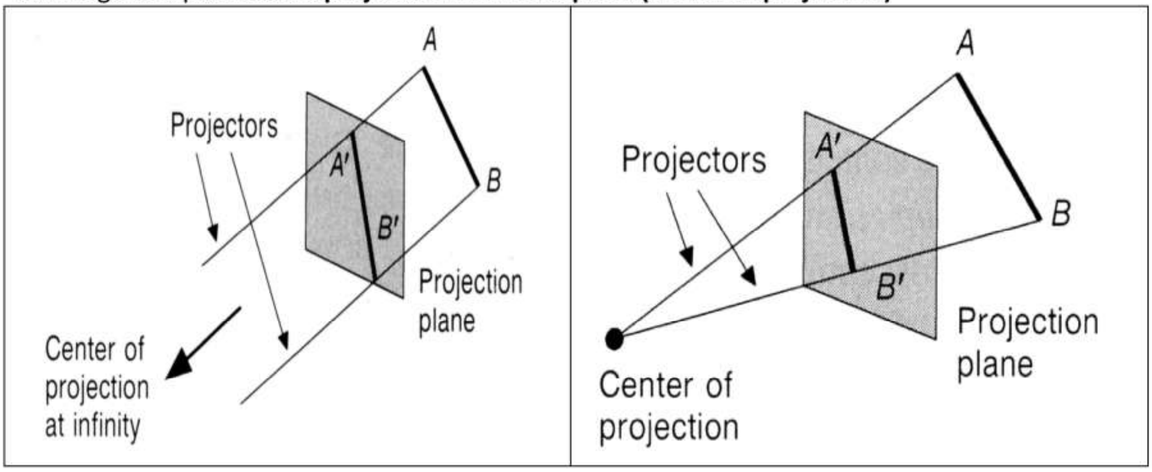
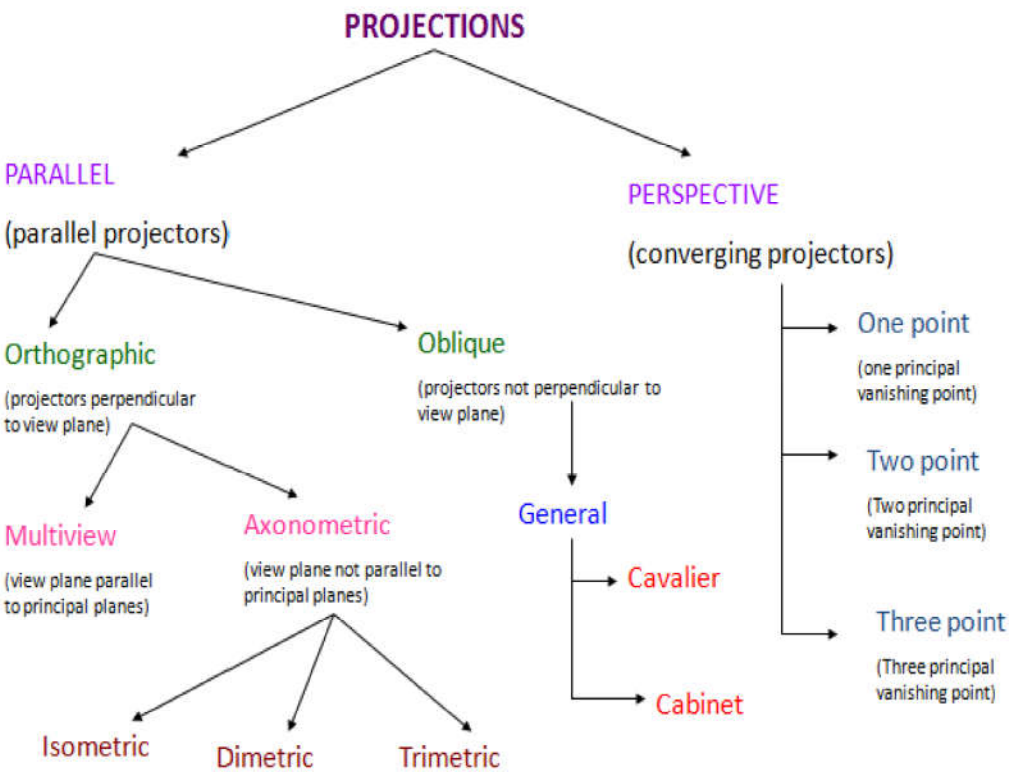
UNIT 3
PROJECTIONS

- **PROJECTIONS-** Transform 3D objects on to a 2D plane using ***projections***
- **<u>2 types of projections</u>**
    - *Perspective*
    - *Parallel*
- In **parallel projection**, coordinate positions are transformed to the view plane along parallel lines.
- In **perspective projection**, object position are transformed to the view plane along lines that converge to a point called **projection reference point (center of projection)**





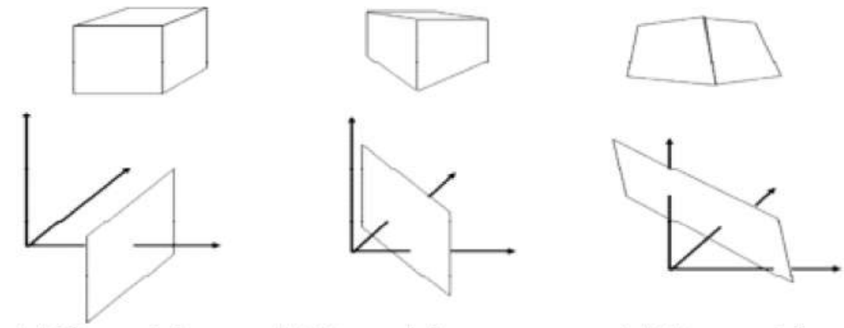
- **Perspective v Parallel**
  - **Perspective:**
    - visual effect is similar to human visual system...
    - has 'perspective foreshortening'
    - size of object varies inversely with distance from the center of projection. Projection of a distant object are smaller than the projection of objects of the same size that are closer to the projection plane.
  - **Parallel:**
    - It preserves relative proportion of object.
    - less realistic view because of no foreshortening
    - however, parallel lines remain parallel.

- **Perspective Projections**
  - **Characteristics:**
    - Center of Projection (CP) is a finite distance from object
    - Projectors are rays (i.e., non-parallel)
    - *Vanishing points*
    - Objects appear smaller as distance from CP (eye of observer) increases
    - Difficult to determine exact size and shape of object
    - Most realistic, difficult to execute
  - When a 3D object is projected onto view plane using perspective transformation equations, any set of parallel lines in the object that are *not* parallel to the projection plane, converge at a vanishing point.
  - There are an infinite number of vanishing points, depending on how many set of parallel lines there are in the scene.
    - If a set of lines are parallel to one of the three principle axes, the vanishing point is called an *principal vanishing point*.
    - There are at most 3 such points, corresponding to the number of axes cut by the projection plane.

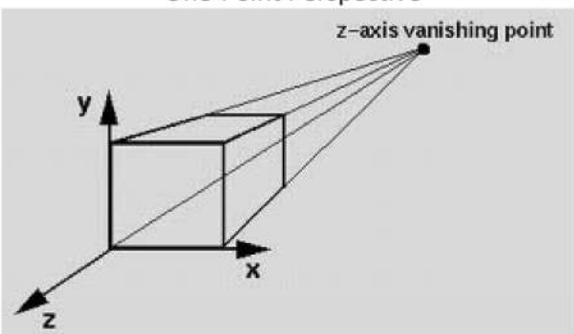
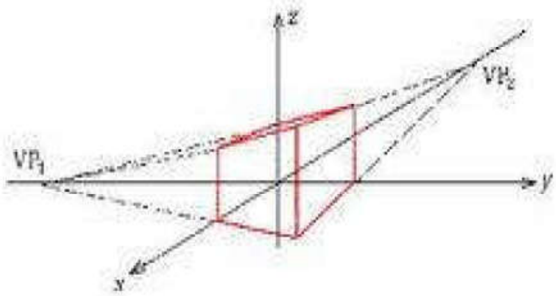
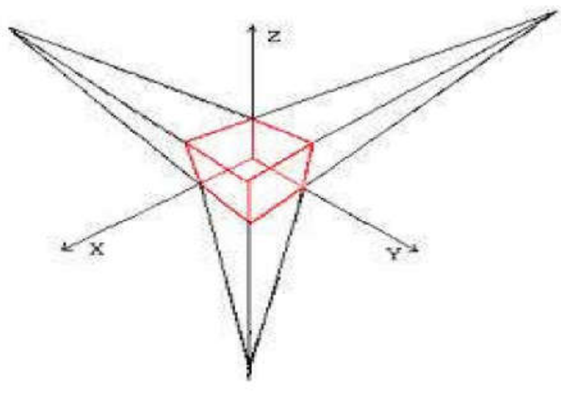
- ***Vanishing points***
  - Certain set of parallel lines appear to meet at a different point
    - The V*anishing point* for this direction
  - Principal vanishing points are formed by the apparent intersection of lines parallel to one of the three principal x, y, z axes.
  - The number of principal vanishing points is determined by the number of principal axes intersected by the view plane.
  - Sets of parallel lines on the same plane lead to *collinear* vanishing points.
    - The line is called the *horizon* for that plane

- Classes of Perspective Projection
  - ✓ **One-point**
    One principle axis cut by projection plane
    One axis vanishing point
  - ✓ **Two-point**
    Two principle axes cut by projection plane
    Two axis vanishing points

- ✓ **Three-point**:
  Three principle axes cut by projection plane
  Three axis vanishing points

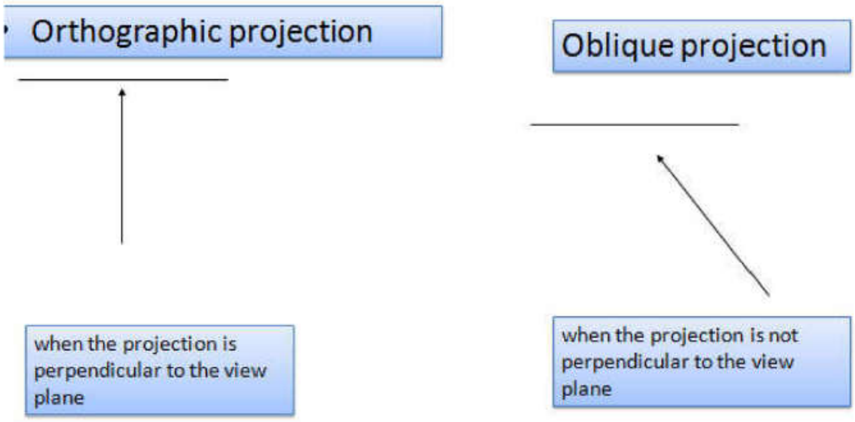


(a) One point (b) Two point (c) Three point

One-Point Perspective	Two-point perspective projection:
	
Three-point perspective projection 	

Parallel Projections

- We can define a parallel projection with a projection vector that defines the direction for the projection lines.
- 2 types:
  - **Orthographic** :
    - when the projection is perpendicular to the view plane.
    - In short, direction of projection = normal to the projection plane.
    - the projection is perpendicular to the view plane.
  - **Oblique**
    - when the projection is not perpendicular to the view plane. In short,
    - direction of projection ≠ normal to the projection plane.
    - Not perpendicular.



Orthographic (or orthogonal) projections:

- Front, side and rear orthographic projection of an object are called **elevations** and the top orthographic projection is called **plan view**.
- all have projection plane perpendicular to a principle axes.
- Here length and angles are accurately depicted and measured from the drawing, so engineering and architectural drawings commonly employee this.
- However, As only one face of an object is shown, it can be hard to create a mental image of the object, even when several views are available.

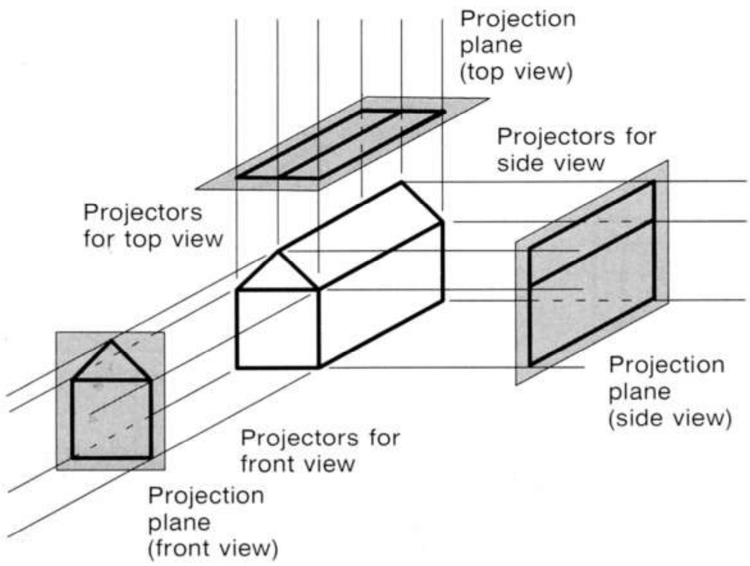
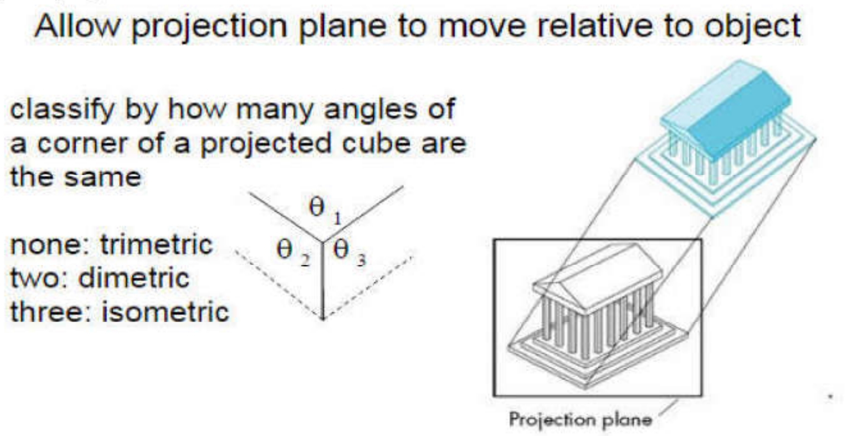


Fig: Orthogonal projections

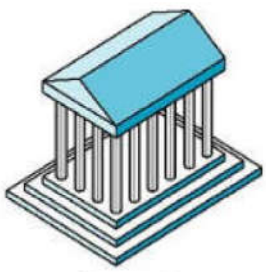
Axonometric orthographic projections

- Orthographic projections that *show more than one face of an object* are called **axonometric** orthographic projections.



- The most common axonometric projection is an **isometric** projection where the projection plane intersects each coordinate axis in the model coordinate system at an equal distance.

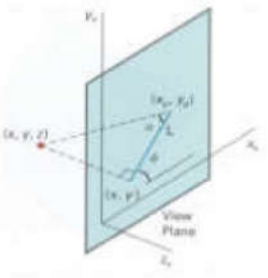
Dimetric Trimetric Isometric

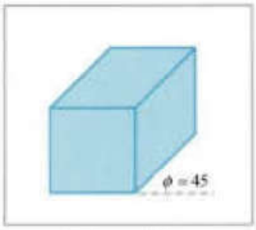


Oblique projection

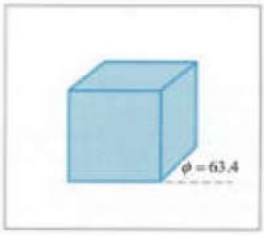
Projectors are not perpendicular to the view plane

- DOP not perpendicular to view plane





Cavalier
(DOP θ = 45°)



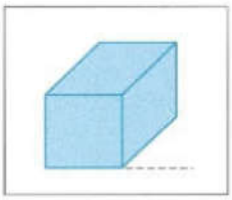
Cabinet
(DOP θ = 63.4°)

- 2 common oblique parallel projections:
  Cavalier and *Cabinet*

➢ **Cavalier projection**:

All lines perpendicular to the projection plane are projected with no change in length.

- Cavalier Projection- It is obtained when the angle between the oblique projectors and the plane of projection is 45 degree and the foreshortening factors for all three principal directions are equal.
- In Cavalier projection , the resulting figure is too thick.



➢ **Cabinet projection**:

– Lines which are perpendicular to the projection plane (viewing surface) are projected at 1 / 2 the length .

– This results in foreshortening of the z axis, and provides a more “realistic” view.

- Cabinet Projection- It is used to correct the deficiency that is produced by Cavalier projection.
- An oblique projection for which the foreshortening factor for the edge perpendicular to the plane of projection is one-half is called Cabinet projection.
- For a cabinet projection, the angle between the projectors and the plane of projection is 63.43.