

# ECOR 1010

## Lecture 5

Engineering Graphics - 1

# How Do Engineers Communicate?

- Engineers convey information in three principal ways
  - Written Documents
  - Oral Presentations
  - Graphically
- Sometimes a combination is needed

# Importance of Engineering Graphics

- The majority of engineering information is transmitted by graphical means
- But unambiguous written and verbal communication is also central to successful engineering communication

# Example – Describing an Object

- Written Communication
  - Made of metal, this tool has a handle and a heavy irregular shaped head
  - The handle has a rubber grip
  - The length of the head runs perpendicular to the handle
  - The head has a rounded blunt end for impact, along with two flattened stems formed by a tapered groove at the opposite end
  - The length of the tool is approximately 30 cm and it weighs about 1 kg

# A Picture is Worth ...

- Graphical Communication



**Figure 12.1** This picture is worth at least 75 words.

# The Point

- Obviously, graphics can convey some information in an easier to understand way
- Imagine how difficult some things would be without graphical communication:
  - Advertising
  - Instructions
  - Education
  - Engineering!

# Advantages of Graphical Communication

- Clear
- Concise
- Efficient
- Reduced Ambiguity

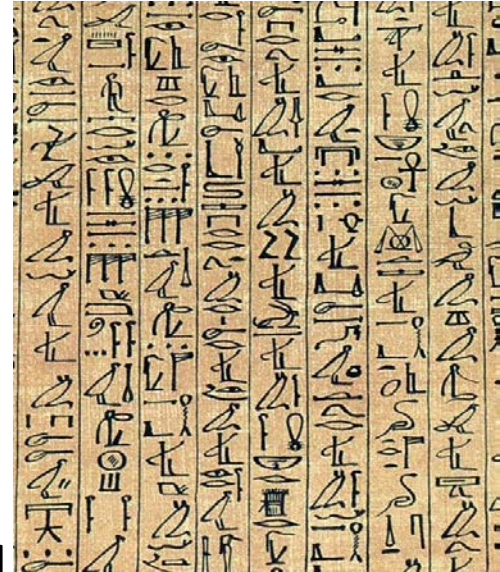
# Graphical Representation



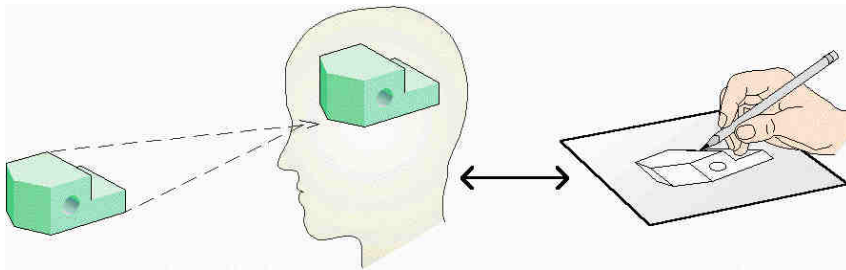
"Wait! Wait! ... Cancel that, I guess it says 'help.'"

# Engineering Graphics

- Graphics is a universal language
- The earliest forms of written communication were pictorial
  - Egyptian Hieroglyphics
- Engineering graphics are directed towards graphical problem solving
- A good drawing is “worth a thousand words”
- Moreover, good engineering graphics are self explanatory!



# Graphical Representation



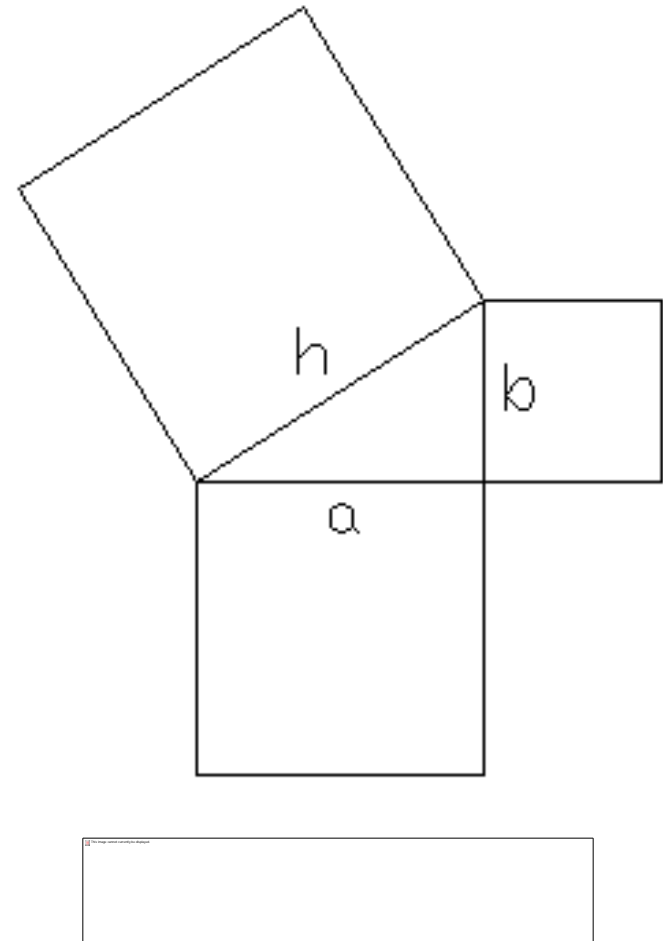
- Practical engineering problems stem from problems associated with the graphical representation of ideas that have to be turned into physical reality: **parts**
- A visual image is formed in the mind, reviewed, modified, and ultimately communicated to someone else in the form of graphics

# Graphical Representation

- It is crucial that the graphical representation be clear and unambiguous
- The image must be precise and exact

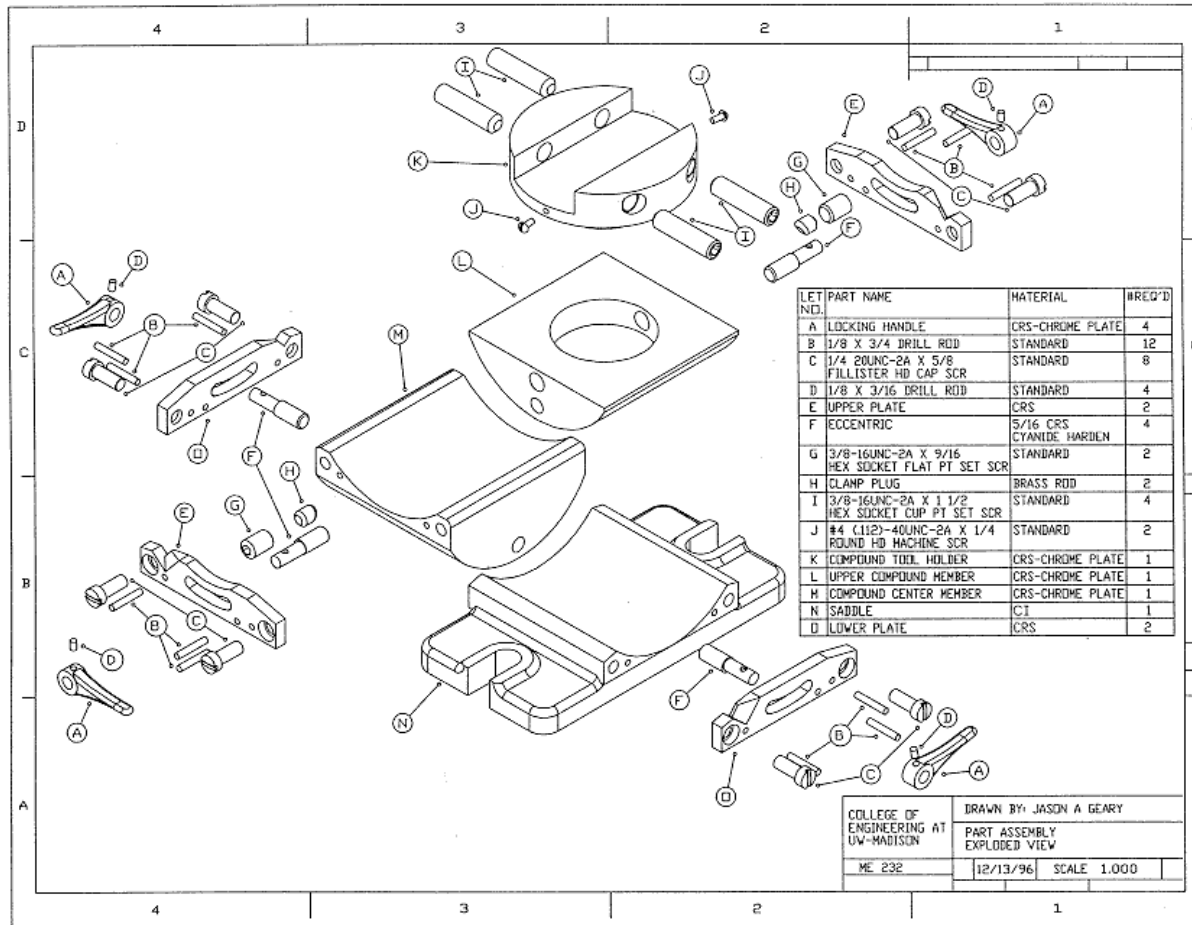
# Engineering Graphics & Geometry

- The word geometry means “earth measure”
- Geometry as a science may have begun in Egypt, to measure the areas of fields to assess taxes
- Calculus and algebra are abstractions of geometry
  - e.g., Pythagorean theorem
- Ancient Indian, Chinese, Egyptian, Greek and Roman builders, among others, used graphics to solve complex design problems associated with large structures

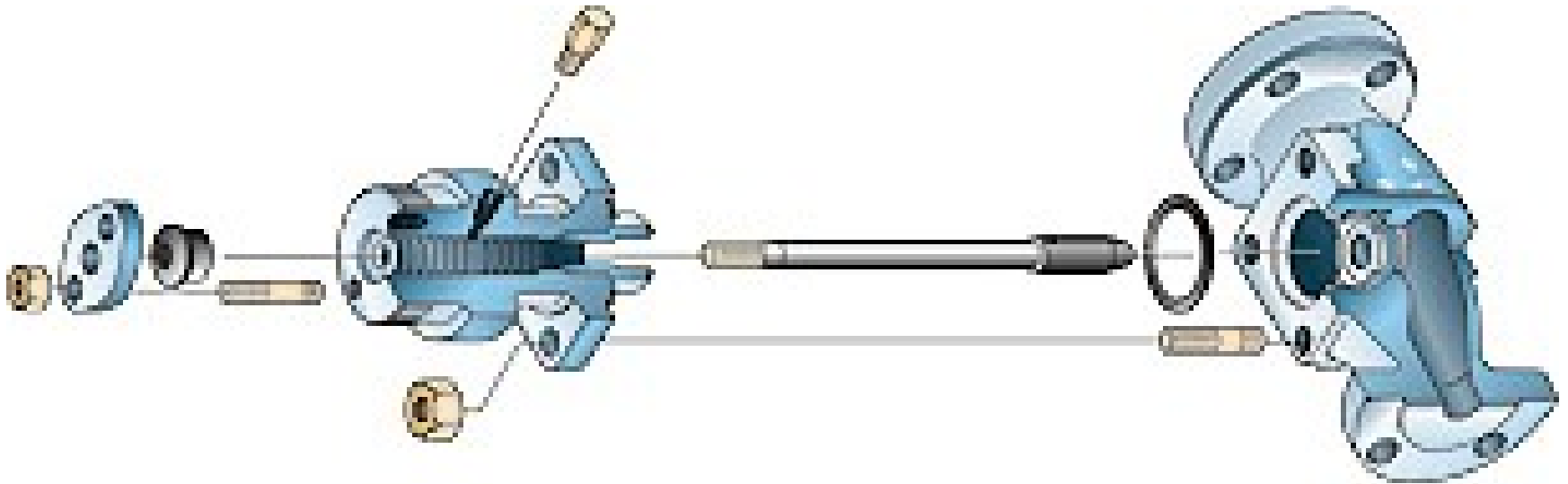




# Production Assembly Drawings



# Pictorial Assembly Drawings



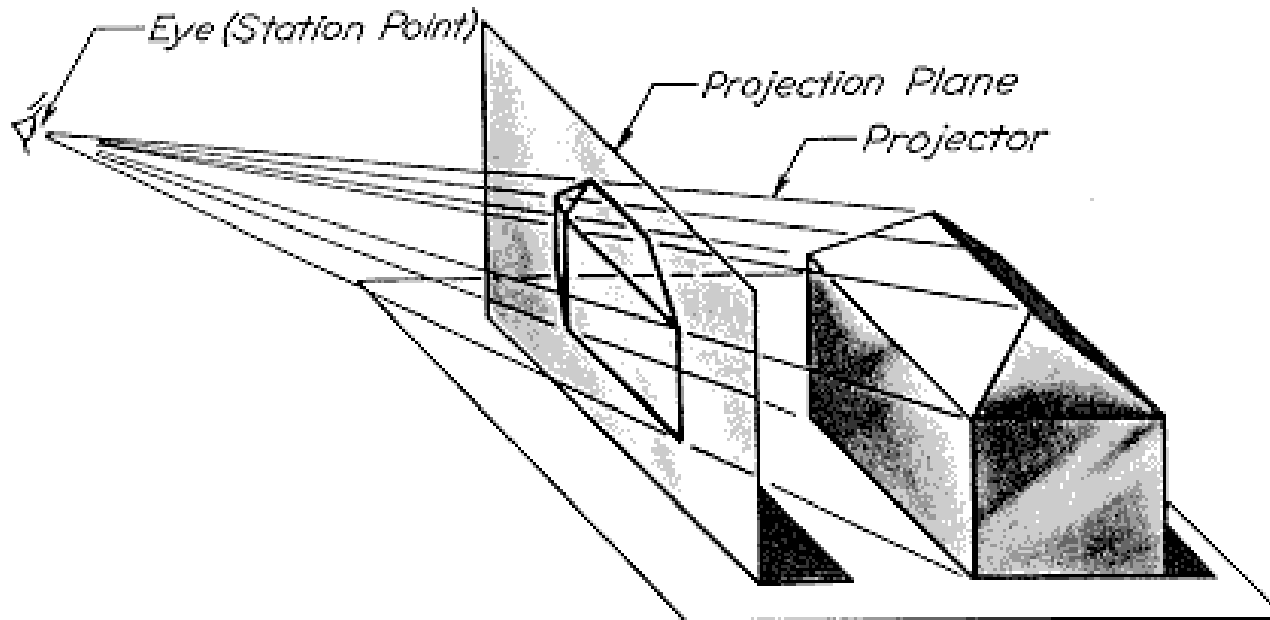
Pictorial assembly (exploded) drawing  
Used to illustrate catalogues, user manuals, etc.

# Perspective Projection

- In perspective projection the projectors intersect at finite points, called vanishing points (VP)
- The representation on the projection plane may be considered the view that would be seen by a single eye at a known point in space (station point)
- The picture is formed on the projection plane by the intersections of the projecting lines from the object to the focal point of the eye

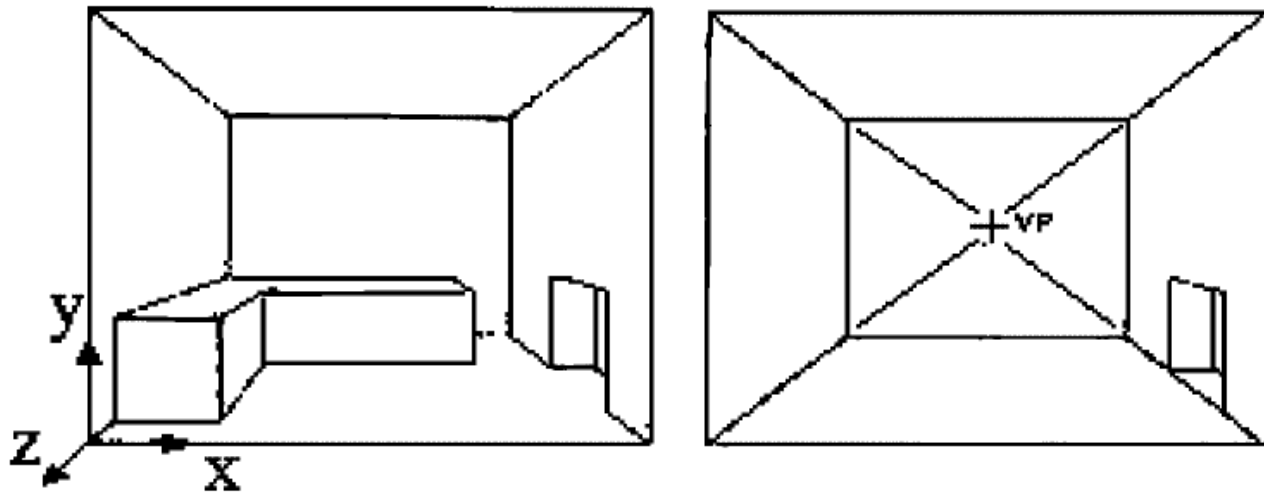
# Perspective Projection

- Perspective projection is used primarily by architects and commercial artists to describe the external appearance of an object



# Perspective Projection

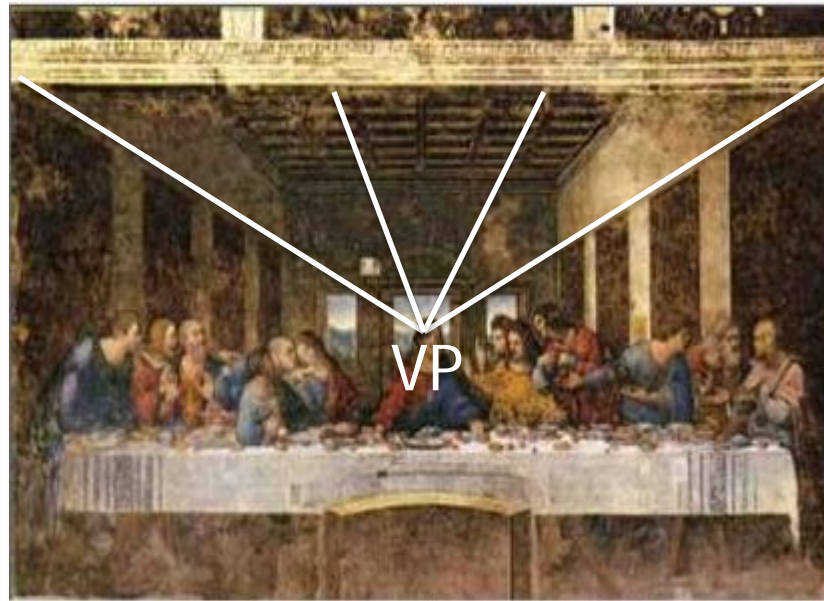
- One-Point Perspective
  - The projection plane is parallel to two principal axes. Receding lines along one of the principal axis converge to a vanishing point
  - A one-point perspective is used almost exclusively for interior-room views. It gives the observer the illusion of looking into the room



**Figure 12.12** One-point perspective.

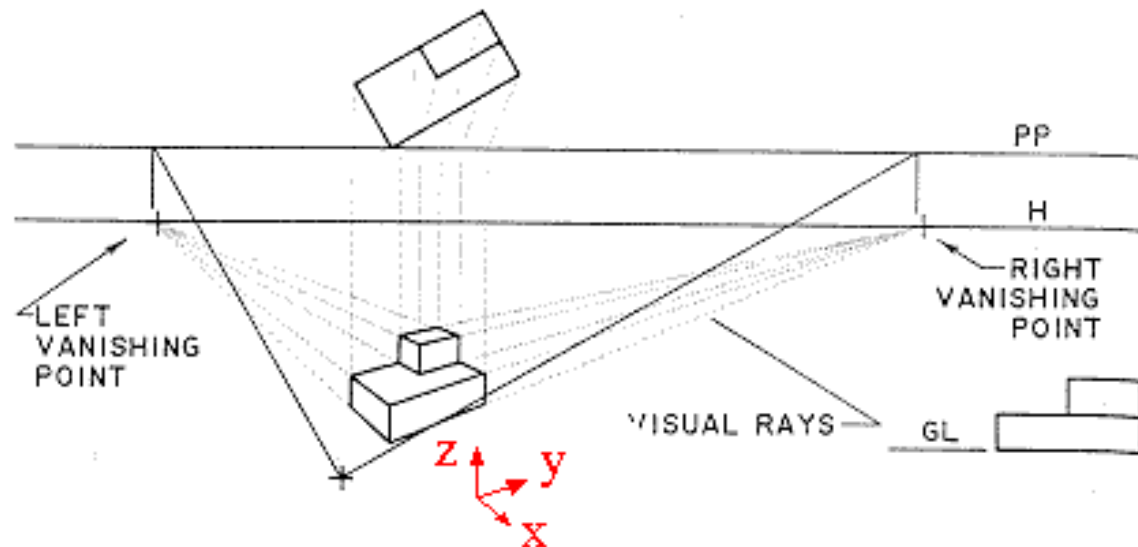
# Perspective Projection

- LeonardoDa Vinci: The Last Supper employed one-point perspective to focus the attention of the viewer to the vanishing point (VP)



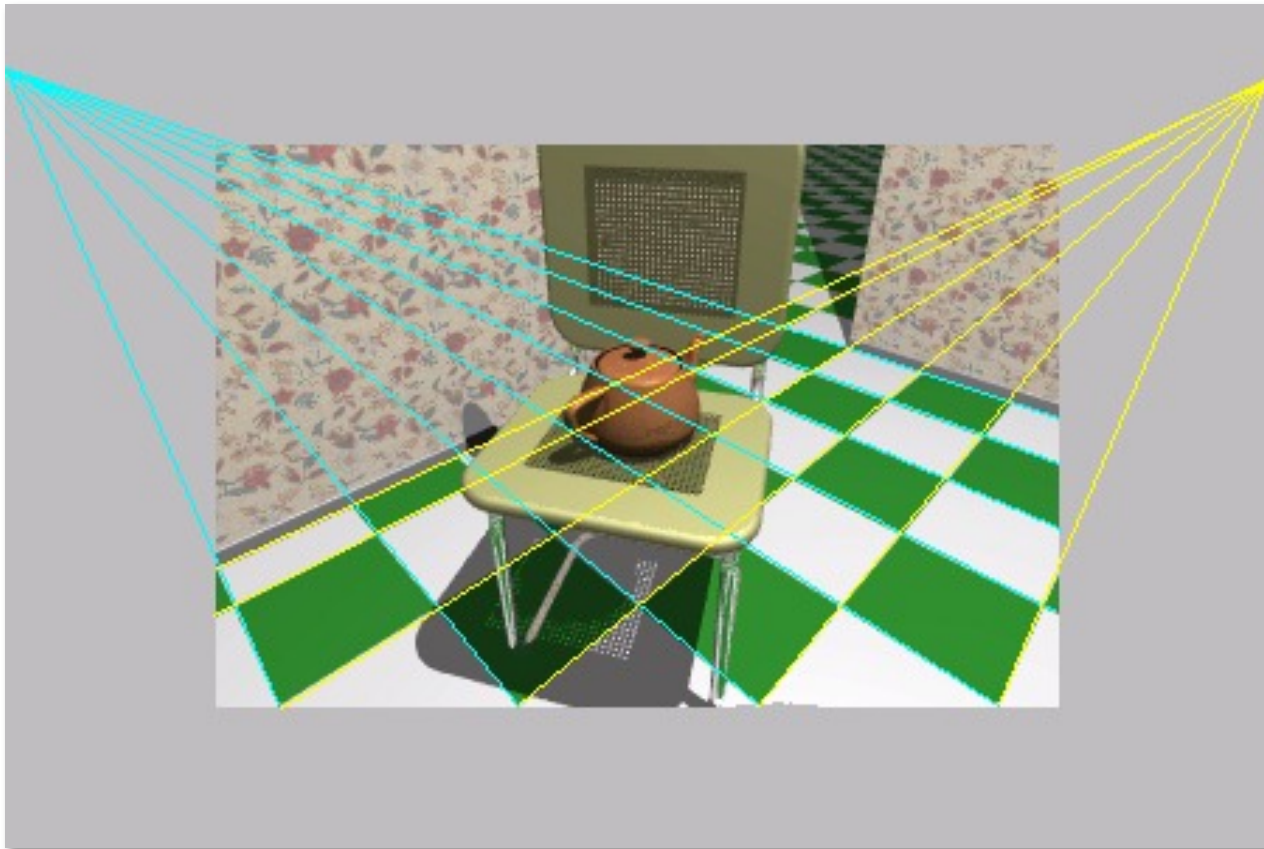
# Two-Point Perspective

- Often used in architectural renderings
- If the projection plane intersects exactly two principal axes, a two-point perspective projection occurs
- In this perspective the visual rays converge at two vanishing points



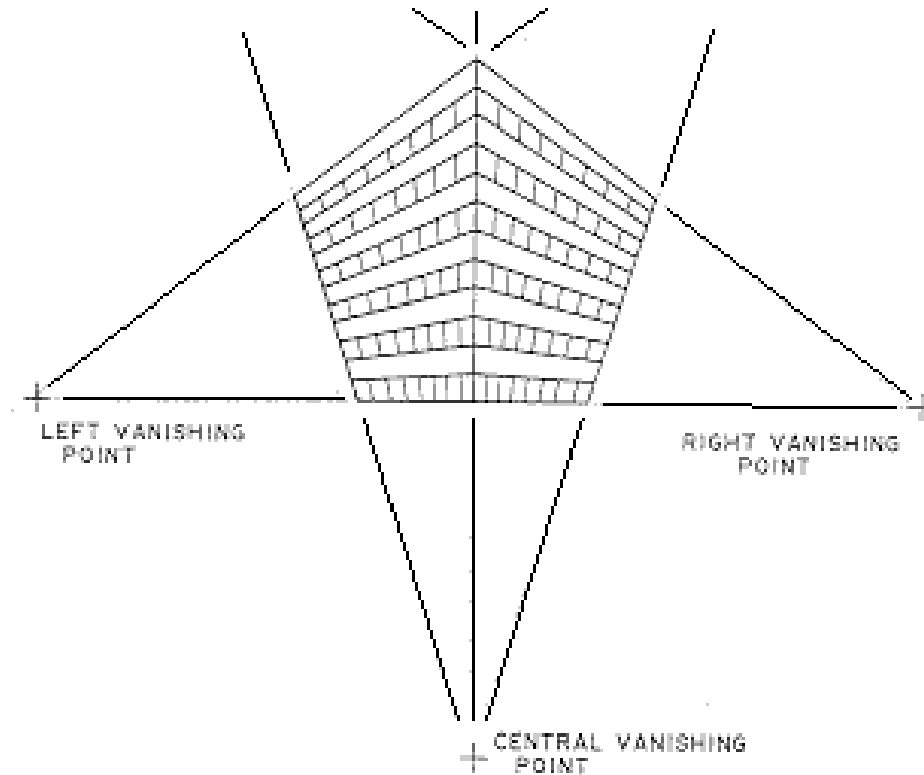
# Perspective Projection

- Computer graphics two-point example



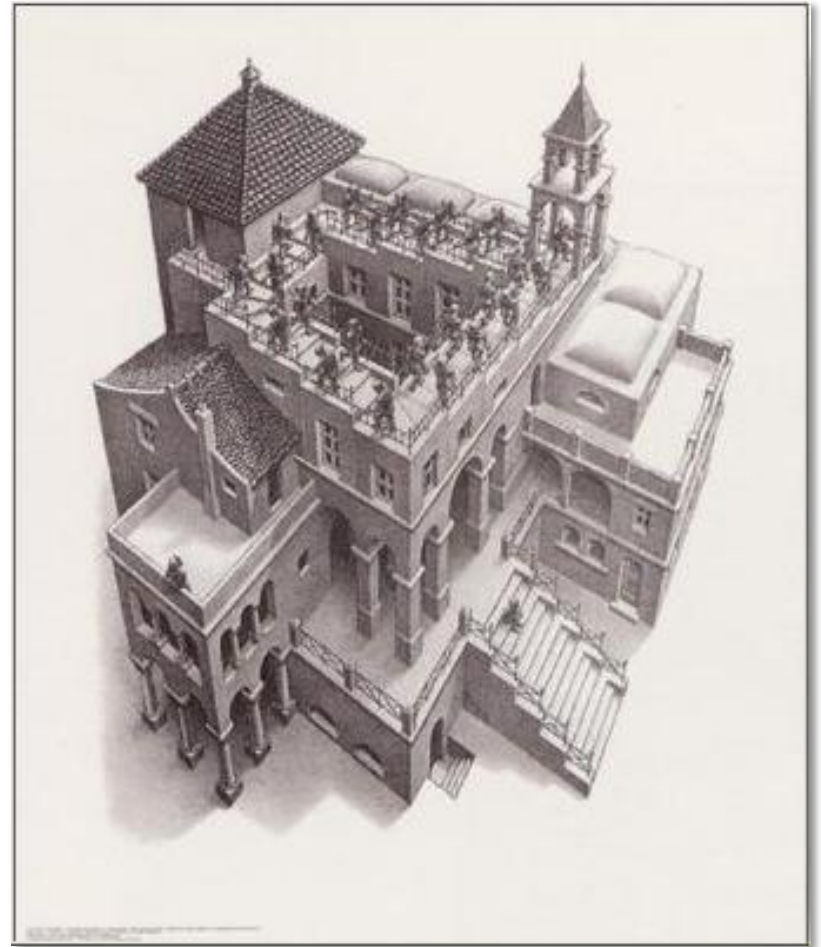
# Perspective Projection

- If the projection plane is not parallel to any principal axis, a three-point projection occurs with the visual rays converging to three vanishing points

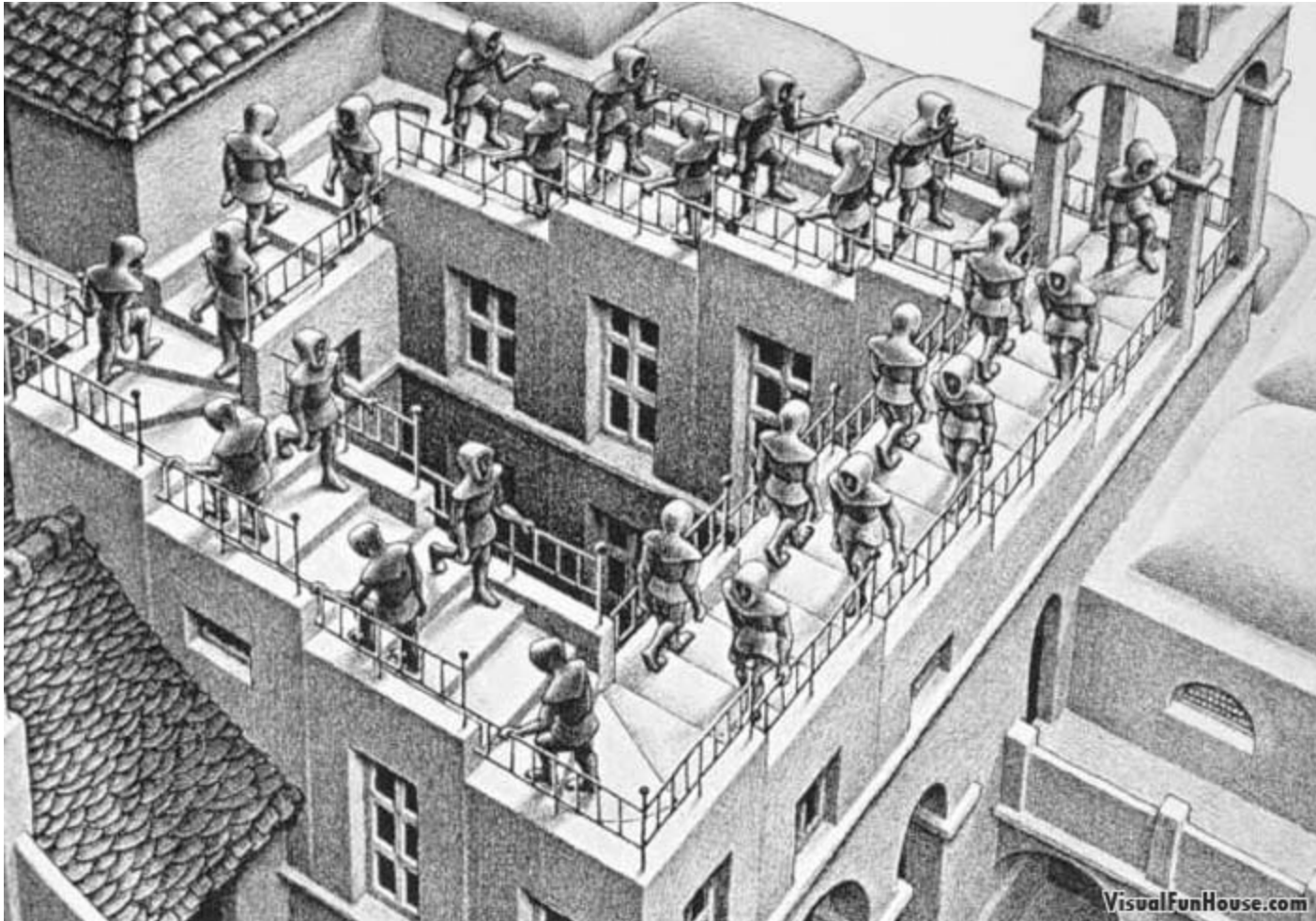


# Perspective Projection

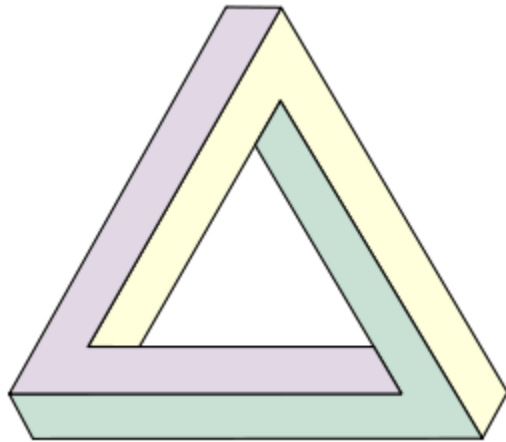
- M.C. Escher created optical illusions using three-point perspective in “Ascending and Descending”



# Perspective Projection



Just because you can draw it does  
not mean you can build it ...

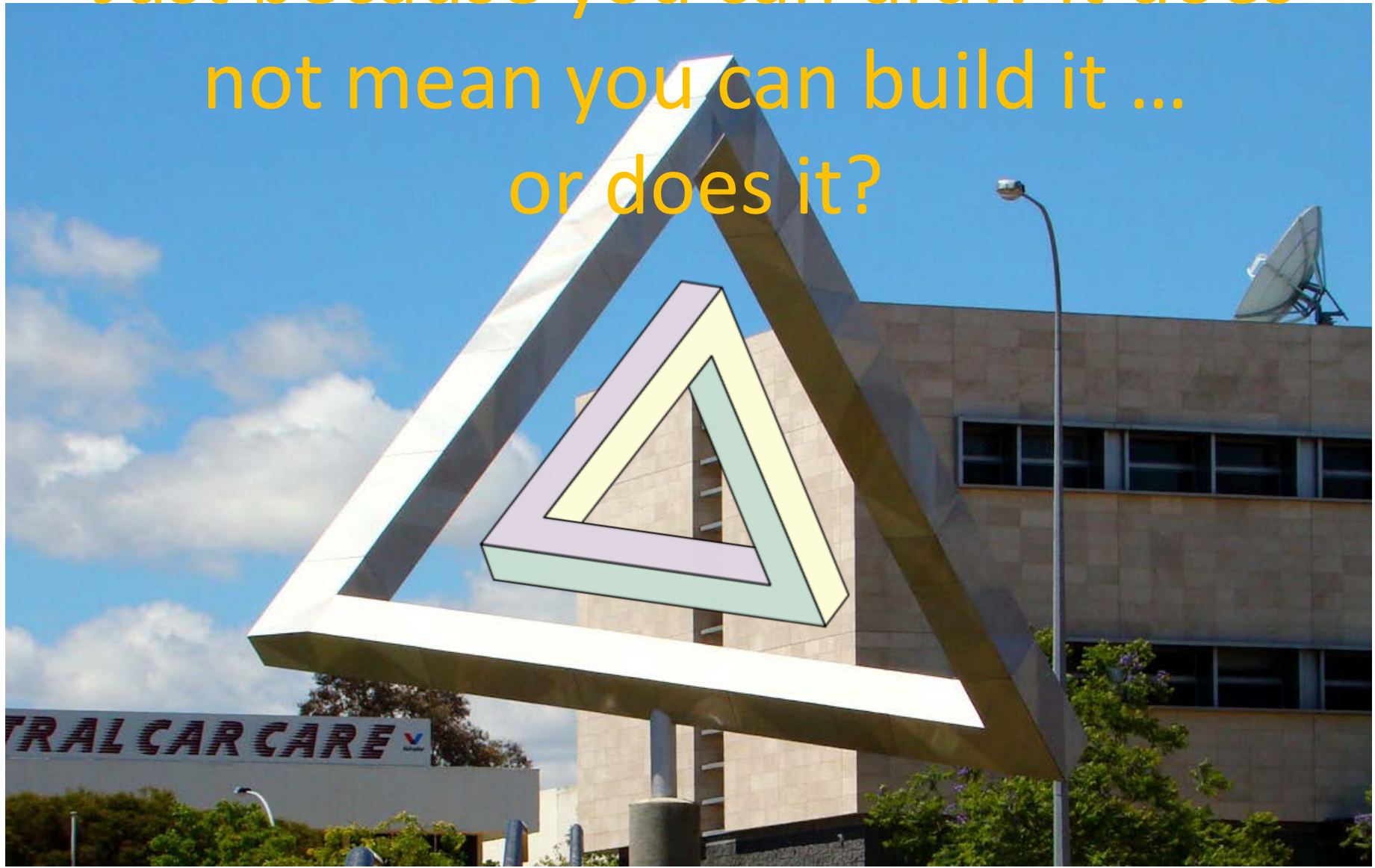


Penrose Triangle



Escher`s Waterfall

Just because you can draw it does  
not mean you can build it ...  
or does it?



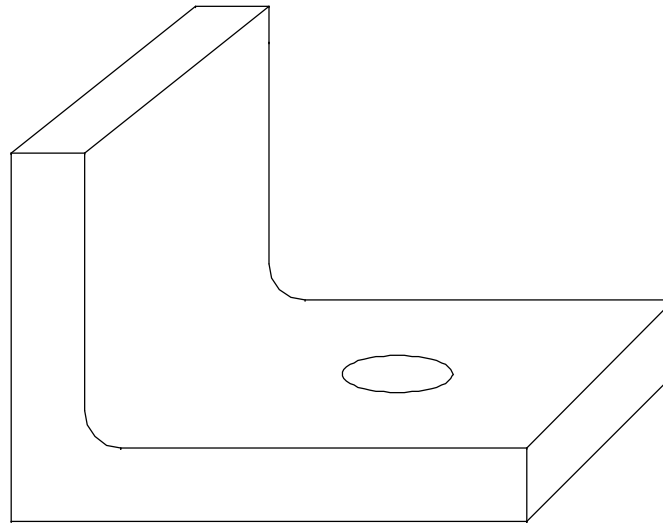
**Brian McKay and Ahmad Abas in Perth Australia**





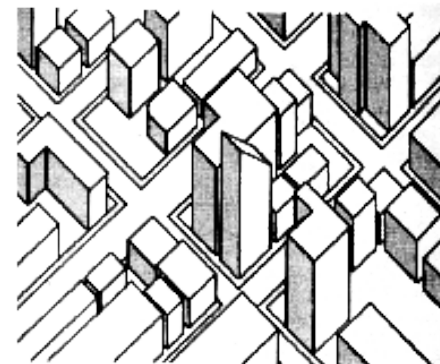
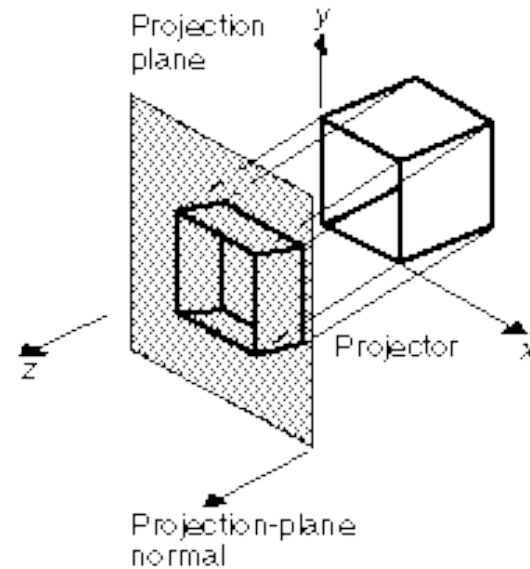
# Oblique Projection

- Front face of object is parallel to the viewer, therefore that face is true size
- Projection lines do not converge to a vanishing point



# Oblique Projection

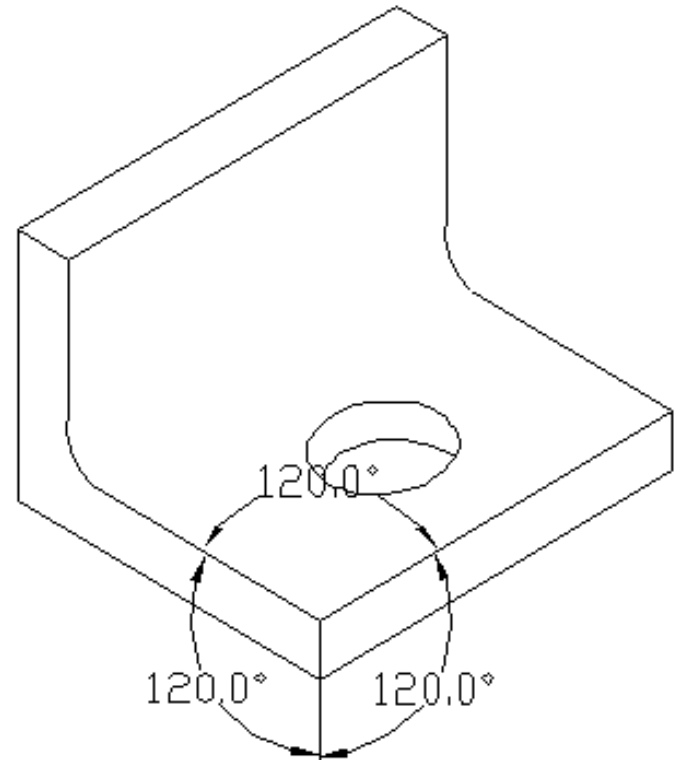
- Parallel projectors are at an oblique angle (*i.e.*, not  $90^\circ$ ) to the paper plane
- Used to give an indication of depth
- Presents the exact shape of one face
- Lack of perspective foreshortening makes it easier to compare sizes



Foreshortening is a technique used in perspective to create the illusion of an object receding strongly into the distance or background.

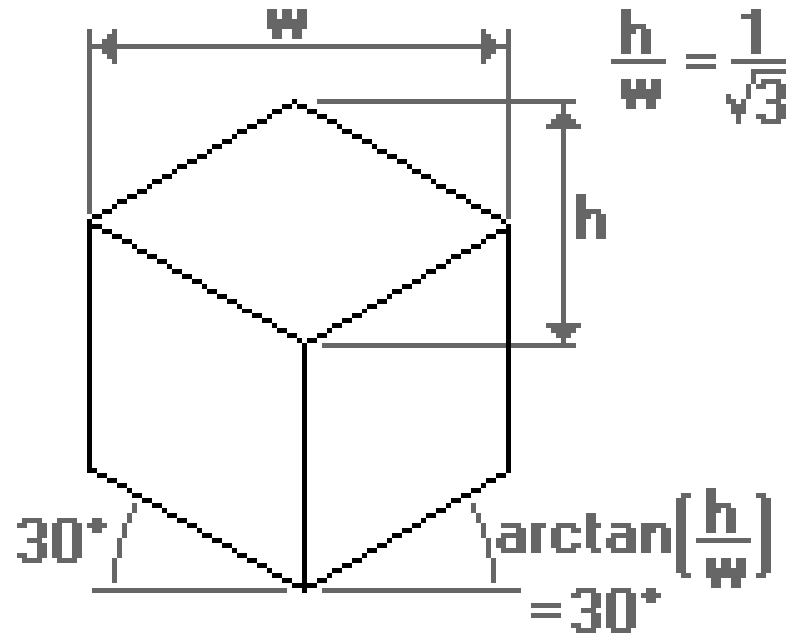
# Isometric Projection

- Parallel lines remain parallel instead of converging to a vanishing point
- Axis are each 120 degrees apart
- Special case of *Axonometric* projection
  - Viewed so as to reveal more than one side



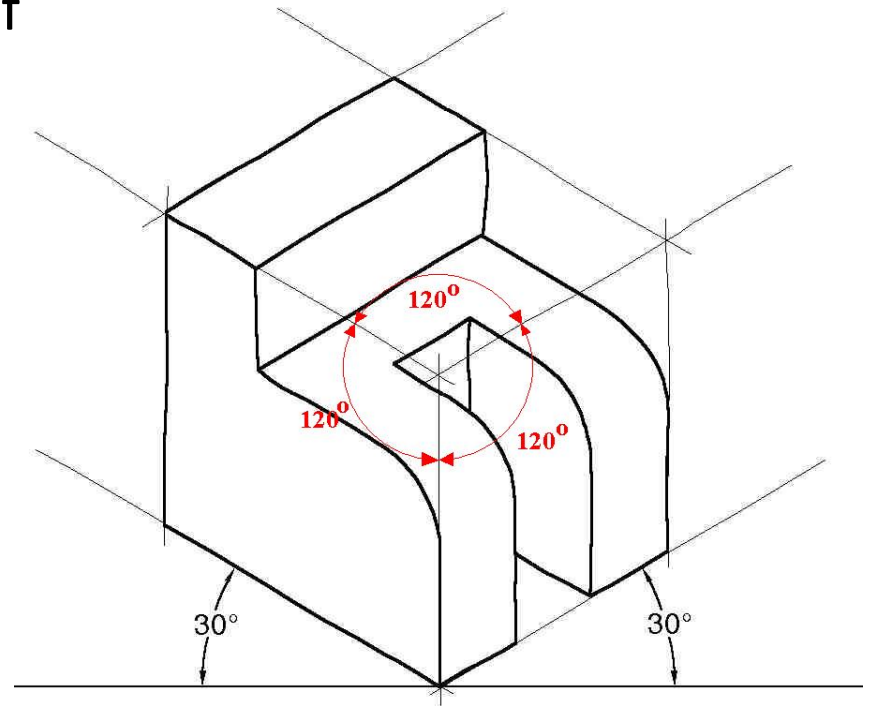
# Isometric Projection

- Isometric projection uses parallel projectors (orthogonal projection), but it shows more than one face of the object (axonometric)
- The x-, y- and z-axes have the same metric: a unit (say, a cm) along the x-axis is equally long along the y- and z-axes
- In a cube, all edges in the 2D picture have the same length
- The projected cube is also symmetric; all sides are rhombuses (a rhombus is a parallelogram with sides that are equal in length)

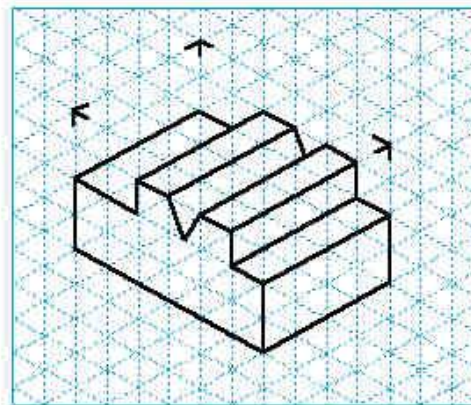
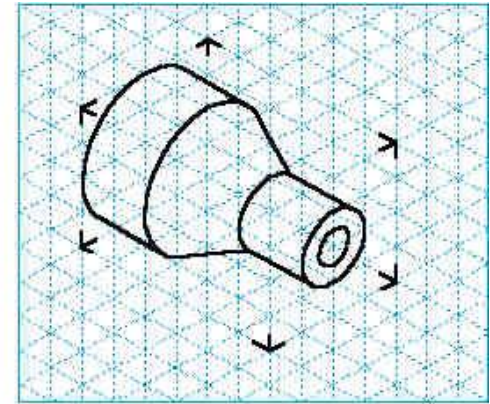
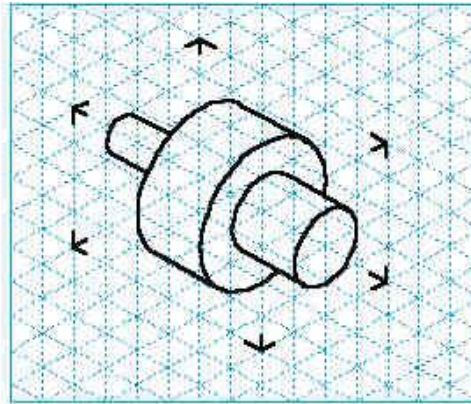
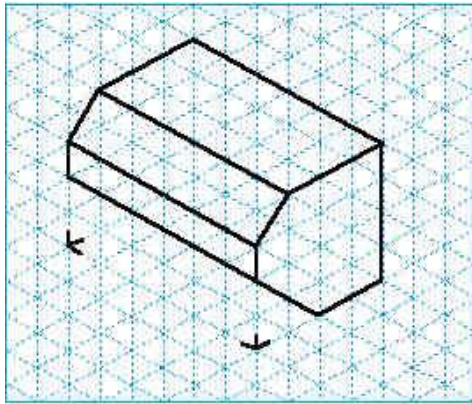


# Isometric Sketching

- Isometric projection uses parallel projectors (orthogonal projection), but it shows more than one face of the object (axonometric)
- The x-, y- and z-axes have the same metric: a unit (say, a cm) along the x-axis is equally long along the y- and z-axes
- In a cube, all edges in the 2D picture have the same length
- The projected cube is also symmetric; all sides are rhombuses (a rhombus is a parallelogram with sides that are equal in length)



# Isometric Sketch Paper



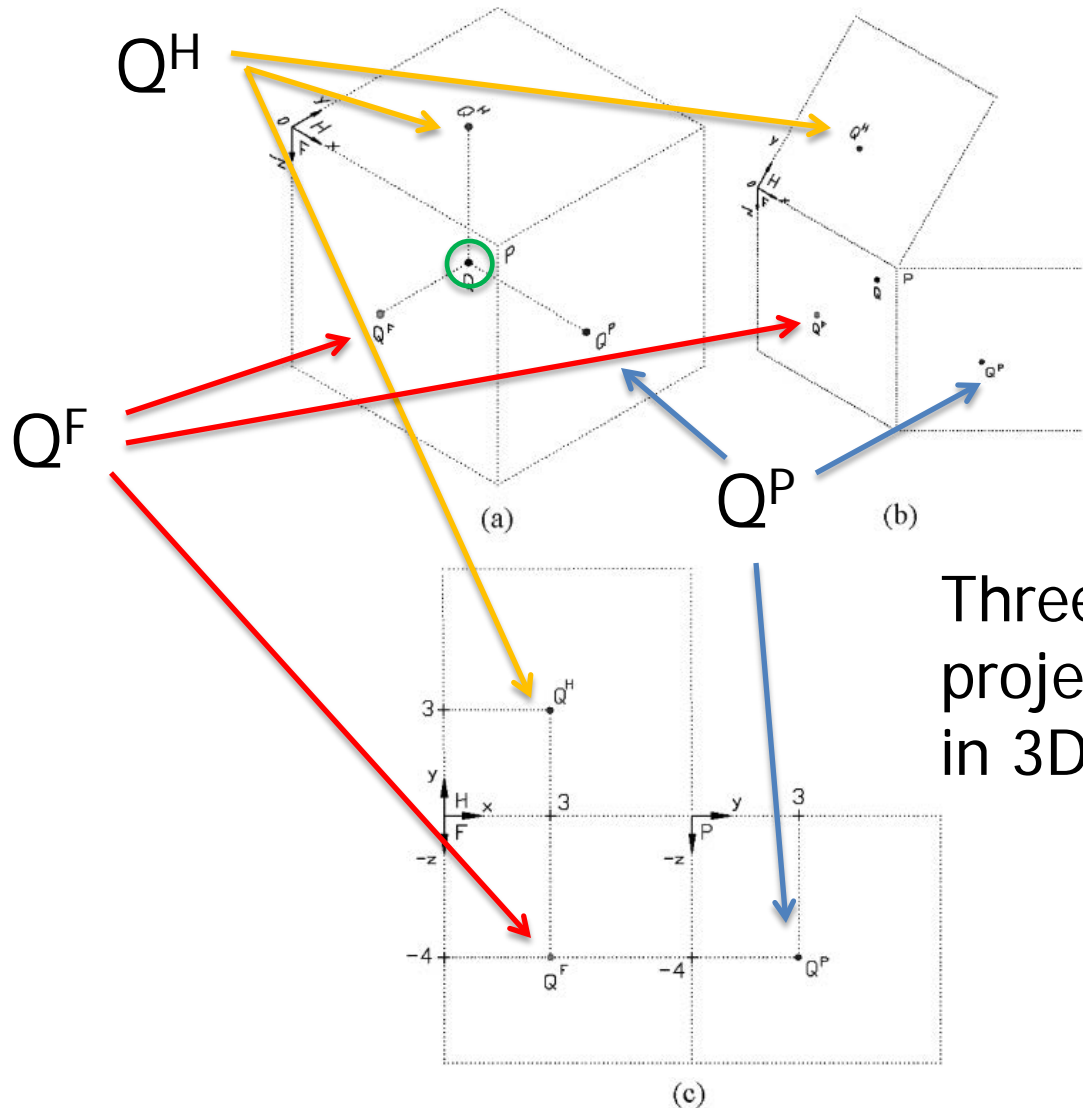
# Orthographic Projection

- The most important graphical drawing method
- 2D representations of a 3D object
- Extensively used in Engineering
- Useful when technical information is needed
- They enable parts to be made
- Often an isometric view is included with the standard views

# Orthographic Projection

- Orthographic projection is the geometric backbone of a technical drawing
- In order for the technical drawing to be useful, many conventions must be followed
  - The information in the drawing has to be clear and concise
  - Conventions apply to things like object placement, line types, and dimensioning

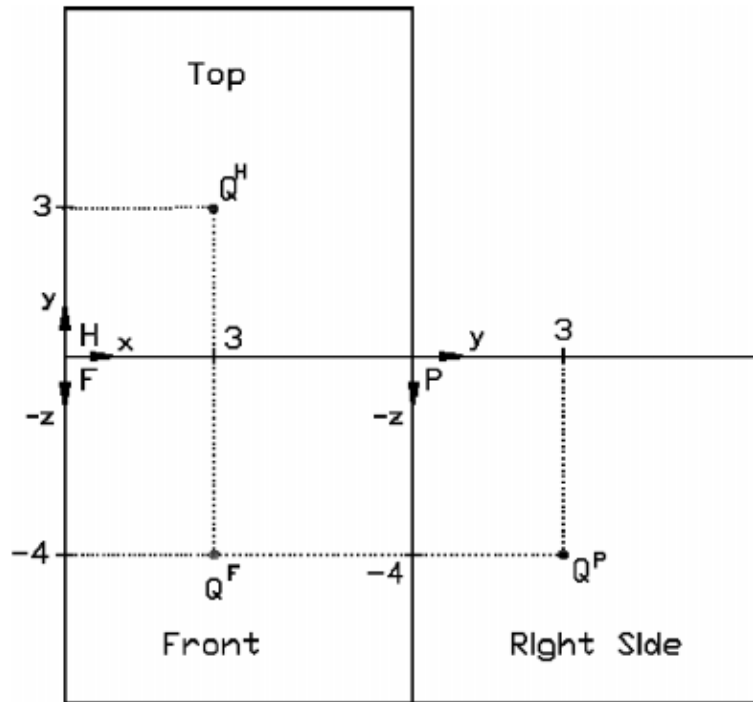
# Orthographic Projection



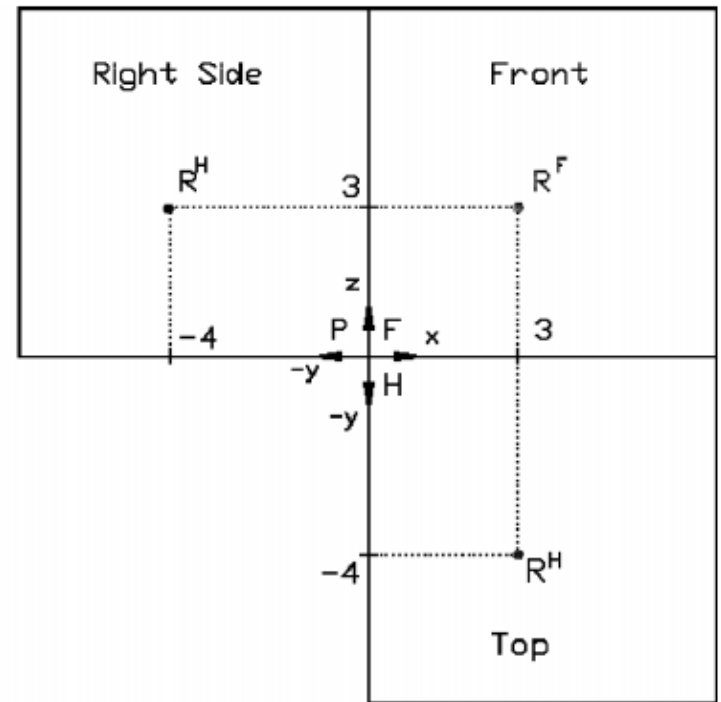
Three orthographic projections of a point in 3D space

Figure 12.7 Three orthographic projections of a point in 3D space.

# Orthographic Projection



(a) Third angle projection of  $Q(3,3,-4)$



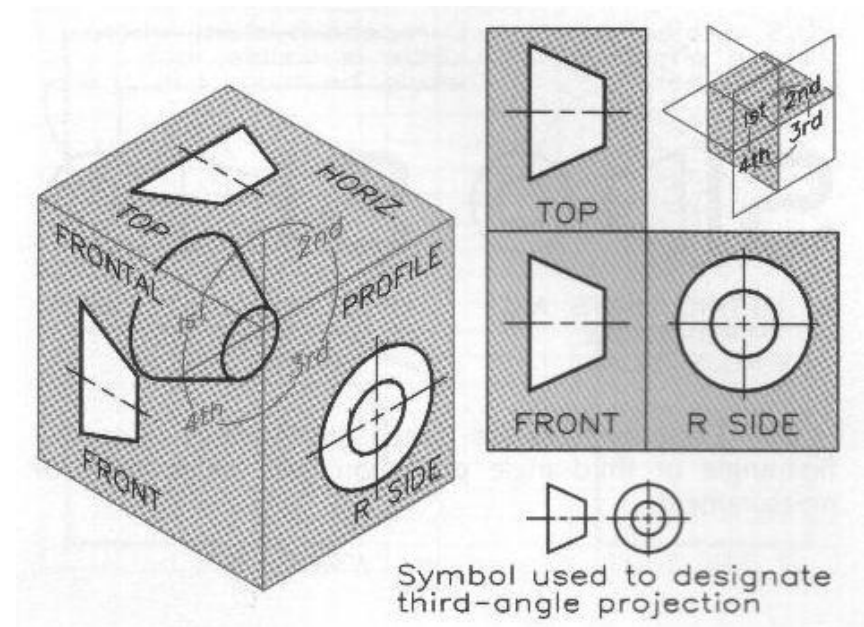
(b) First angle projection of  $R(3,-4,3)$

**Figure 12.8** Three relative positions of the principal planes in third and first angle projection.

# Third-Angle Orthographic Projection

## Third-Angle Projection

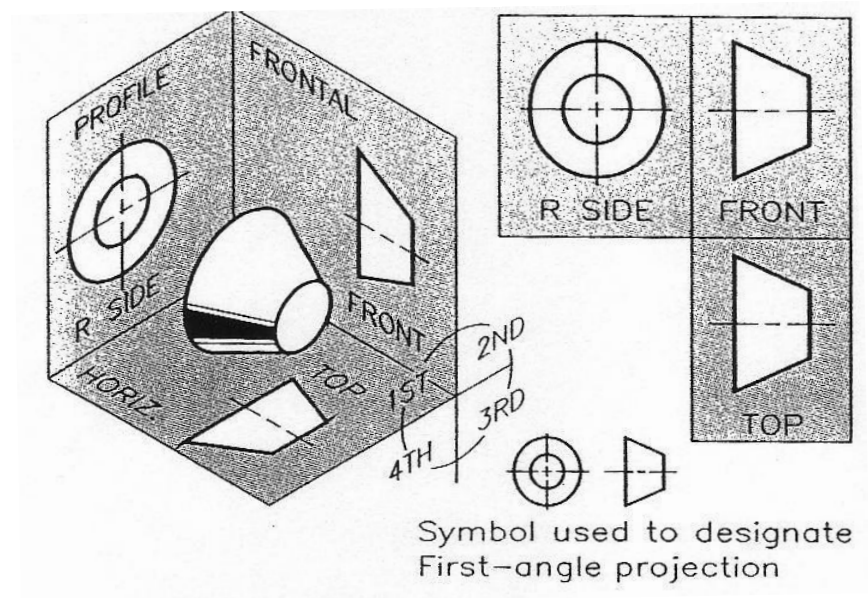
- The object is placed in the third quadrant and then viewed from the first quadrant
- Projection planes are between the observer and object
- Used in Canada, U.S., and Britain
- First-Angle Projection used in Europe
- The top view is placed over the front view; the right-side view is to the right of the front view



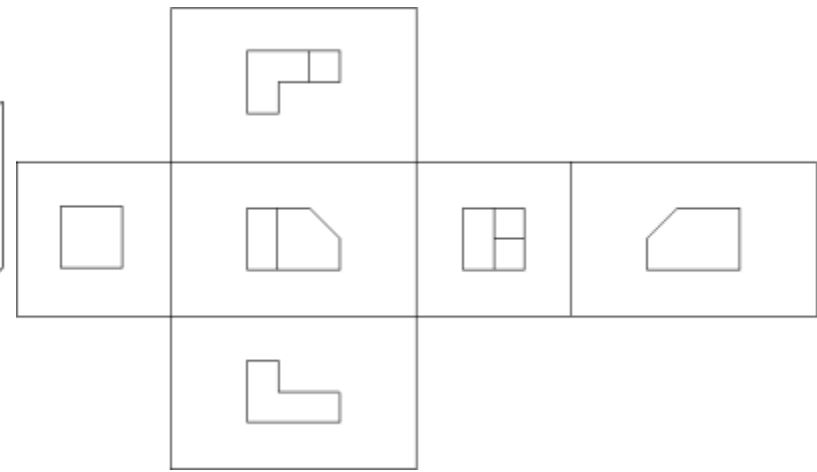
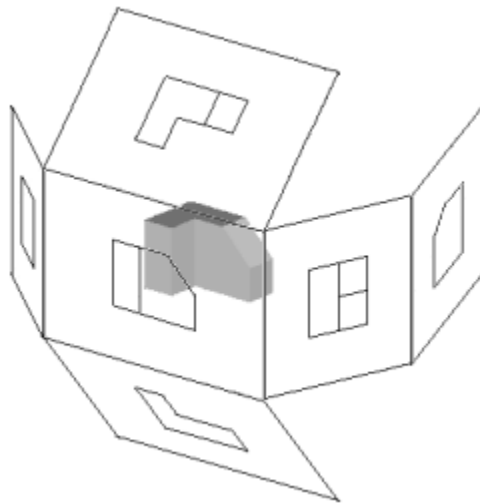
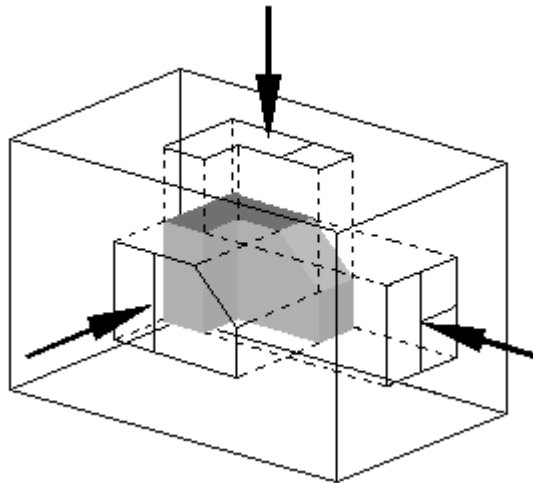
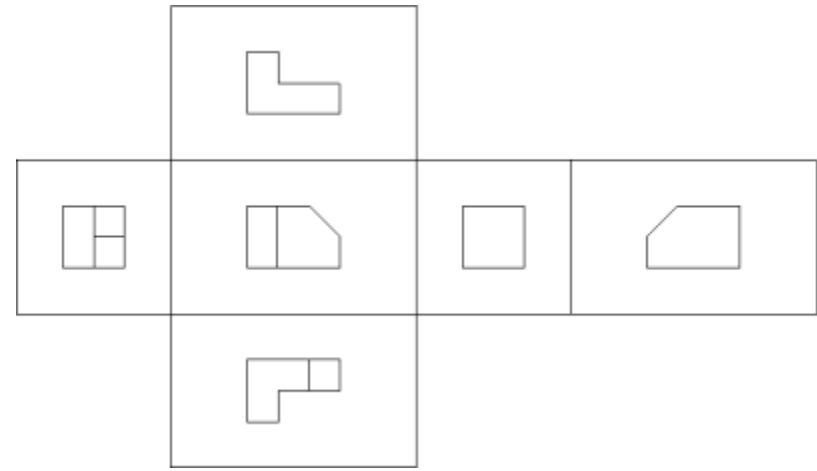
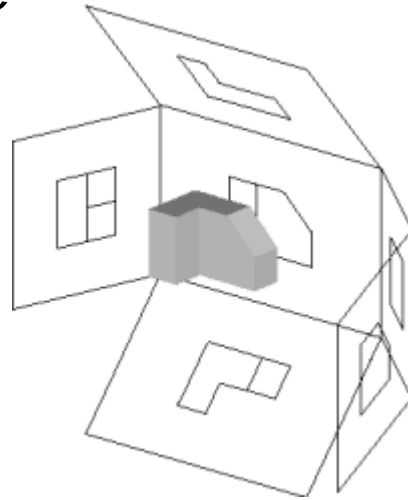
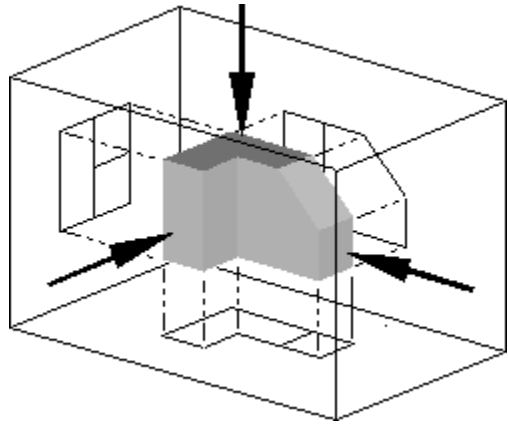
# First-Angle Orthographic Projection

## First-Angle Projection

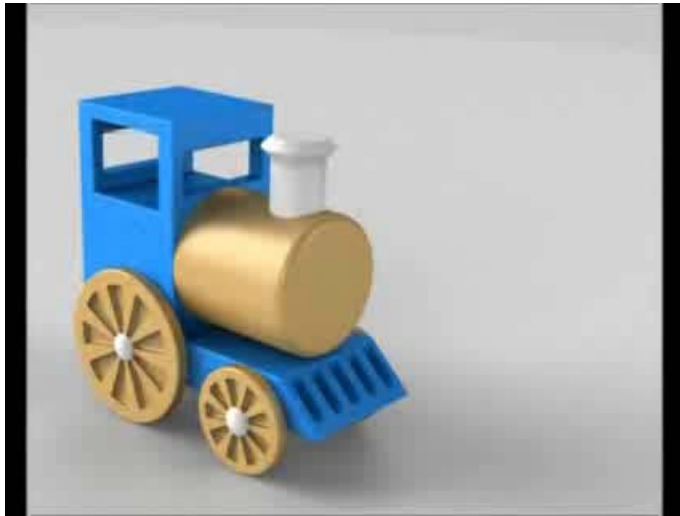
- The object is placed in the first quadrant and viewed from the first quadrant
- The object is between the observer and projection planes
- Used in most of the world
- The top view is placed below the front view. The right-side view is to the left of the front view

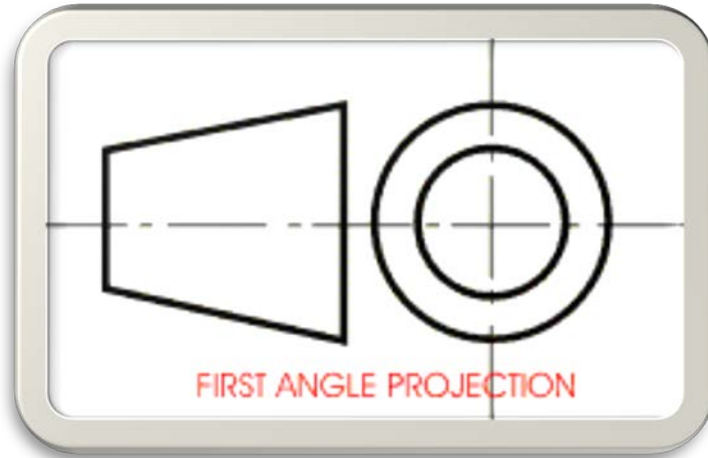


# First Angle



# Third Angle



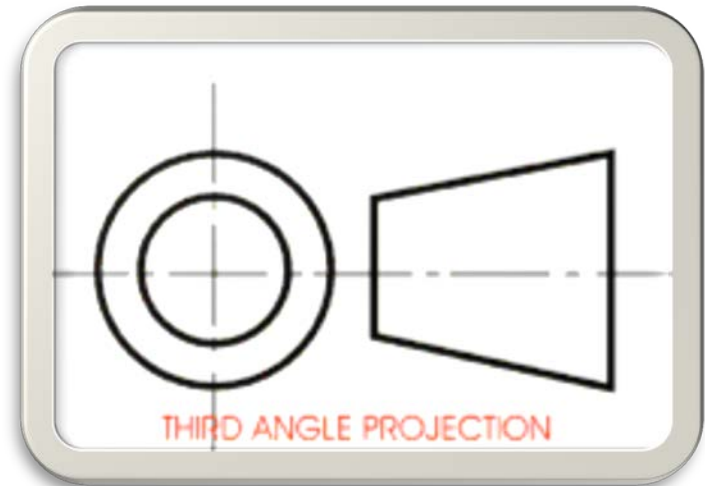


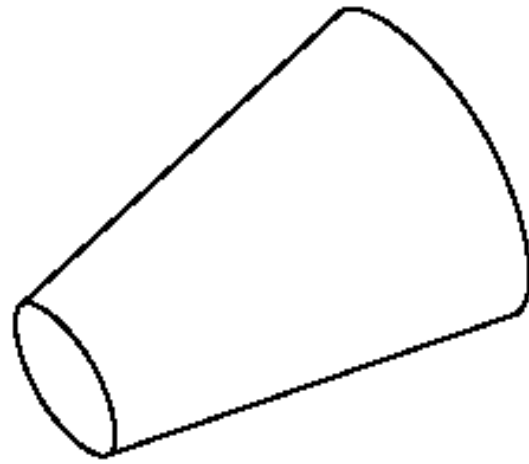
## Symbol for FIRST ANGLE

- Wide end is next to the circle

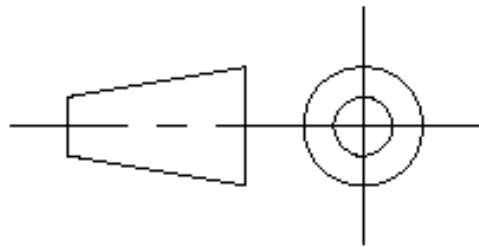
## Symbol for THIRD ANGLE.

- Narrow end is next to the circle.

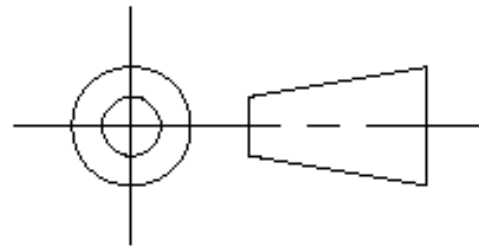




**truncated cone**

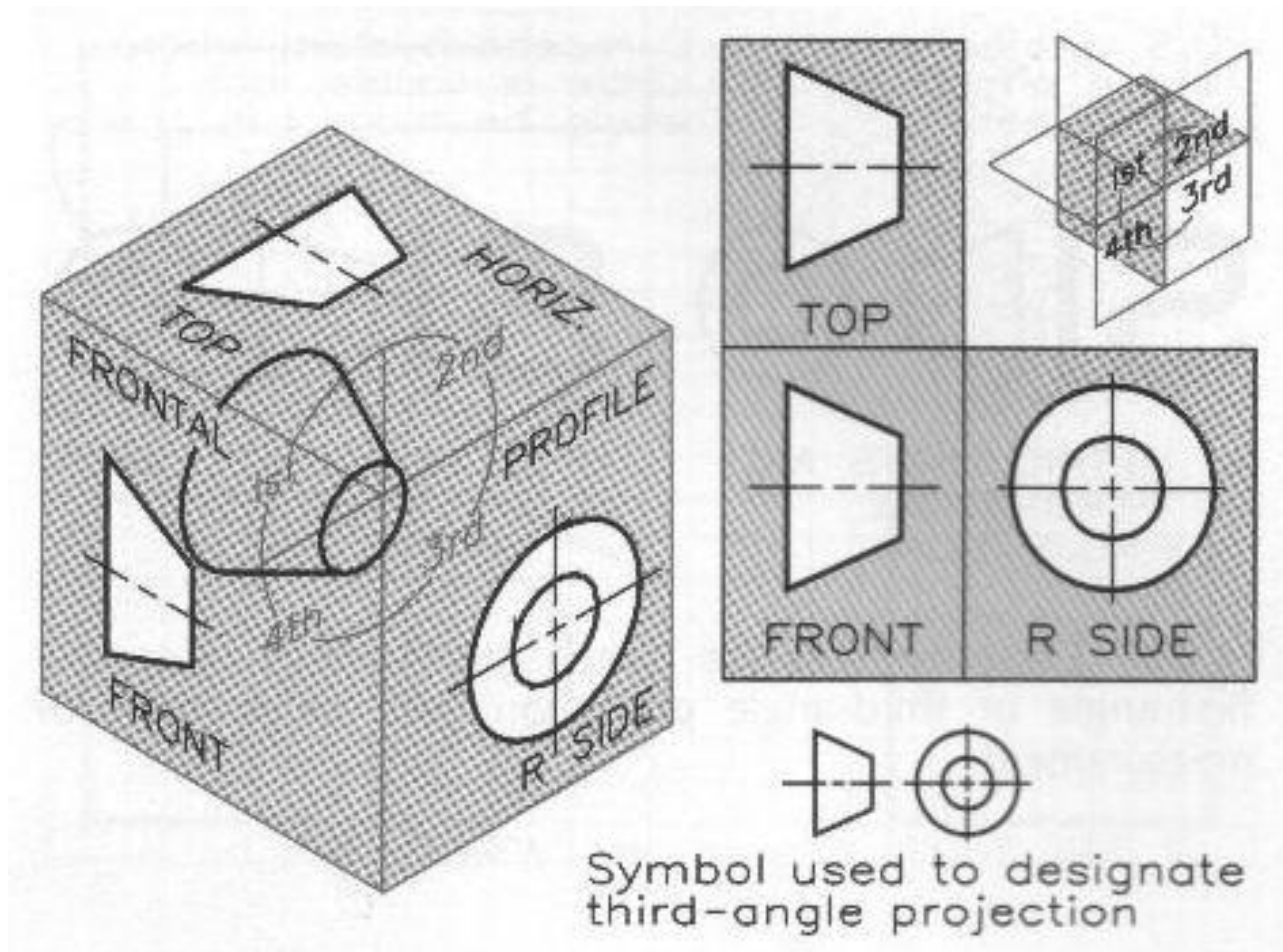


**first-angle symbol**



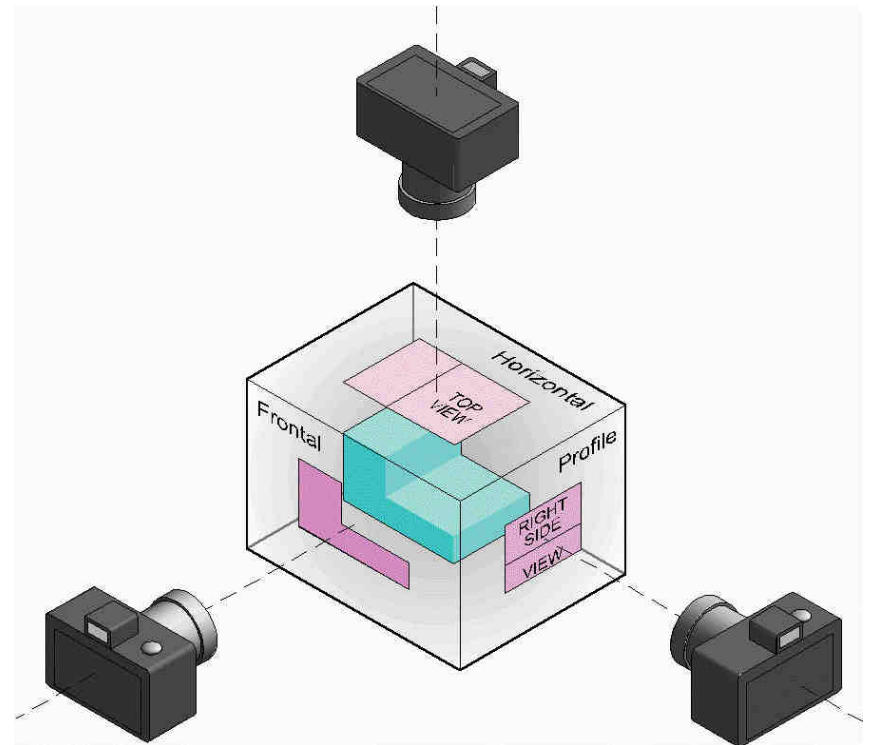
**third-angle symbol**

# We use Third-Angle Projection



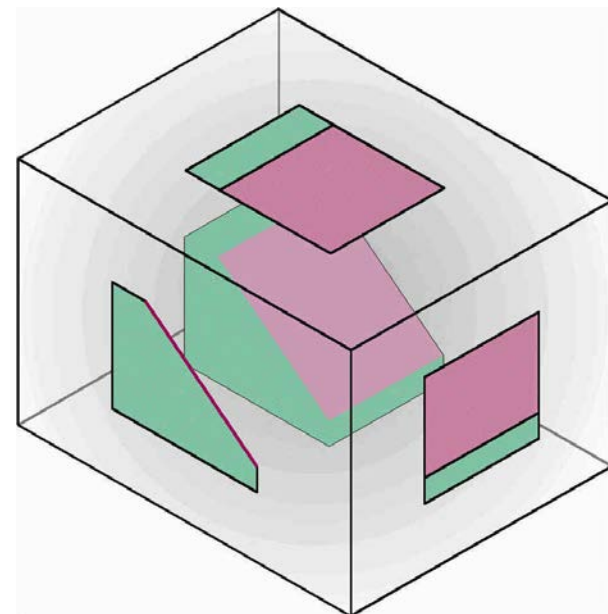
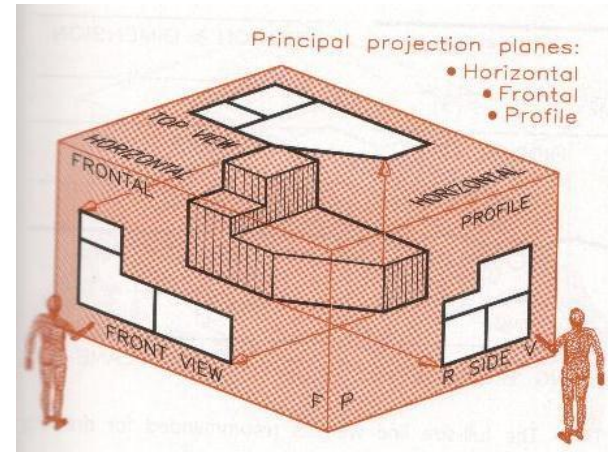
# Orthographic Projection

- The bracket in the figure is a simple part, but describing it with words is difficult
- Is it hard to make a 3D drawing of it?
- Not if you know how to project it *orthographically!*
- Orthographic projection represents different views separated by  $90^\circ$  as the viewer moves around it



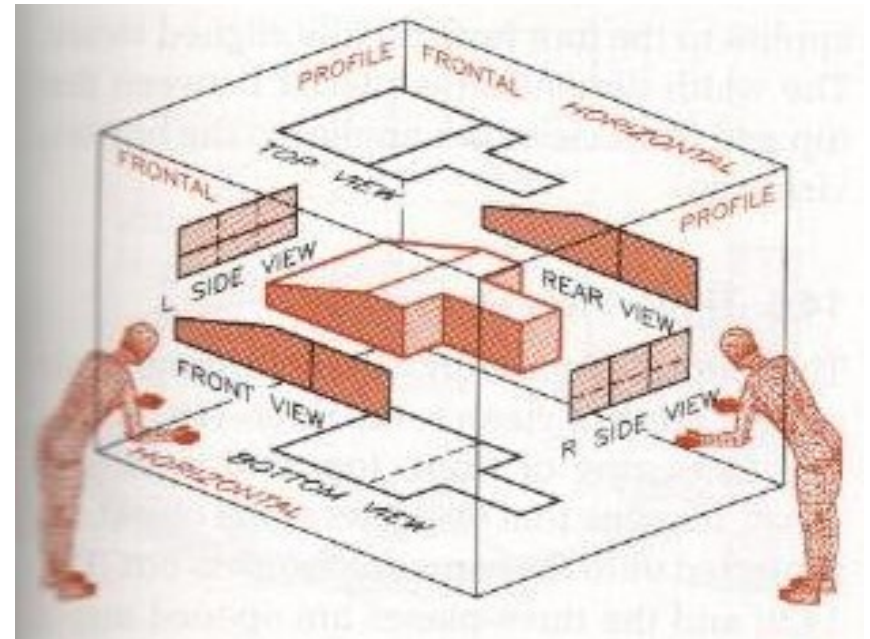
# Orthographic Projection

- Orthographic projection involves projecting views of an object onto the sides of an imaginary rectangular glass box
- The projectors in any one view are parallel to each other and perpendicular (orthographic, or orthogonal) to the projection planes (the sides of the rectangular glass box)



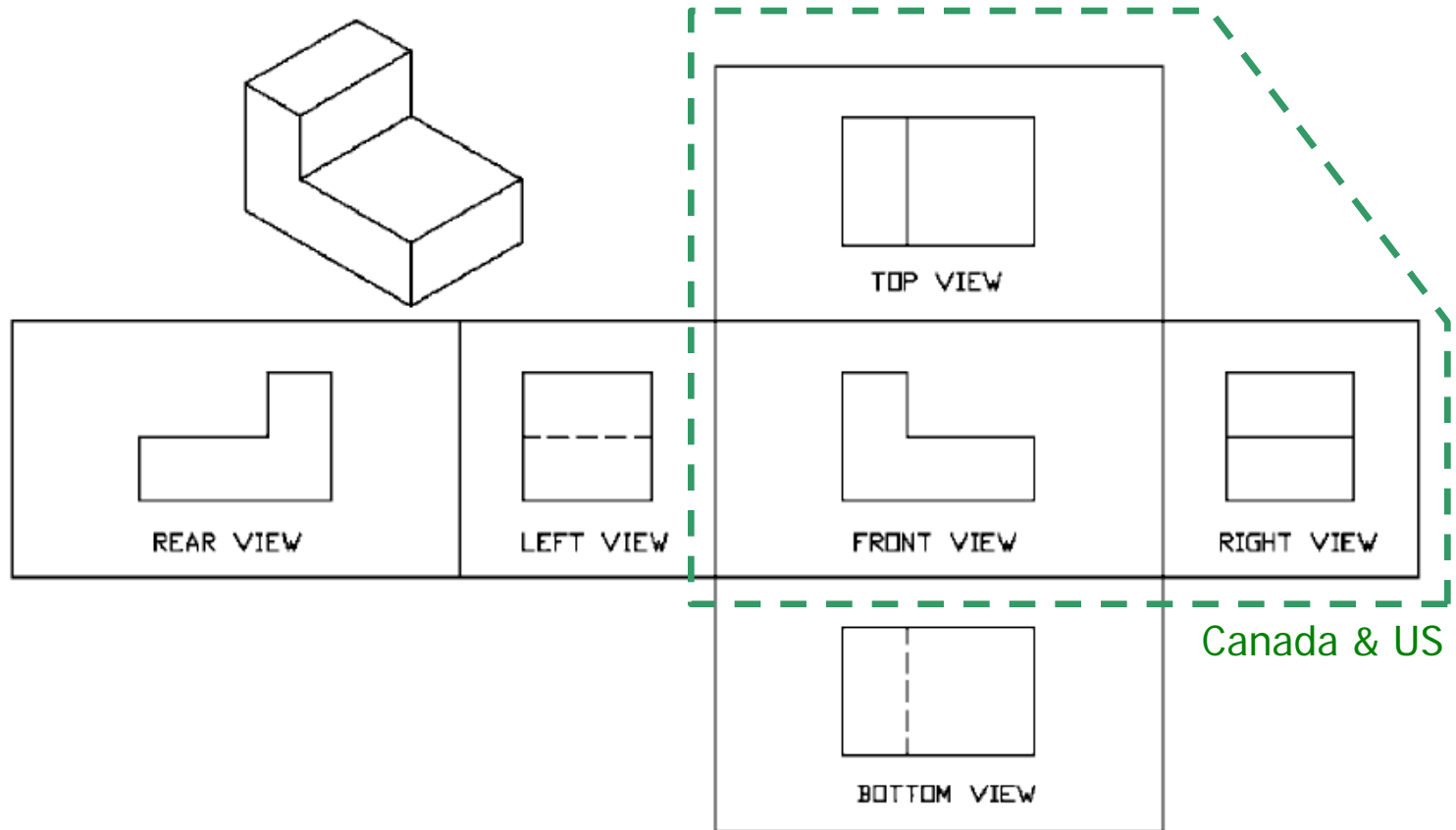
# Orthographic Projection

- Six principal views can be drawn in orthographic projection
- Imagine a glass box with the views projected onto its six planes





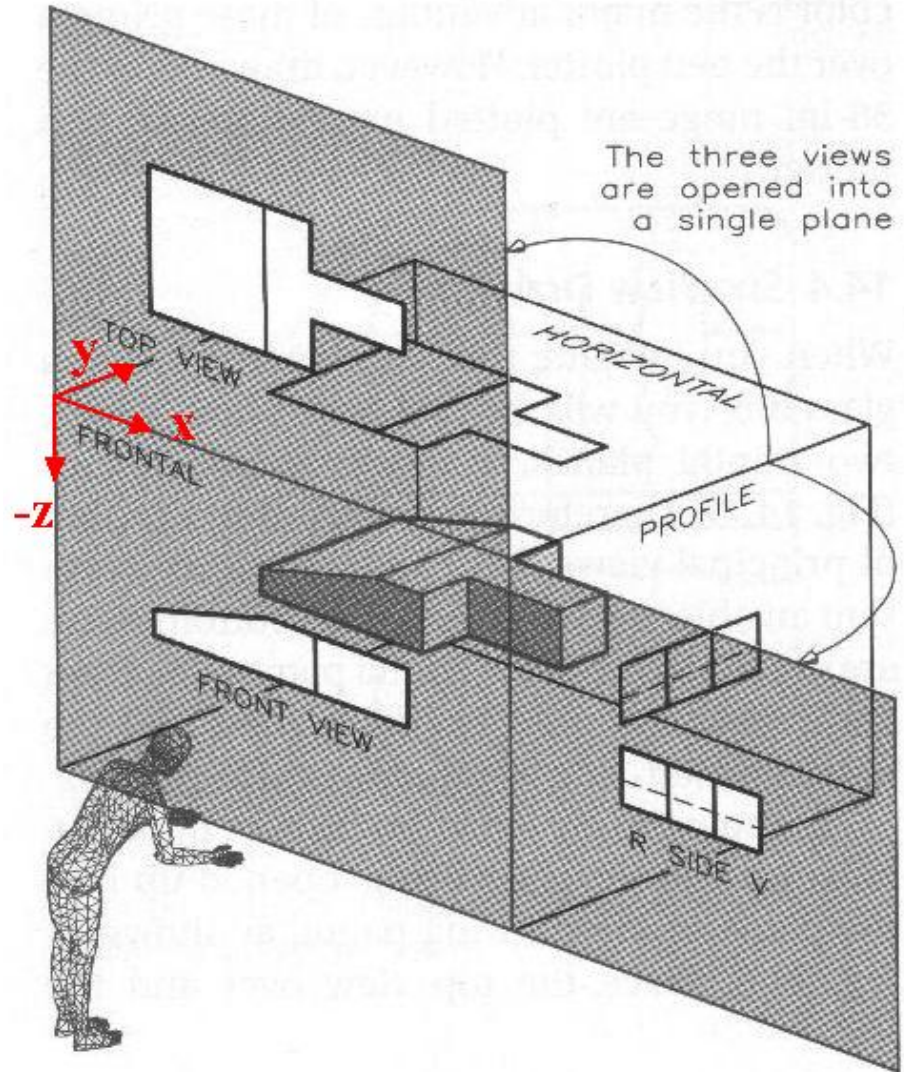
# Orthographic Projection

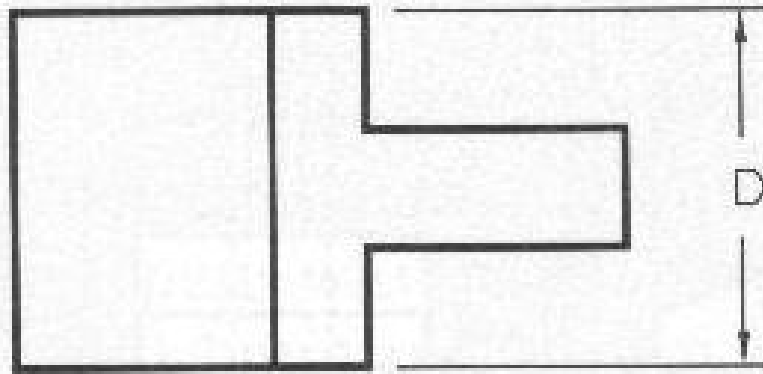


**Figure 12.20** Six principal views.

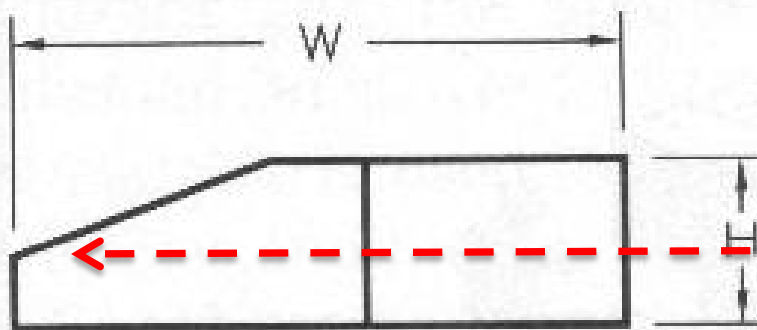
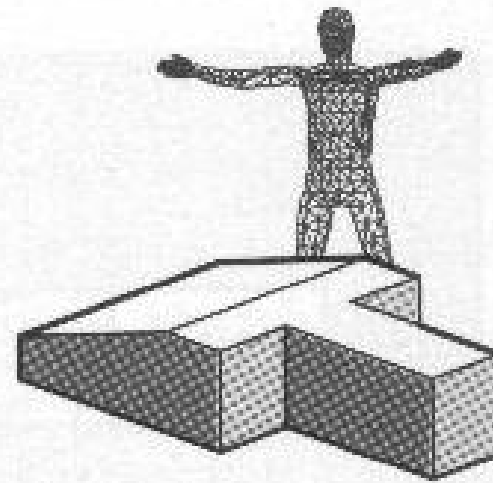
# Three-View Drawings

- We use third-angle projection
- Three-view drawings typically, though not always, consist of top, front, and right-side views
- Imagine the object is placed in the box and orthographically projected onto the three planes
- The box is then opened into the frontal plane

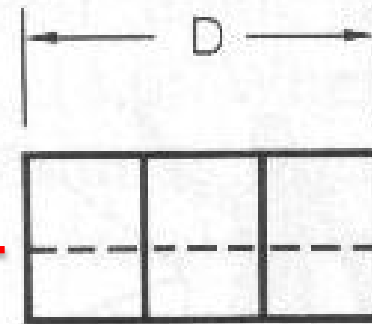




TOP VIEW



FRONT VIEW

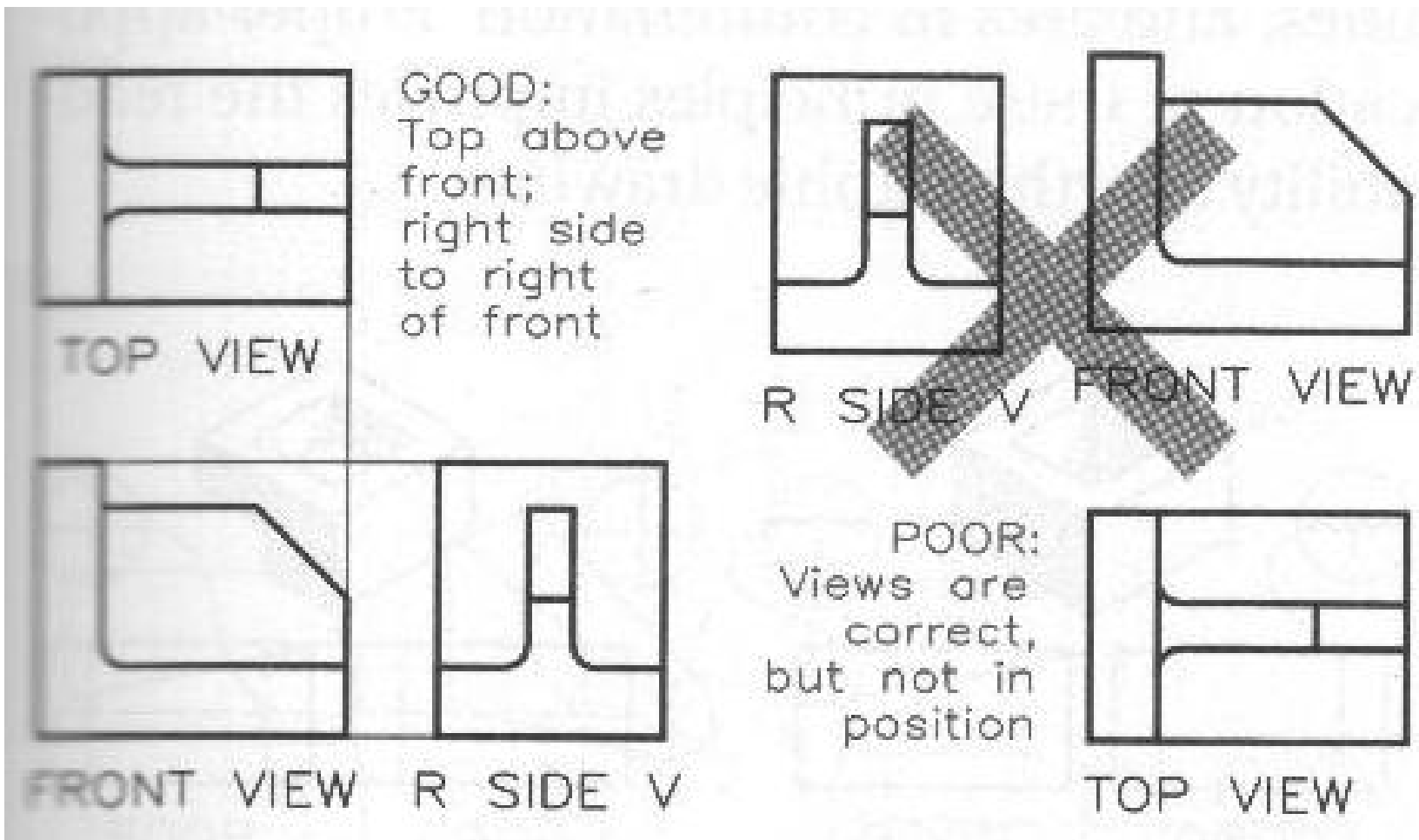


R SIDE V

Hidden  
line

## Three-View Drawings

Width, Height, and Depth dimensions can be represented, giving enough information to construct the object

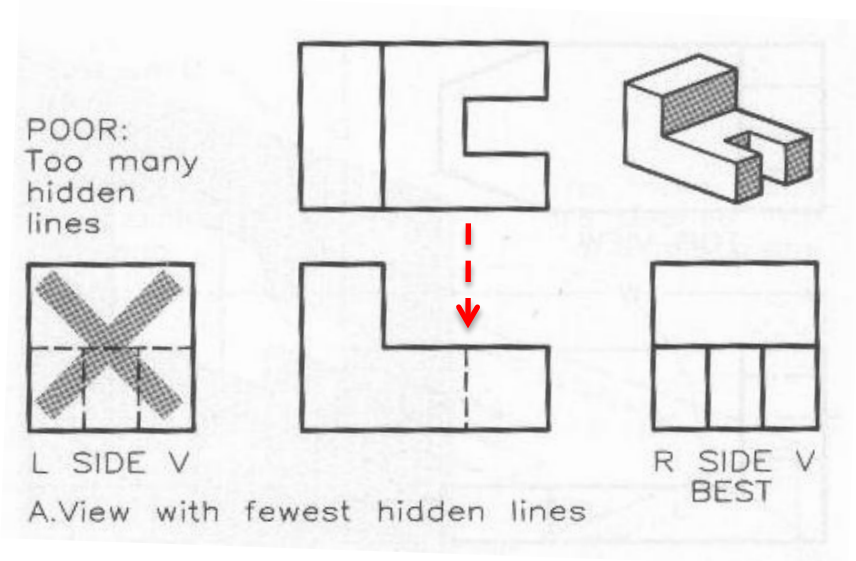


## Arrangement of Views

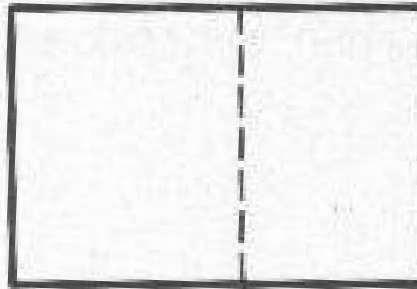
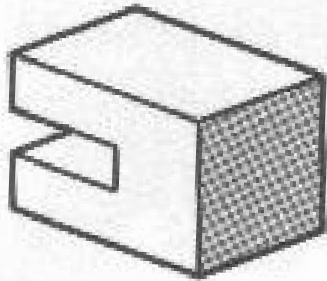
- The three views must be arranged according to the projection convention (first-angle or third-angle)
- Top and side views are projected from and aligned with the front view

# Selection of Views

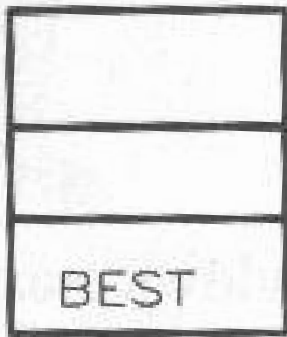
- The most descriptive view is usually selected to be the front view
- The remaining views are selected such that they contain the fewest hidden lines
- If a tie occurs (say between the left and right-side views) use the conventional view (top or right-side)



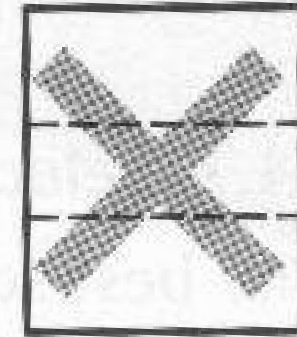
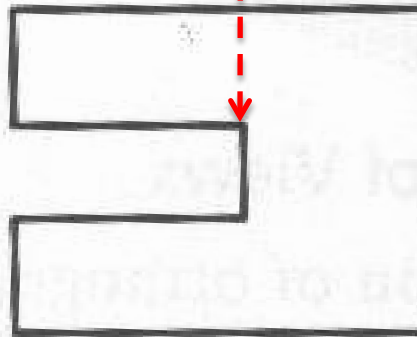
# Selection of Views



POOR: Too many hidden lines



L SIDE V

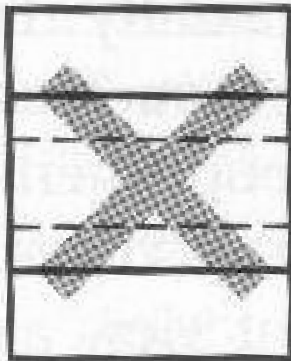
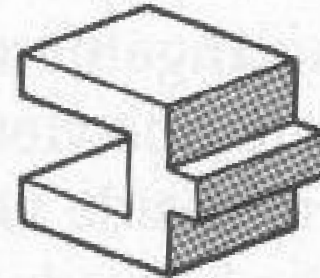
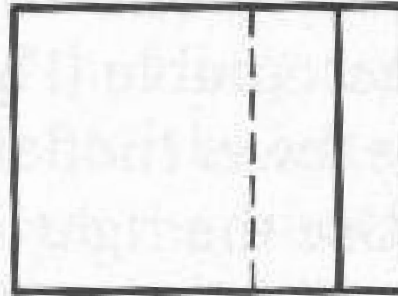


R SIDE V

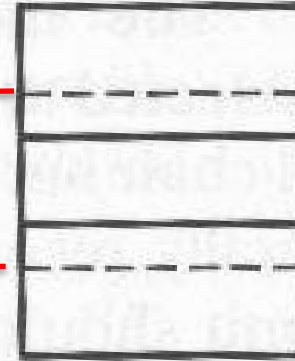
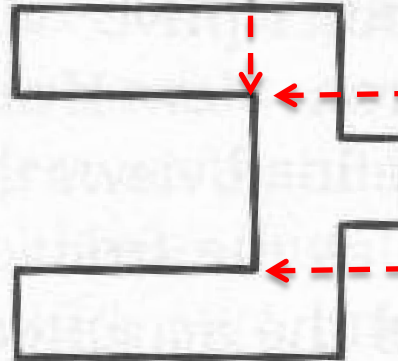
B. Left-side view can be used

# Selection of Views

Same no. of hidden lines; Right-Side View preferred



L SIDE V



R SIDE V  
BEST

C. Right-side view preferred

# Assignment

- Read Chapters 12 & 14