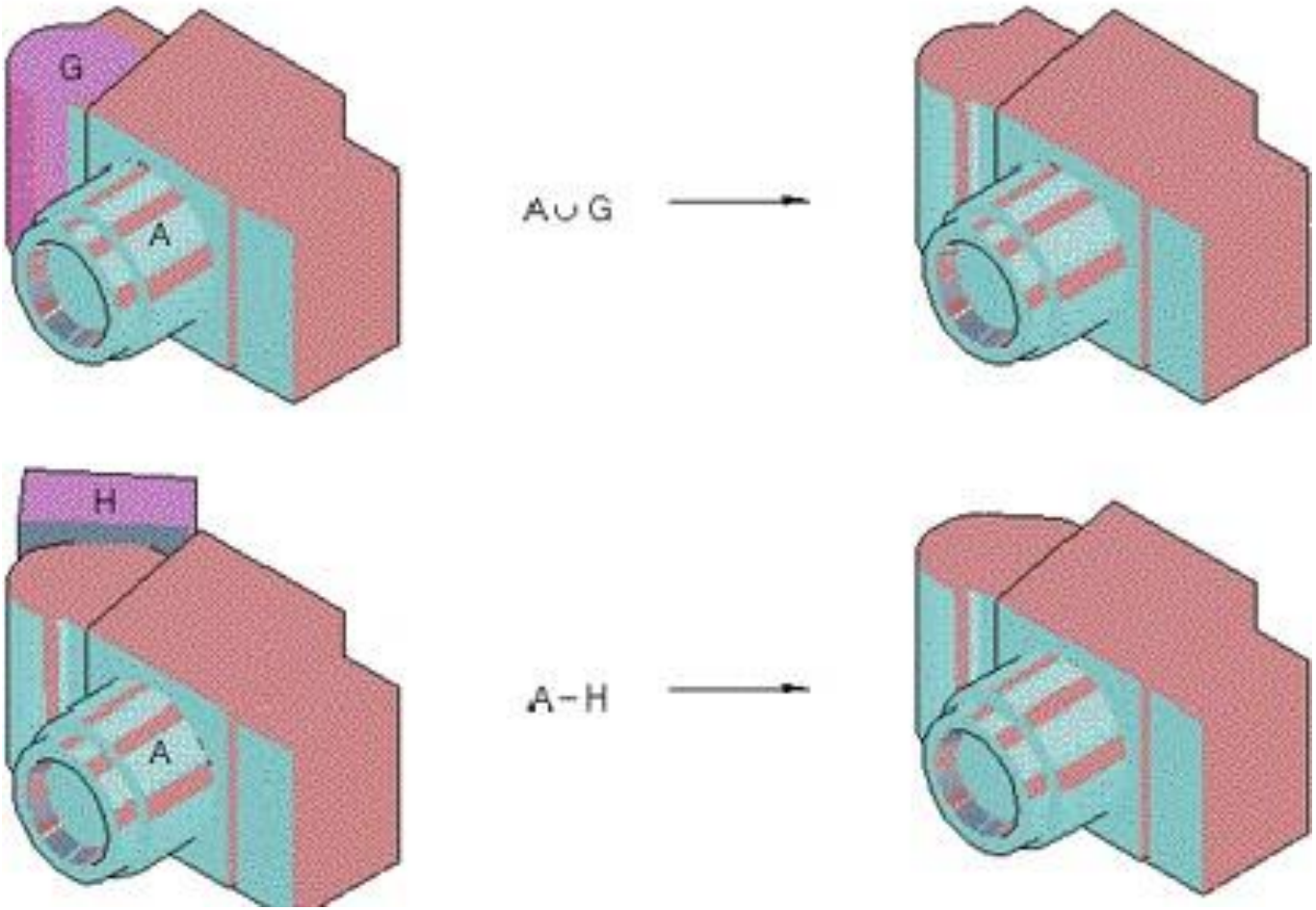
Conceptual Generation of a Complex Shape



Conceptual Generation of a Complex Shape



Conceptual Generation of a Complex Shape

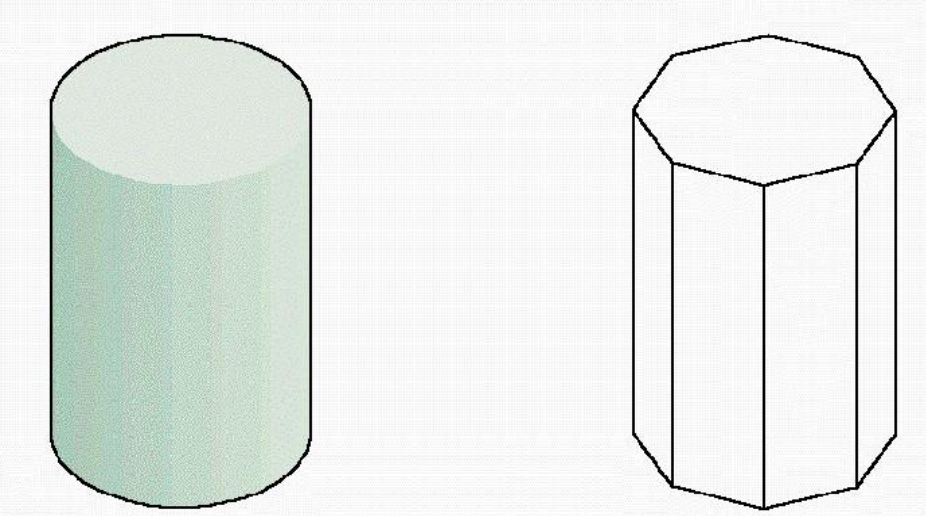


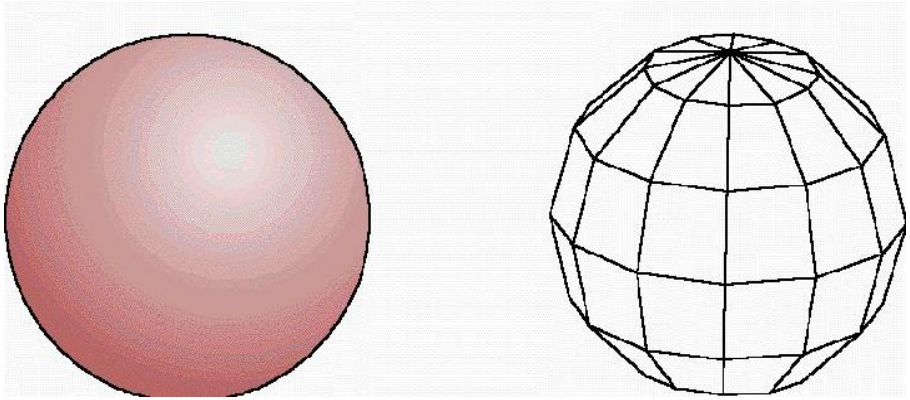
Shape Generation

- Two different aspects of shape generation:
  - Conceptual shape generation – when the geometry does not exist and when a functional doable 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 to 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 formable 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 with 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

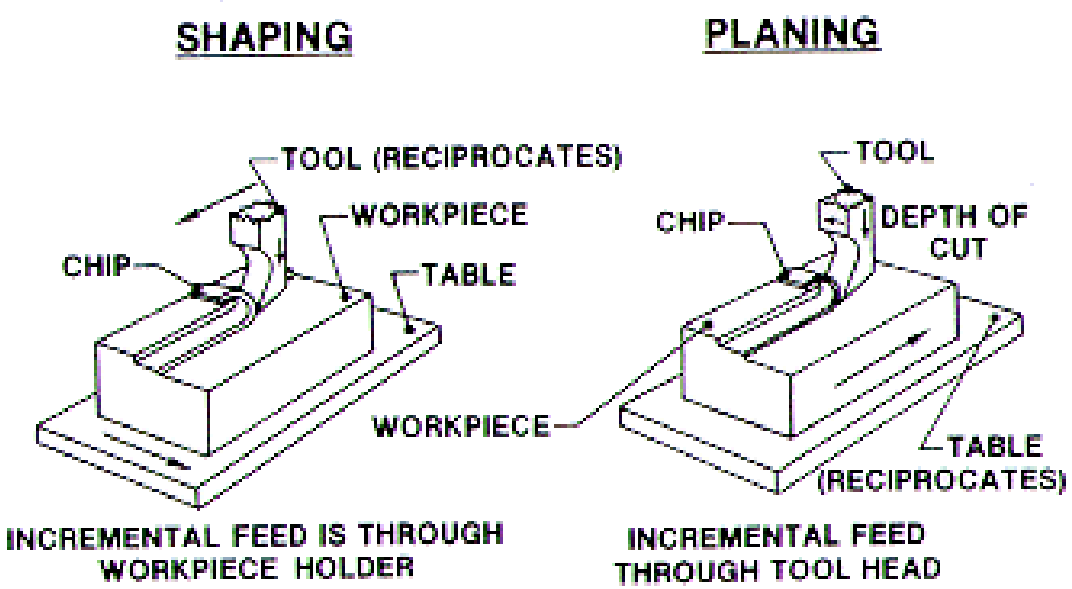
CASTING PROCESS

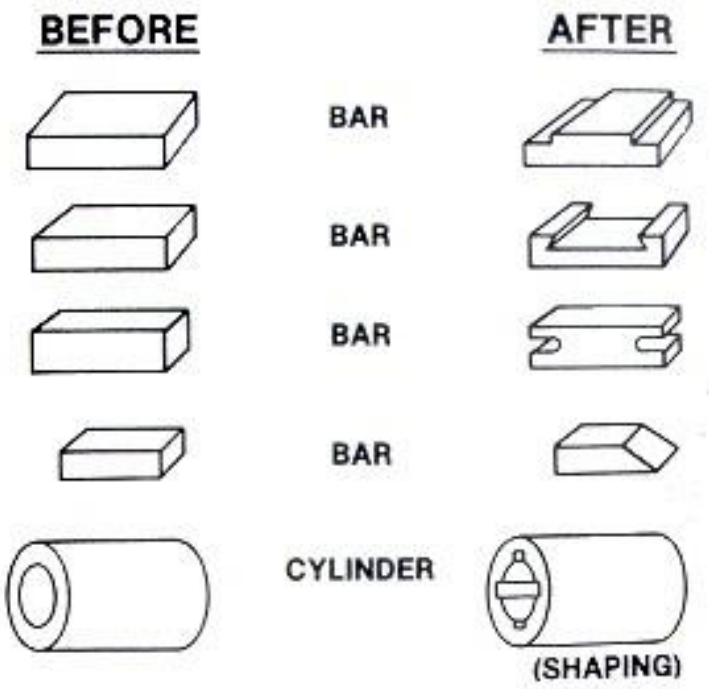
JOINING PROCESS

NON-CONVENTIONAL PROCESSES

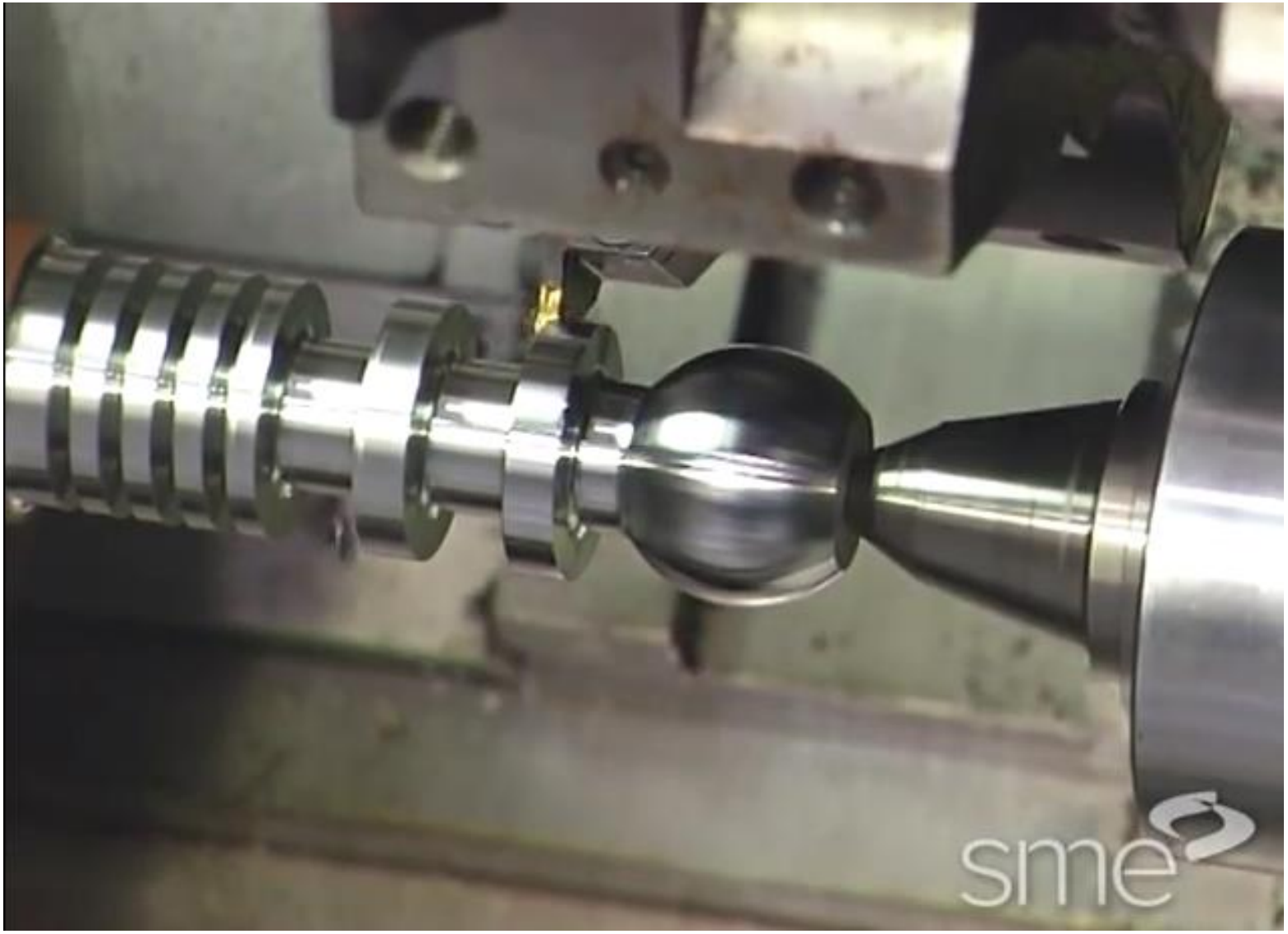
Shaping and planing

Generation of Flat surfaces

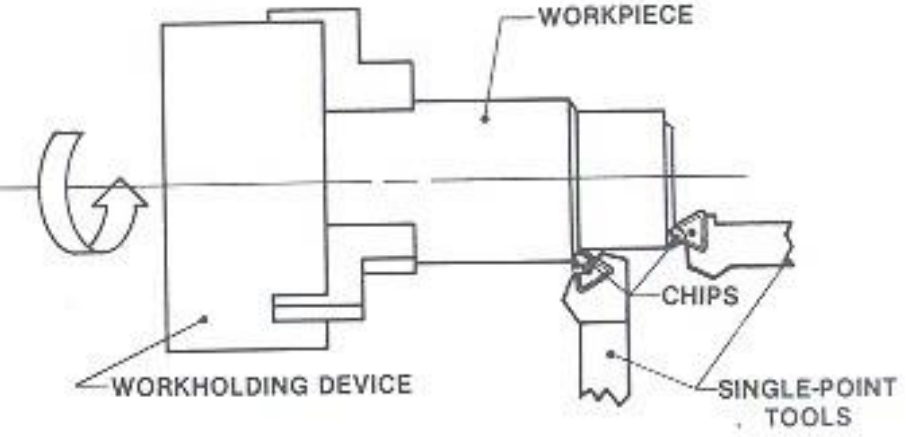


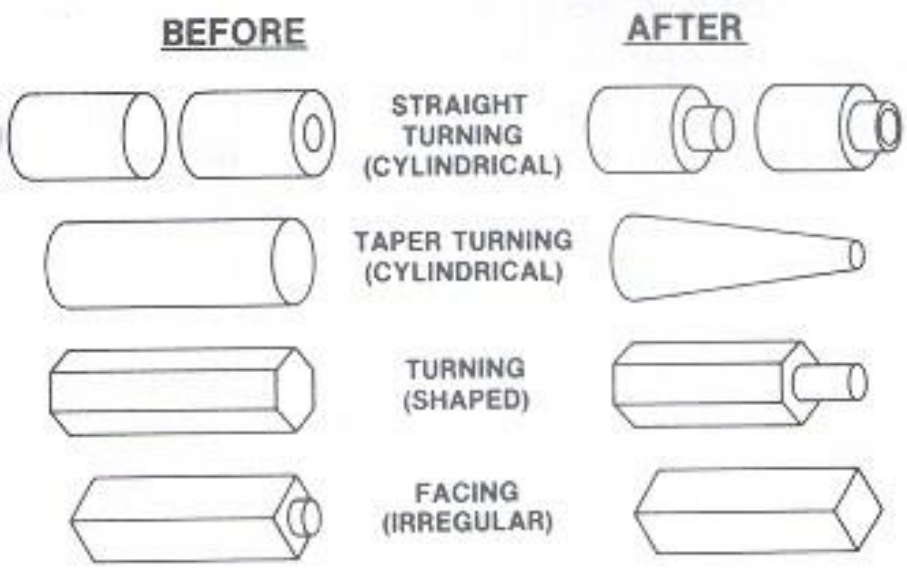


Turning

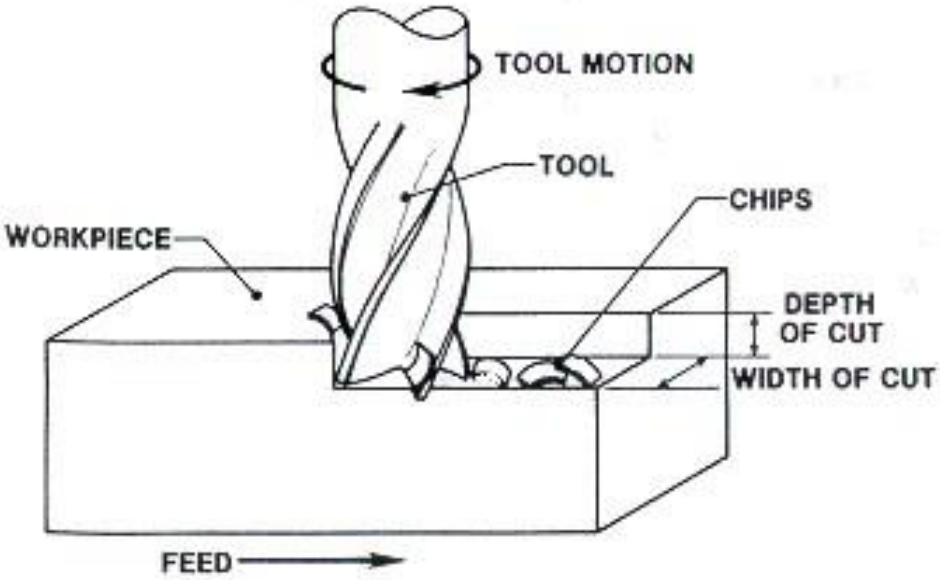


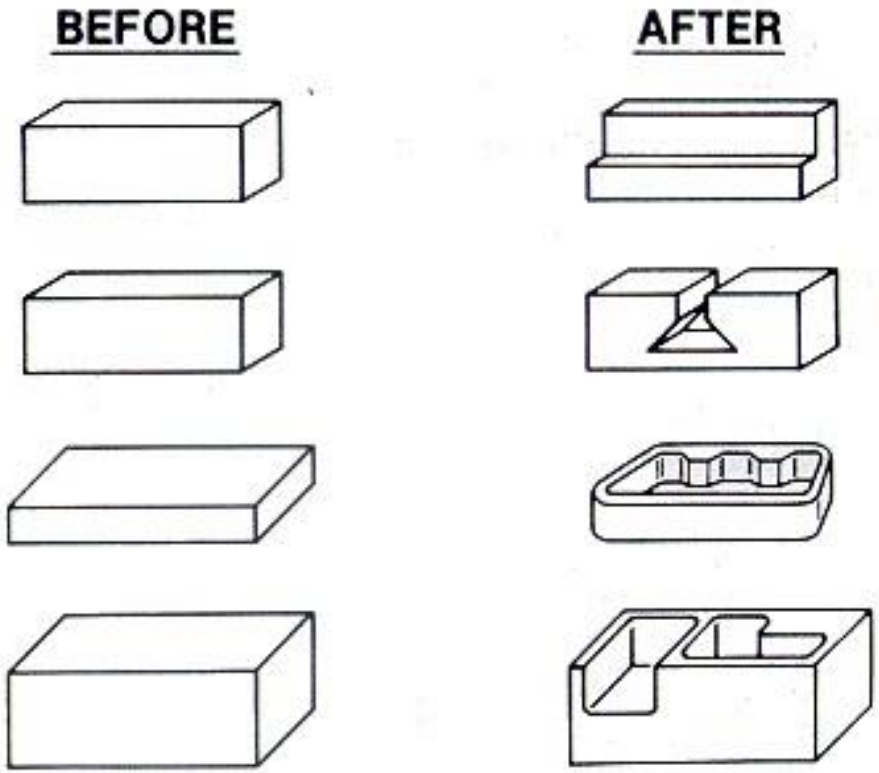
Turning


WORKPIECE
CHIPS
WORKHOLDING DEVICE
SINGLE-POINT TOOLS

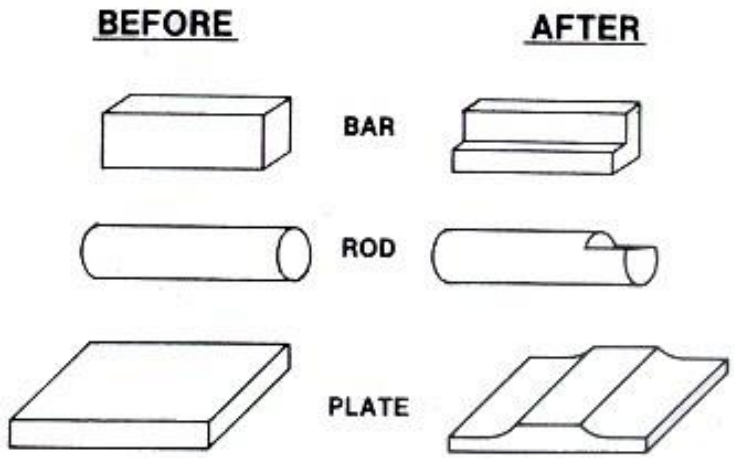

BEFORE
AFTER
STRAIGHT TURNING (CYLINDRICAL)
TAPER TURNING (CYLINDRICAL)
TURNING (SHAPED)
FACING (IRREGULAR)

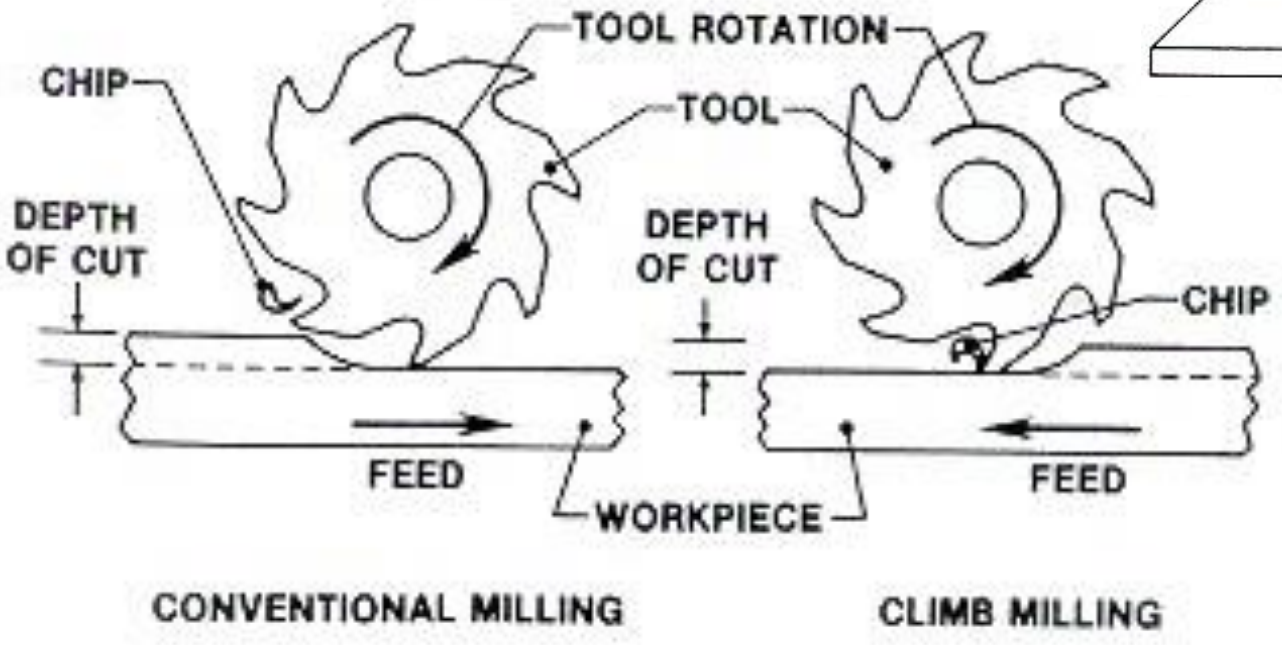
Milling


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


BEFORE
AFTER

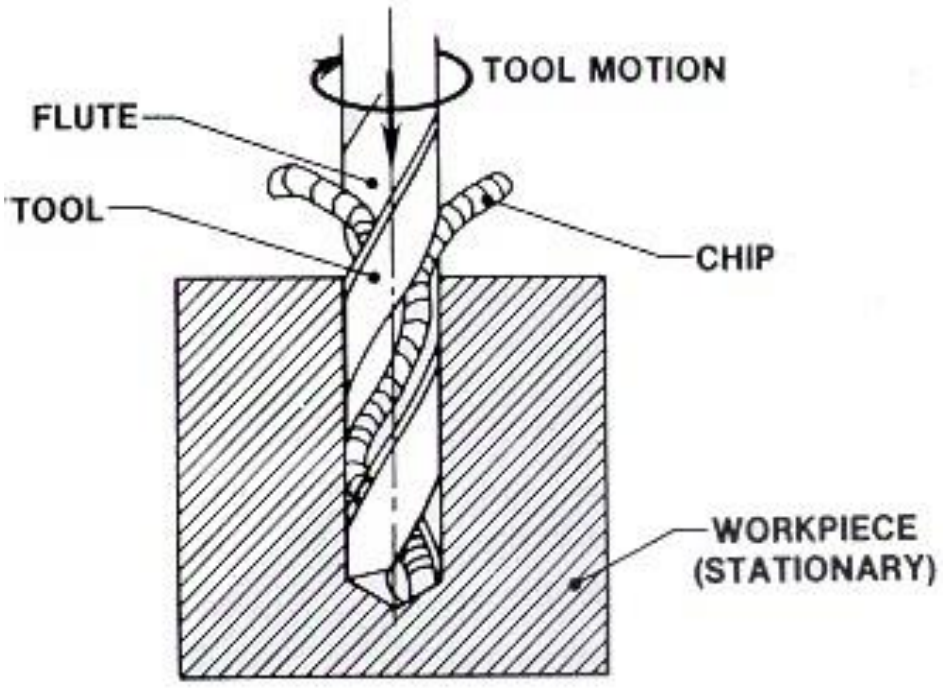
Milling

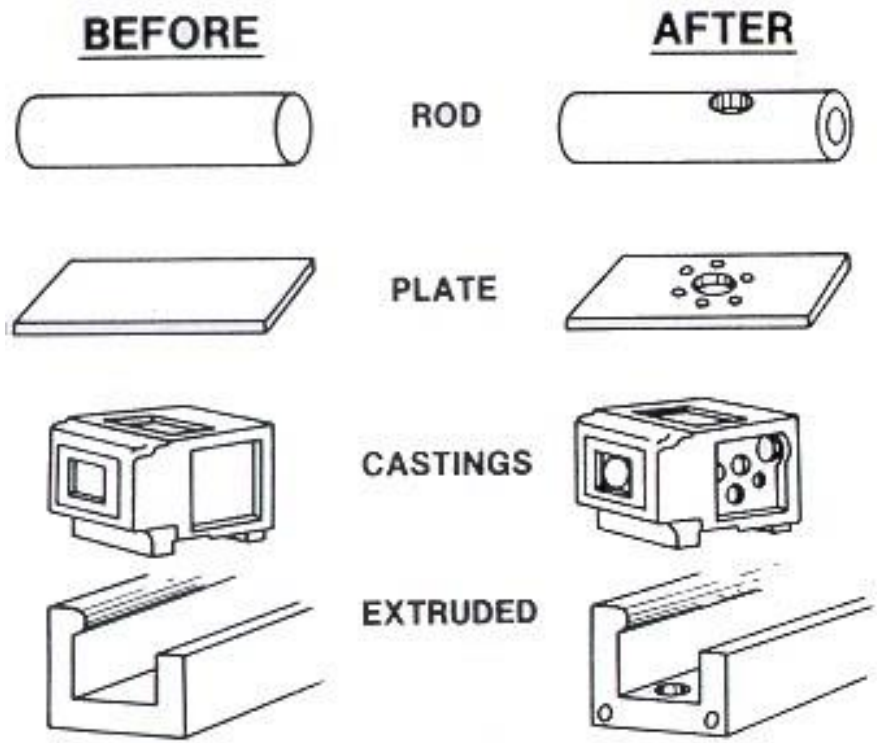

BEFORE
AFTER
BAR
ROD
PLATE


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

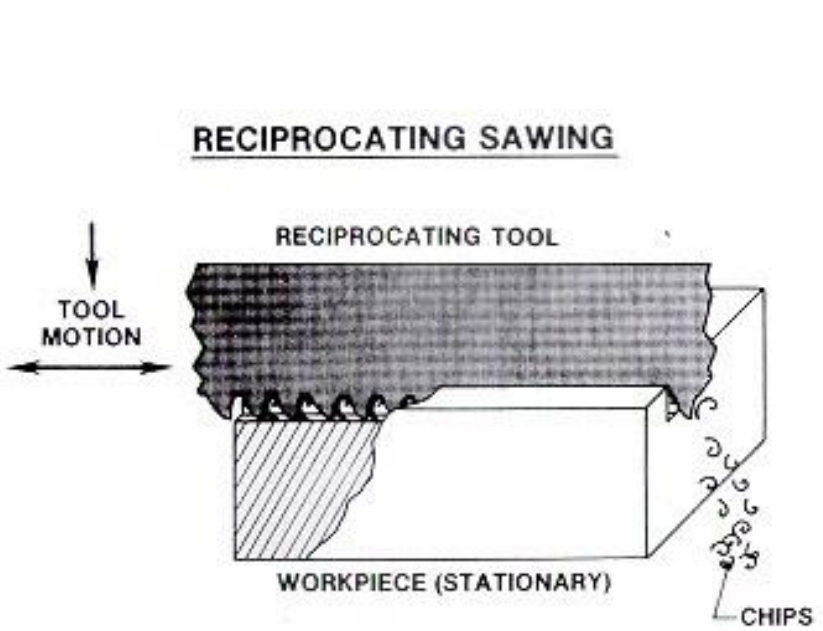
Milling

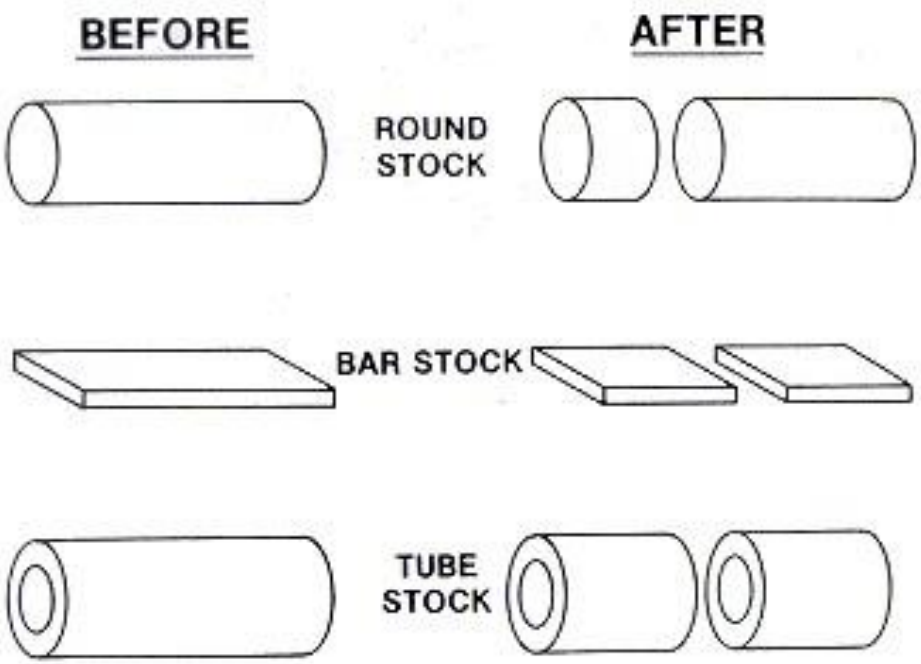
Drilling


TOOL MOTION
FLUTE
TOOL
CHIP
WORKPIECE
(STATIONARY)

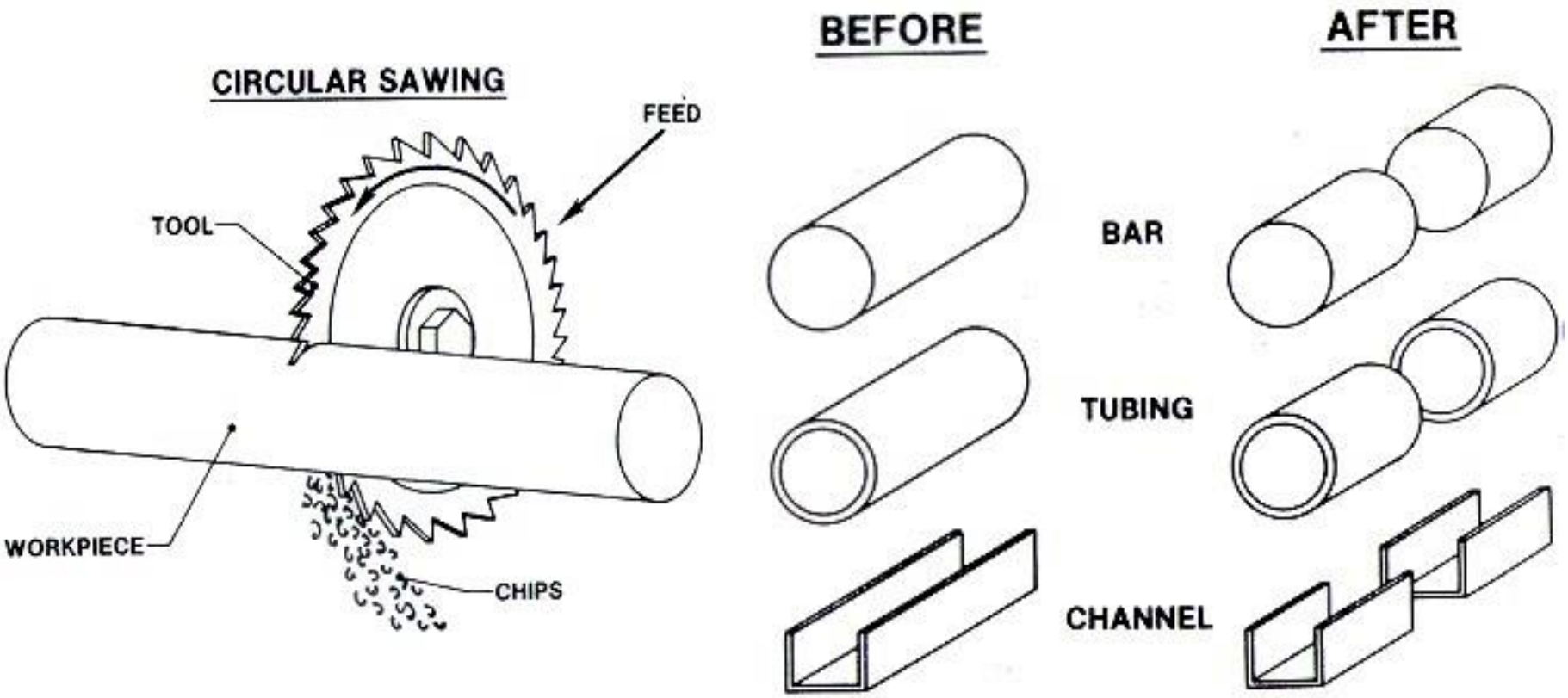

BEFORE
AFTER
ROD
PLATE
CASTINGS
EXTRUDED

Sawing

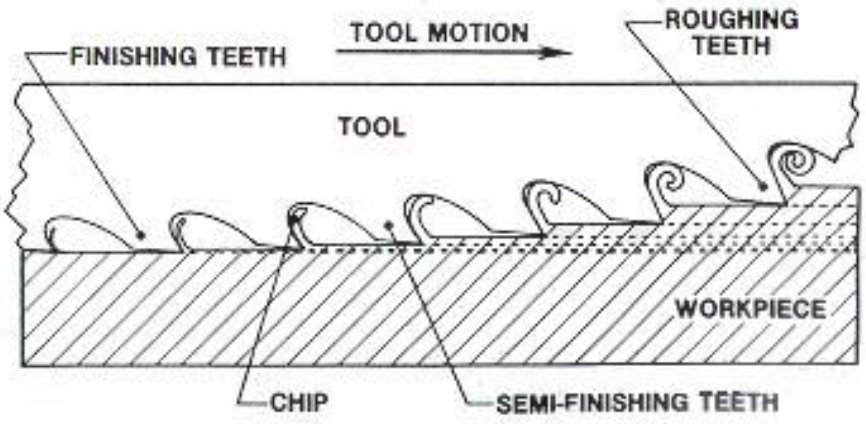

RECIPROCATING SAWING
RECIPROCATING TOOL
TOOL MOTION
WORKPIECE (STATIONARY)
CHIPS

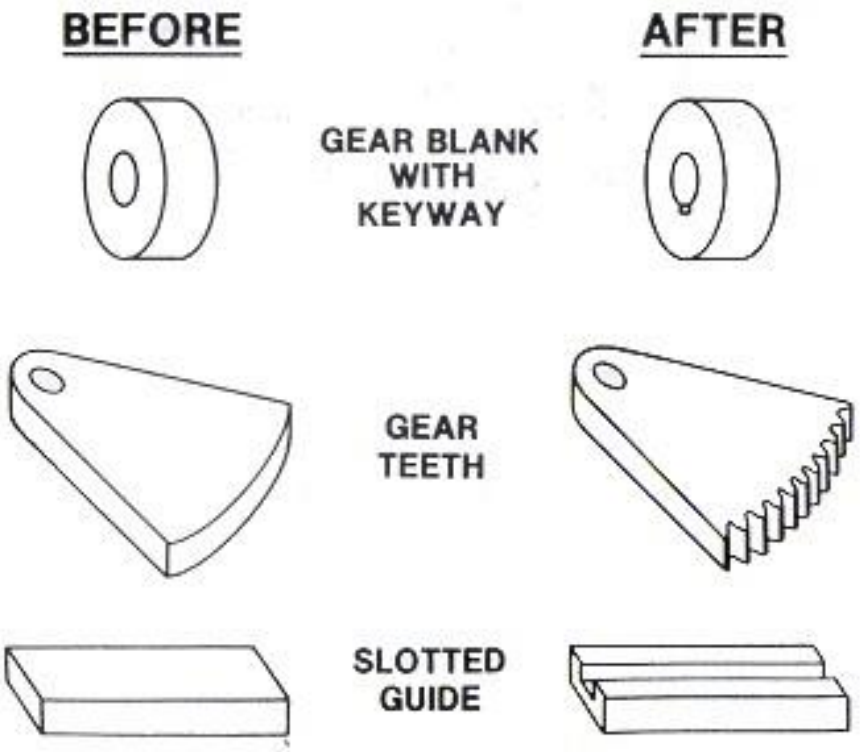

BEFORE
AFTER
ROUND STOCK
BAR STOCK
TUBE STOCK

Sawing

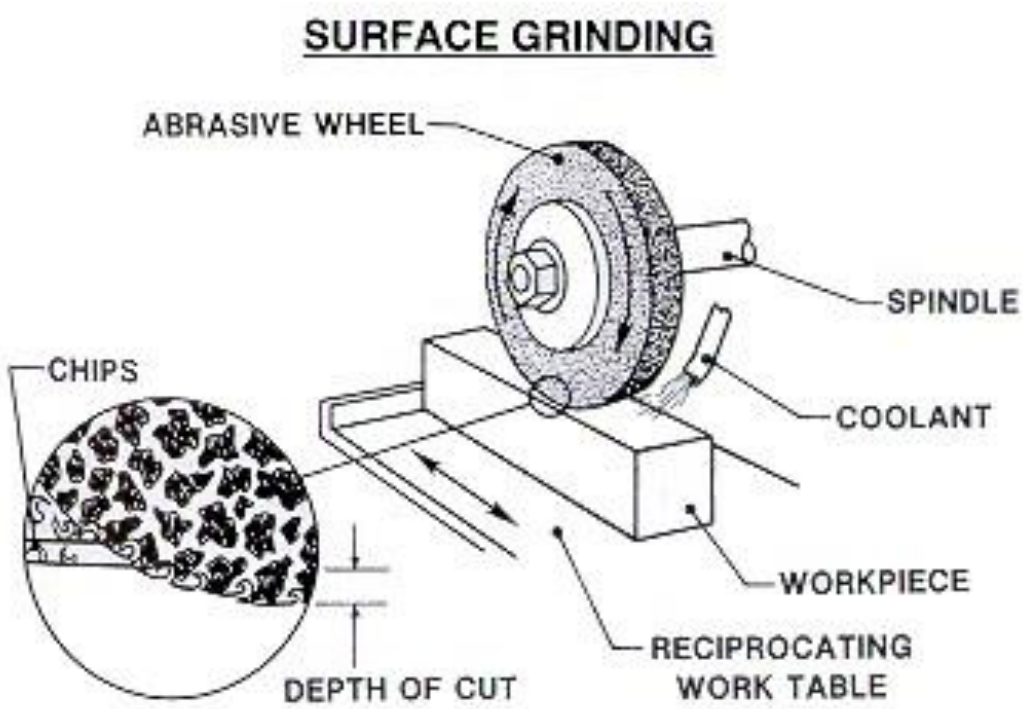

CIRCULAR SAWING
FEED
TOOL
WORKPIECE
CHIPS
BEFORE
AFTER
BAR
TUBING
CHANNEL

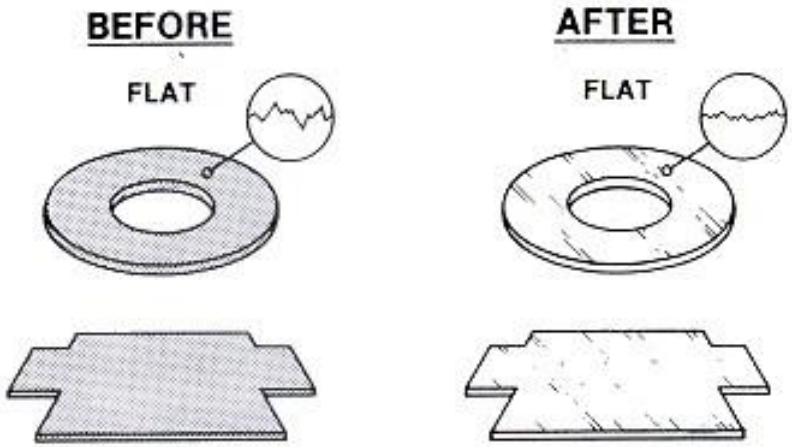
Broaching


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

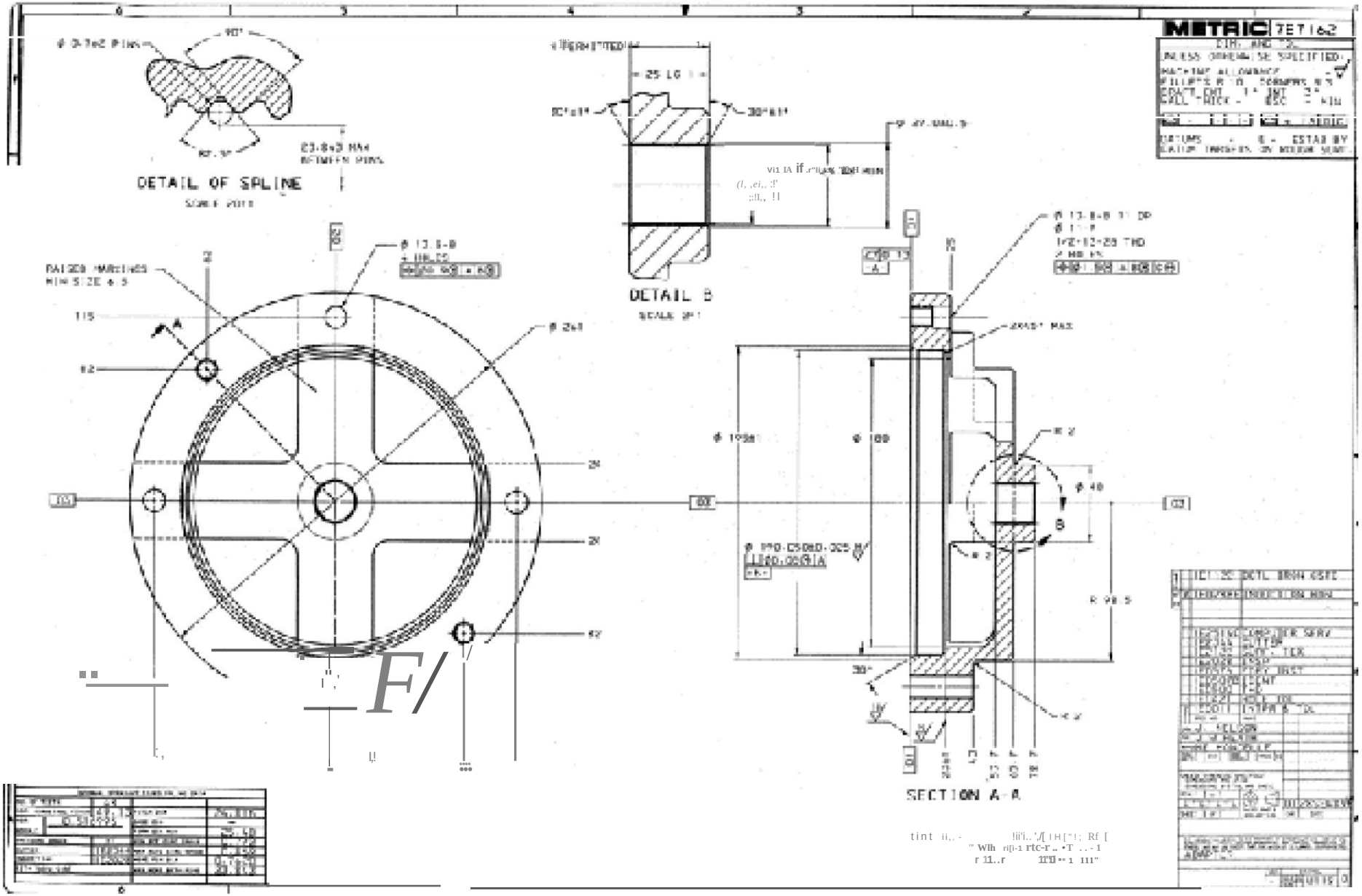

BEFORE
FLAT
AFTER
FLAT

MECH211 Lecture 3

SECTION VIEWS

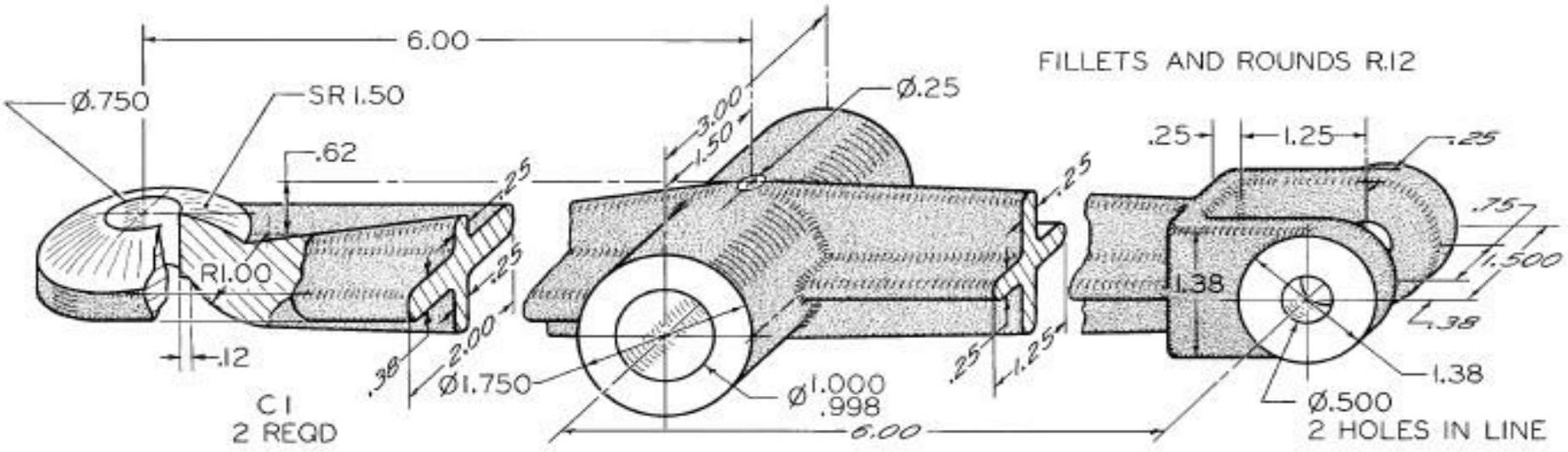
Purpose of Sectioning

- Provides 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

Sectional Views

Why do we use sectional views?



Sectional Views Types

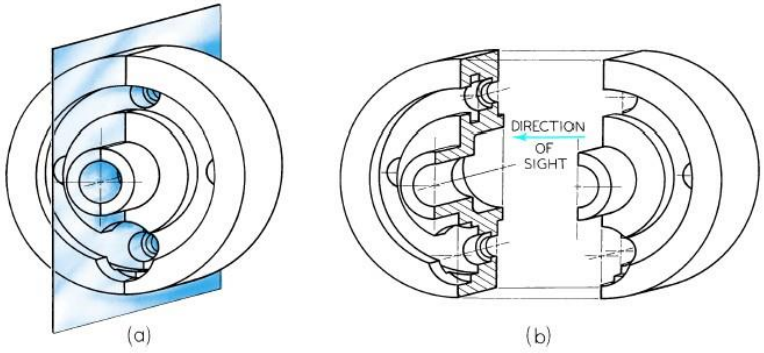
- Full Sections
- Half Sections
- Offset Sections
- Broken Sections
- Revolved Sections (Aligned)
- Conventional Breaks
- Partial Views

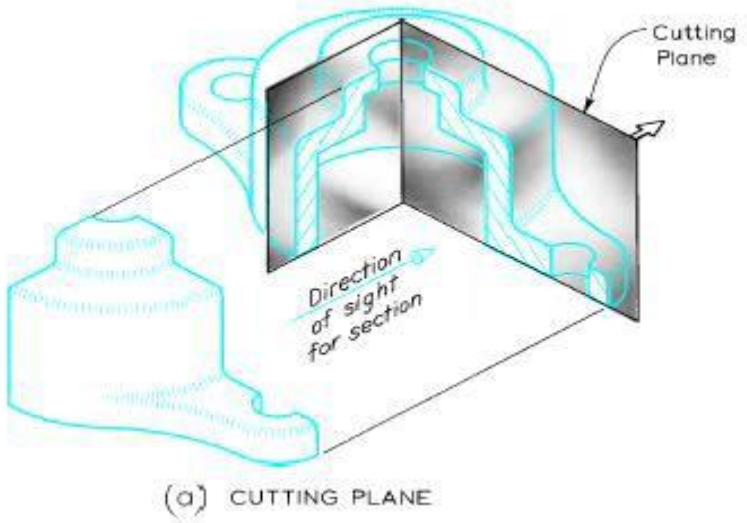
Elements in Sectional Views

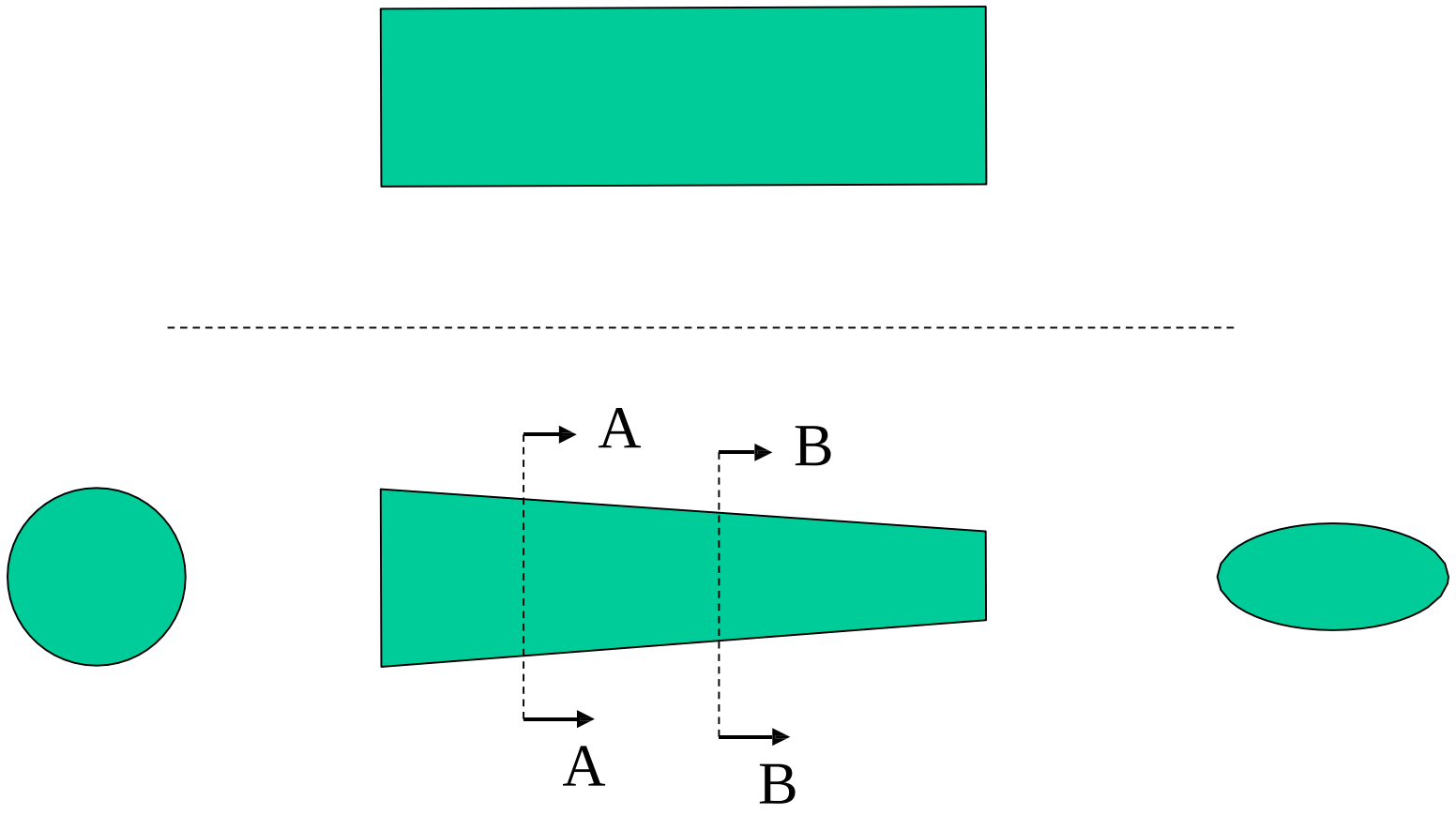
Cutting Plane

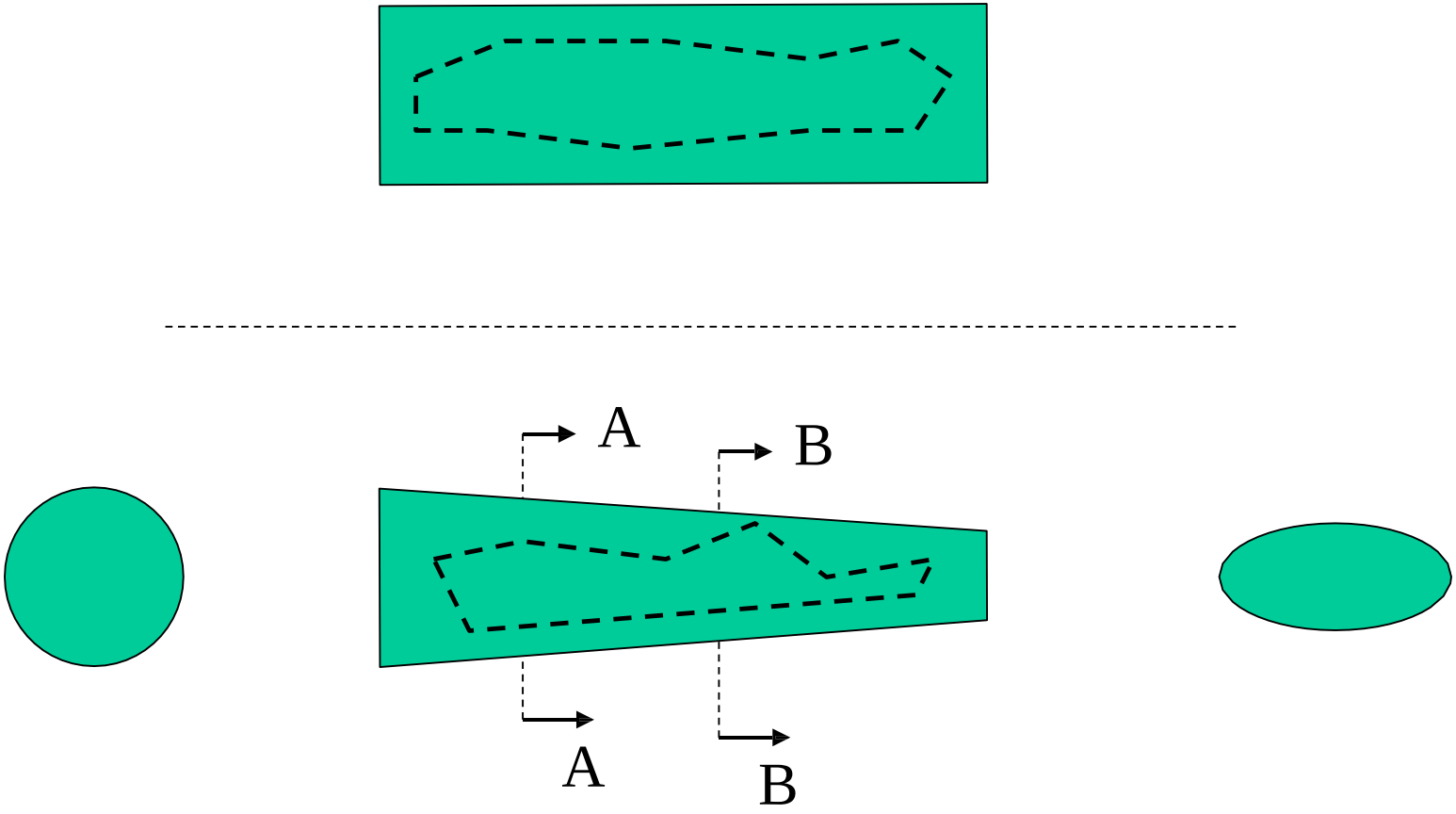
An imaginary plane passes through the part to expose the interior construction.

Different cutting planes make different types of sectional views

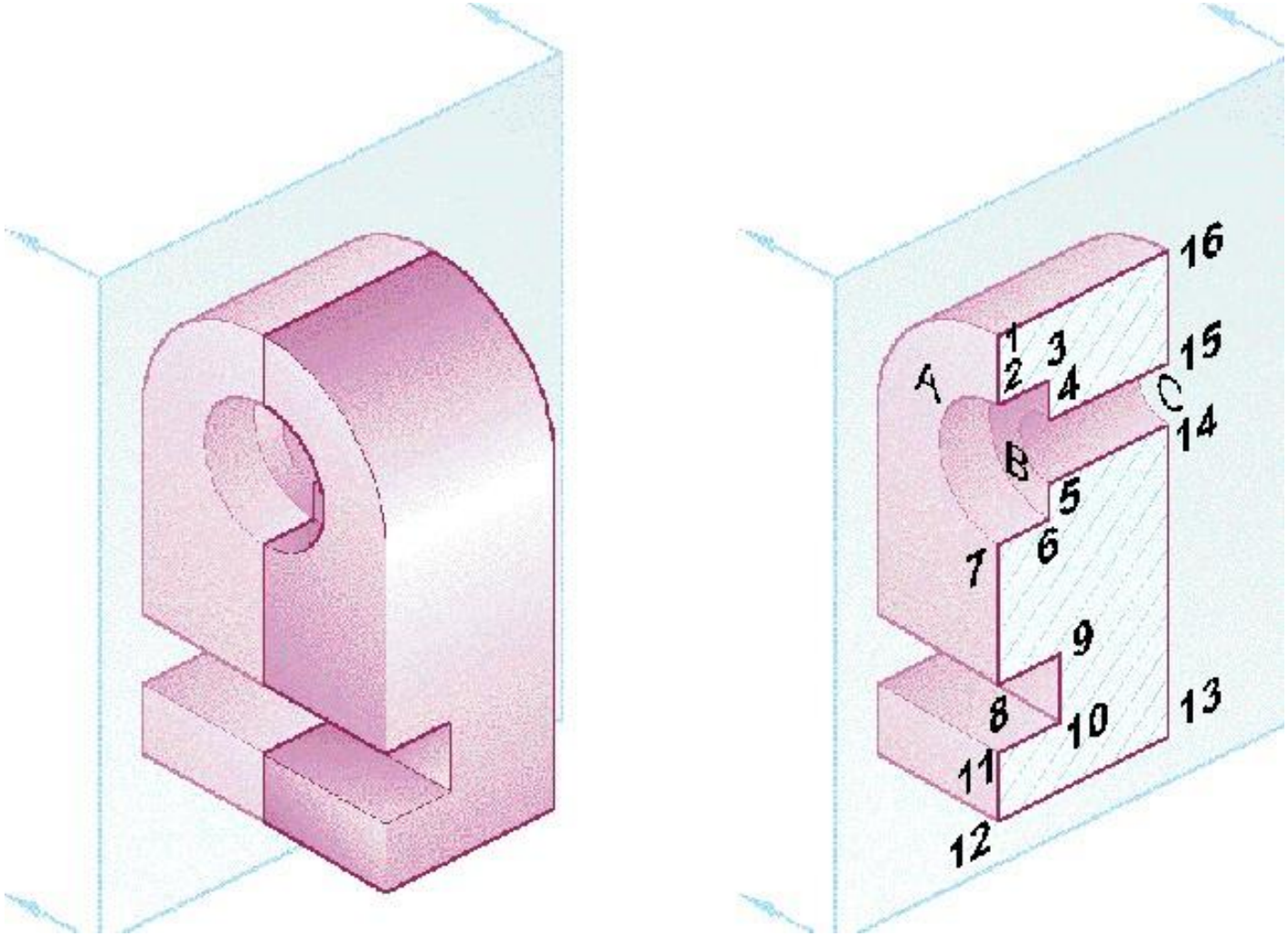




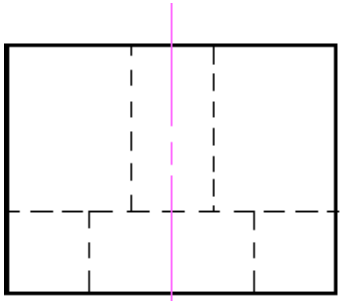

A
B
A
B
Section AA
Section BB

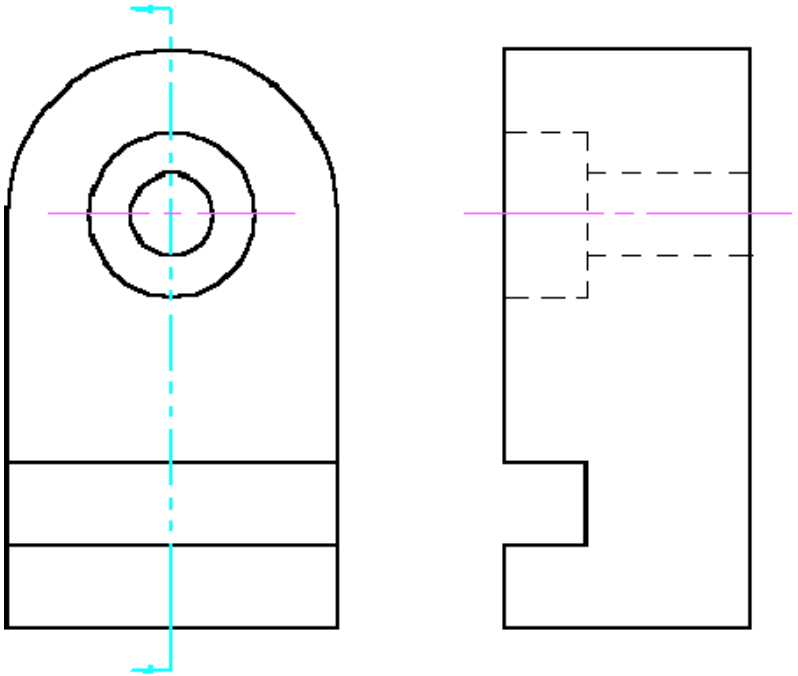

A
B
A
B
Section AA
Section BB

The Cutting Plane

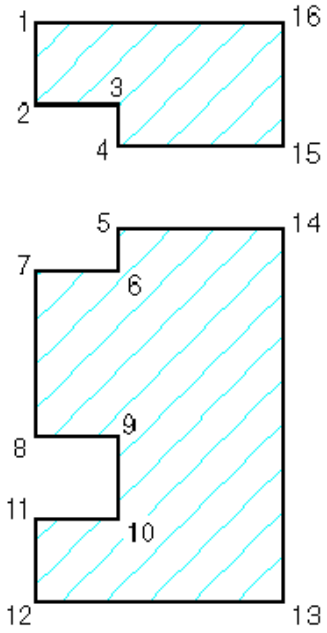


Is the Section View Really Needed?

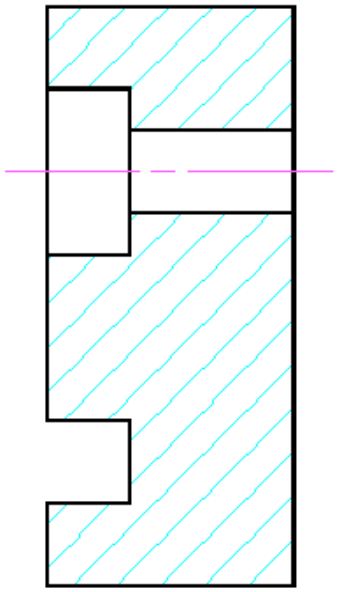




Normal multiview drawing



(A)

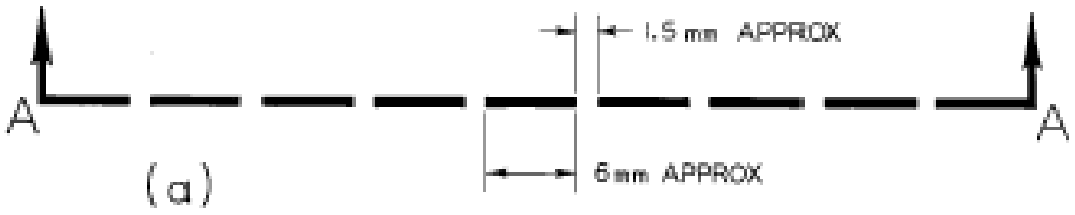


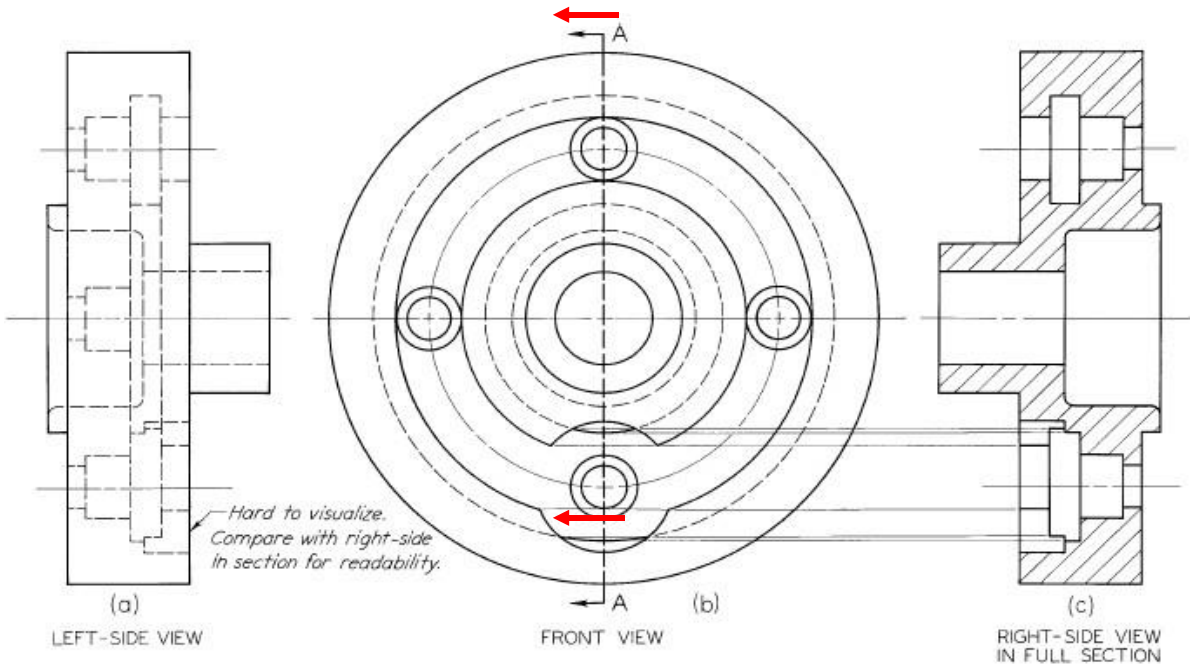
(B)

Elements in Sectional Views

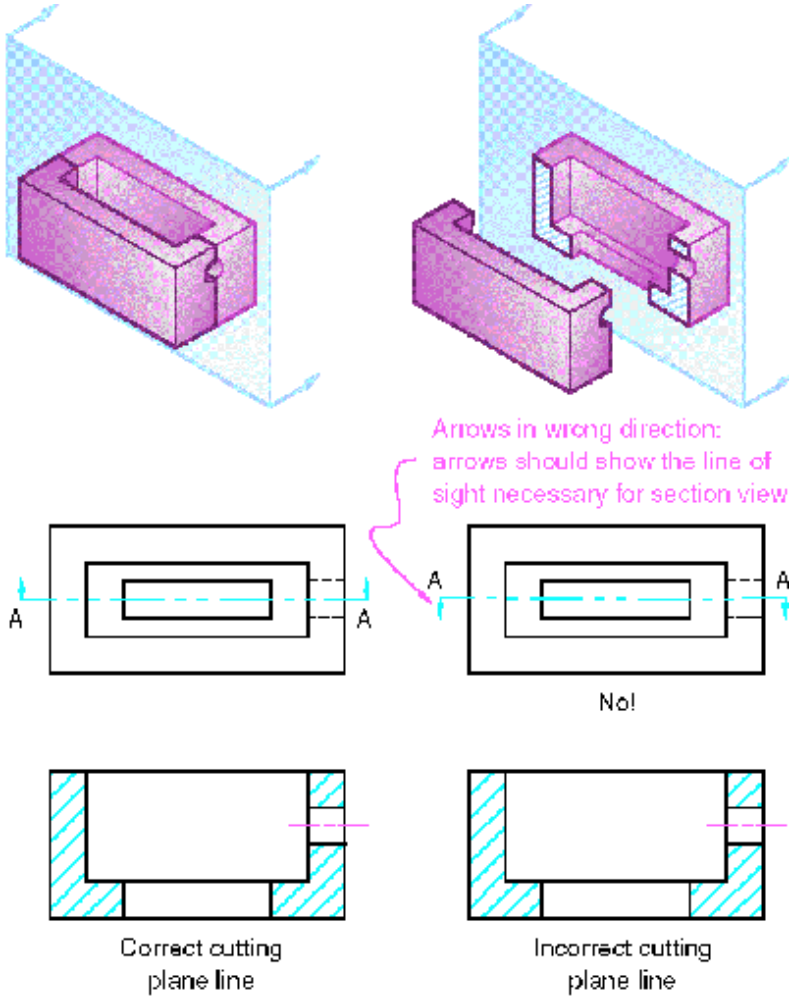
Cutting-Plane Line

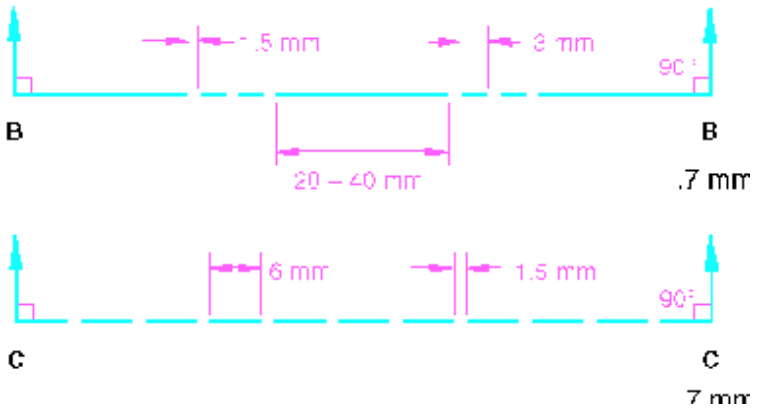
- Location
- Line Type
- Arrowheads
- Capital Letters



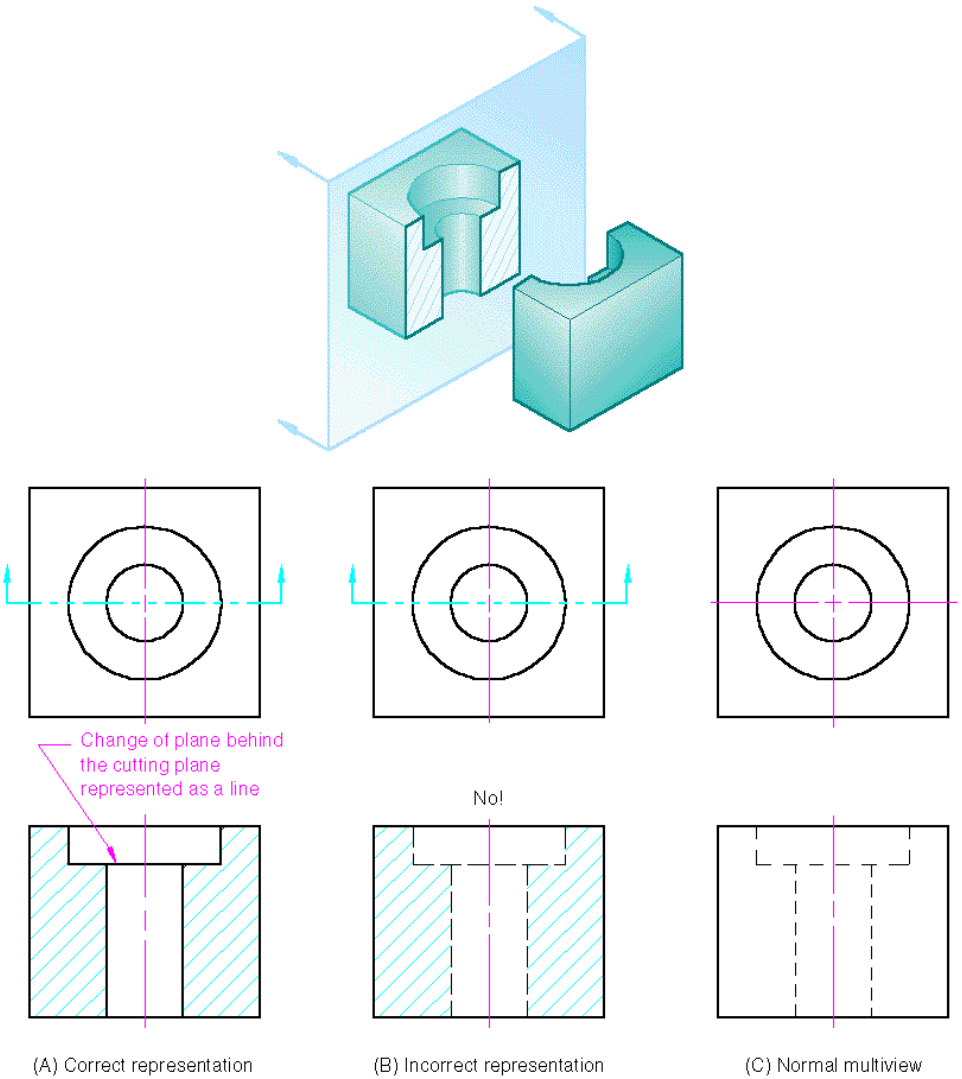


Indicate the Cutting Plane

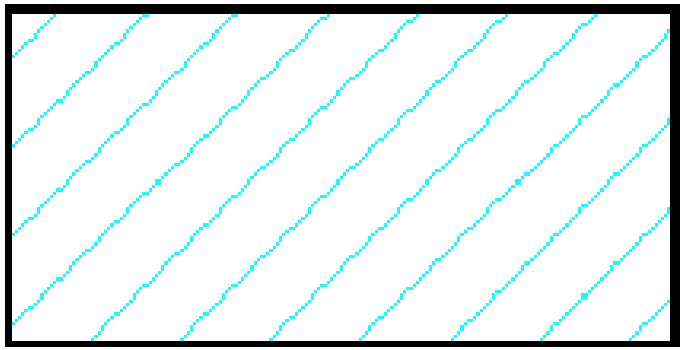




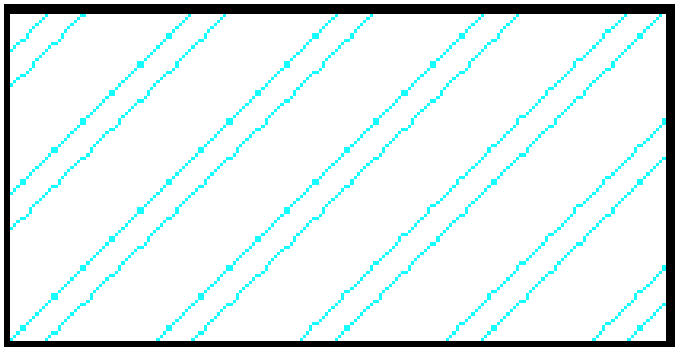
Basic Representation Rules



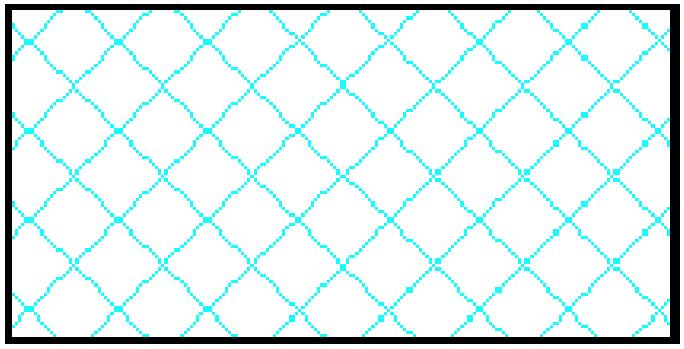
Section Lines (Lining)



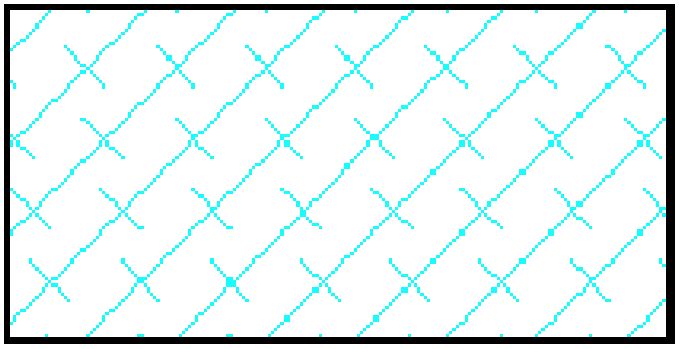
(A) Cast or malleable iron and general use for all materials



(B) Steel

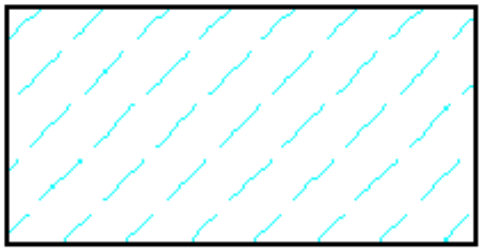


(D) White metal, zinc, lead, babbitt, and alloys

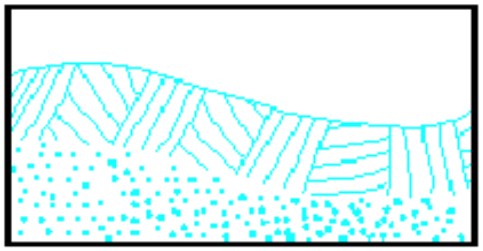


(E) Magnesium, aluminum, and aluminum alloys

Section Lines

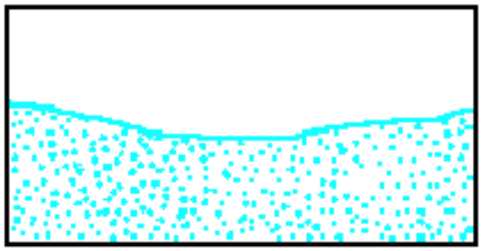


(M) Marble, slate, glass, porcelain, etc.

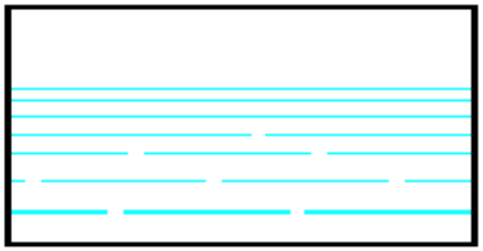


(N) Earth

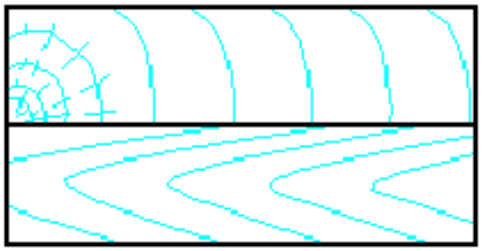
(O) Rock



(P) Sand

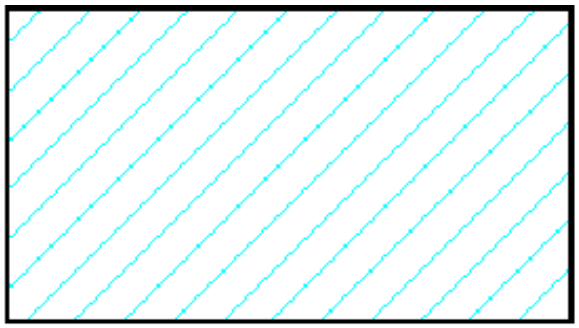


(Q) Water and other liquids

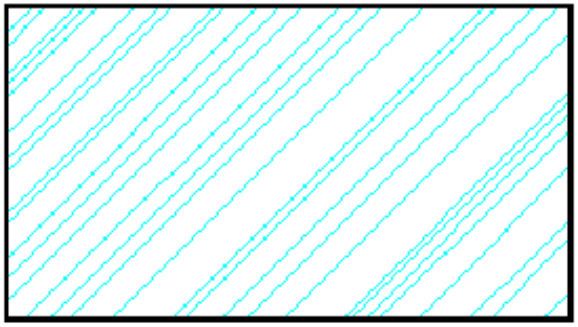


(R) Across grain
With grain > Wood

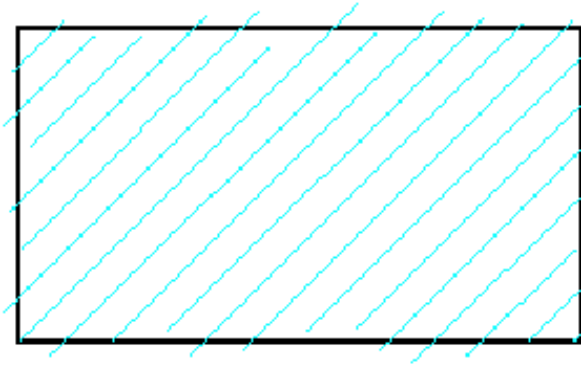
Common Mistakes



Correct
(45°; Equal spacing)

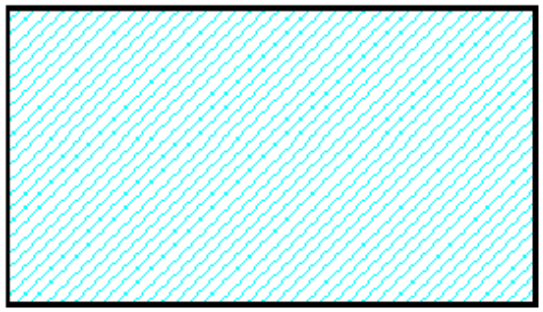


Incorrect
(Linework is inconsistently spaced)

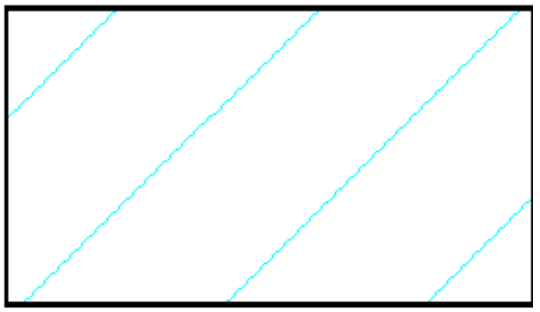


Incorrect
(Linework fails to end at boundaries of area)

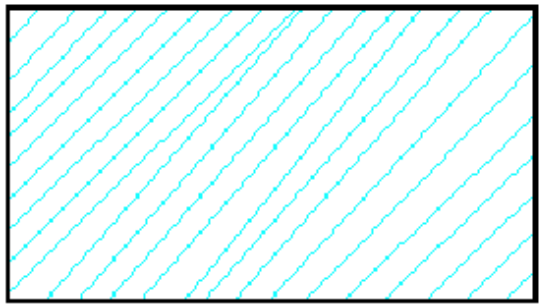
Common Mistakes



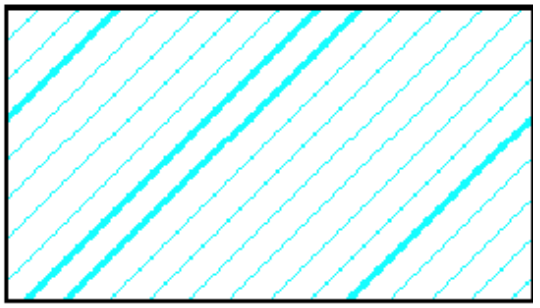
Incorrect
(Linework is too closely spaced)



Incorrect
(Linework is too widely spaced)

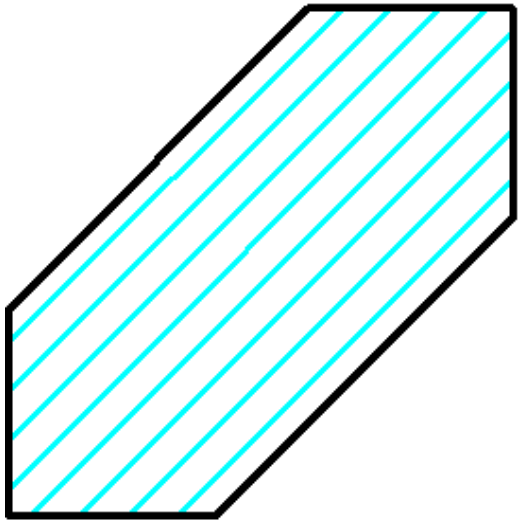


Incorrect
(Linework is not consistent in direction)

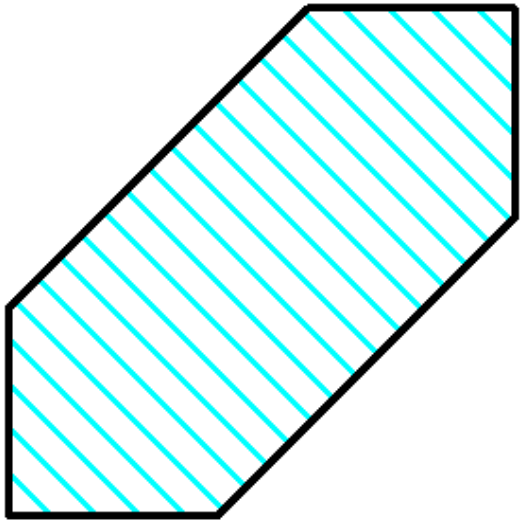


Incorrect
(Linework intensity is inconsistent)

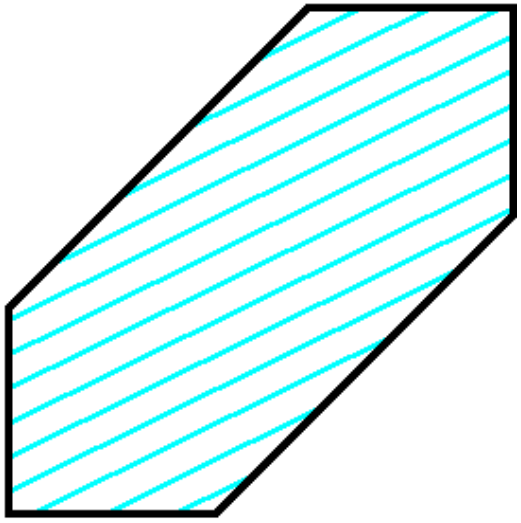
Difficult Cases



(A) Avoid!



(B) Avoid!



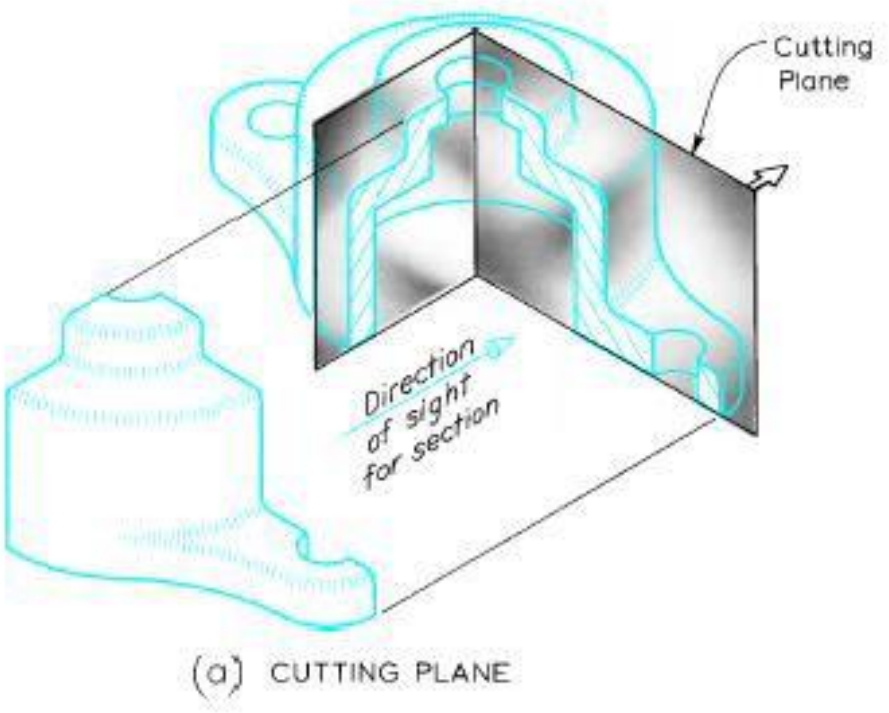
(C) Preferred

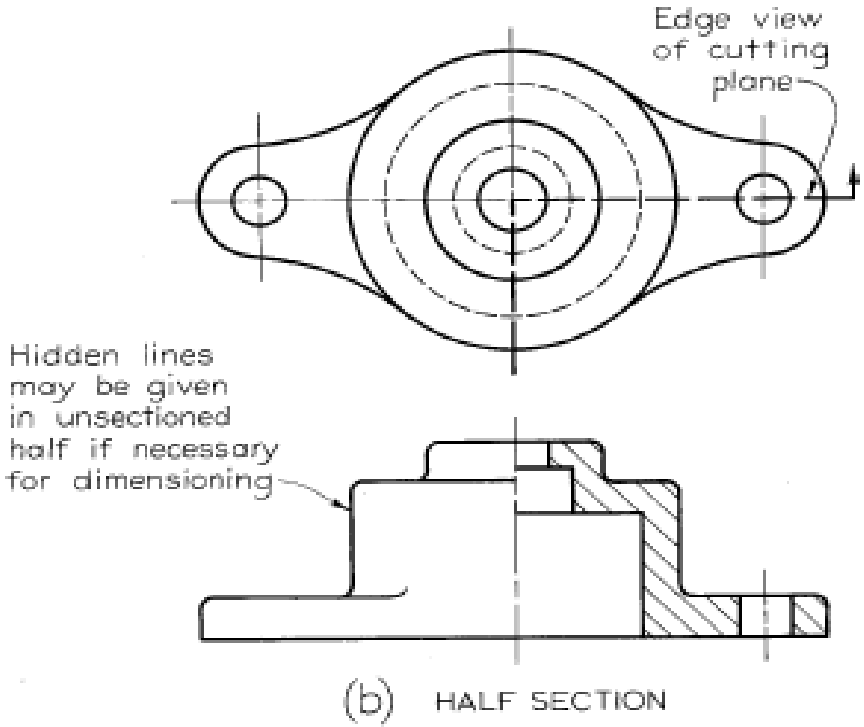
Half Sections

If a cutting plane passes halfway through an object, the result is a half section.

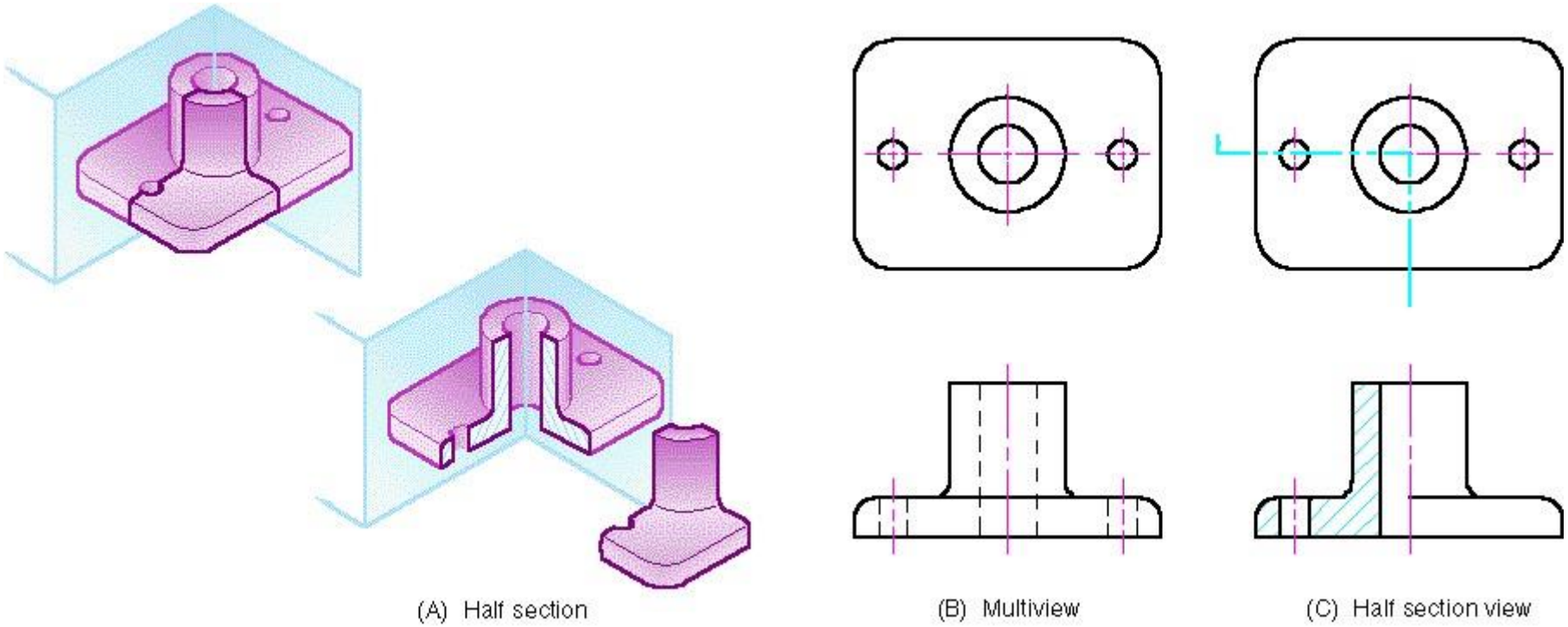
Expose the interior and retain the exterior.

It is often used for symmetrical objects, not for detail drawings.





Half Sections

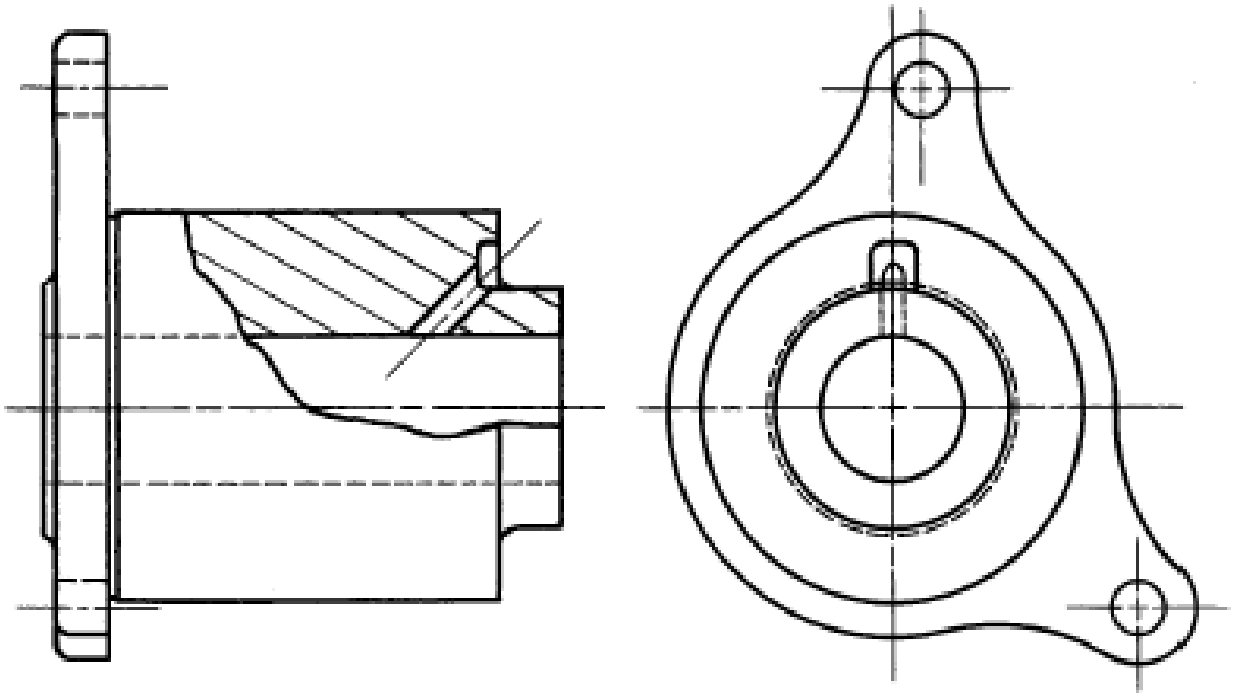


Convenient way to show the view and section in symmetric parts

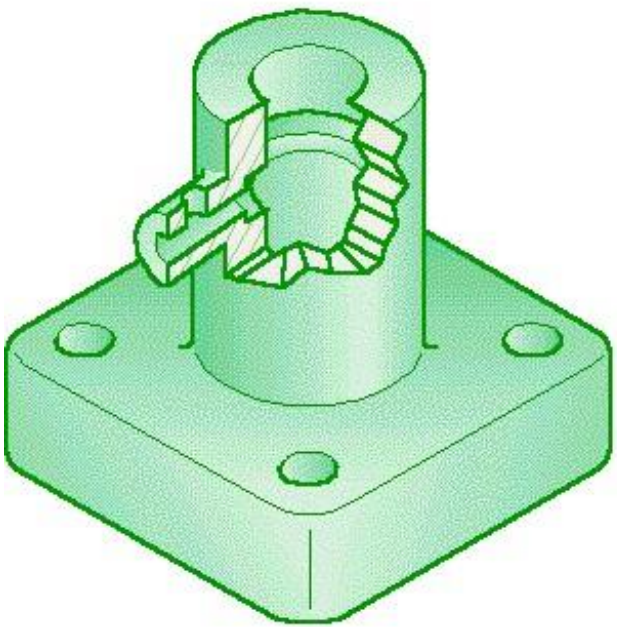
Broken-out Sections

A break line is used for the section if only a partial section of a view is needed to expose interior shapes.

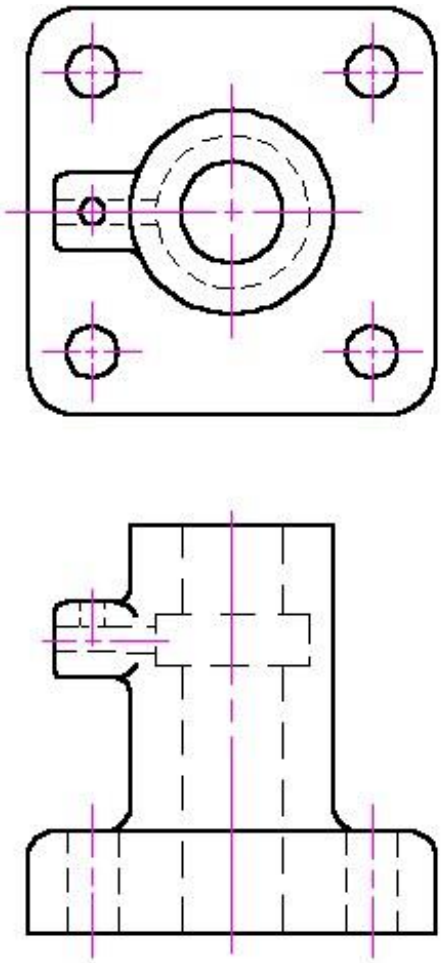
The section is limited.



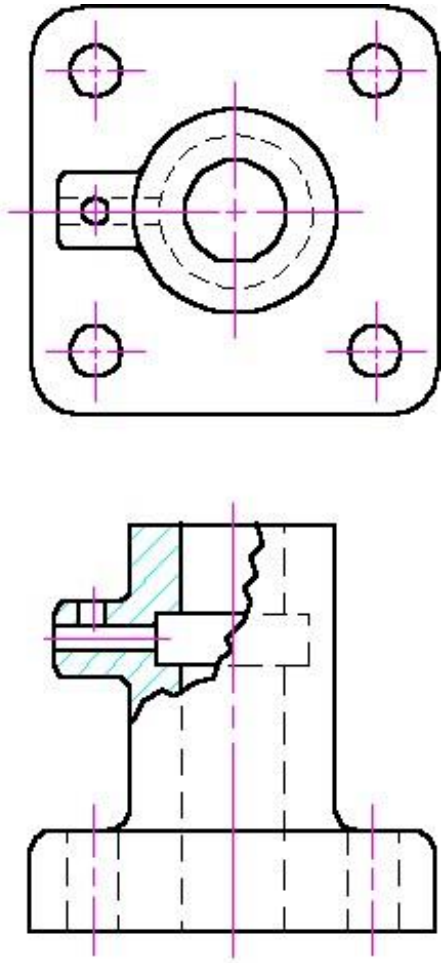
Broken-out Sections



(A) Broken-out section



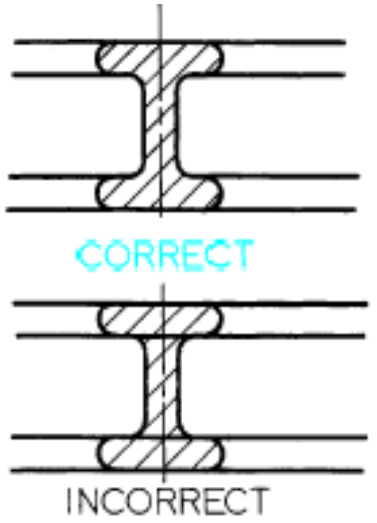
(B) Multiview

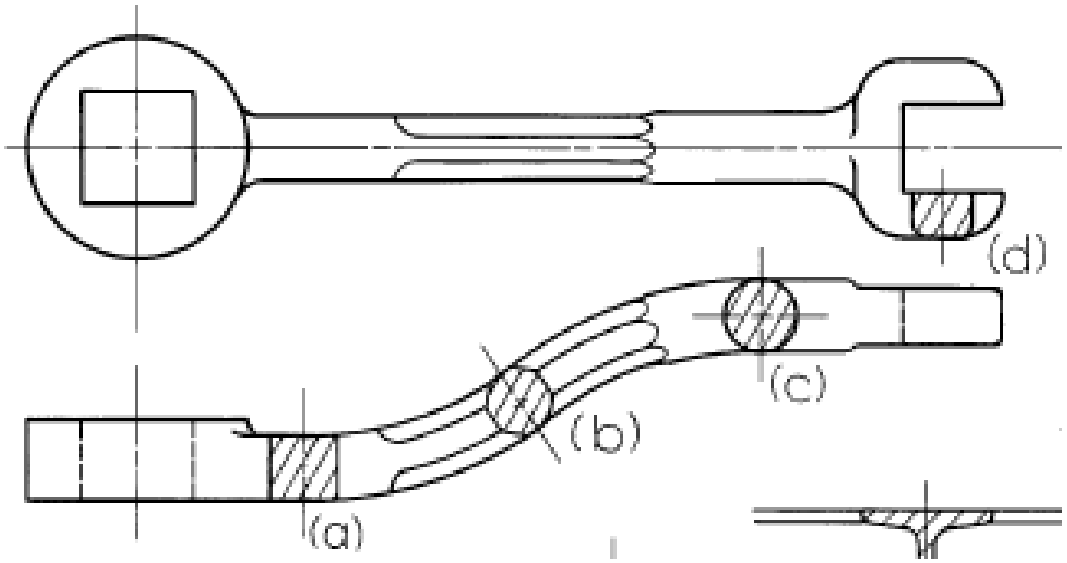


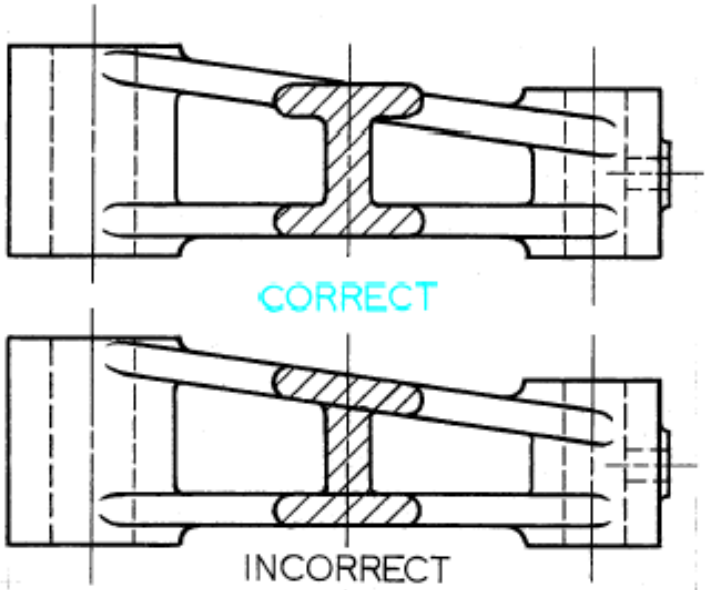
(C) Broken-out section view

Revolved Sections

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

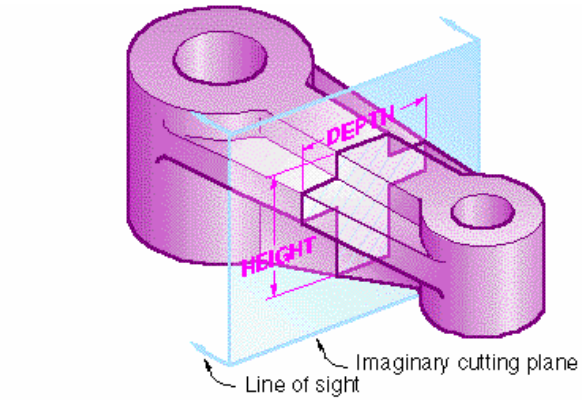


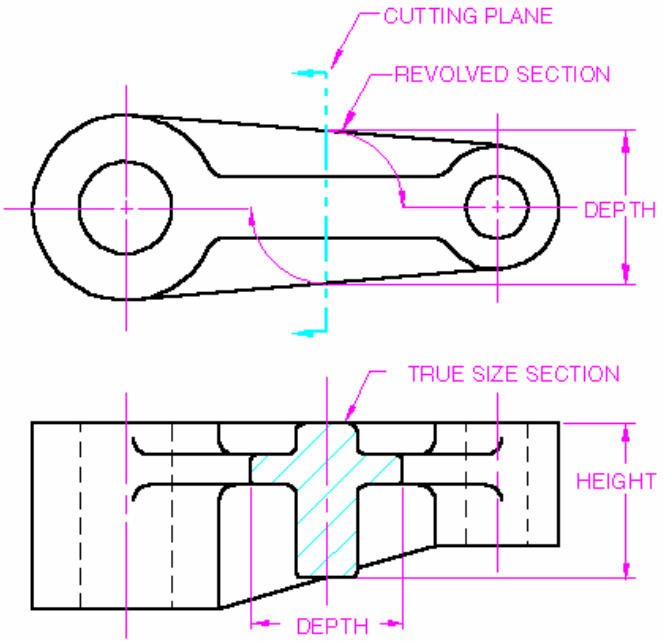




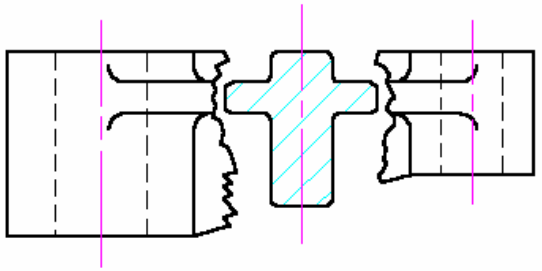
Revolved Sections

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



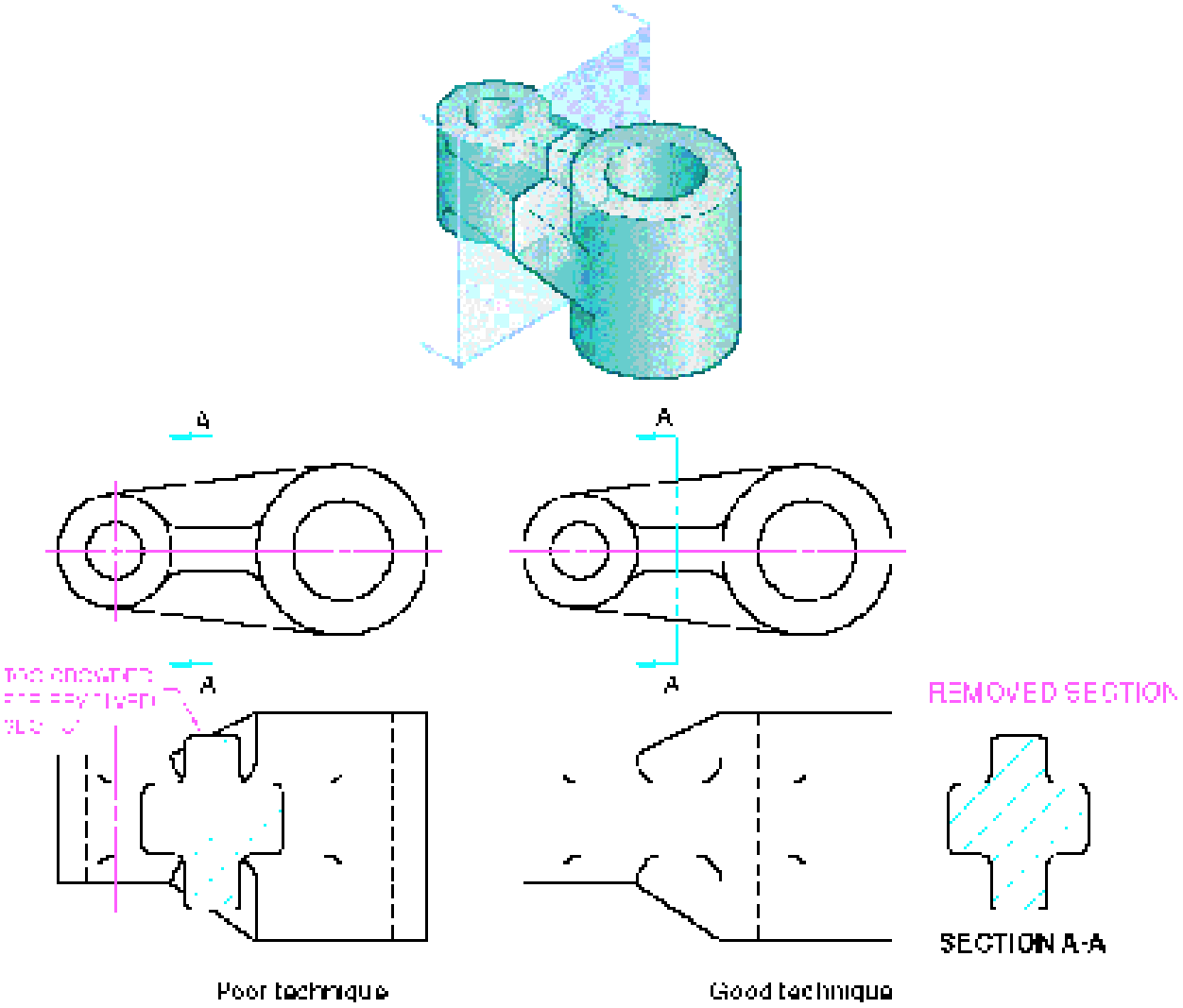


(A) Revolved section

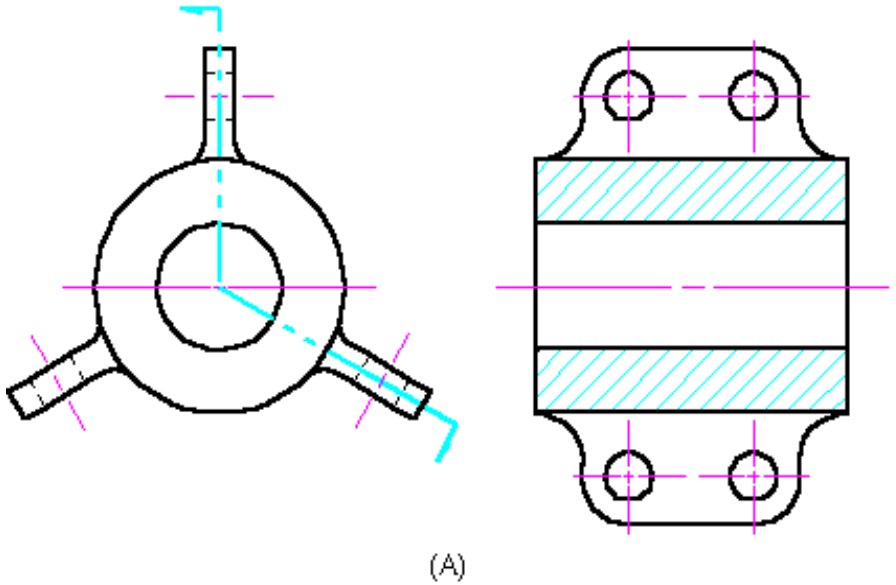


(B) Revolved section; broken view

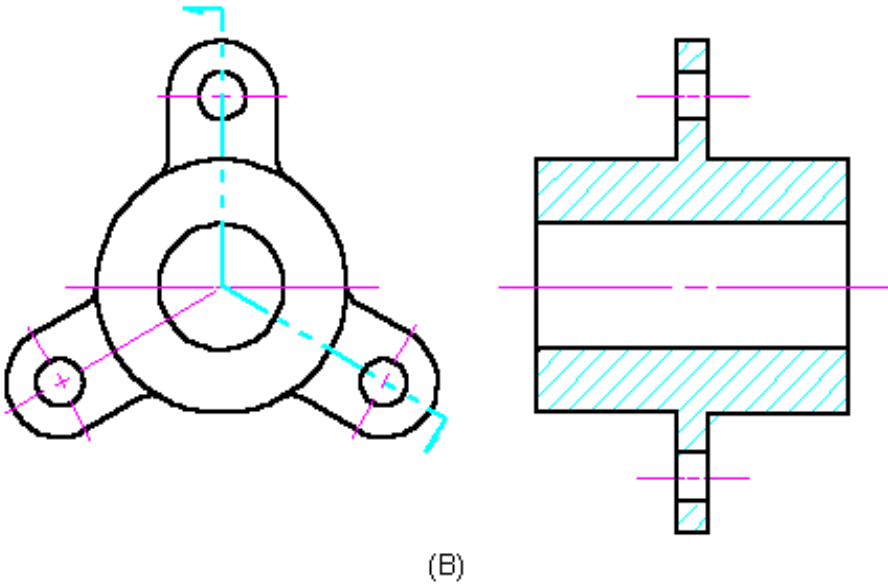
Removed Section



Aligned Sections

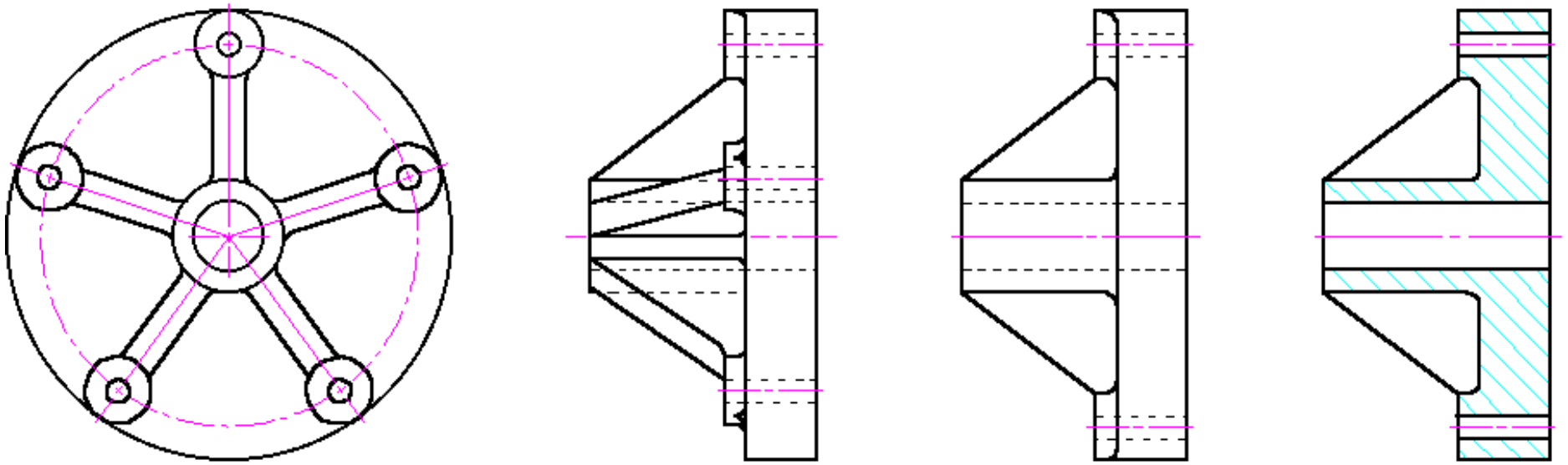


(A)



(B)

Aligned Sections



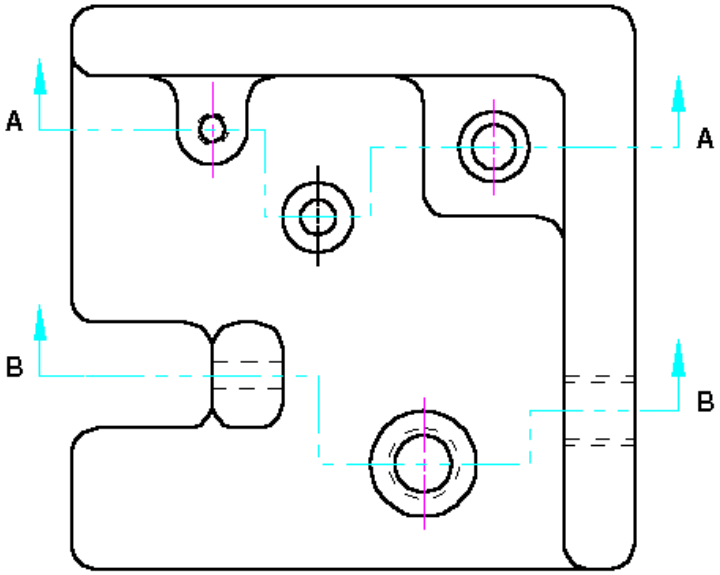
(A) True projection

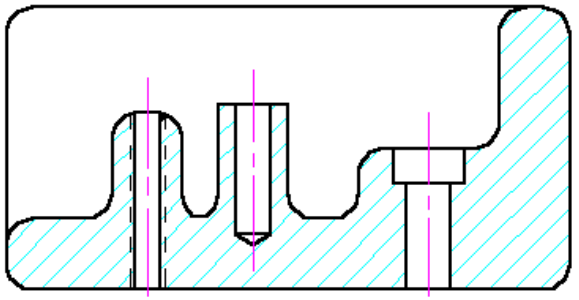
(B) Preferred

(C) Section view

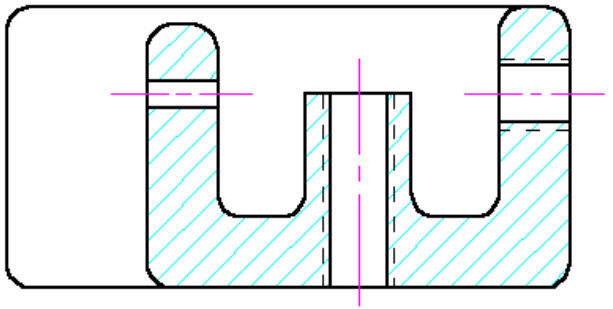
Offset Section

Necessary when features are located in different planes



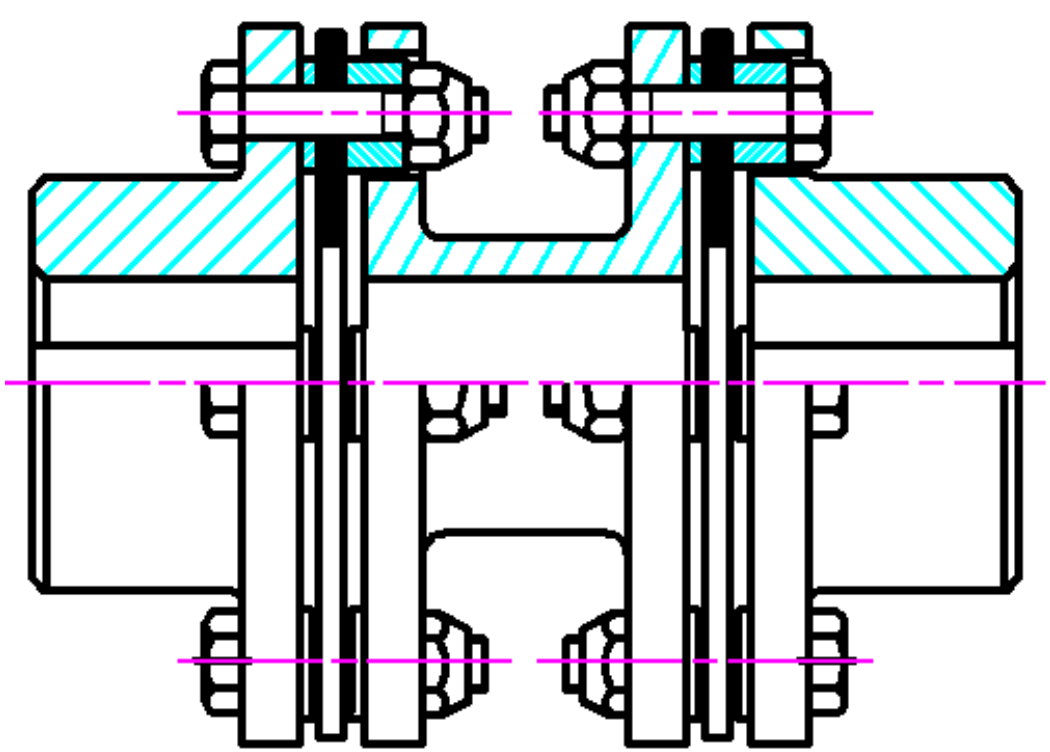


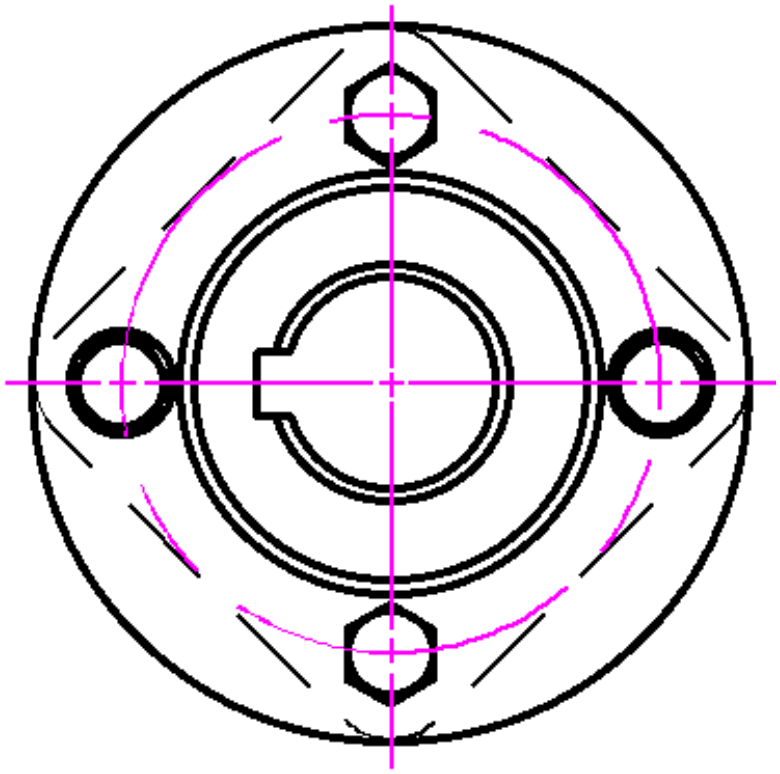
SECTION A-A



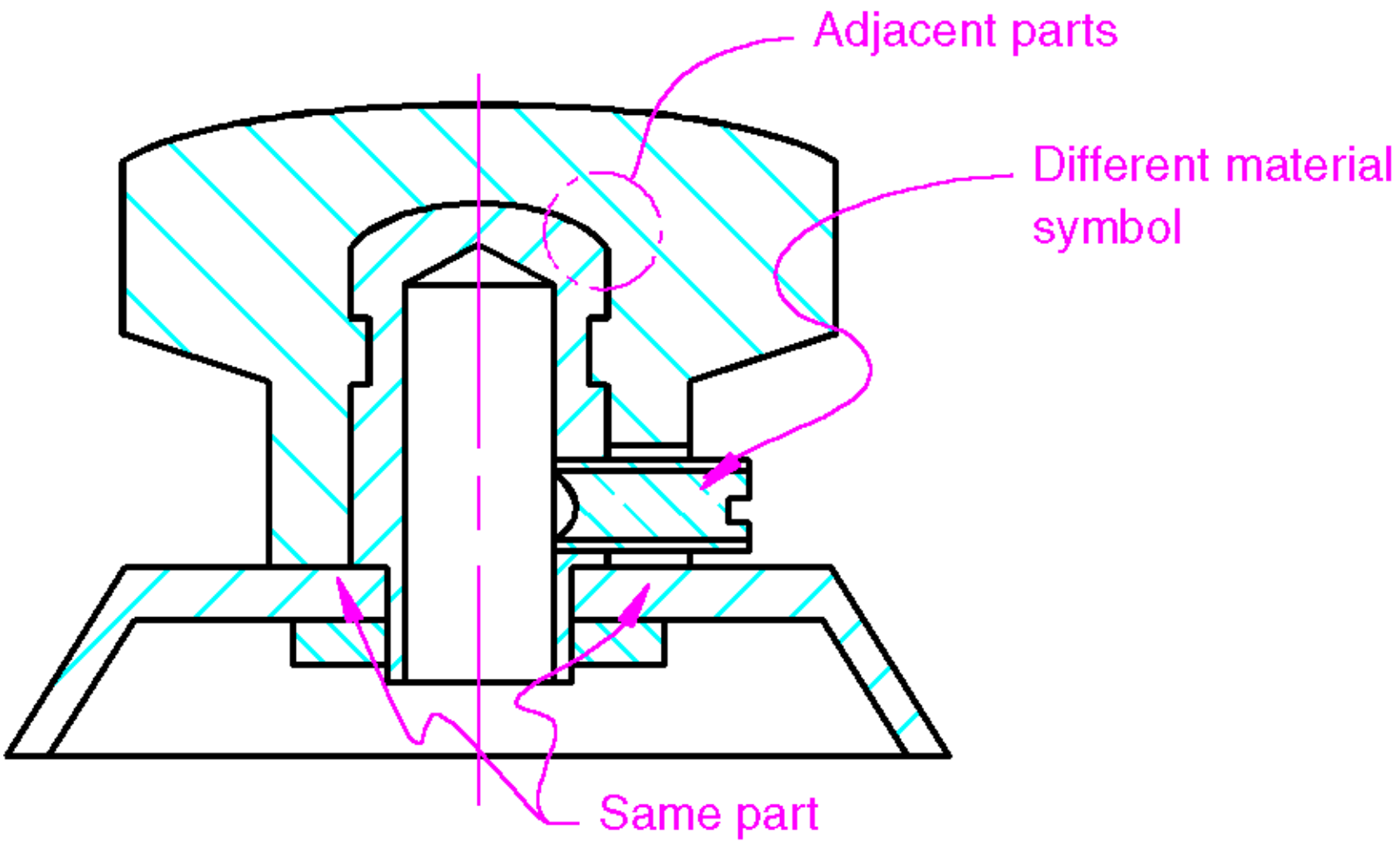
SECTION B-B

Sections Through Assemblies

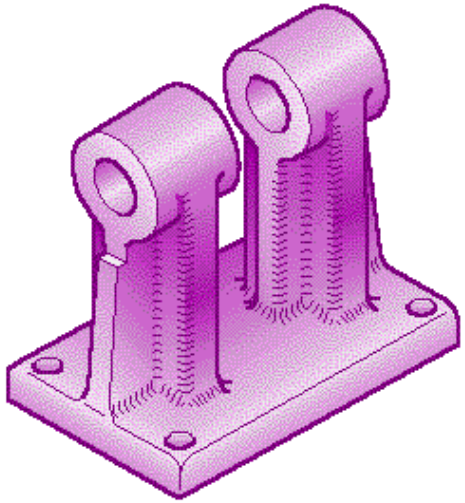


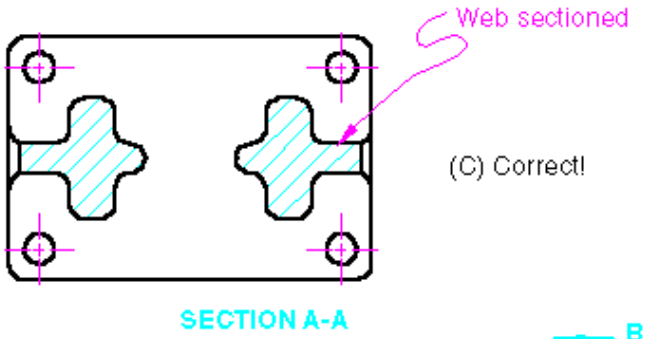


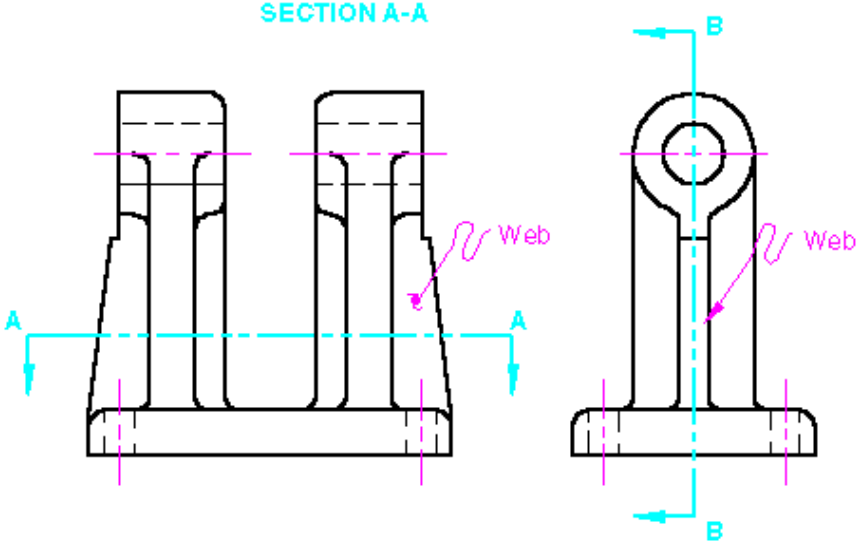
Pay Attention to Lining

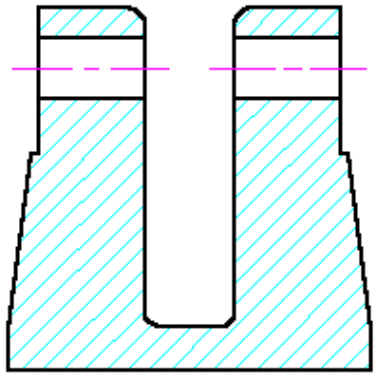


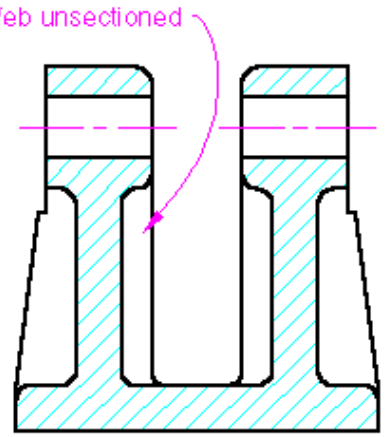
Pay Attention to Representation



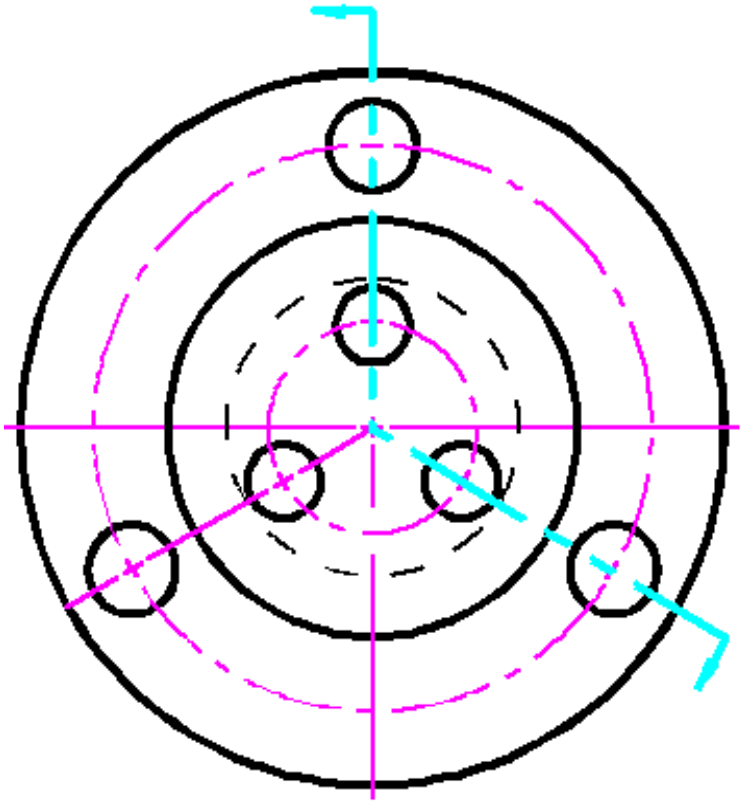


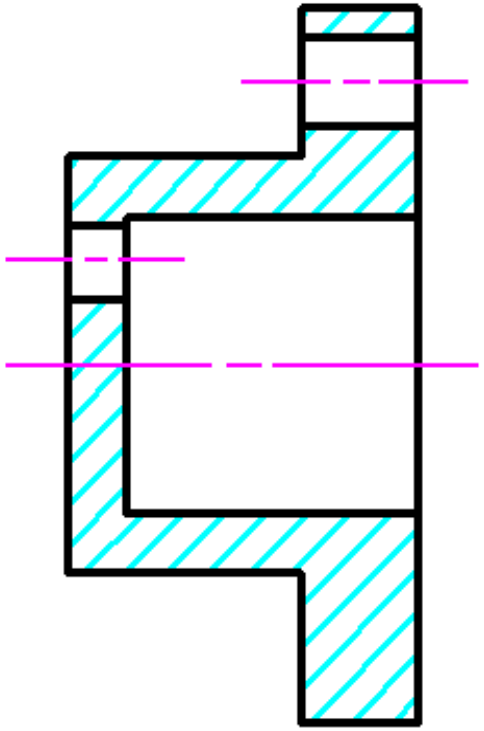




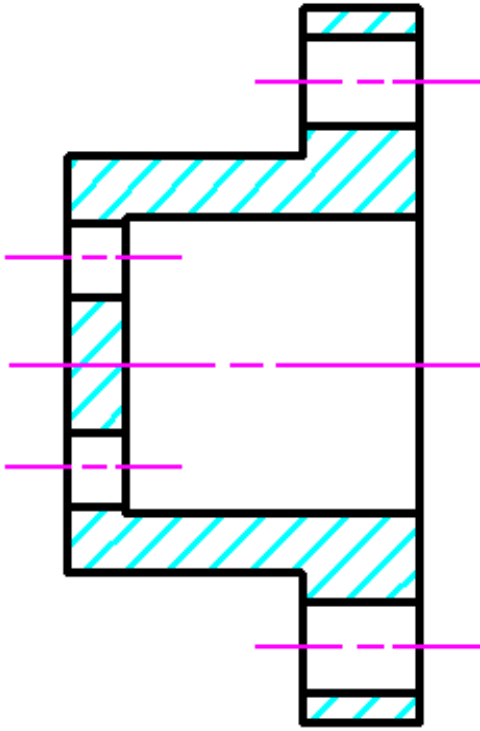


Pay Attention to Representation



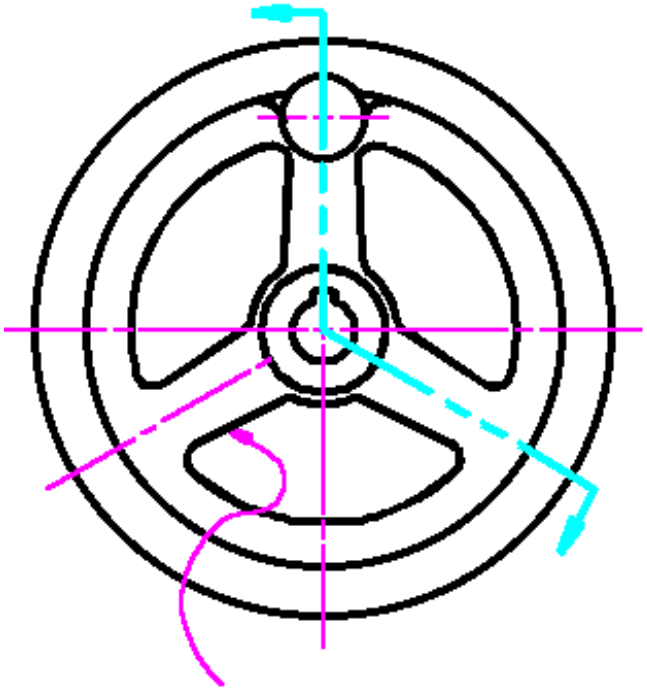


(A) True projection

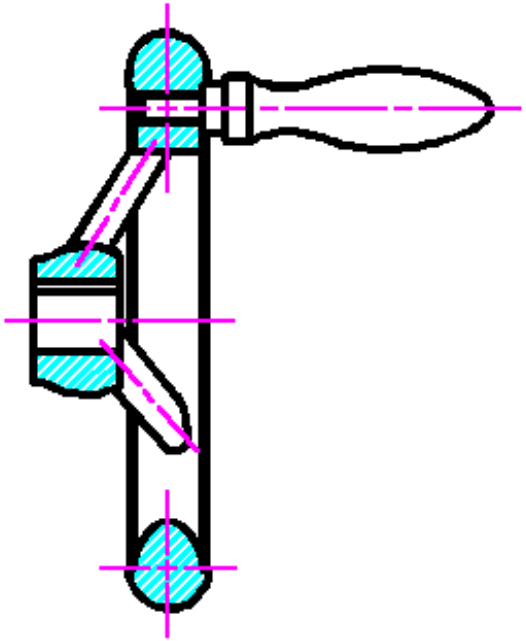


(B) Preferred

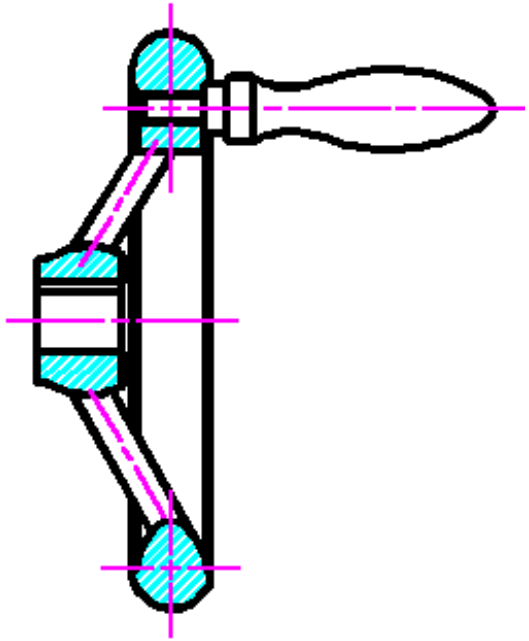
Pay Attention to Representation



Spoke A omitted in the "preferred" section view

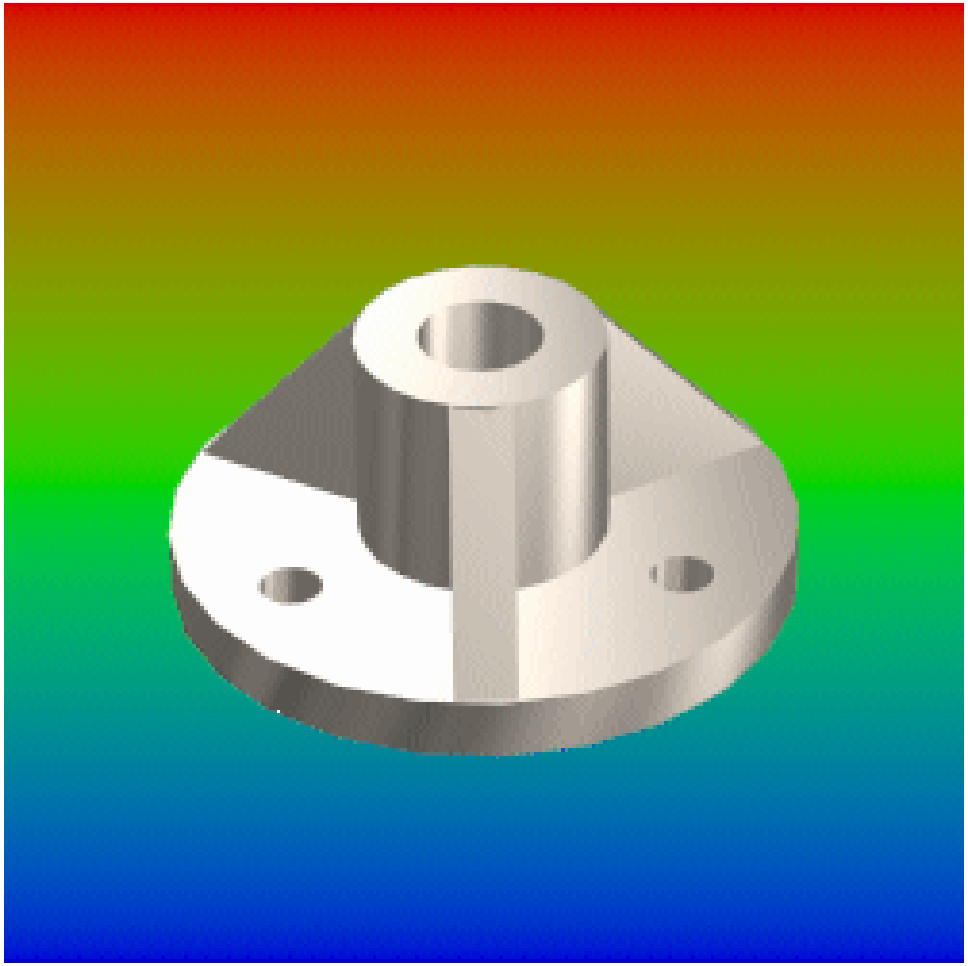


True Projection



Preferred

Section in a Flange



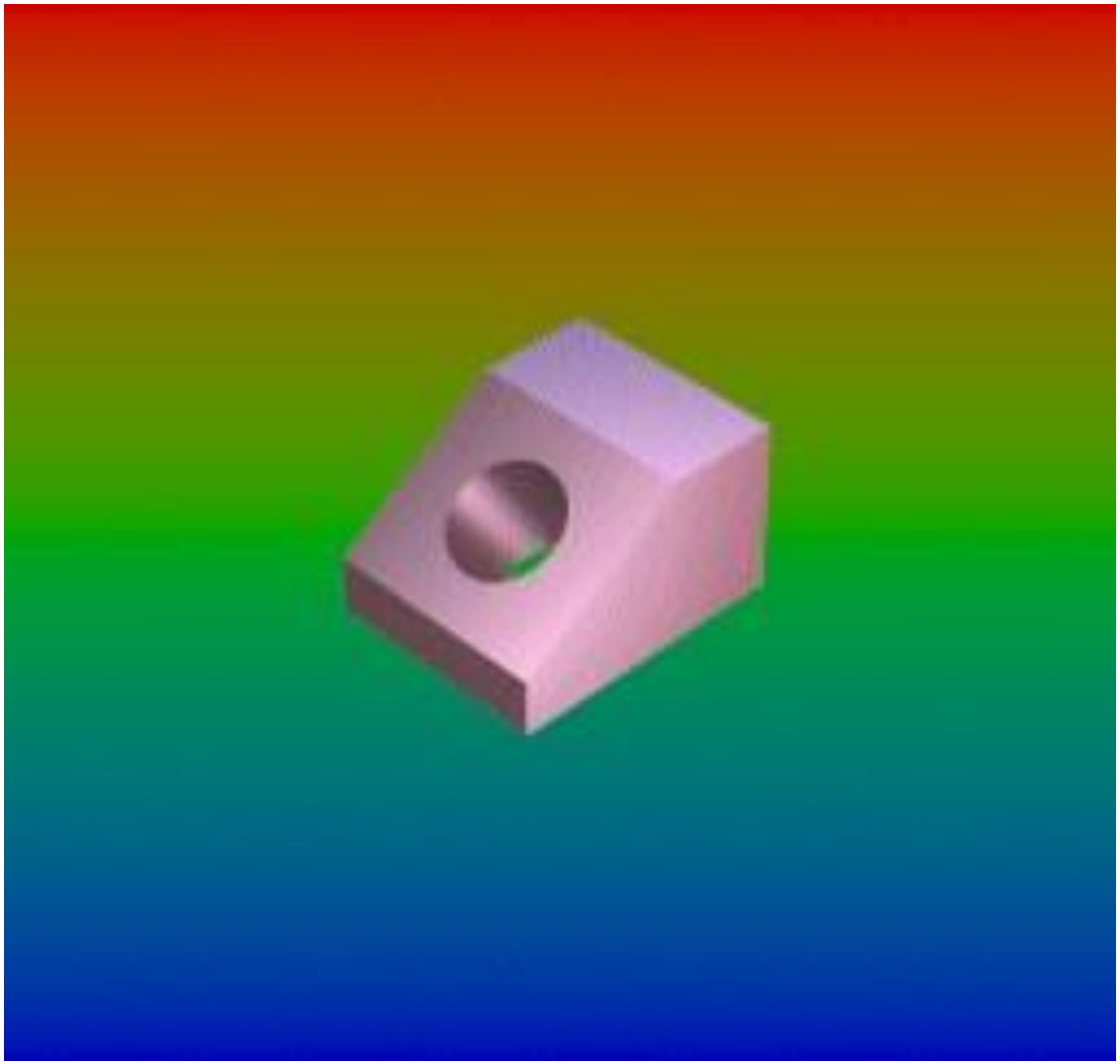
MECH211 – LECTURE 3

AUXILIARY VIEWS

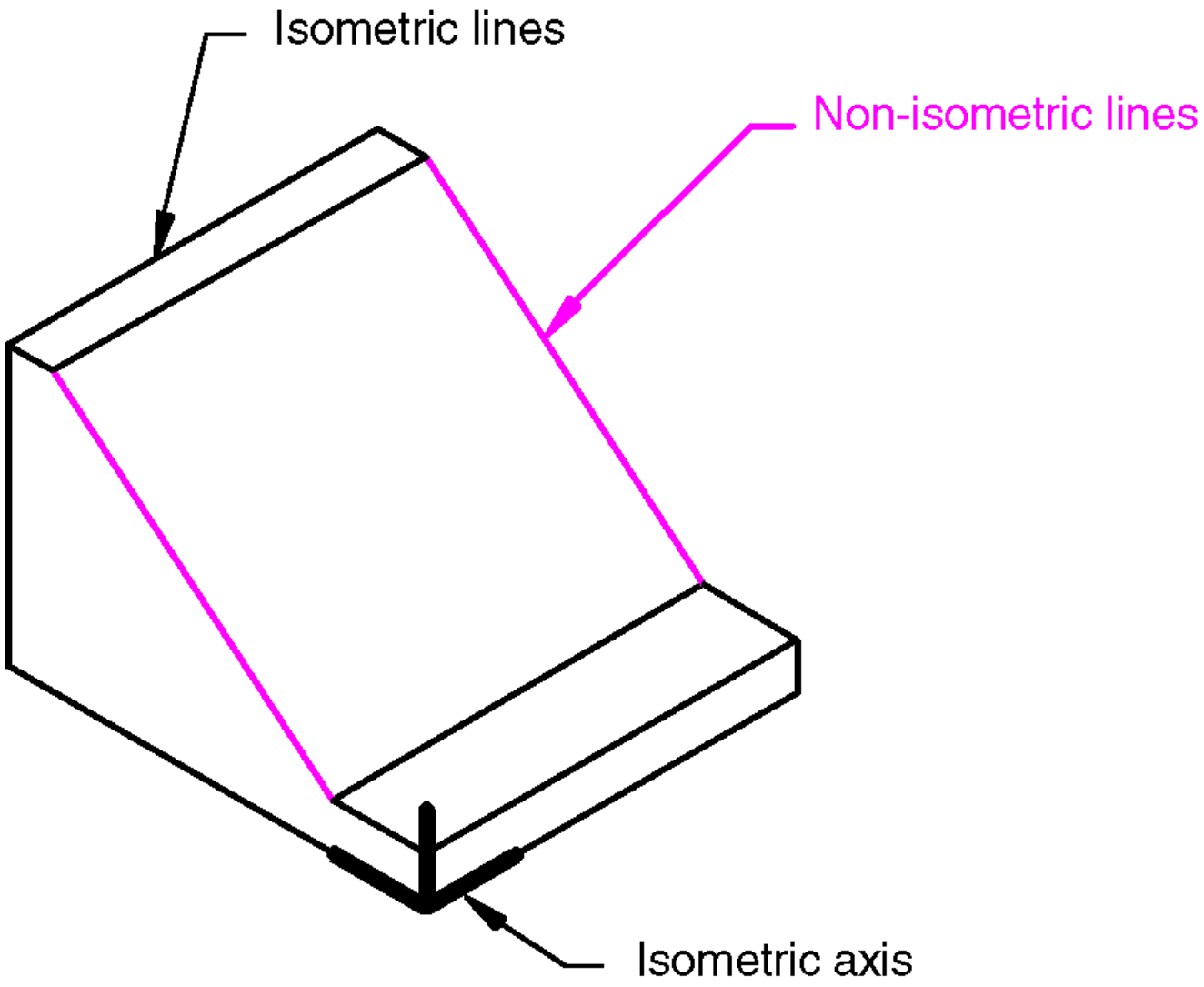
Definitions

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

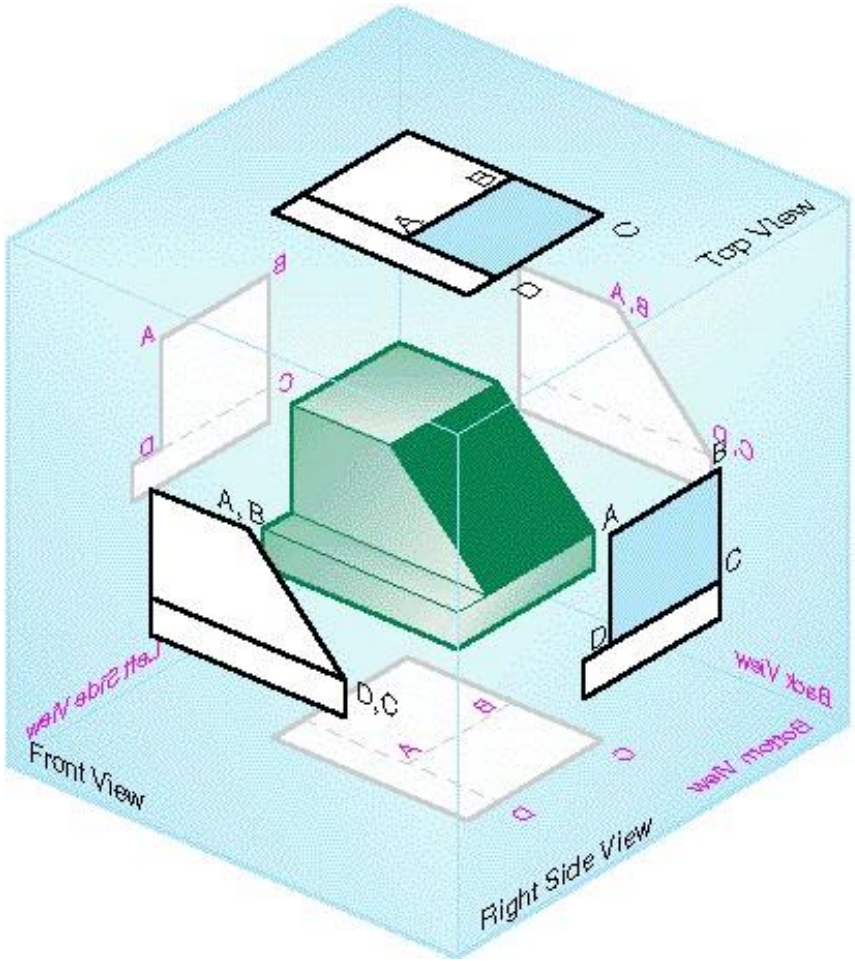
Auxiliary View

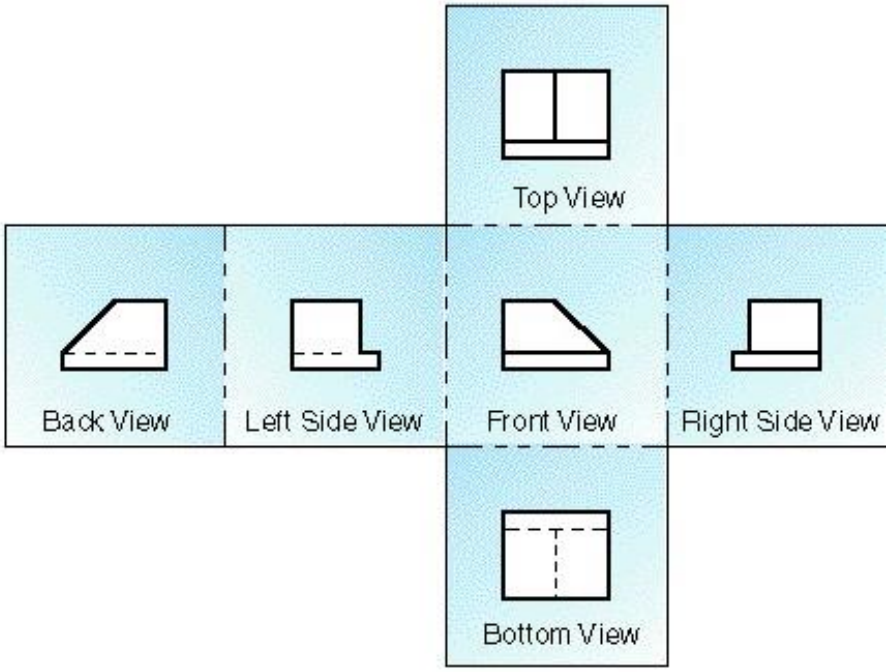


Candidates for Auxiliary Views

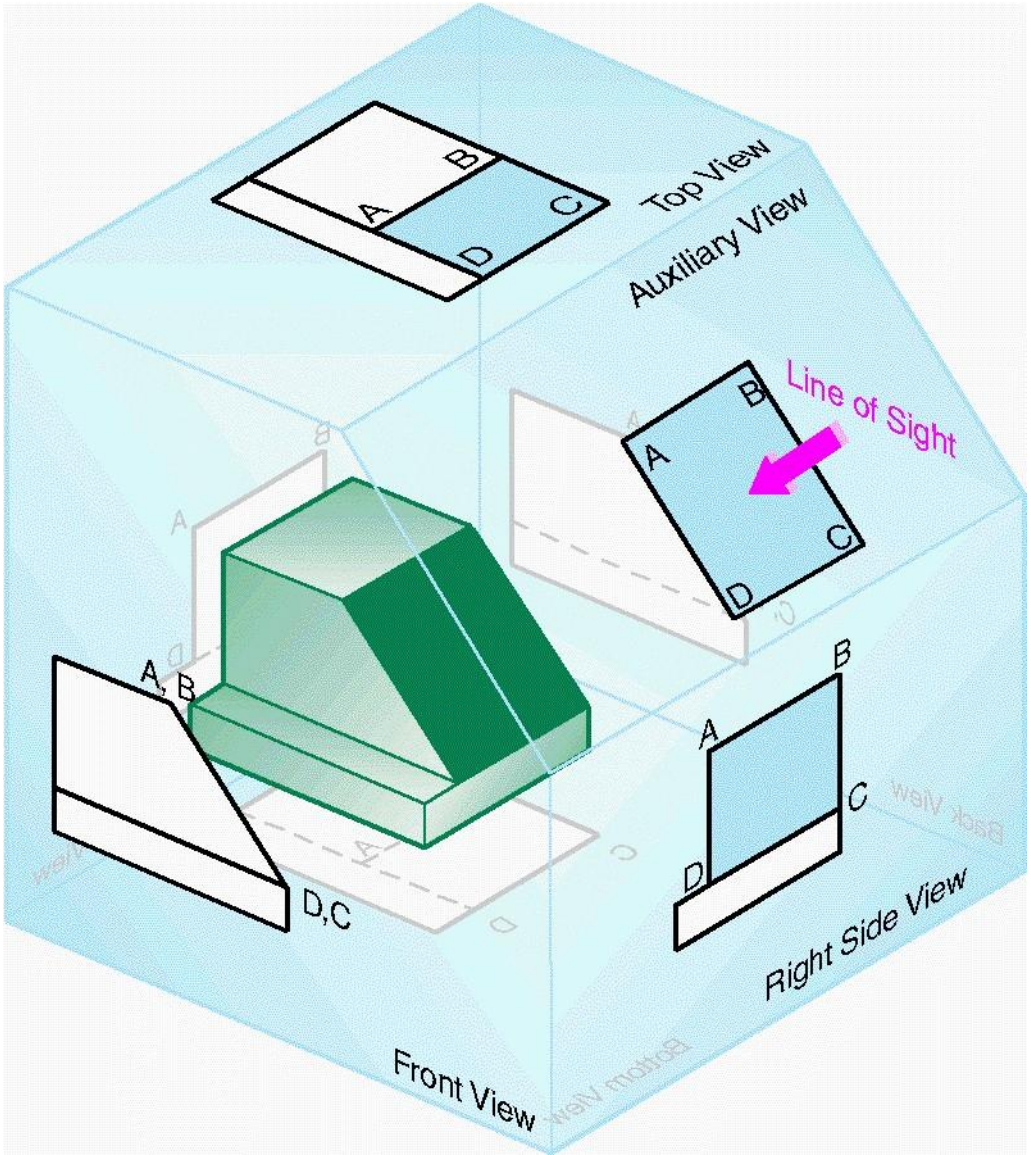


Principal Planes

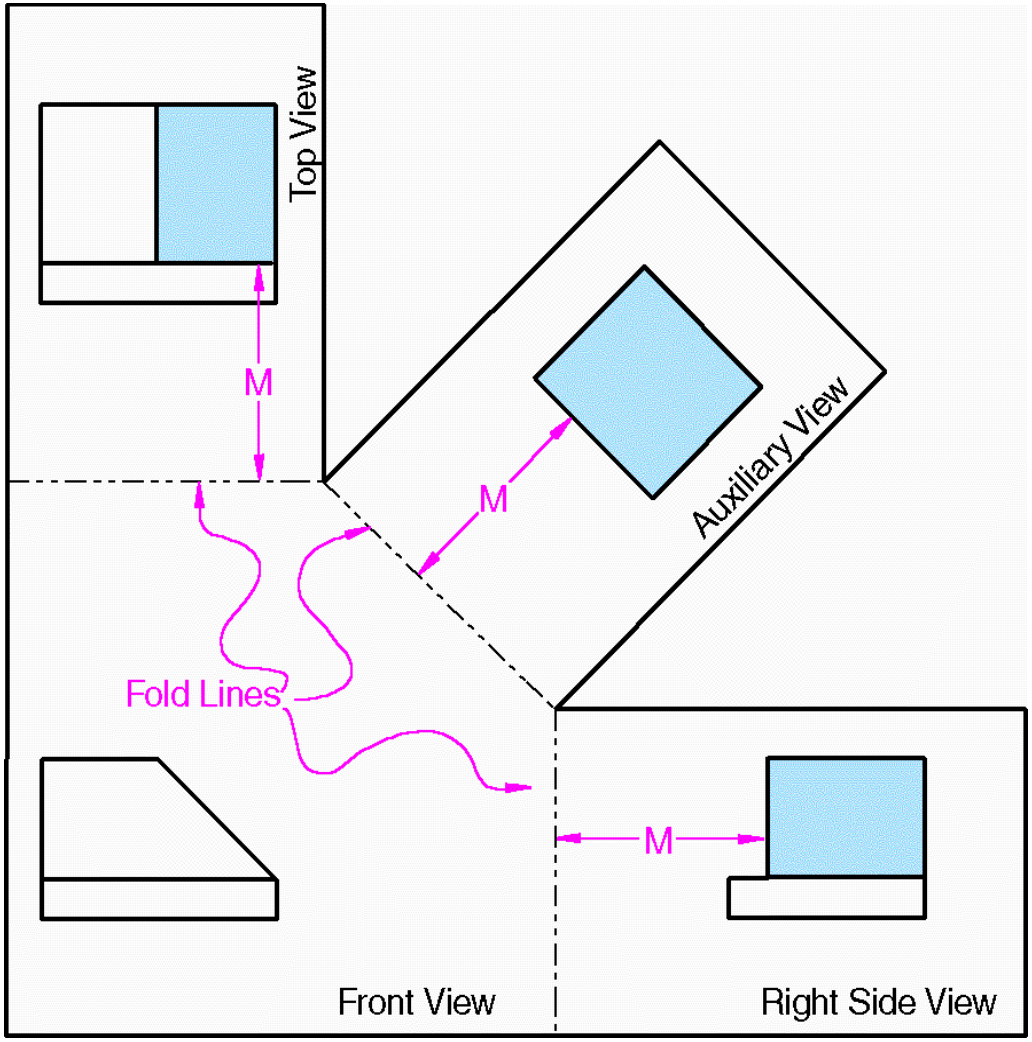




Auxiliary Plane



Primary Auxiliary View



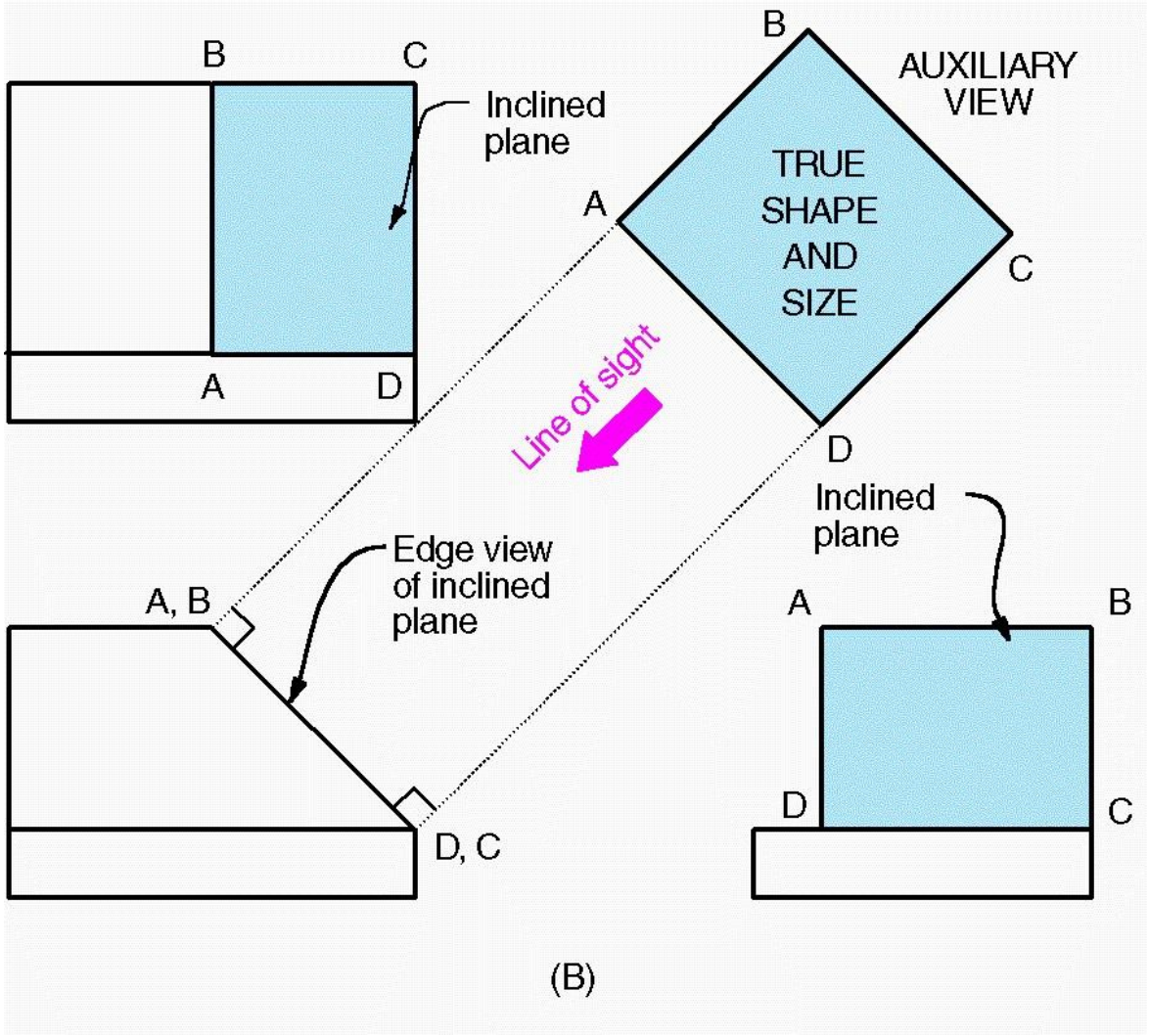
Plane True Dim.

F – Width, Height

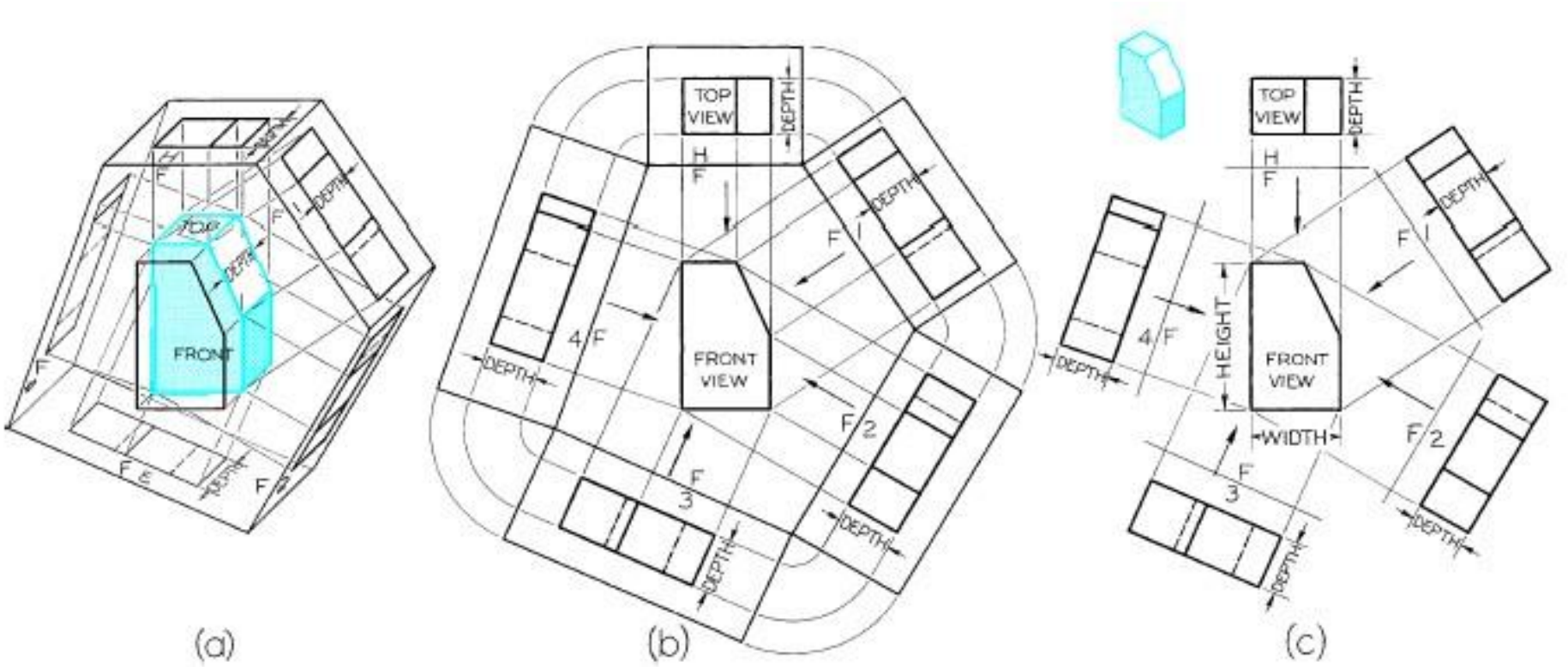
H – Width, Depth

P – Depth, Height

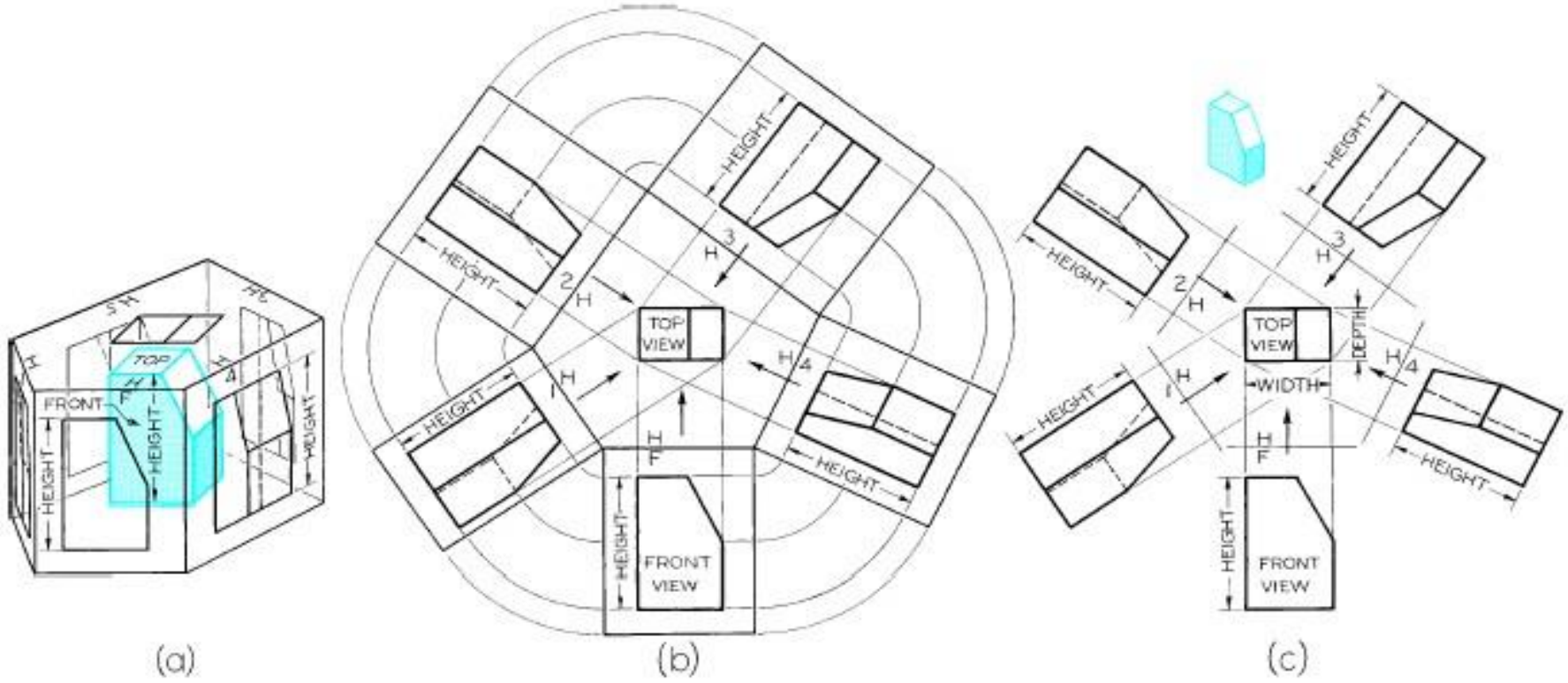
Primary Auxiliary View



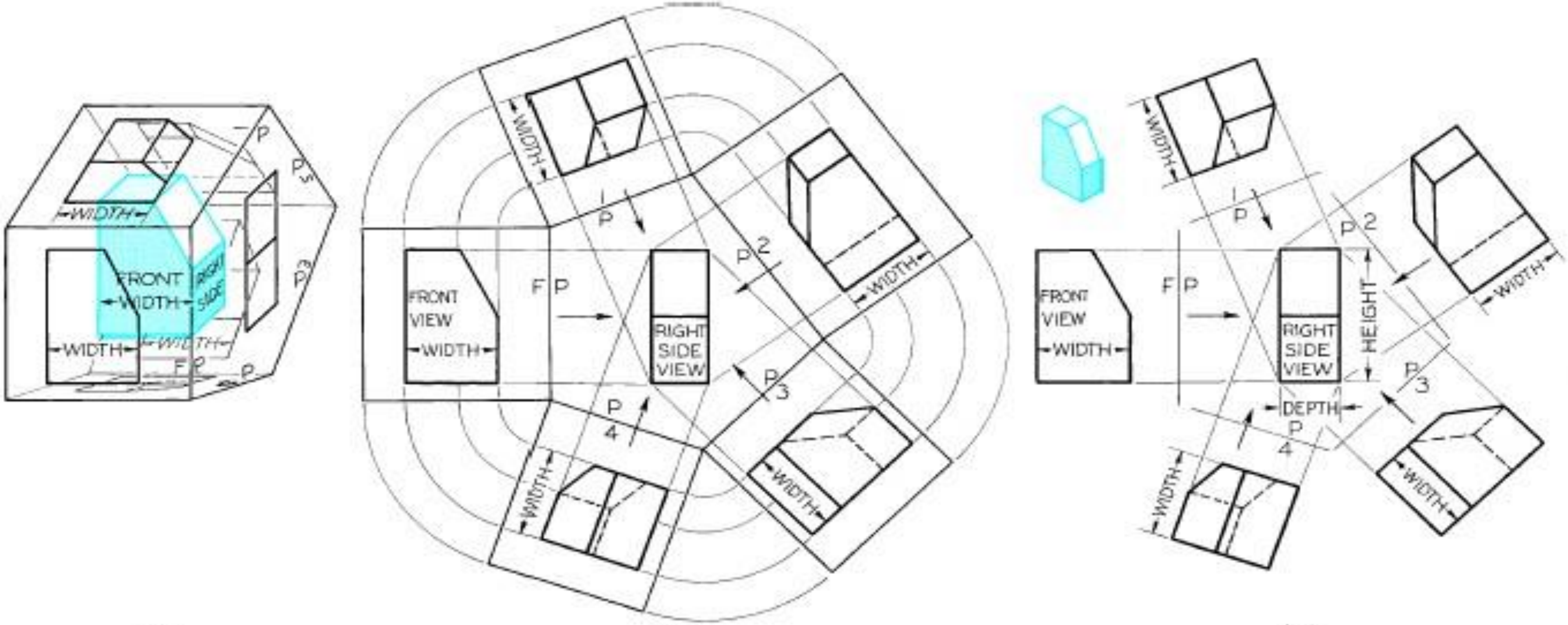
Depth Auxiliary Views



Height Auxiliary Views



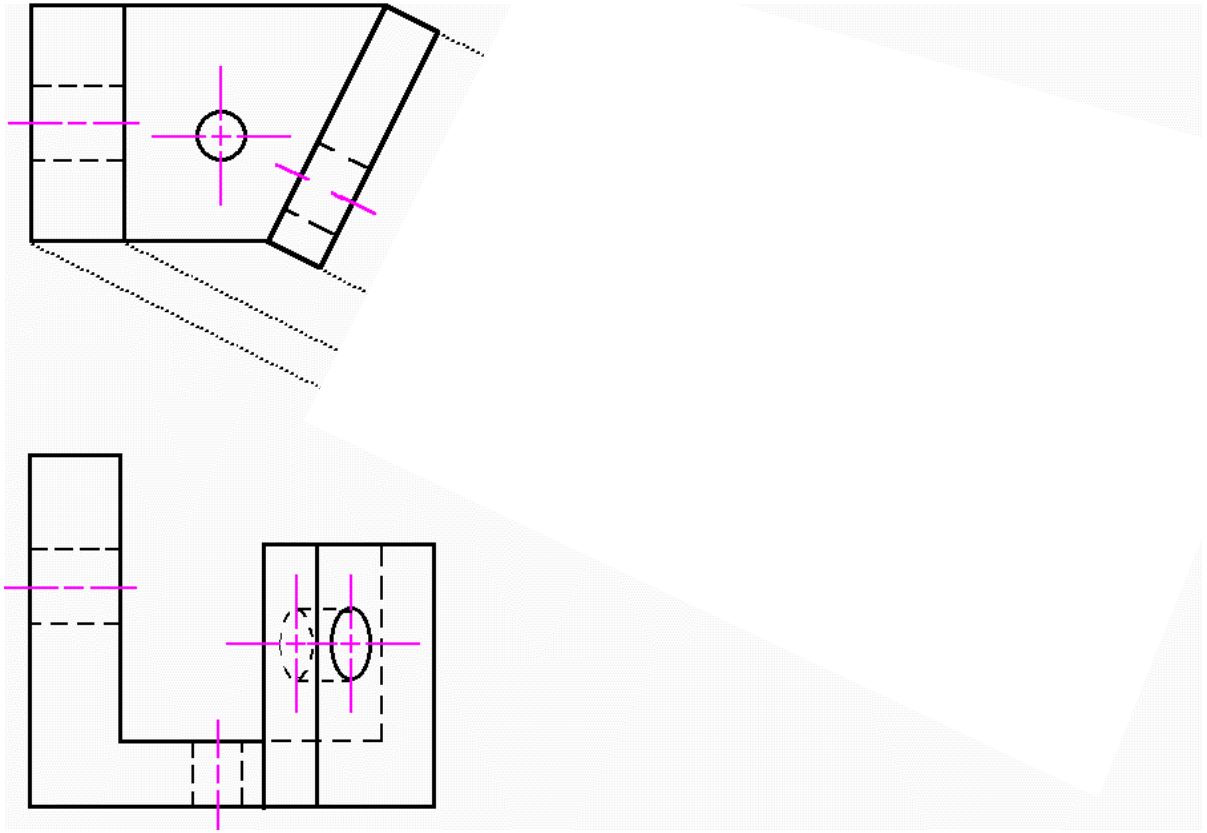
Width Auxiliary Views



(a) (b) (c)

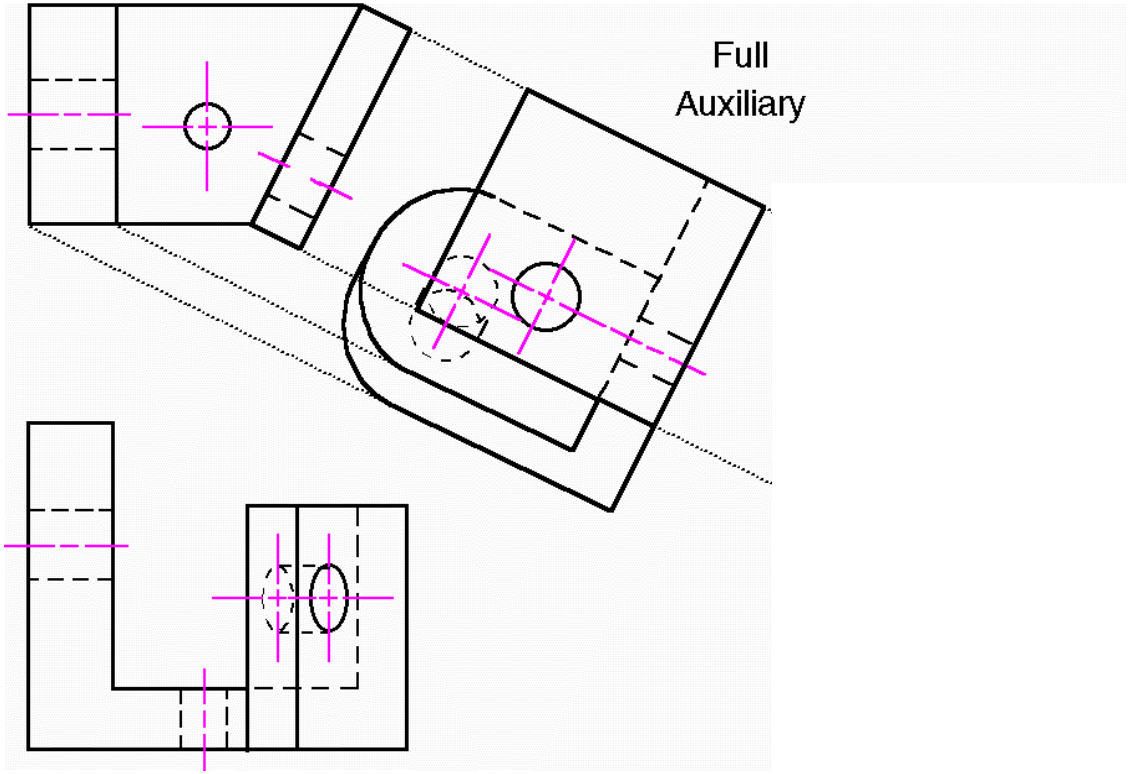
Auxiliary Planes

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



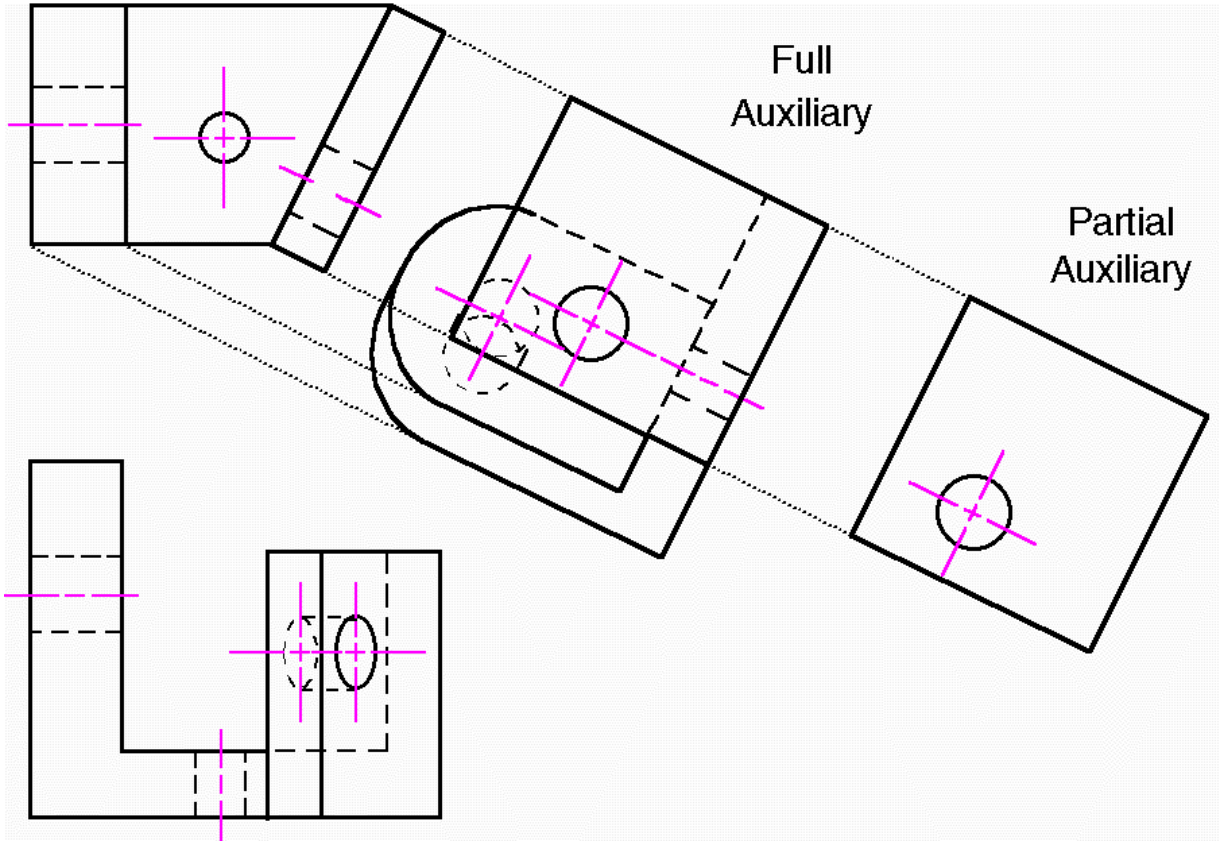
Auxiliary Planes

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



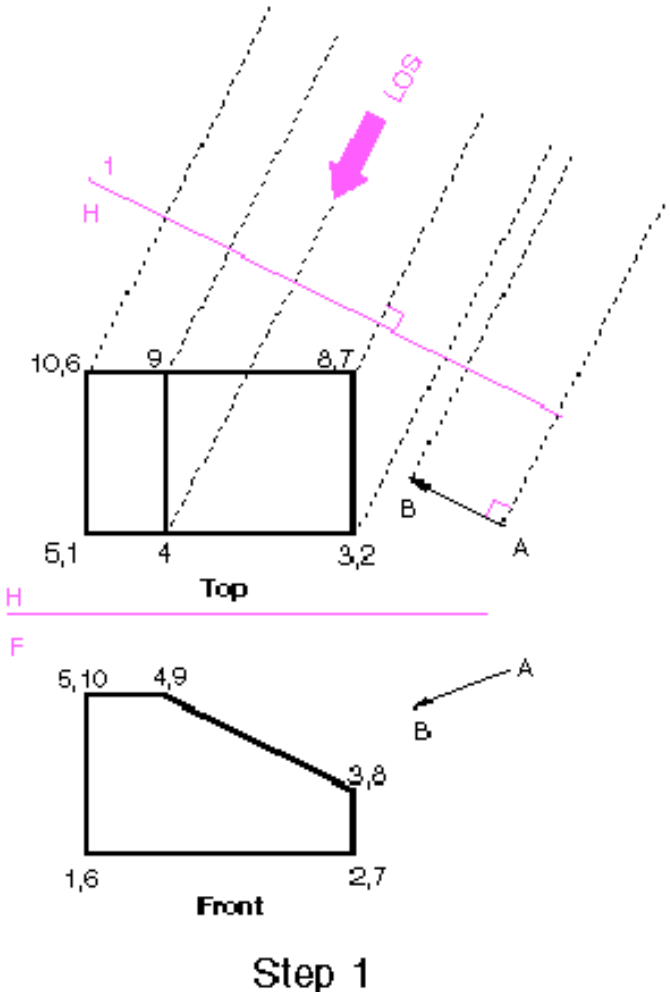
Auxiliary Planes

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



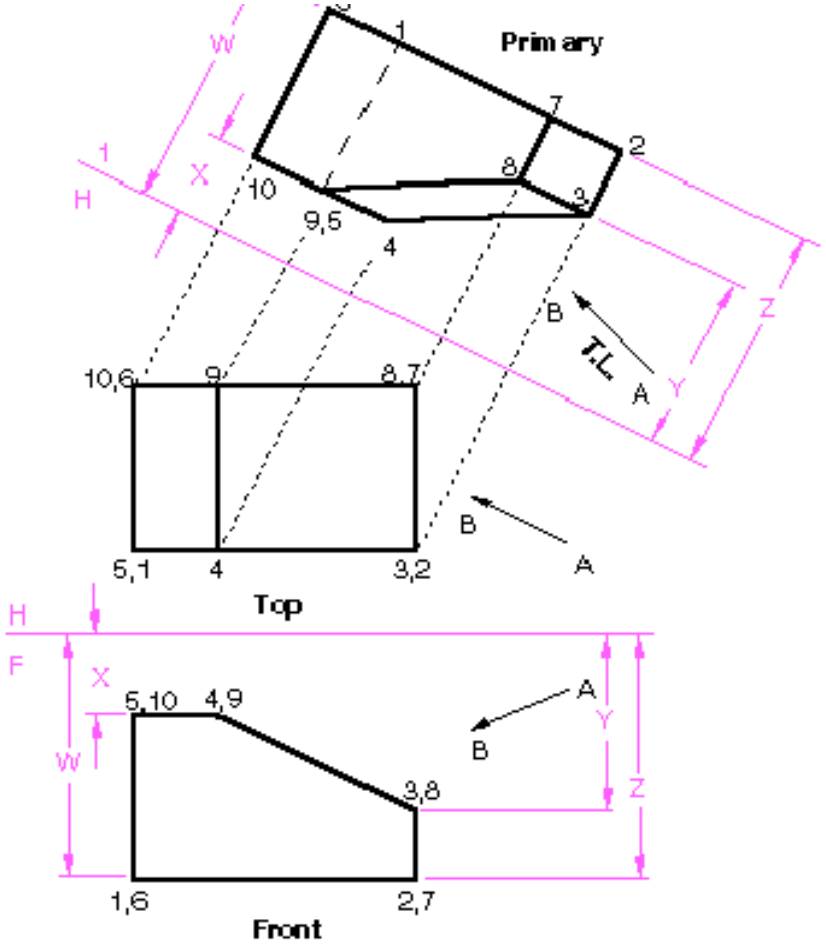
Representing a Full Auxiliary View

Folding-Line Method



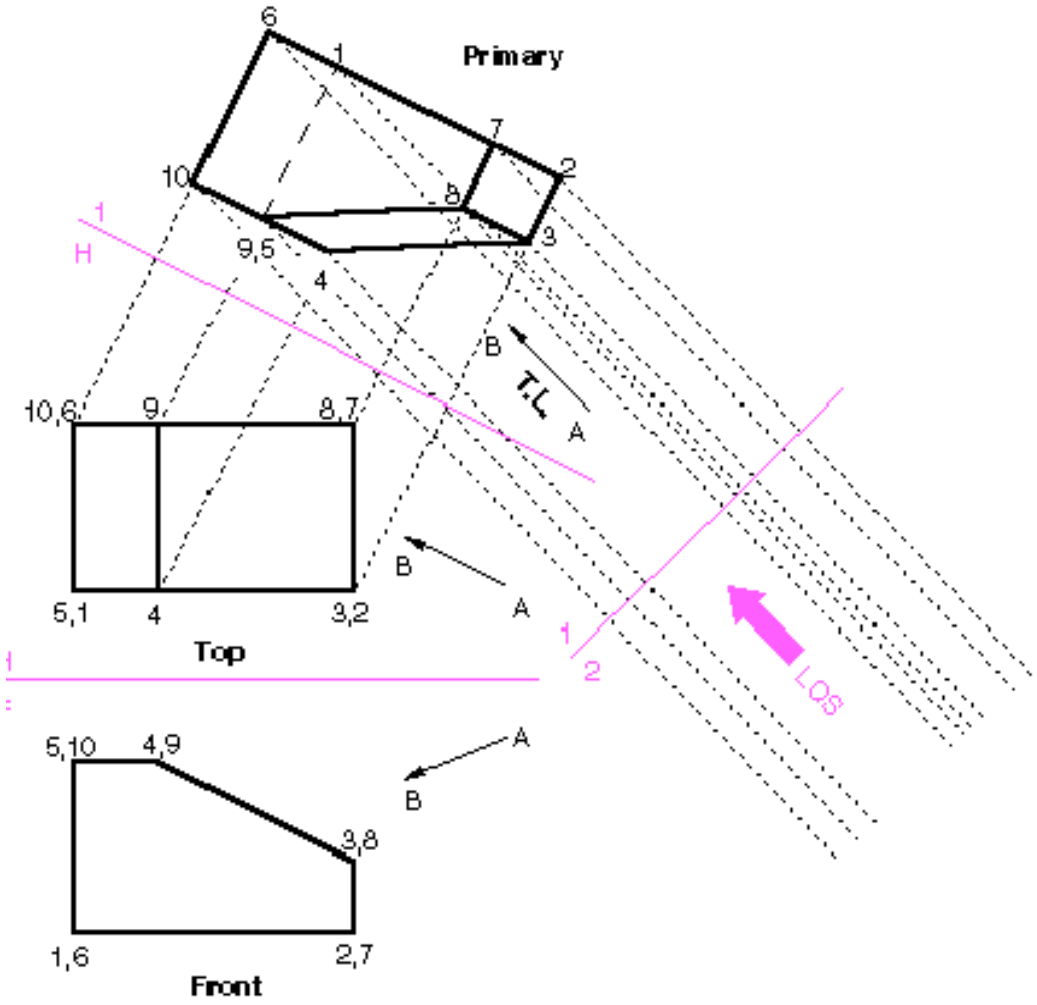
Step 1

Representing a Full Auxiliary View



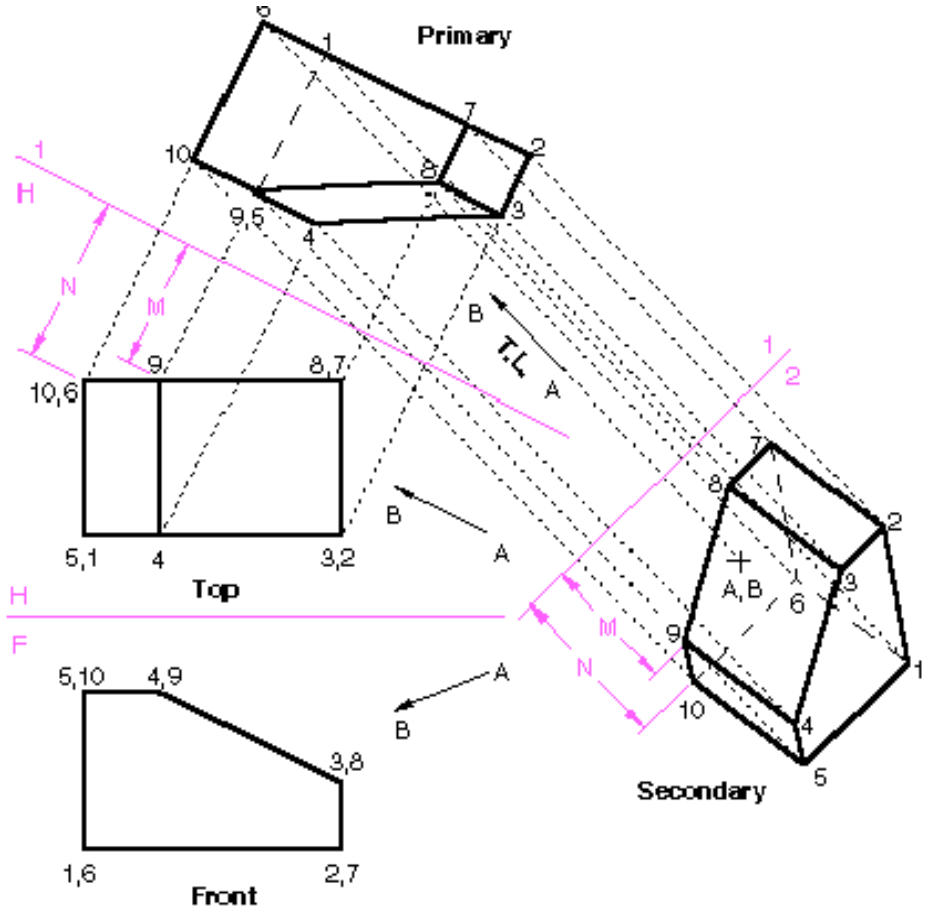
Step 2

Representing a Full Auxiliary View



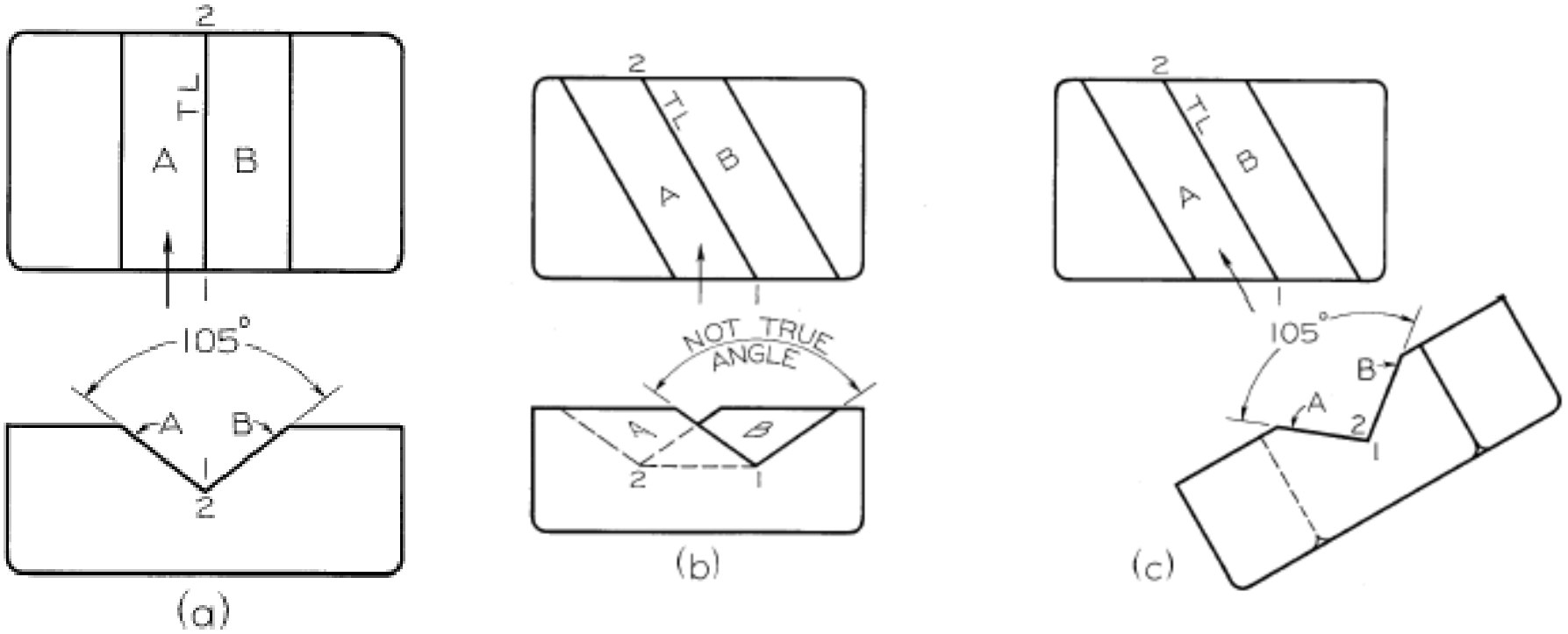
Step 3

Representing a Full Auxiliary View



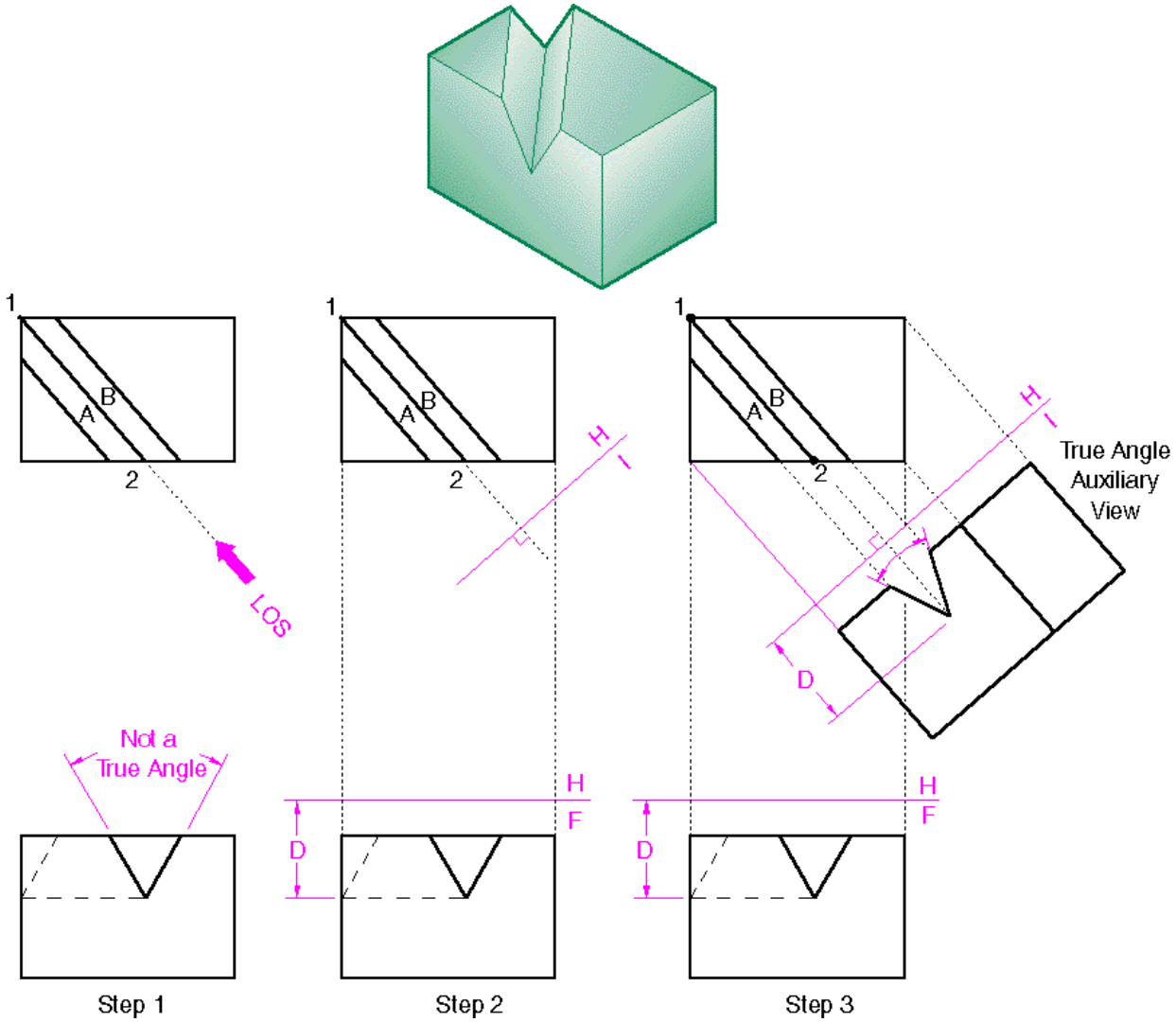
Step 4

Dihedral Angles



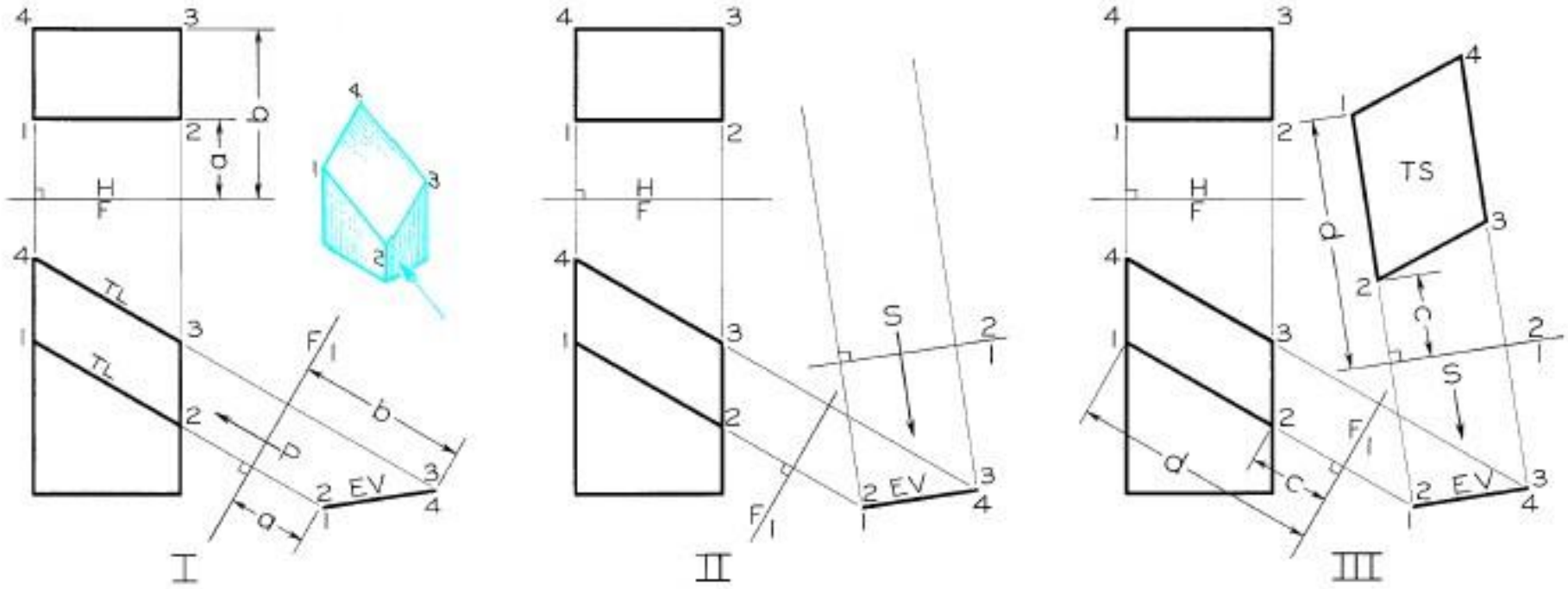
A Practical Problem

Find the angle of the V-cut.



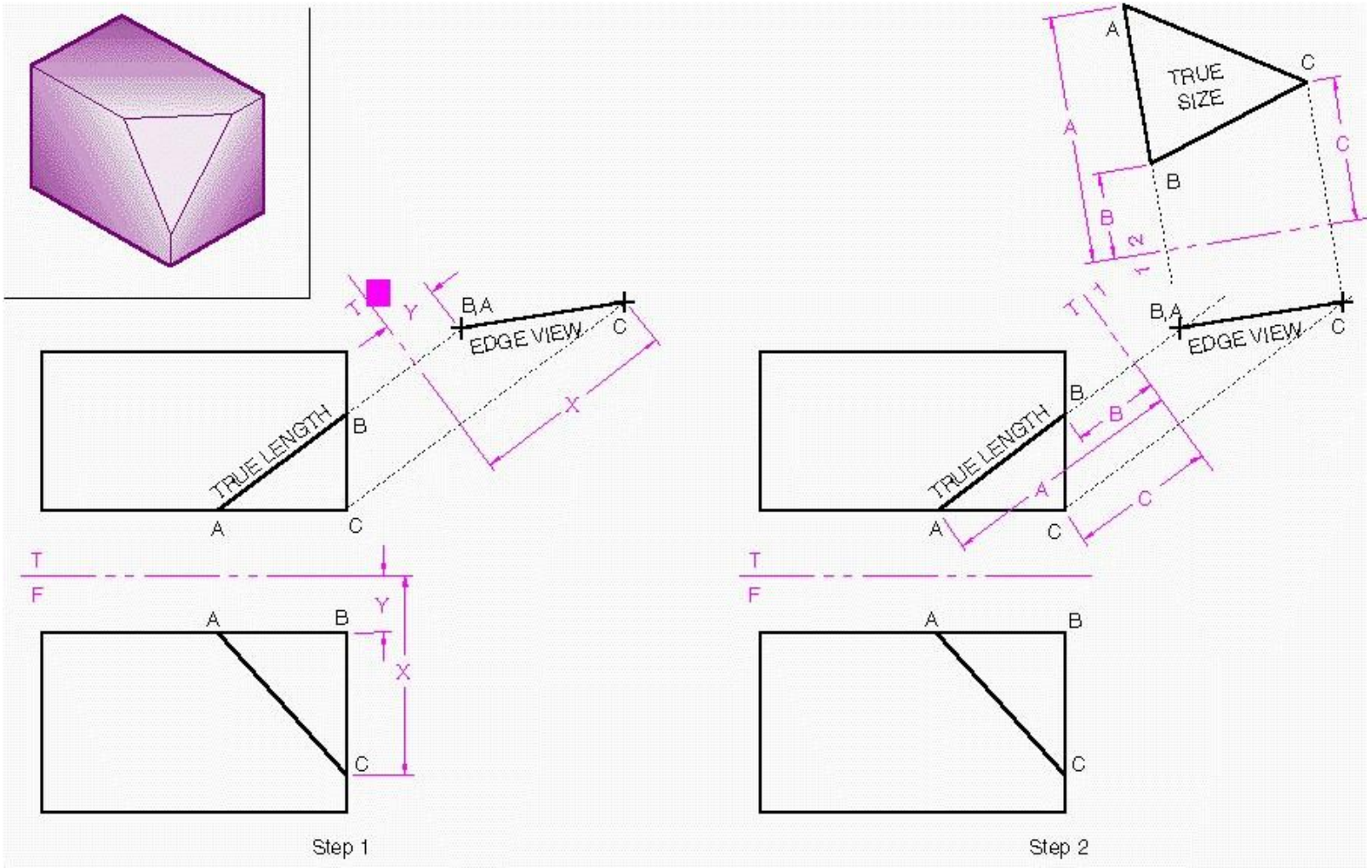
Solution

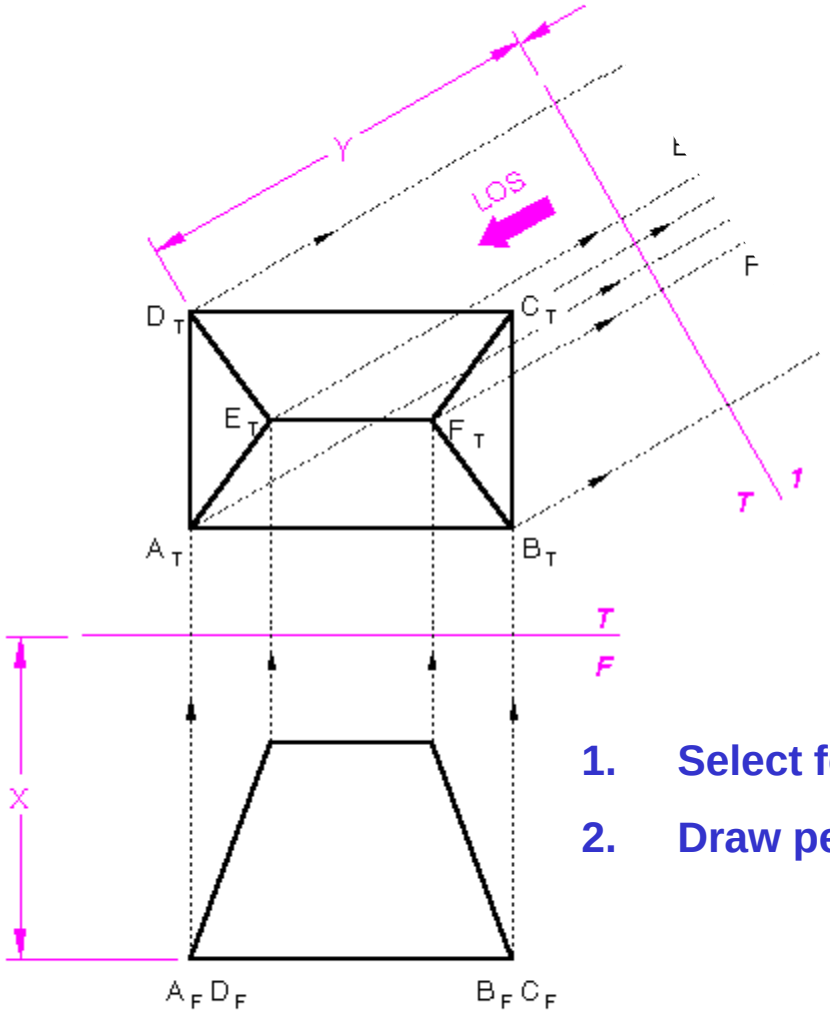
True size of an oblique surface.



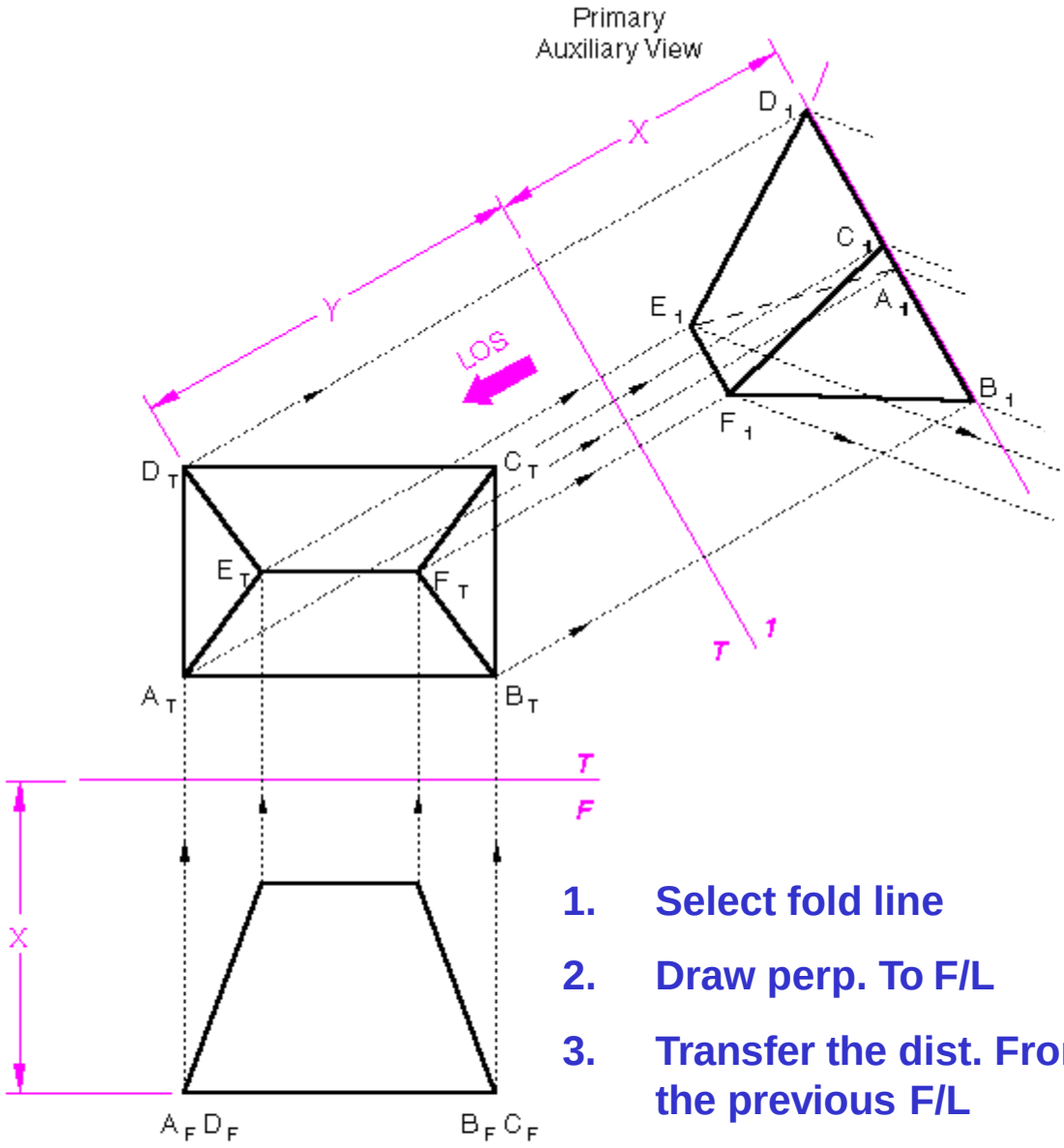
Another Practical Problem

Find the true shape of the section (triangle).

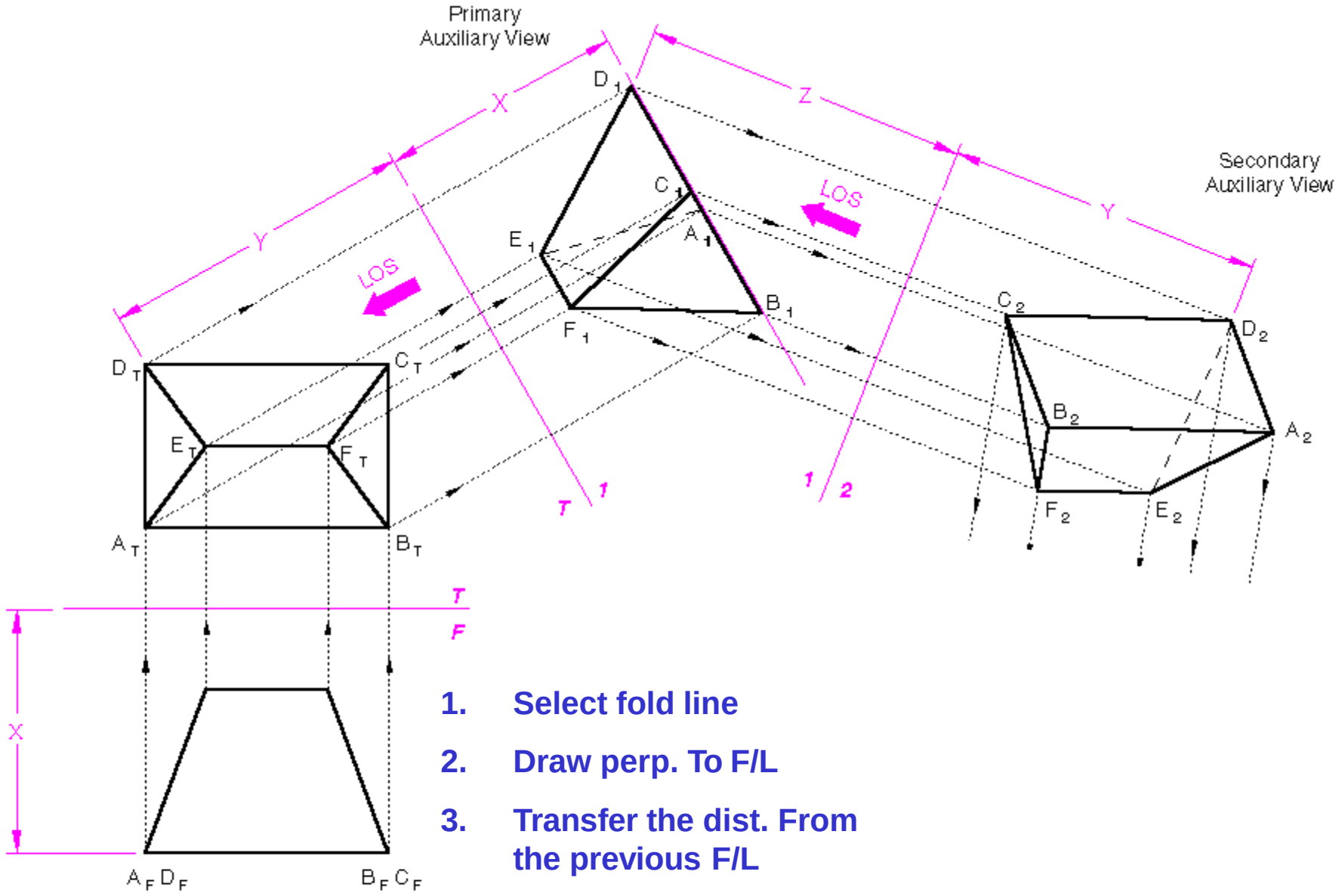




1. **Select fold line**
2. **Draw perp. To F/L**



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**
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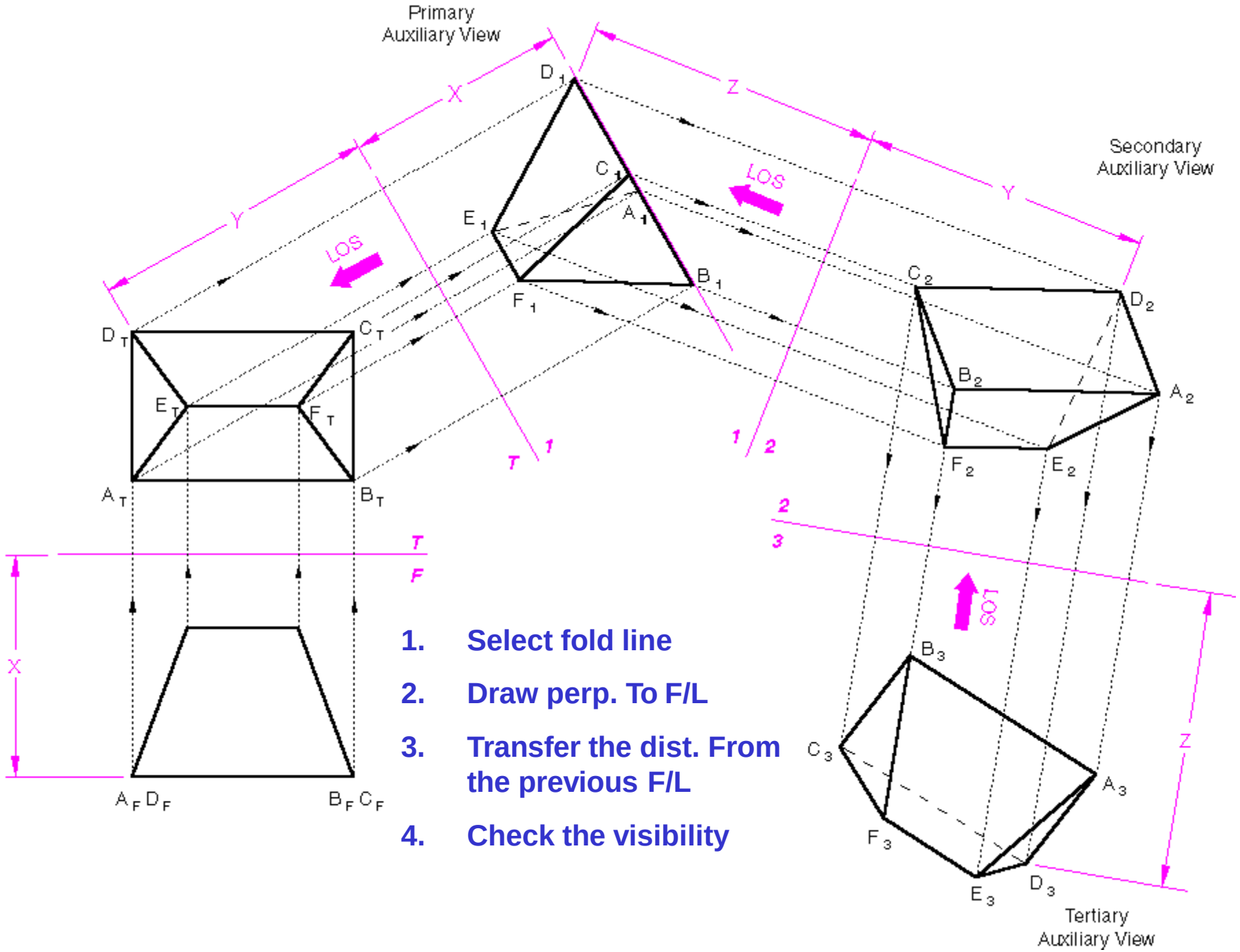
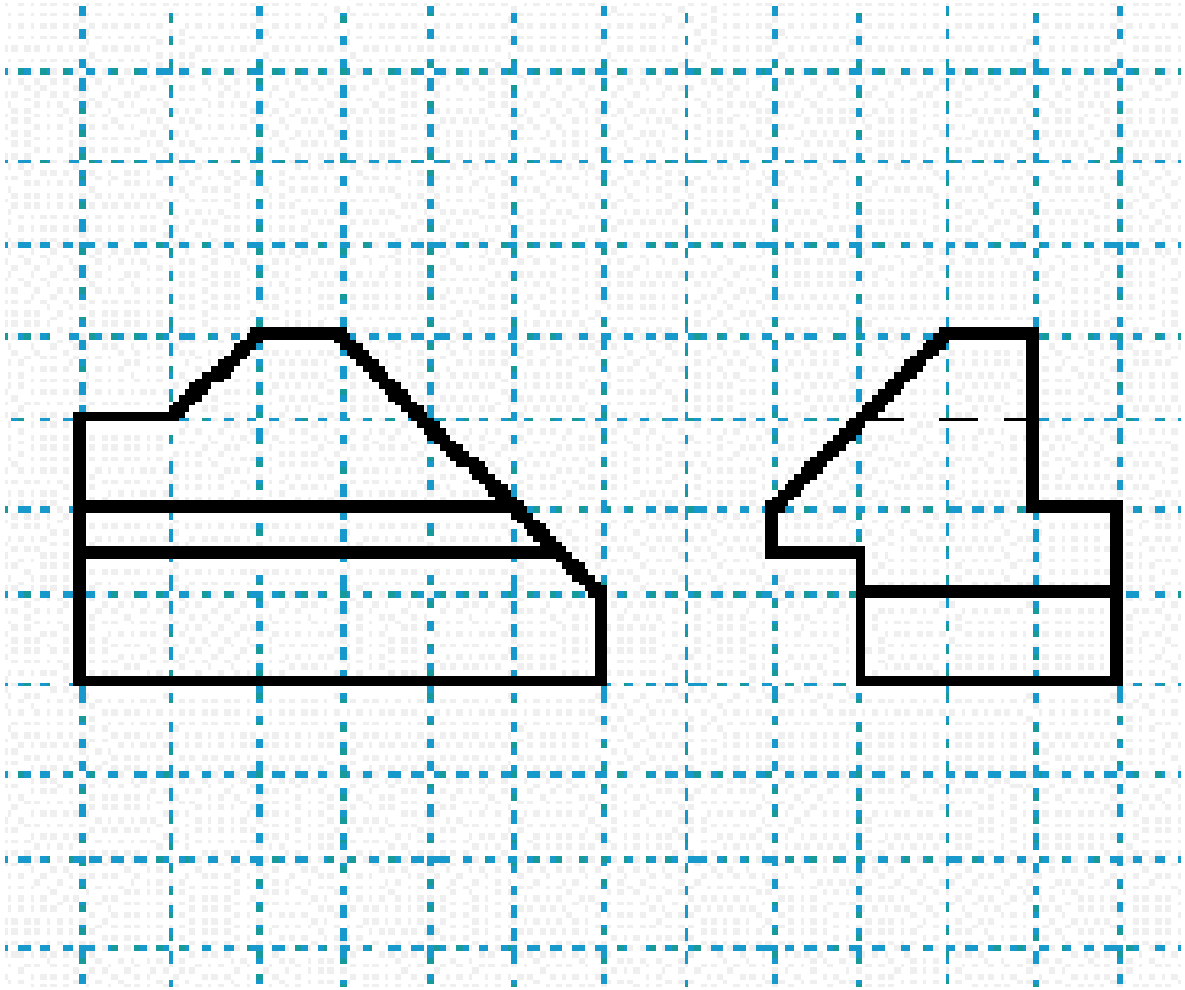


1. **Select fold line**
2. **Draw perp. To F/L**
3. **Transfer the dist. From the previous F/L**
4. **Check the visibility**

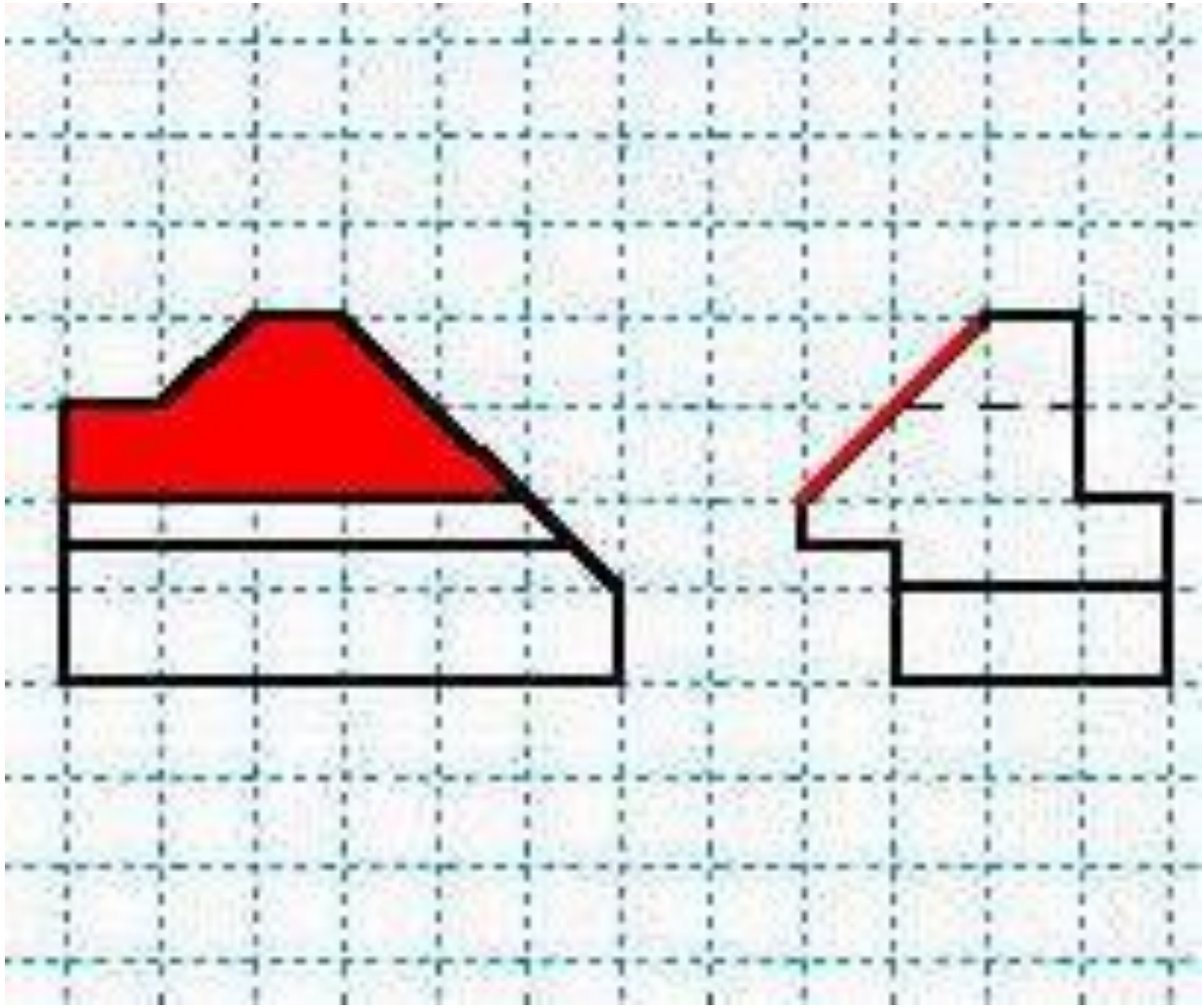
Auxiliary View Problem

Find the true shape of the distorted features



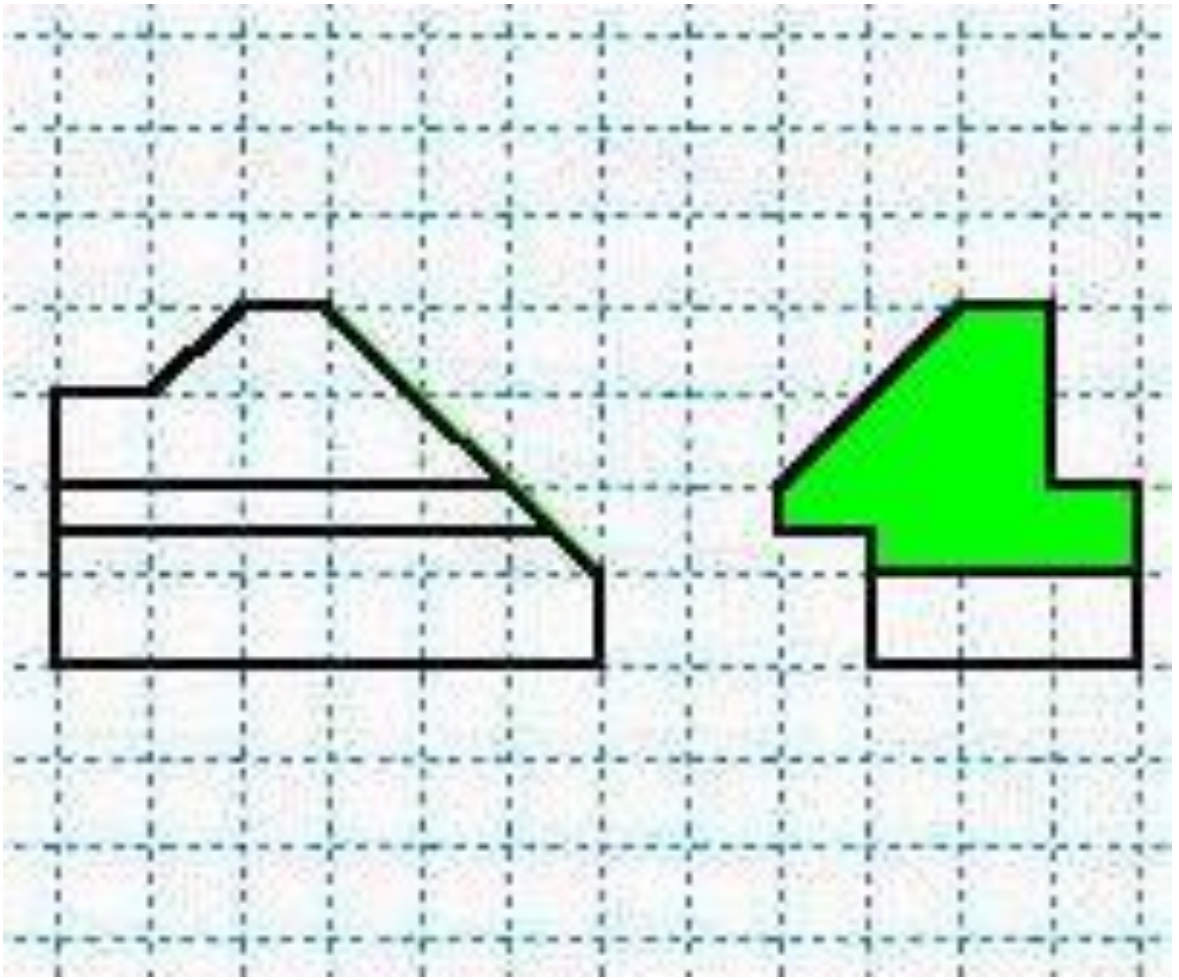
Auxiliary View Problem

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



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