

EE-100 Engineering Laboratory Module2: CAD

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Office Hours: Room 9-345A

Monday (1000-1100)

Wednesday (1000-1100)

CAD Module

Learning Objective 1: Create and interpret mechanical drawings

Learning Objective 2: Recall and demonstrate workshop/industrial safety practices.

- **Week 1**

- Design methodology for scientists and engineers
- Introduction to Engineering Drawing
- Engineering Drawings
 - Standards, Types, Projections
- **Lab Task 5:** Sketch orthographic projections of solid objects

- **Week 2**

- Computer Aided Modeling
 - Intro to PTC Creo and its features
 - 2D sketching
 - Basics of 3D object modeling
- **Lab Task 6:** 3D part modeling.

- **Week 3**

- Advanced features of PTC Creo Parametric 2.0:
- **Lab Task 7:** 3D part modeling

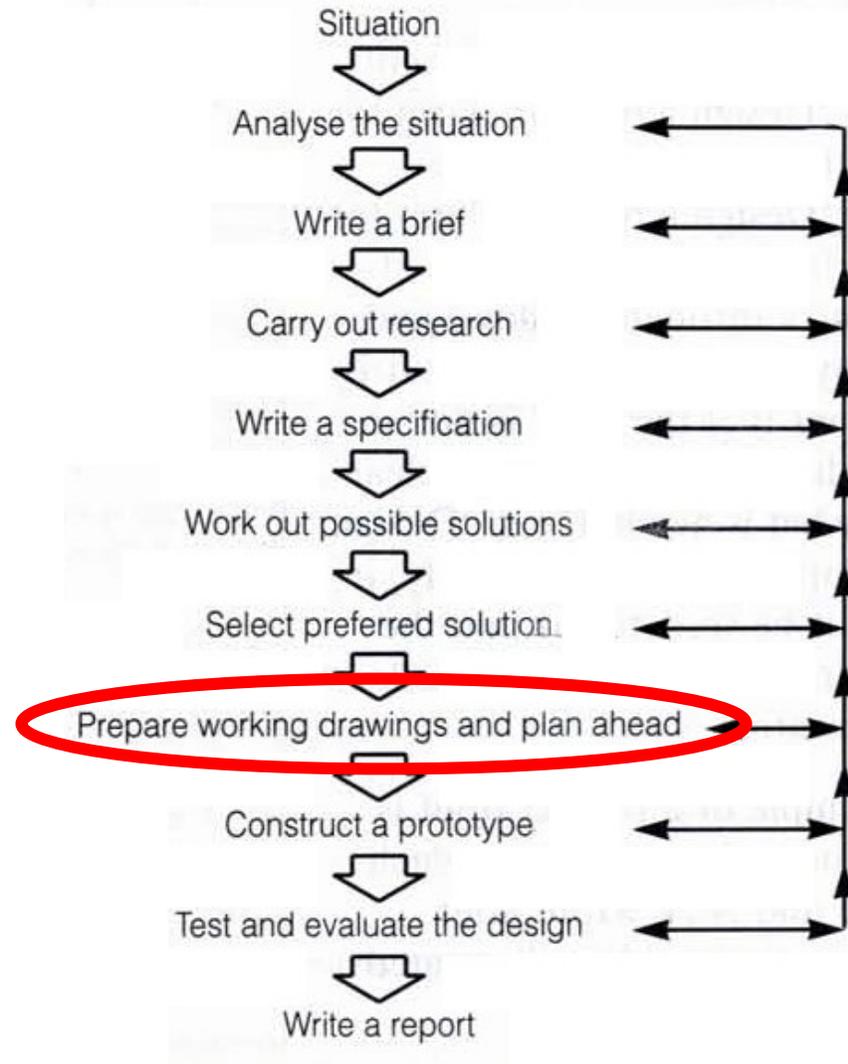
- **Week 4**

- Assembly
- **Lab Task 8:** Assembly task

- **Week 5**

- **Lab Task 9:** Create parts and assembly drawings for a robotic hand (gripper)

Design Methodology for Engineers



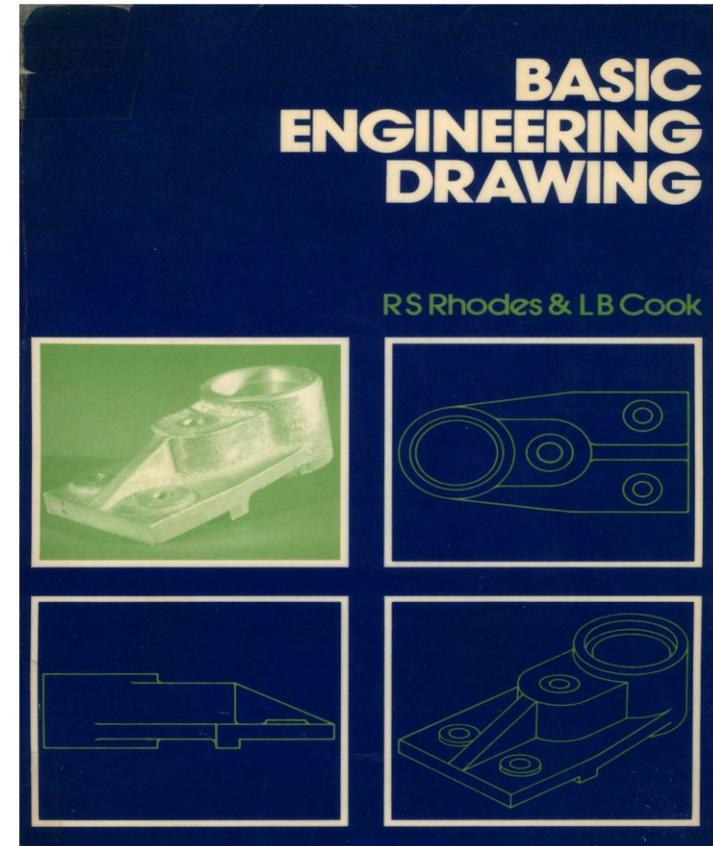
Introduction to Engineering Drawing

- Engineering drawing
- Drawing standards
 - Drawing sheet
 - Line types
- Types of engineering drawings
 - Projections



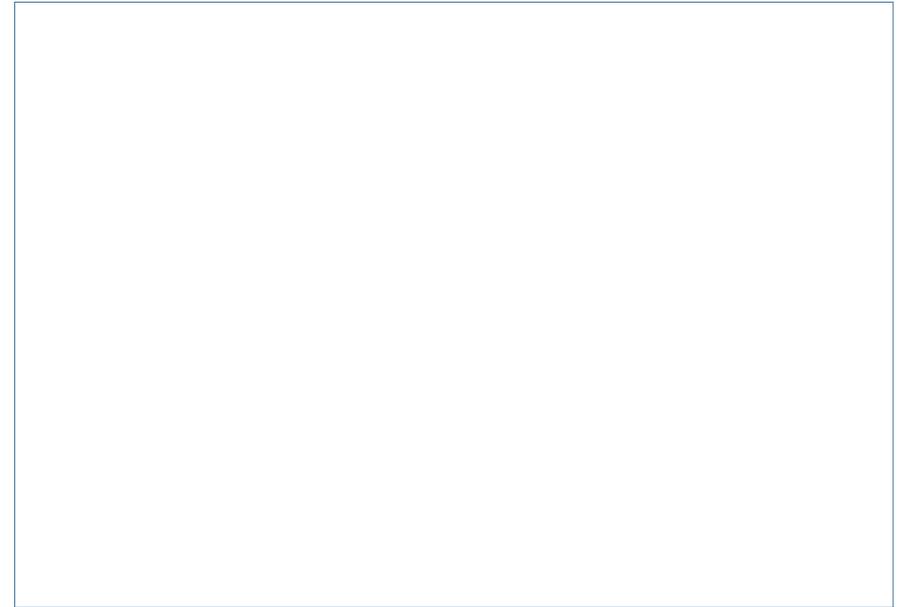
References

- Basic Engineering Drawings by RS Rhodes and LB Cook



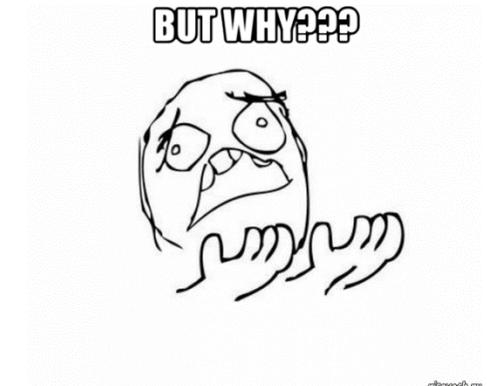
Why use Graphical Language?

1. Try to write a *description* of this object.
2. Test your written description by having someone attempt to *make a sketch* or *visualize* from your description.



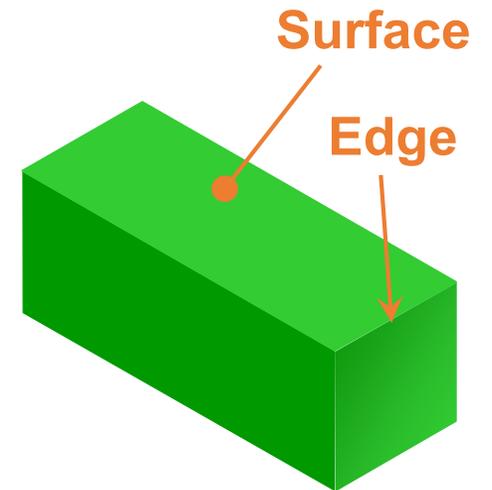
Why use Graphical Language(Cont.)

The word-language is *inadequate* for describing the **size**, **shape** and **features** completely as well as *concisely*.



What is Engineering Drawing?

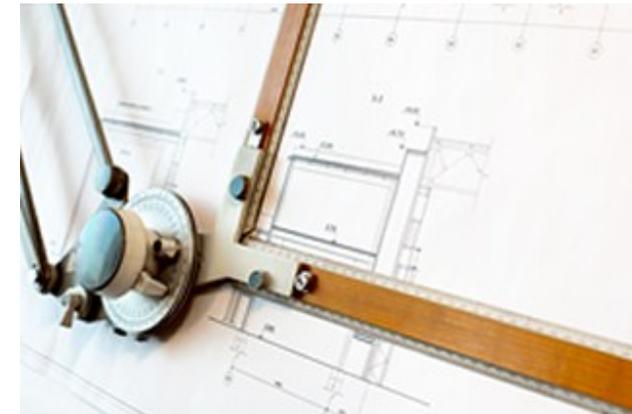
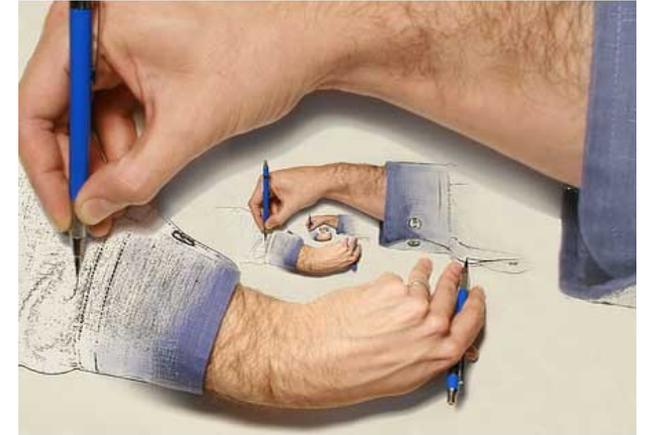
- “*Engineering drawing*” or “*blueprint*” uses geometric entities to represent the features of an object.
- *Features* of an object are surfaces (plane) and edges (line).



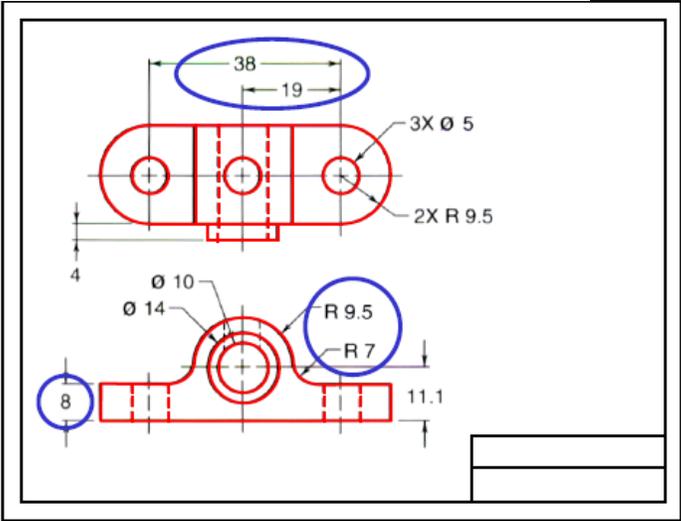
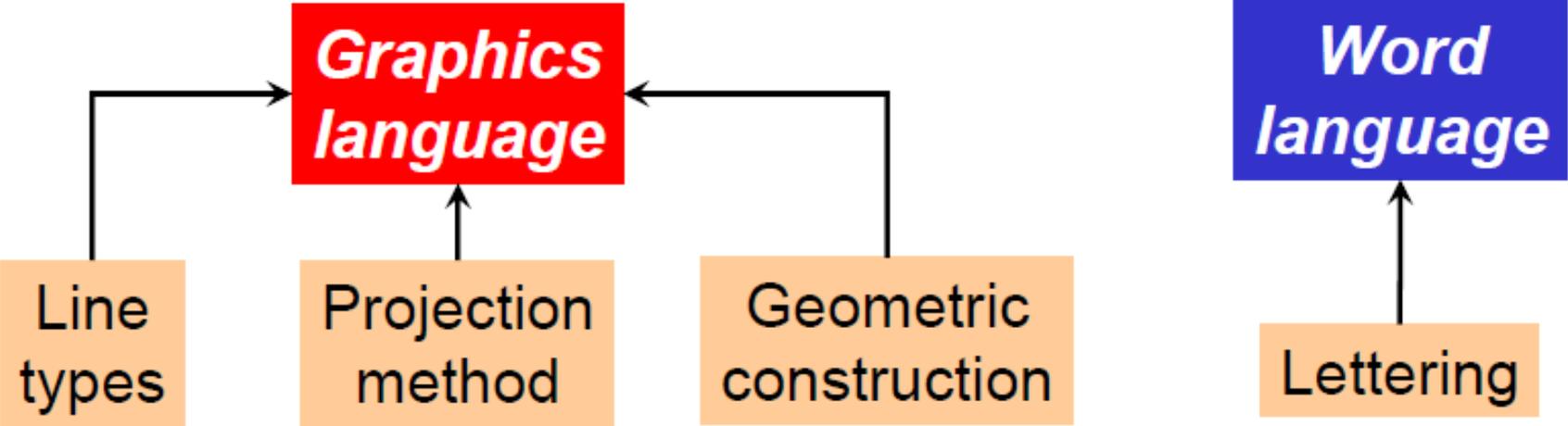
What is Engineering Drawing (Cont.)

- Graphical language use *lines* to represent the *surfaces*, *edges* and *contours* of objects.
- The language is known as “*drawing*” or “*drafting*”.
- A drawing can be done

- *Freehand*
- *Instruments*
- *Computer-Aided*

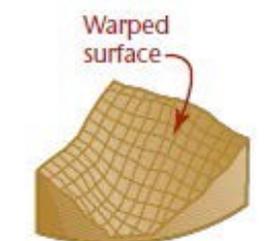
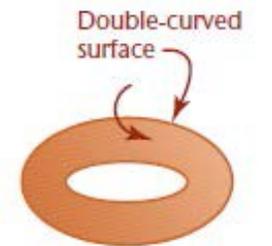
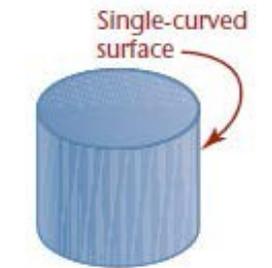
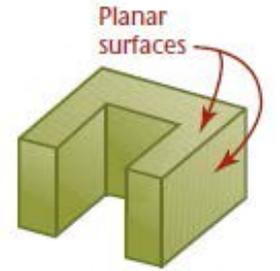


What is Engineering Drawing (Cont.)



Understanding Solids

- Three-dimensional figures.
- Solids are bounded by the surfaces that contain them.
 - **Planar** (flat)
 - **Single** curved (one curved surface)
 - **Double** curved (two curved surfaces)
 - **Warped** (uneven surface)
- Complex Solids are just *combinations* of these basic surfaces.



Identifying Solids' Characteristics

- Edges

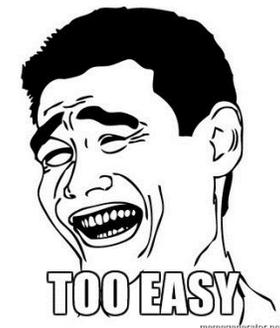
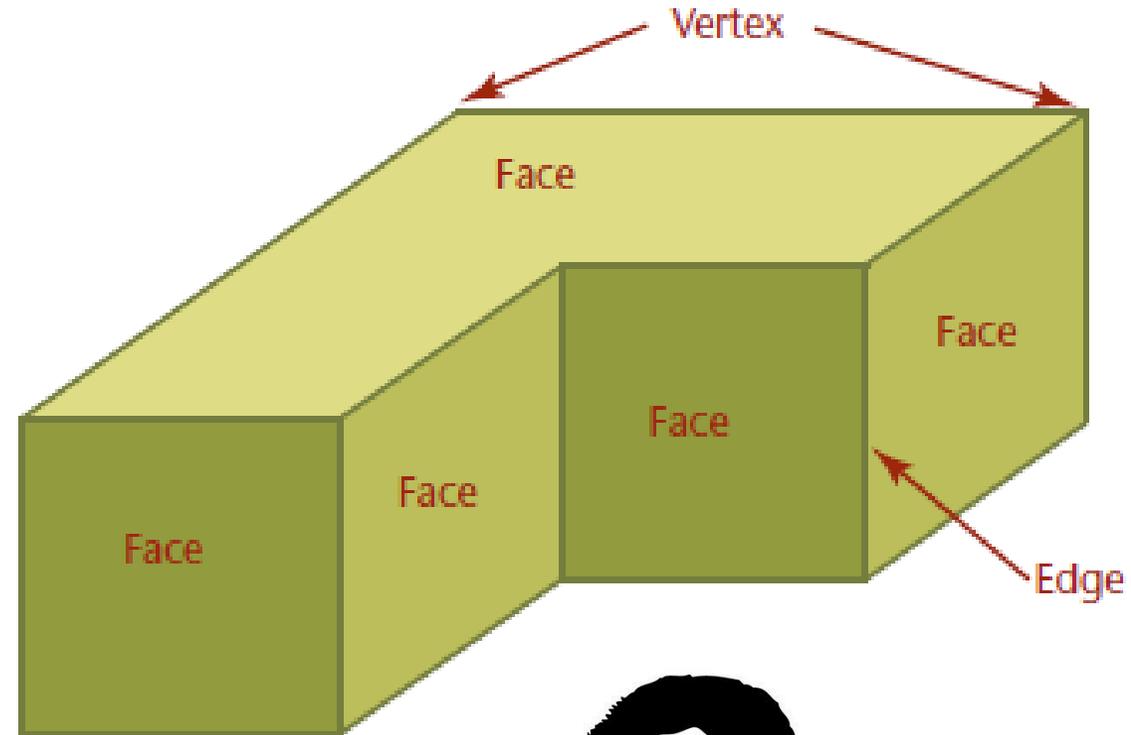
- Formed when two surfaces intersect.
- Represented by visible or hidden lines in drawing

- Vertex

- Formed when three or more surfaces intersect.

- Points

- A point is used to represent a location in space but has no width, height, or depth.



Drawing Standards (Cont)

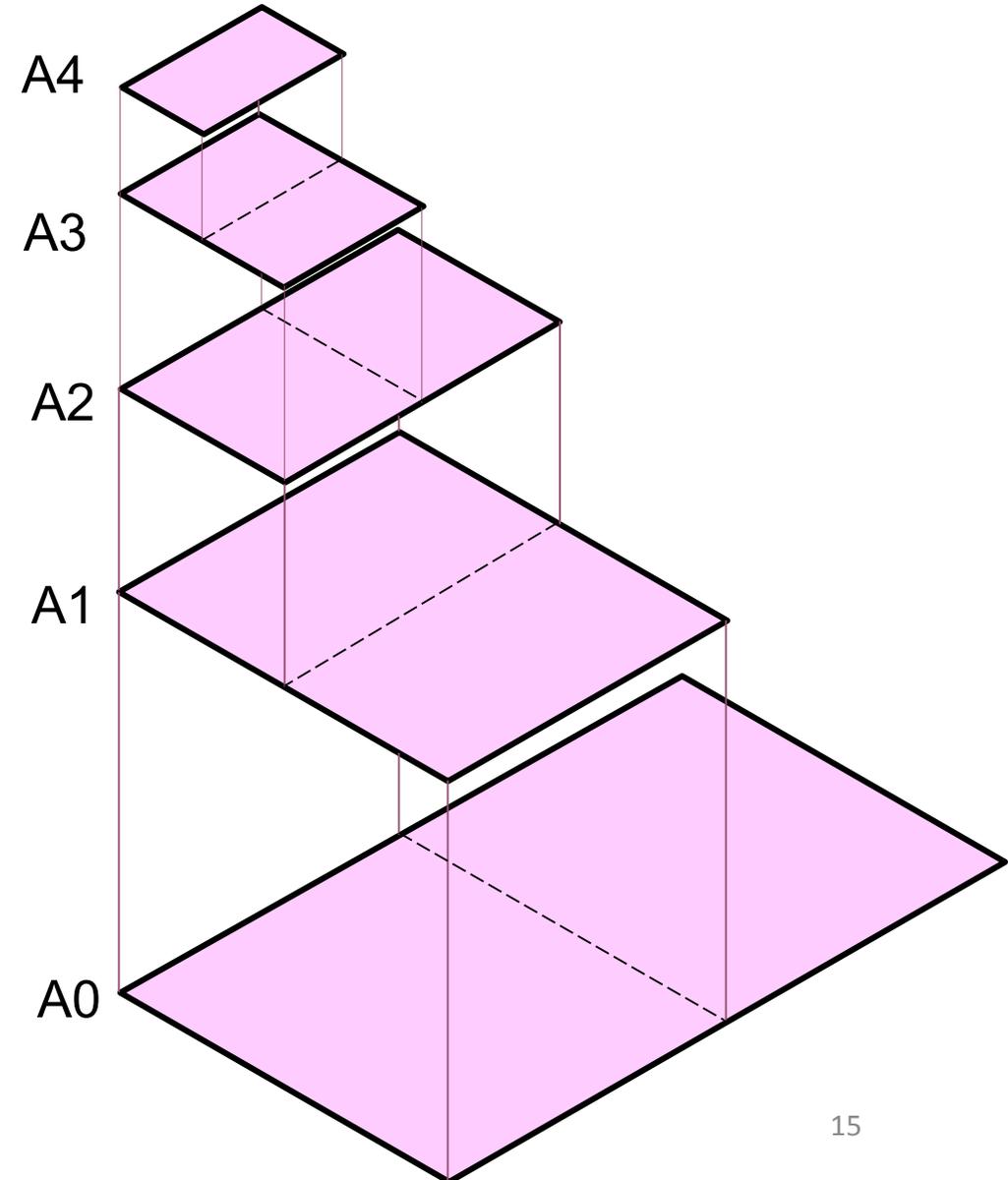
Country	Code	Full name
USA	ANSI	American National Standard Institute
Japan	JIS	Japanese Industrial Standard
UK	BS	British Standard
Australia	AS	Australian Standard
Germany	DIN	Deutsches Institut für Normung
ISO		International Standards Organization



Drawing Standards: Sheets

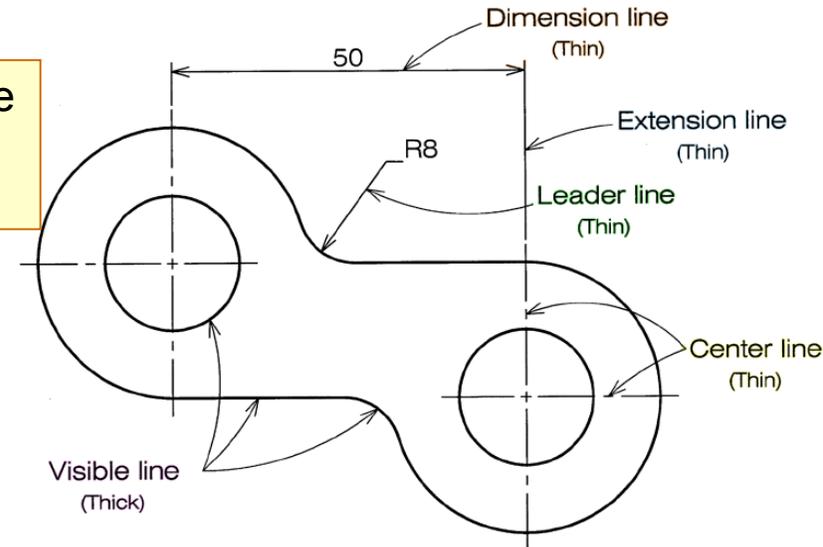
- Trimmed paper of a size A0 ~ A4.
- Standard sheet size (*JIS*)
 - A4 210 x 297
 - A3 297 x 420
 - A2 420 x 594
 - A1 594 x 841
 - A0 841 x 1189

(Dimensions in millimeters)

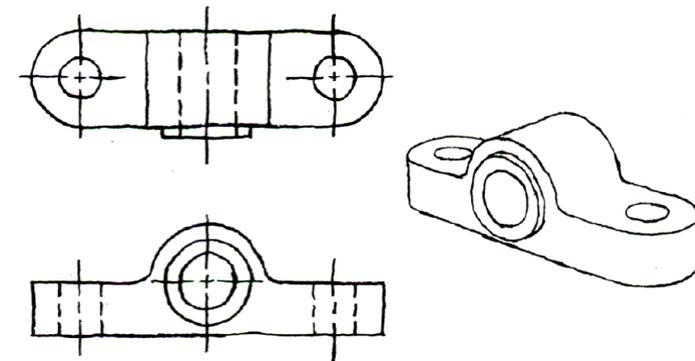


Basic Line Types and Meanings

Thickness \ Style	Thick	Thin
Continuous	 Visible line	 1. Dimension line 2. Extension line 3. Leader line
Dash		 Hidden line
Chain		 Center line

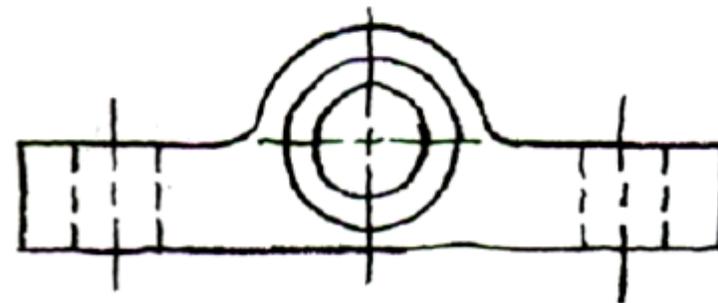
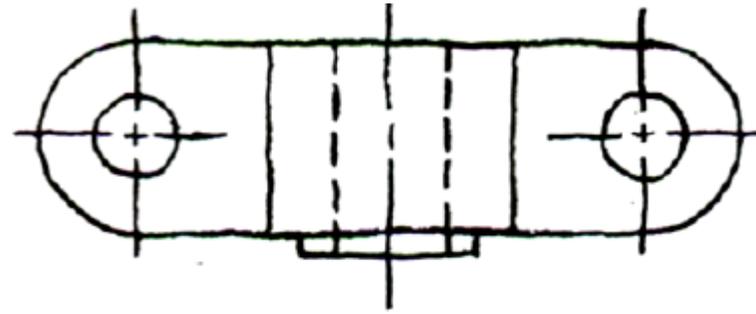
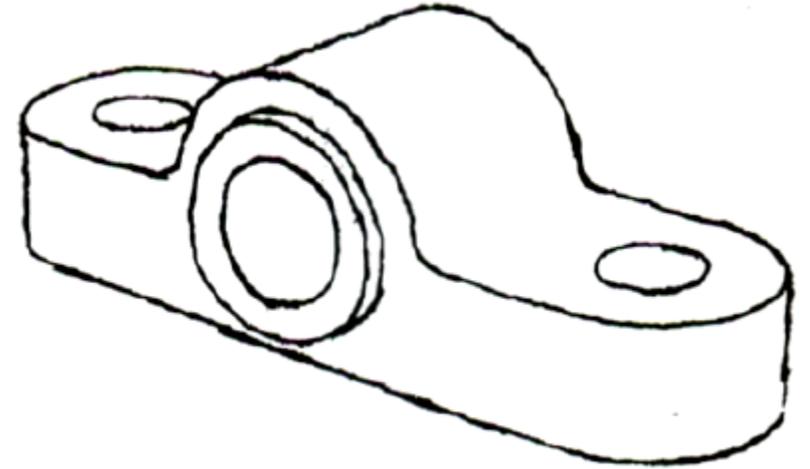


- **Visible line:** represent features that can be seen in the current view.
- **Dimension line, Extension line, Leader line:** indicate the sizes and location of features.
- **Hidden line:** represent features that can not be seen in the current view.
- **Center line:** represents symmetry, path of motion, centers of circles, axis of asymmetrical parts.



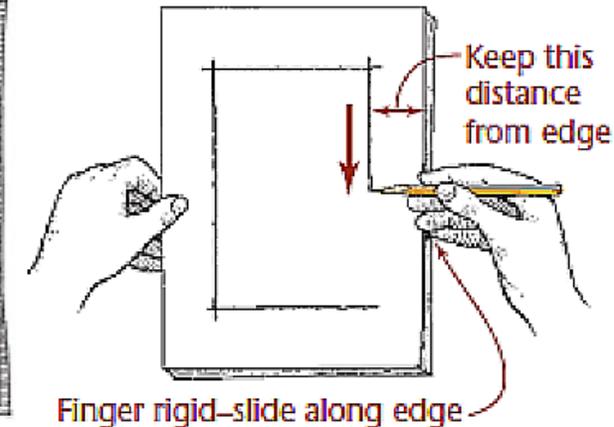
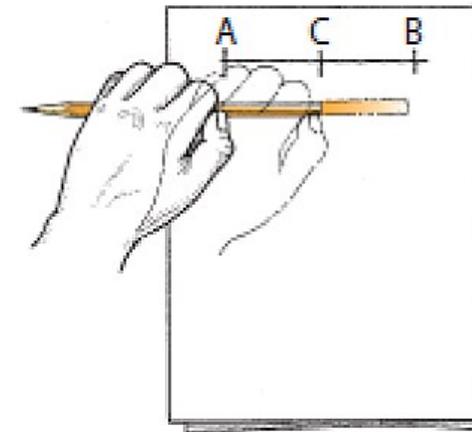
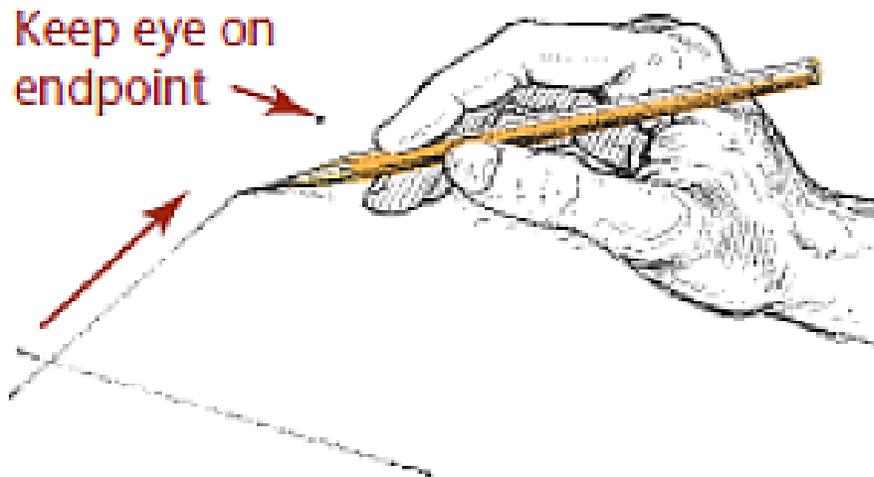
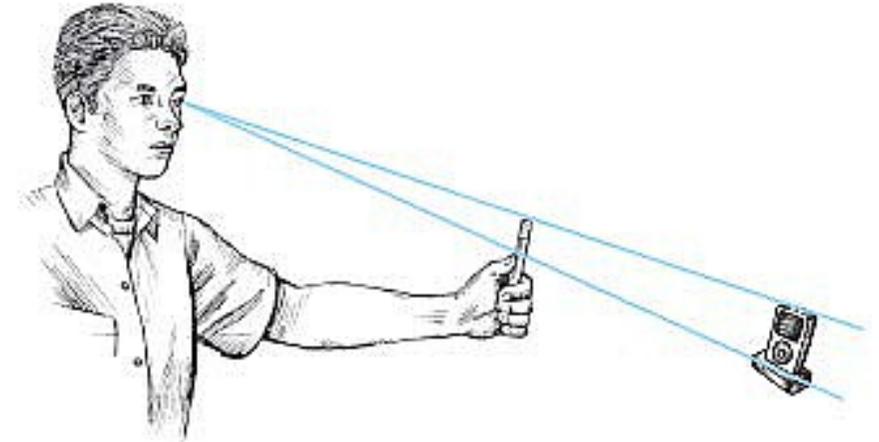
Types of Drawings: Freehand drawing/sketch

- The lines are sketched without using instruments other than pencils and erasers.
- Used at **conceptual stage of design**
- Freehand sketches are a helpful way to **organize your thoughts and record ideas**.
- They provide a **quick, low-cost** way to explore various solutions to design problems so that the best choices can be made.



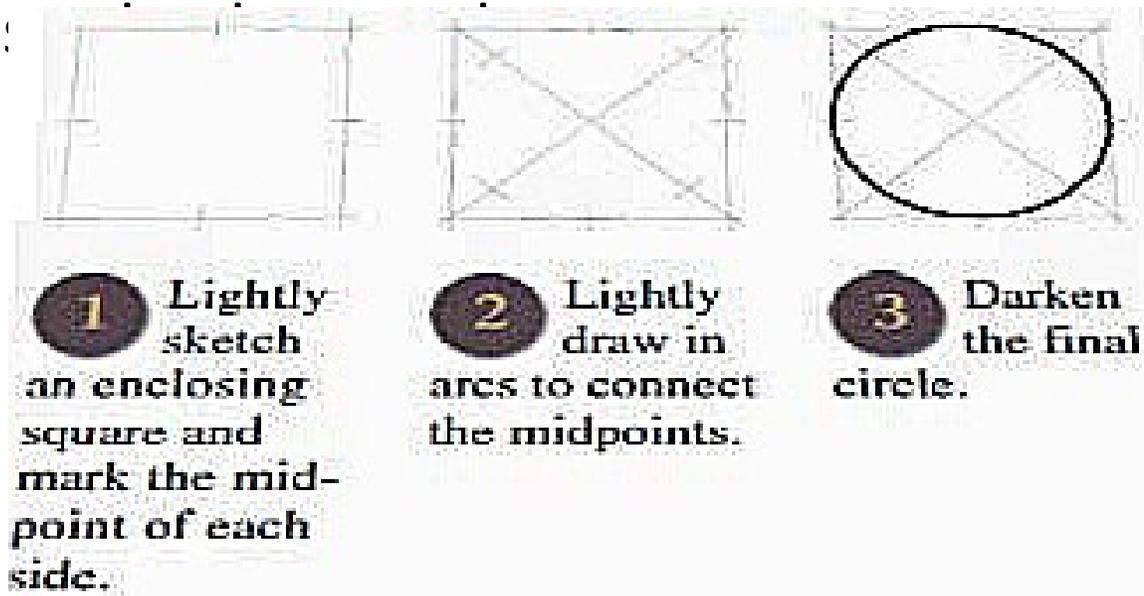
Freehand Sketching Techniques

For *long straight lines*, mark end points and sweep your pencil between them, while keeping your eye on the end point. When you are satisfied with the accuracy of your stroke then apply pressure.

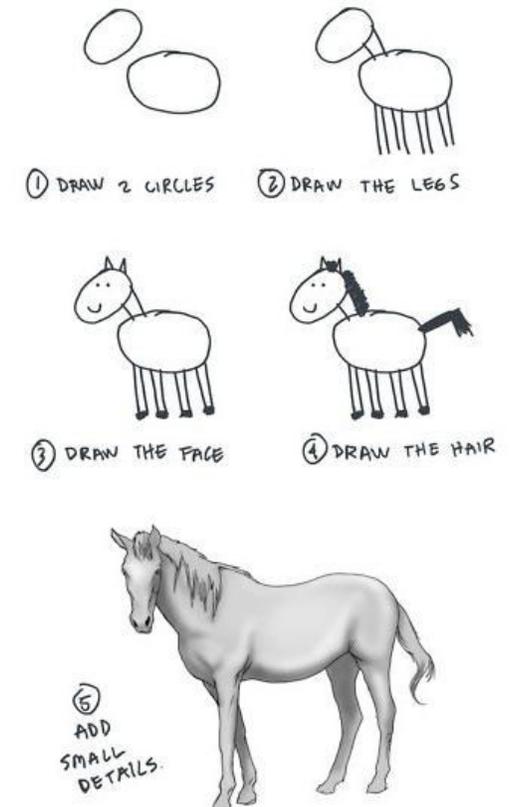


Freehand Sketching Techniques (Cont.)

For *circles*, lightly sketch a square with length of circle diameter. Afterwards, divide the circles into eight equal parts by two straight and two diagonal lines. When you are satisfied with the accuracy of your :



HOW TO: DRAW A HORSE BY VAN OKTOP



Understanding Sketching Techniques

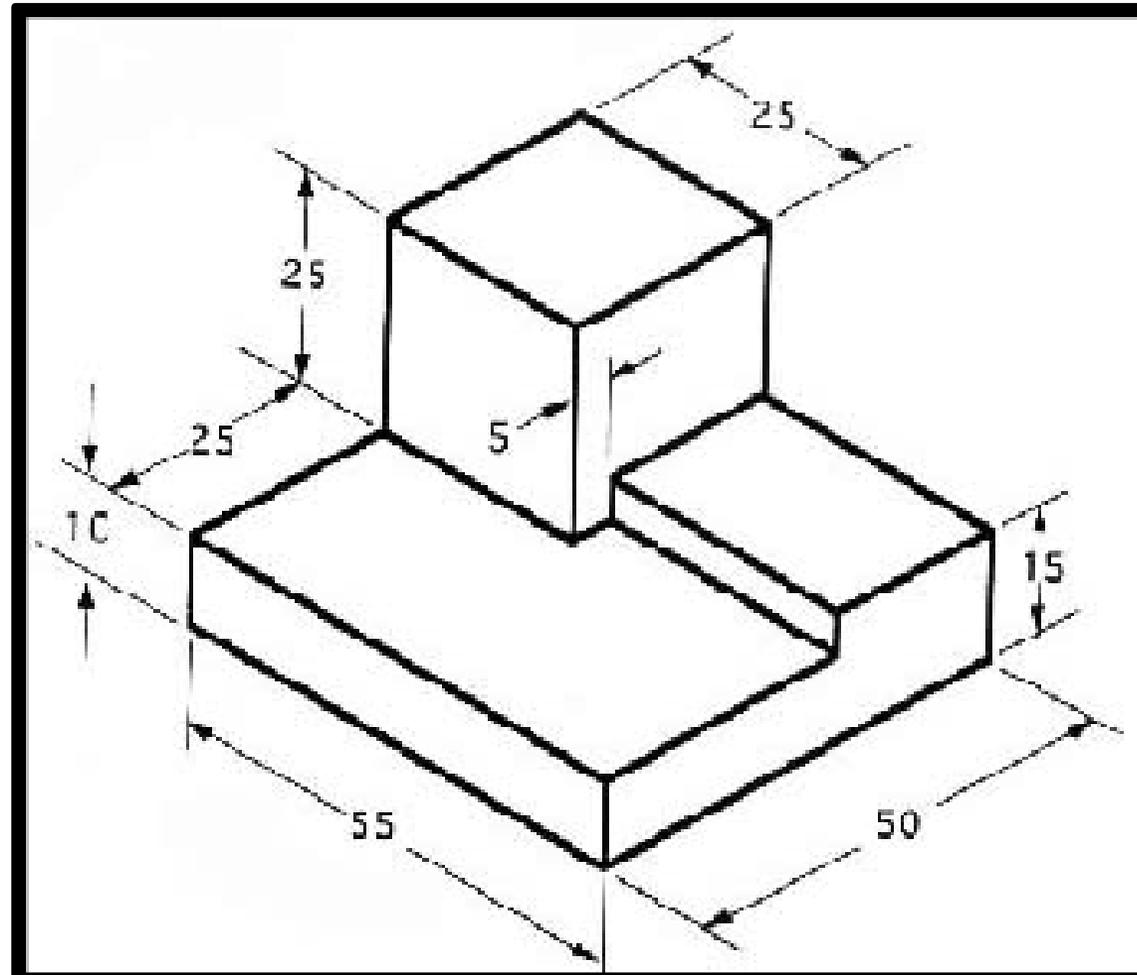
Break down **complex shapes** into simpler geometric primitives



Look for the *essential shapes* of objects and use *construction lines*

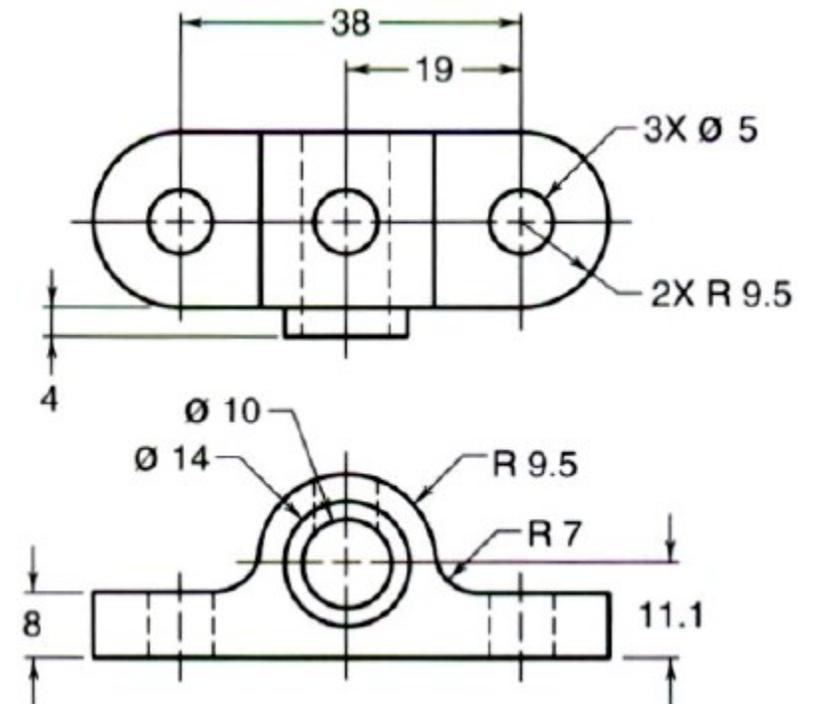


Lab Tasks 5(A): Draw a careful free hand sketch of the following figure



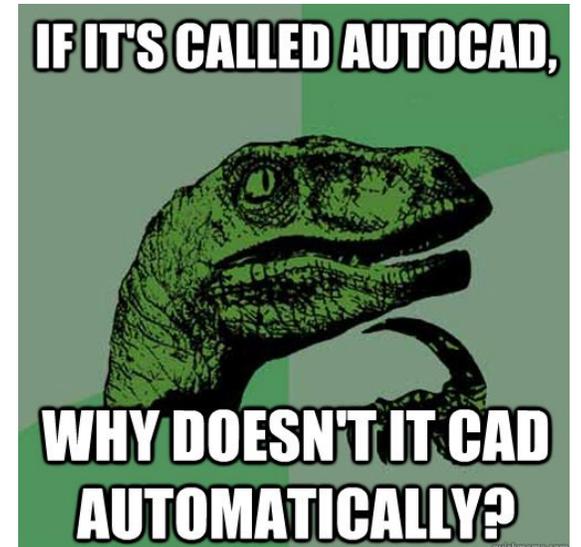
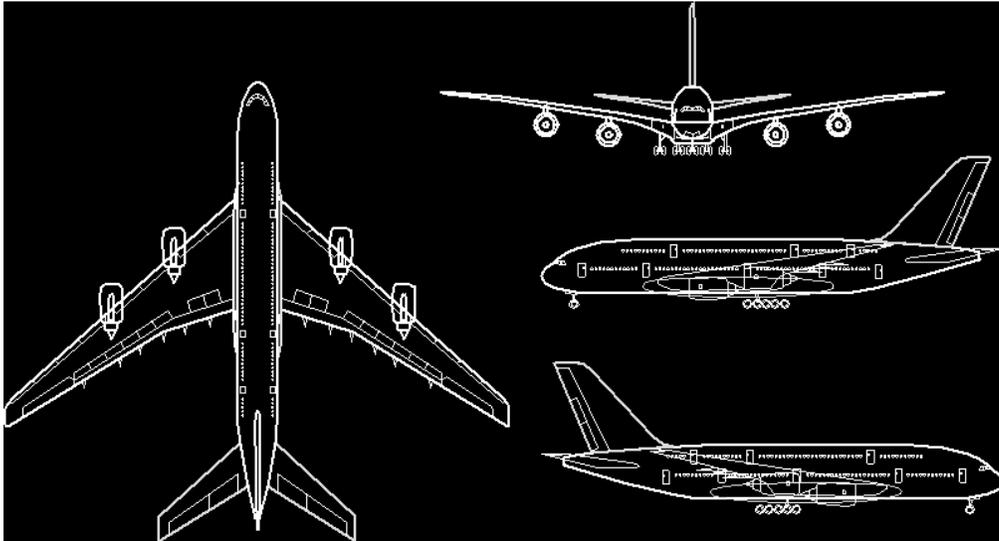
Types of Drawings: Instrument drawing

- Instruments are used to draw straight lines, circles, and curves concisely and accurately. Thus, the drawings are usually made to scale.



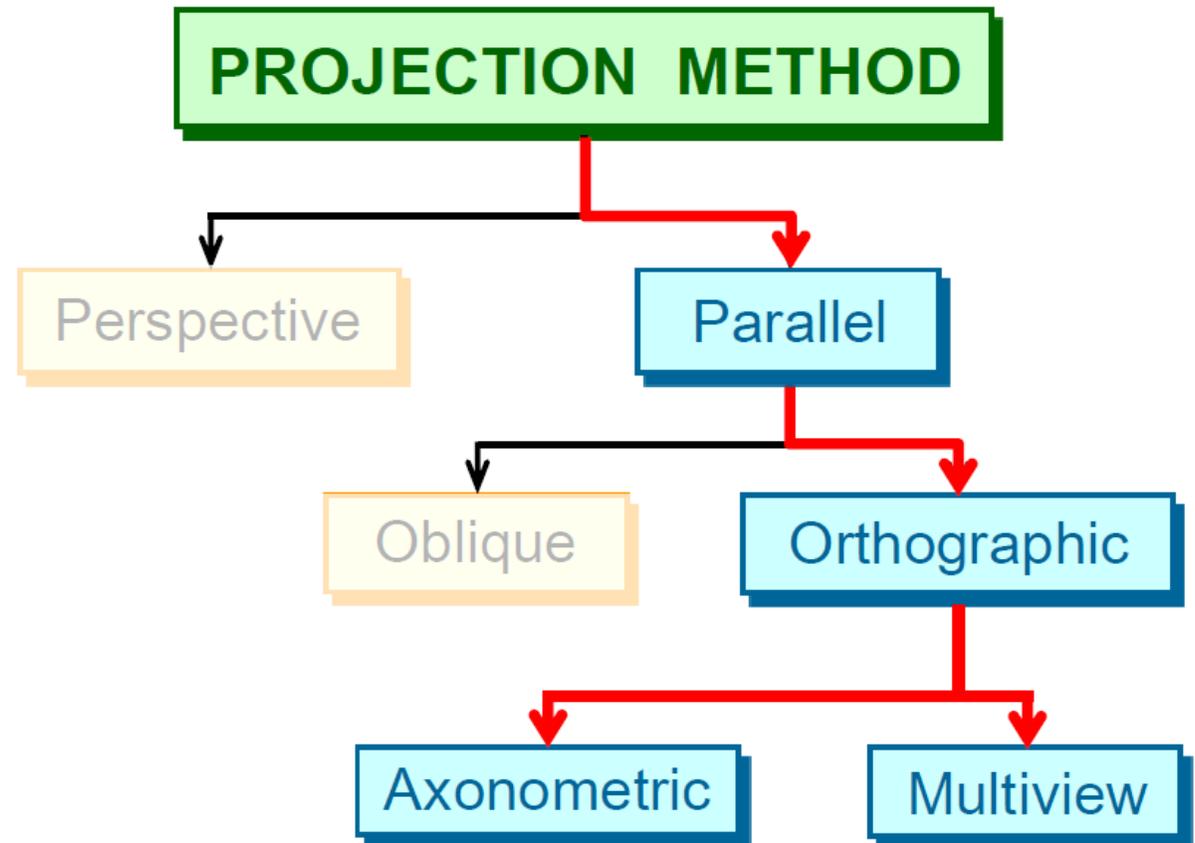
Types of Drawings: Computer Aided Drawing

The drawings are usually made with the help of commercial softwares such as AutoCAD, Solid Works, **Creo** etc.



Engineering Drawing: Projections

- The projection theory is used to graphically represent *3-D objects* on *2-D media* (paper, computer screen).
- The projection theory is based on two variables:
 - Line of sight
 - Plane of projection (image plane or picture plane)

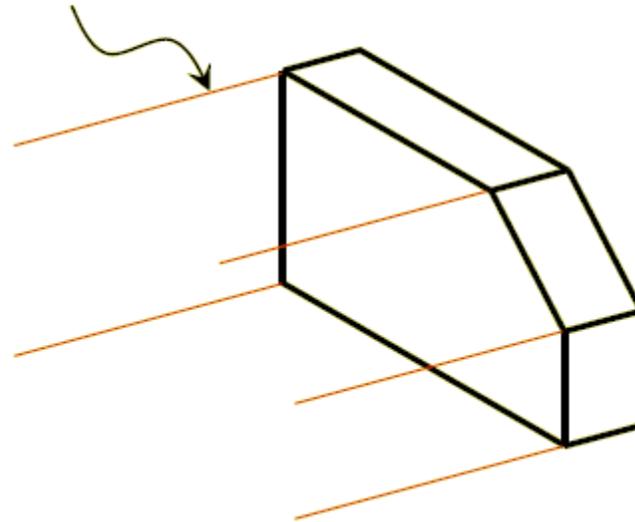


Projection: Line of Sight

- *Line of sight* is an imaginary ray of light between an observer's eye and an object
- There are 2 types of Line of Sight (LOS)
 - Parallel projection
 - Perspective projection

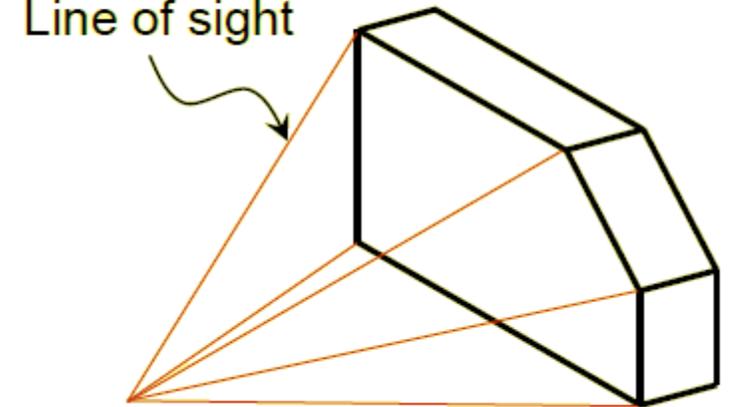
Parallel projection

Line of sight



Perspective projection

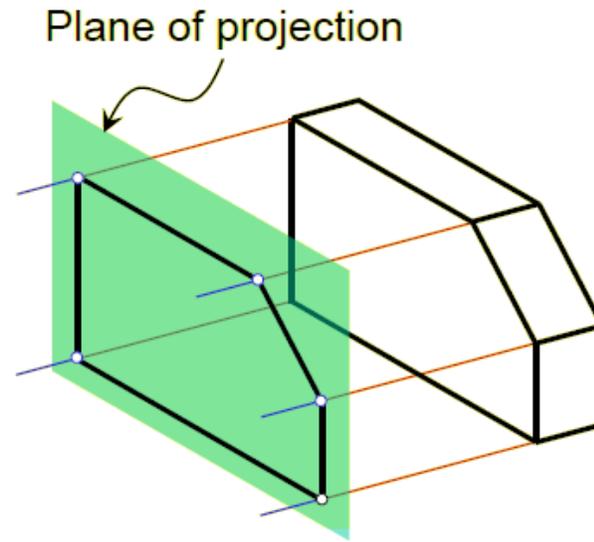
Line of sight



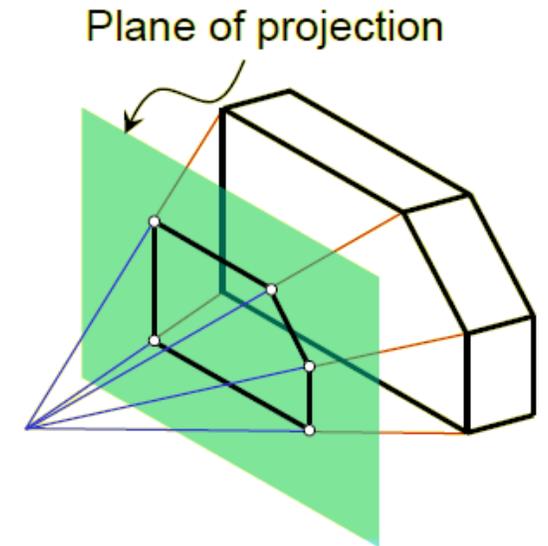
Projection: Plane

- *Plane of projection* is an imaginary flat plane which the image is created
- The image is produced by connecting the points where the LOS pierce the projection plane.

Parallel projection

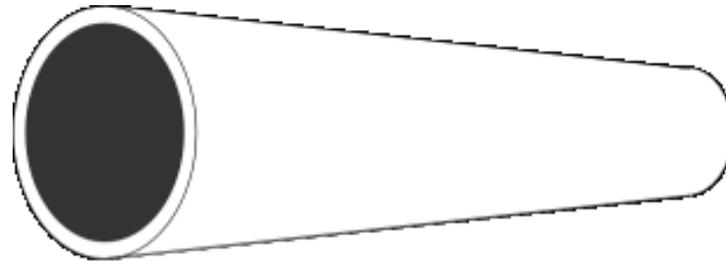
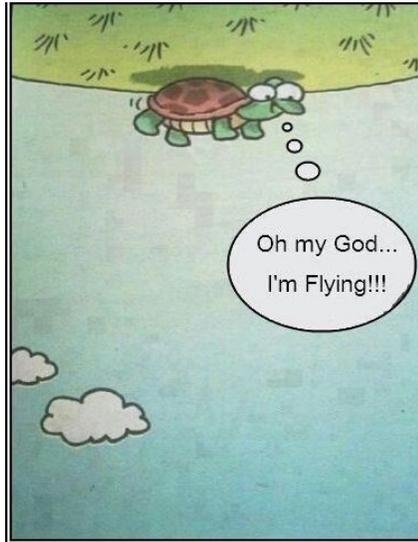


Perspective projection



Disadvantage of Perspective Projection

- It is difficult to create.
- It does not reveal exact shape and size.



Pipe as appearing to the observer

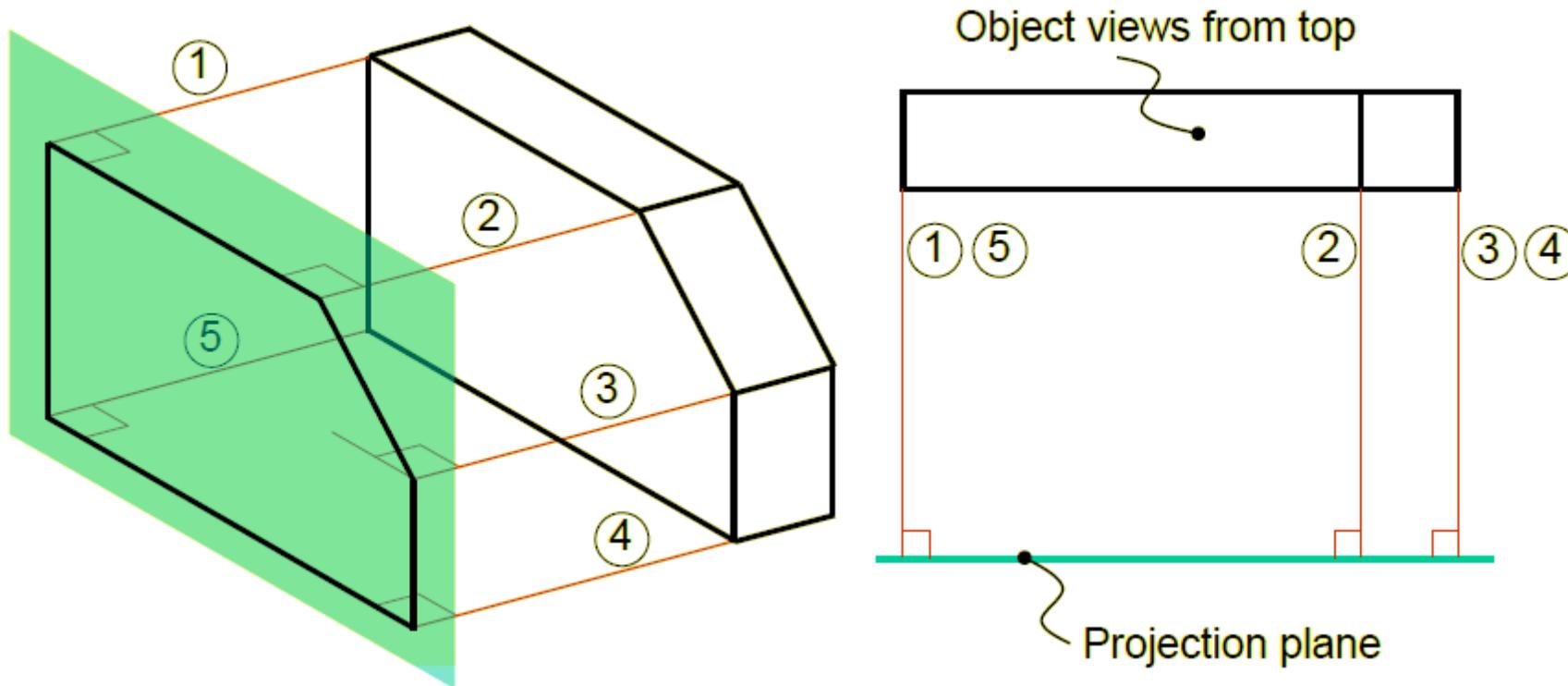


Real Pipe Dimensions



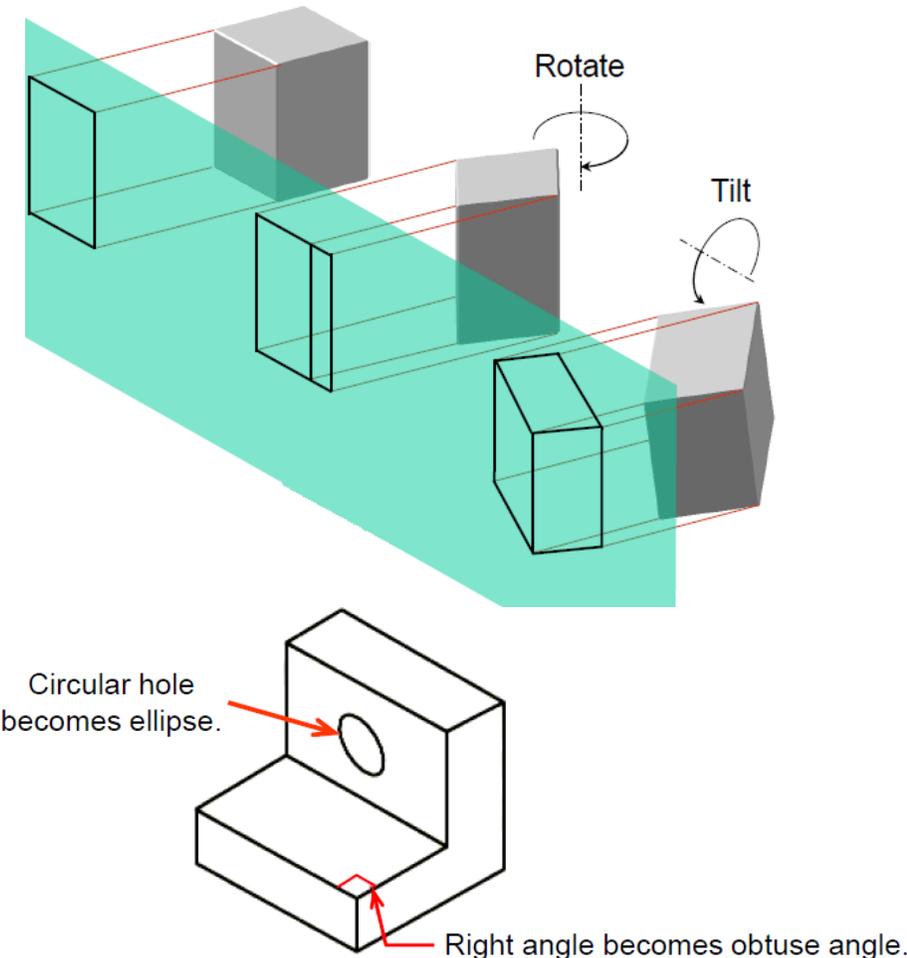
Orthographic Projections

- **Orthographic projection** is a parallel projection technique in which the parallel lines of sight are *perpendicular* to the projection plane



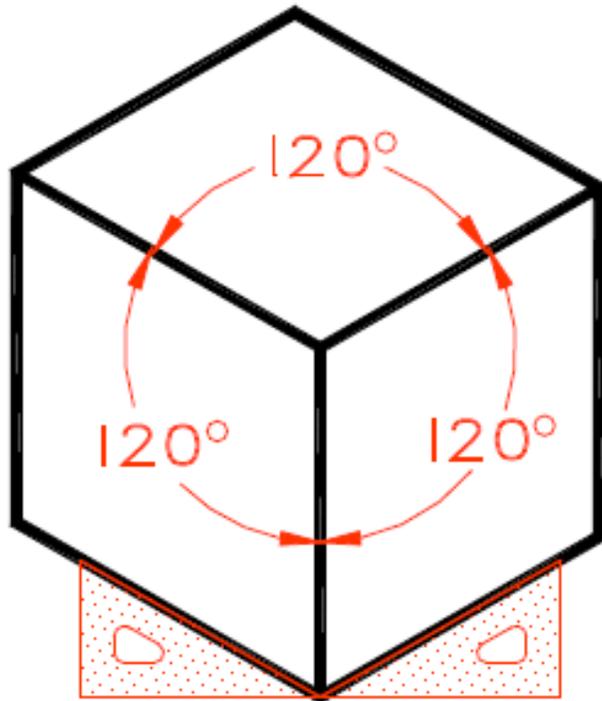
Orthographic Projections (Cont.)

- **Orthographic view** depends on relative position of the object to the line of sight.
 - Two dimensions of an object is shown.
 - More than one view is needed to represent the object.
 - Multi-view drawing
- **Axonometric drawing**
 - Three dimensions of an object in one view.
 - **Advantage:** Easy to understand
 - **Disadvantage:** Shape and angle distortion



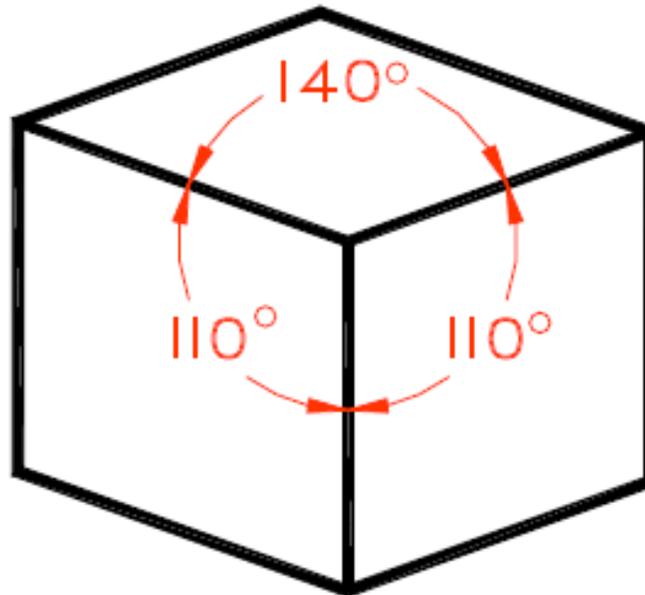
Types of Axonometric

3 Equal axes
3 Equal angles



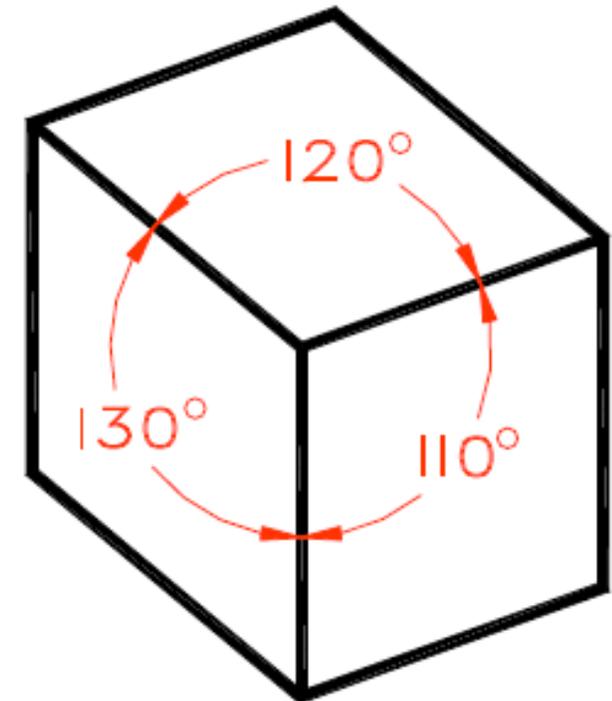
A. ISOMETRIC

2 Equal axes
2 Equal angles



B. DIMETRIC

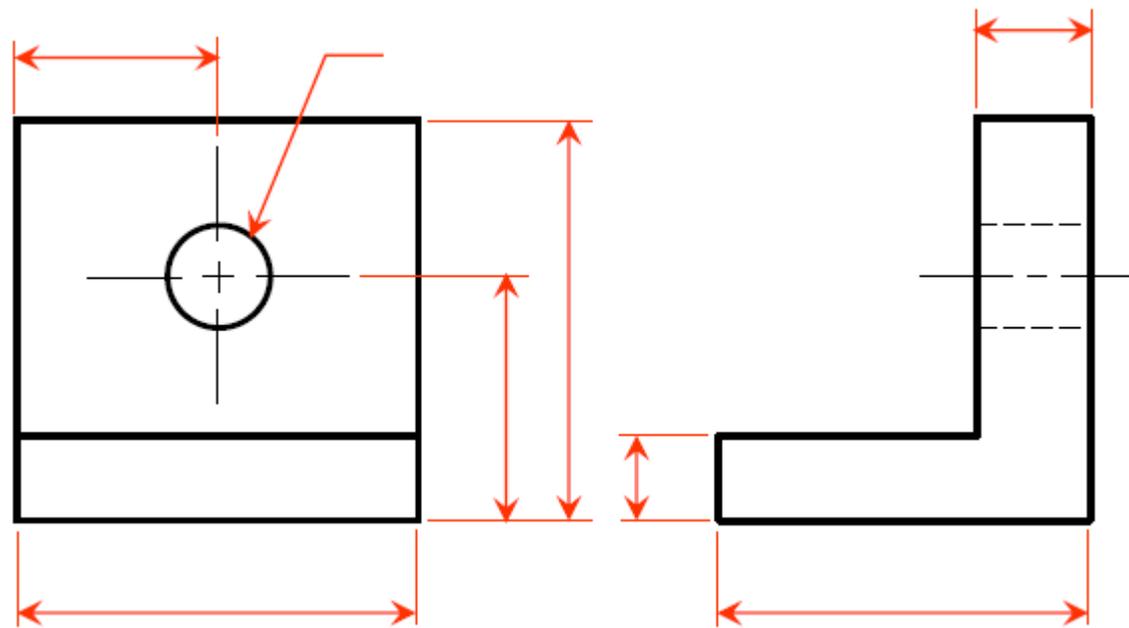
0 Equal axes
0 Equal angles



C. TRIMETRIC

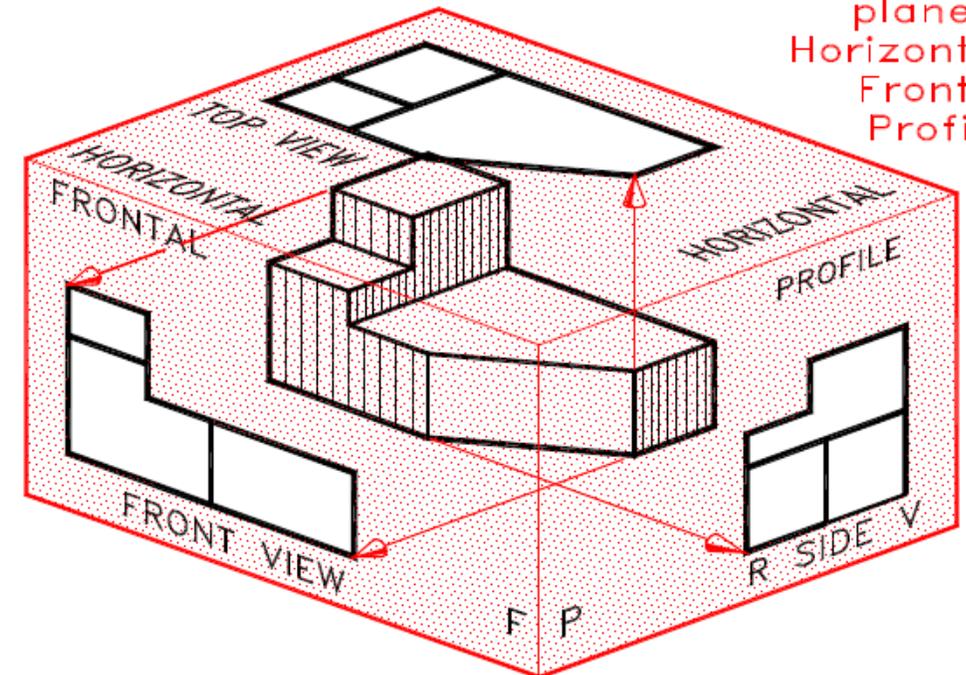
Understanding Orthographic Projections

- **Advantage:** It represents accurate shape and size.
- **Disadvantage:** It requires practice in writing and reading.

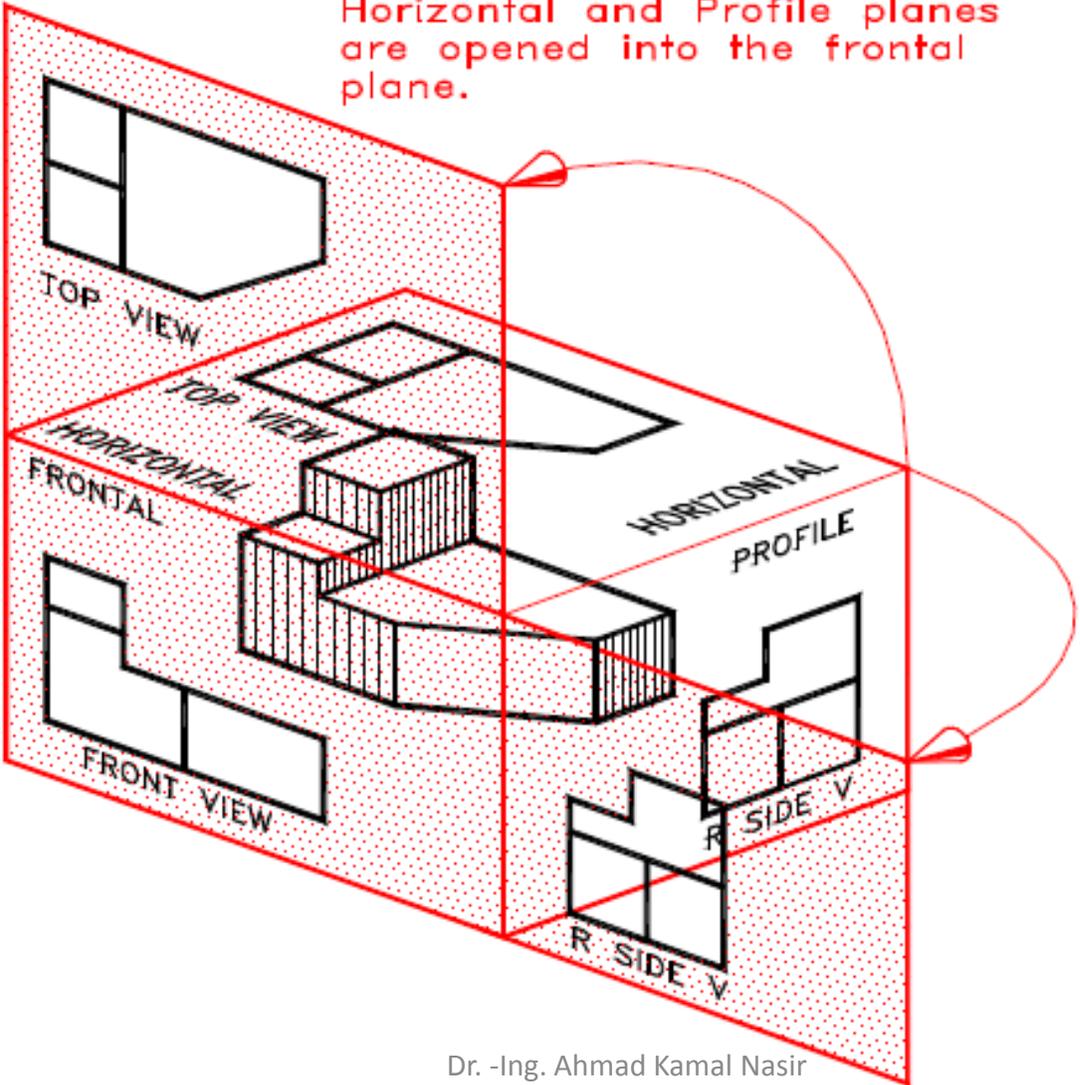


THE GLASS-BOX APPROACH

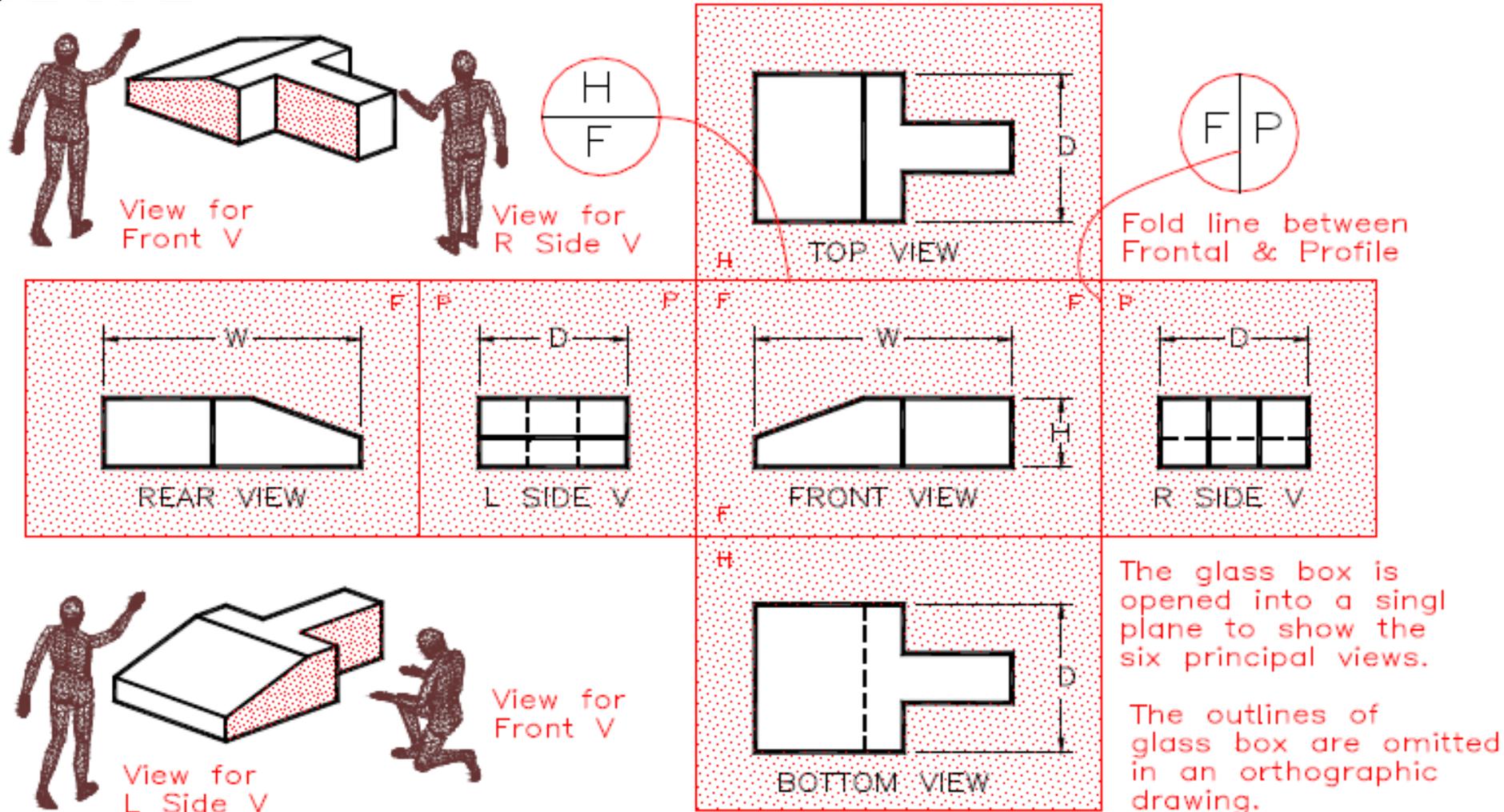
Principal projection planes:
Horizontal
Frontal
Profile



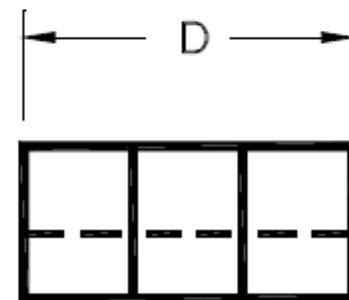
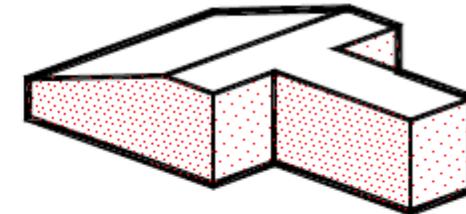
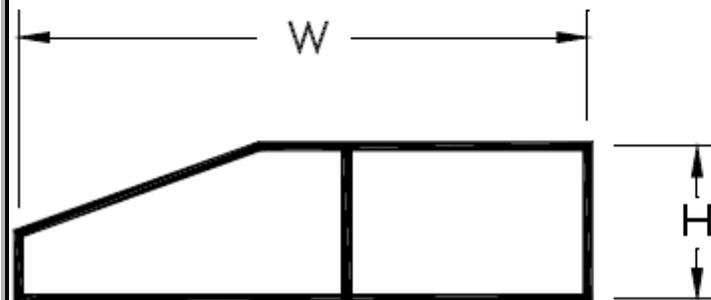
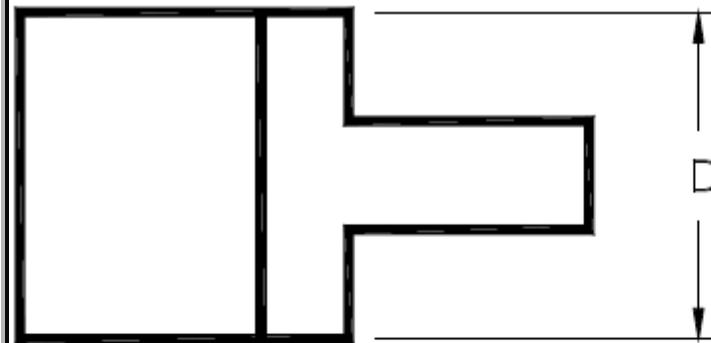
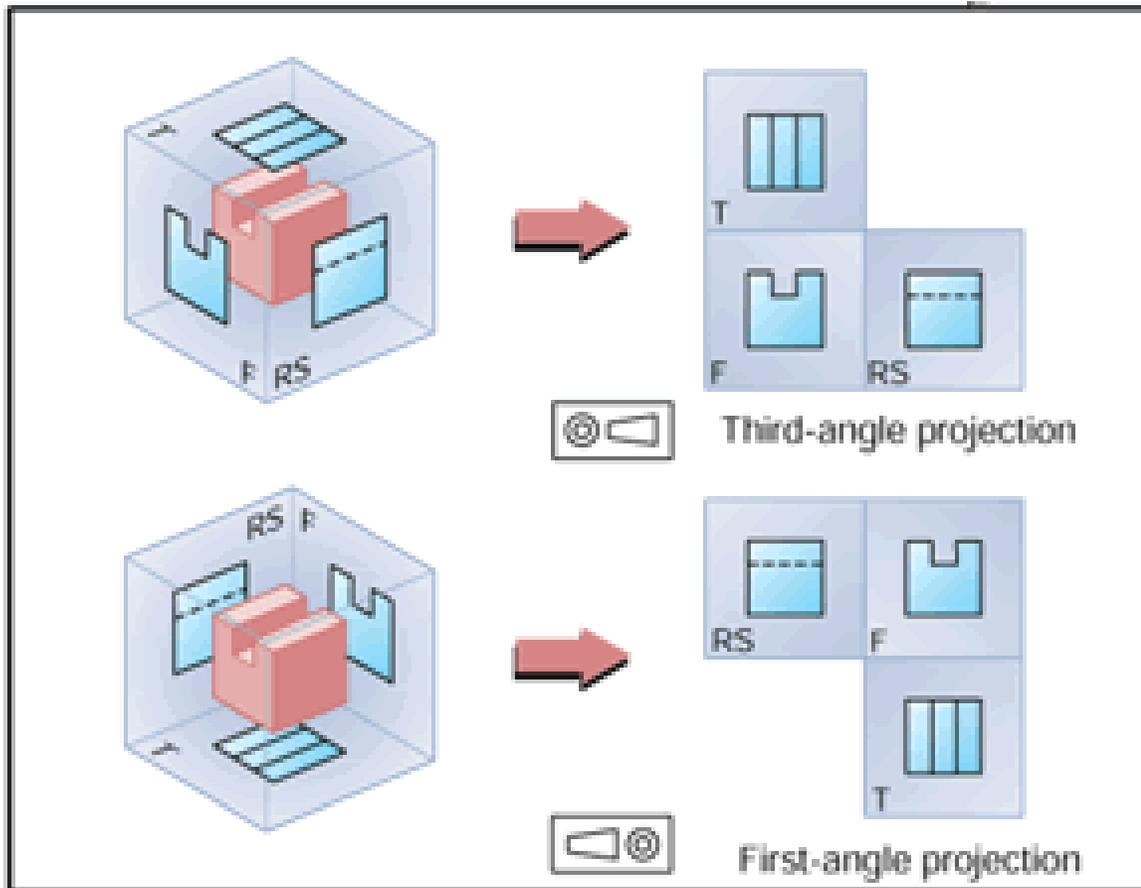
Understanding Orthographic Projections (Cont.)



Orthographic Projections: Final Views

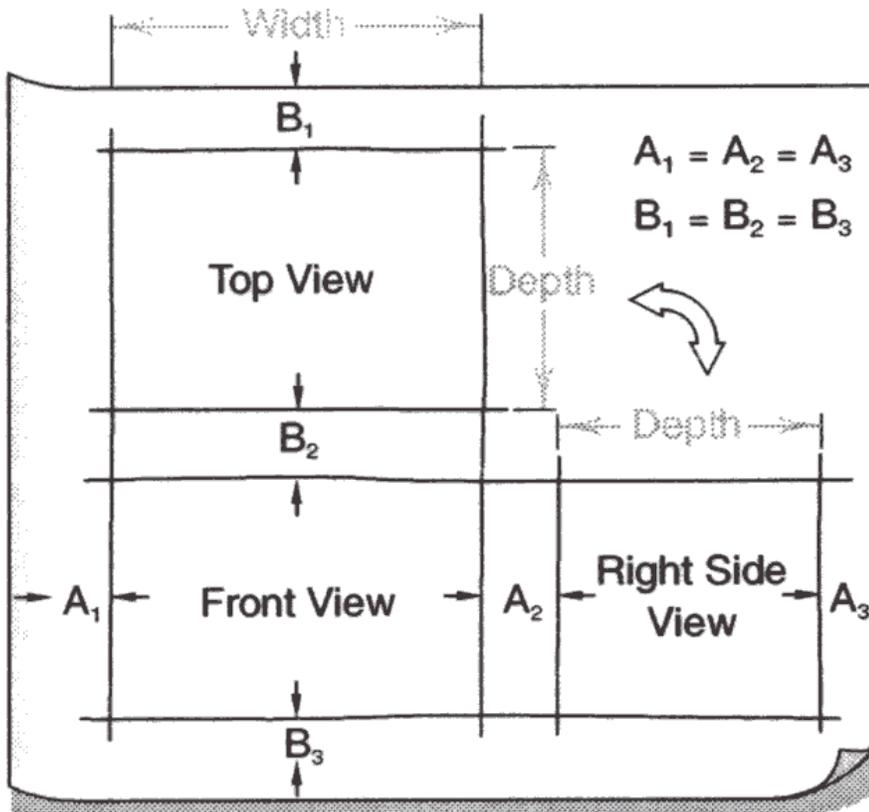


Primary Orthographic Views

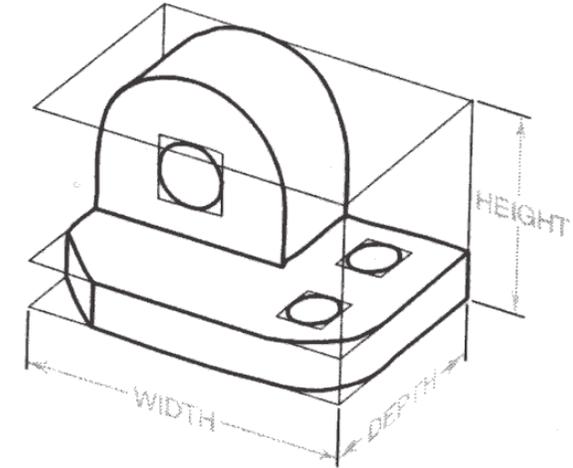
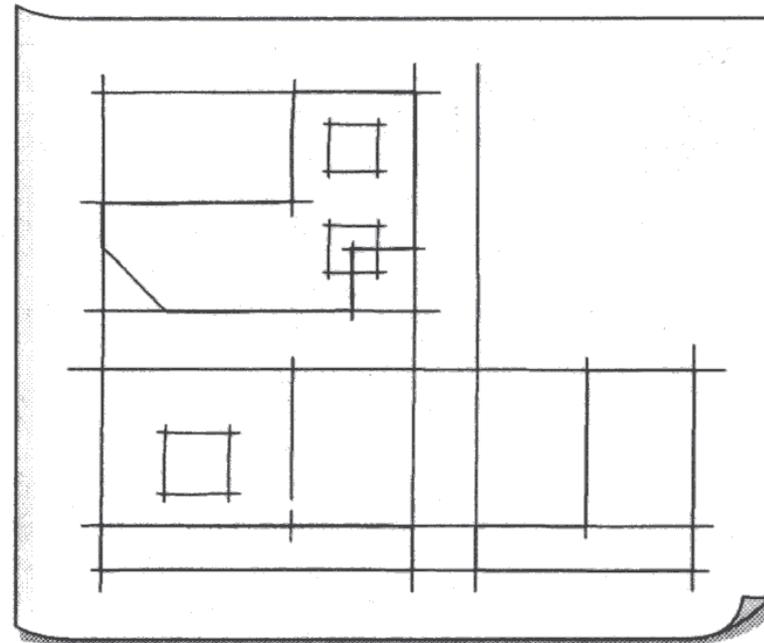


First Angle – International
Third Angle – U.S.

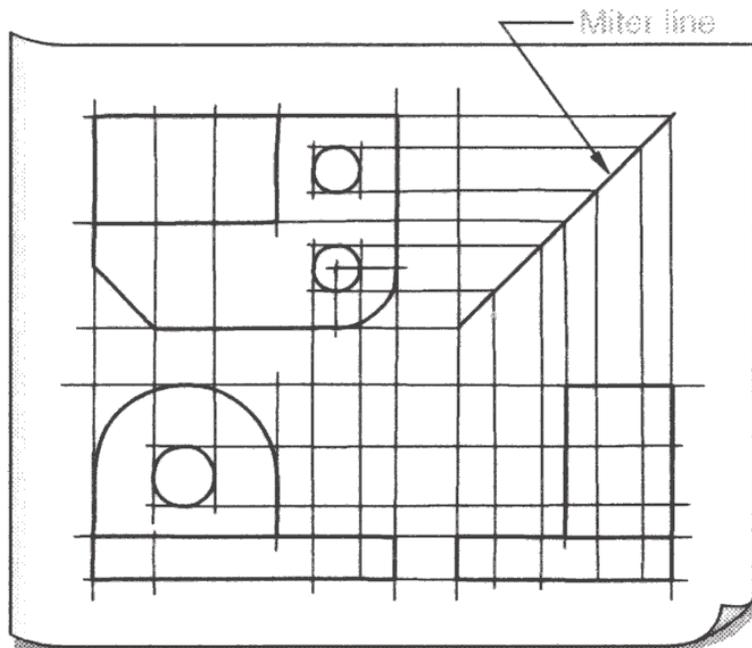
Creating Orthographic Projections



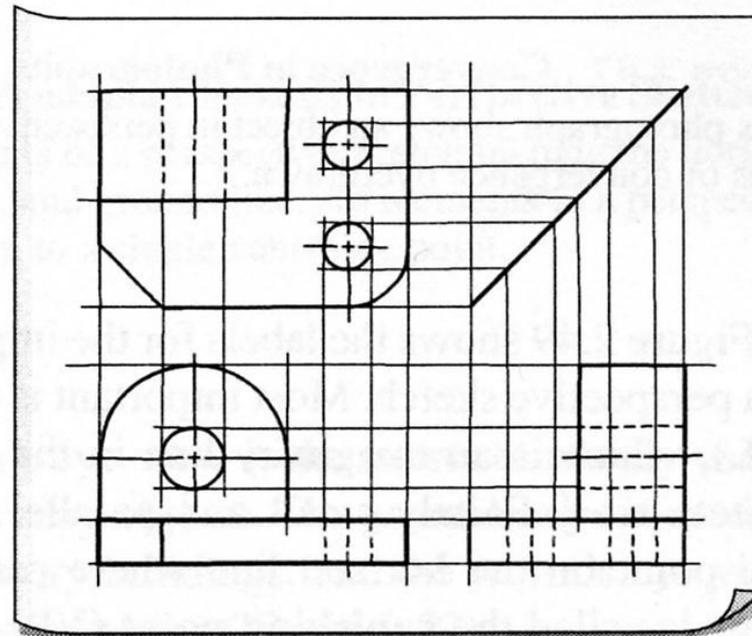
Step 1



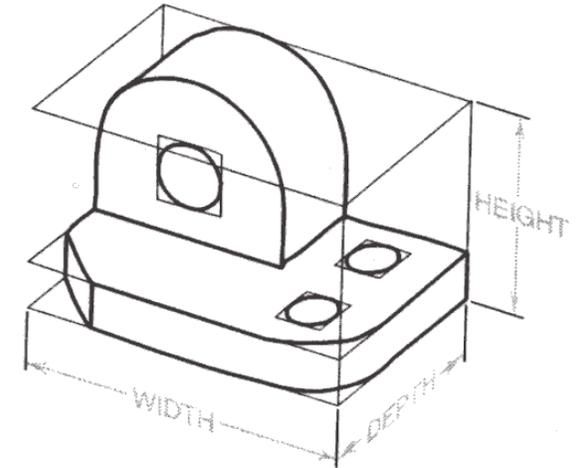
Creating Orthographic Projections



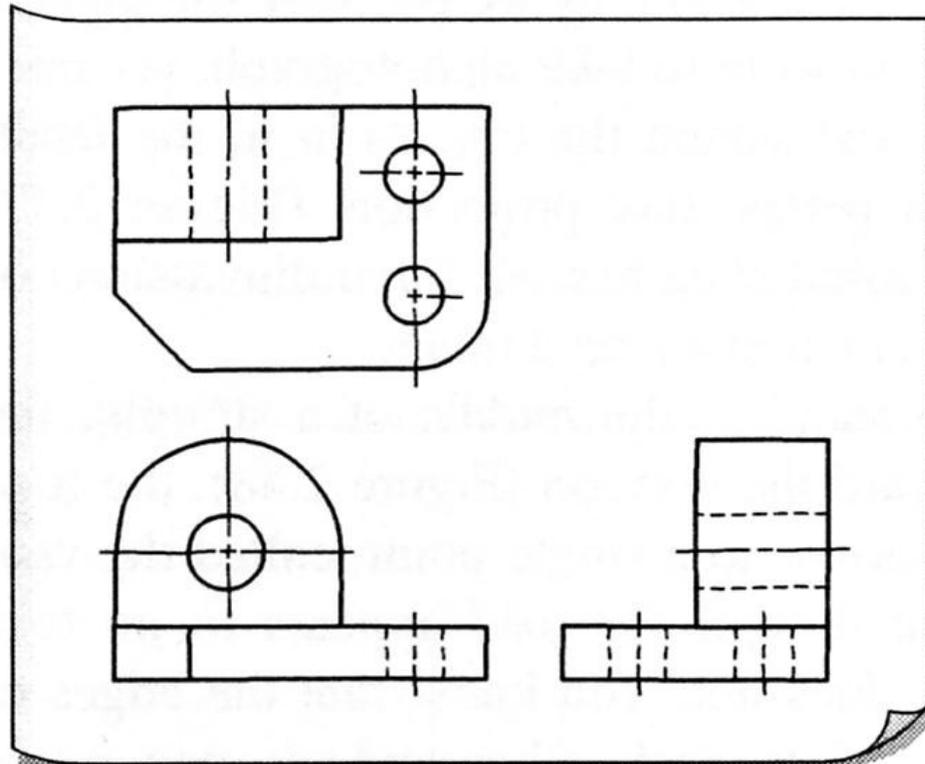
Step 3



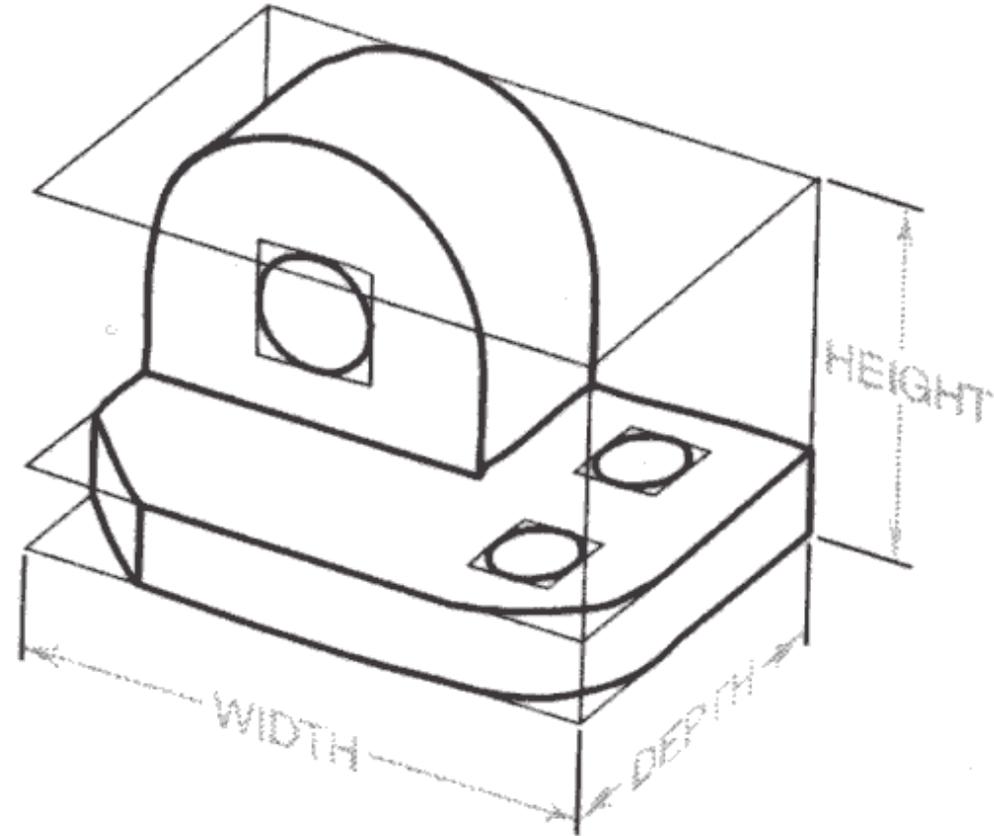
Step 4



Final Orthographic Projections



Completed 3-view sketch





ANY QUESTIONS?

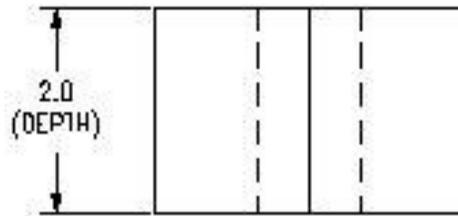
Lab Task 5(B,C,D) : Orthographic Projections

- Draw front views, side views and top views of the items provided.

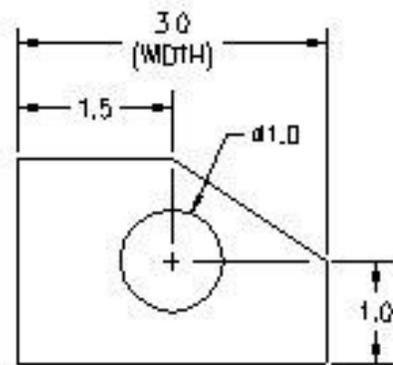


Lab Task 5(E): Isometric Projection

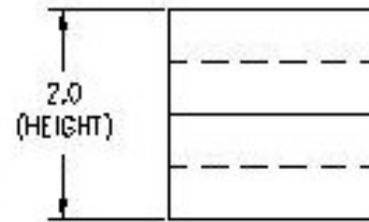
- Draw the isometric view of the part whose orthographic projects are as follows.



TOP VIEW



FRONT VIEW



RIGHT SIDE VIEW

