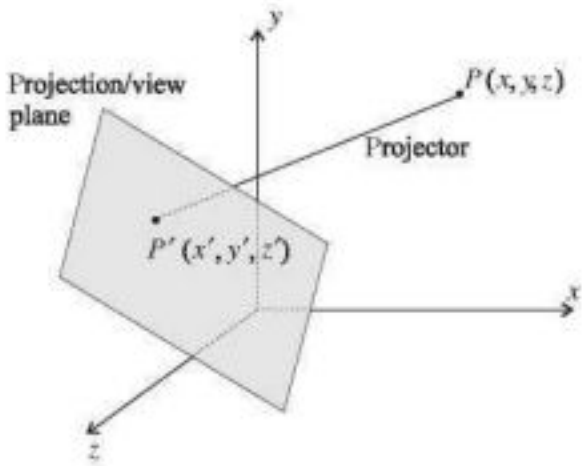
Viewing and Projection

Computer Graphics

Projection

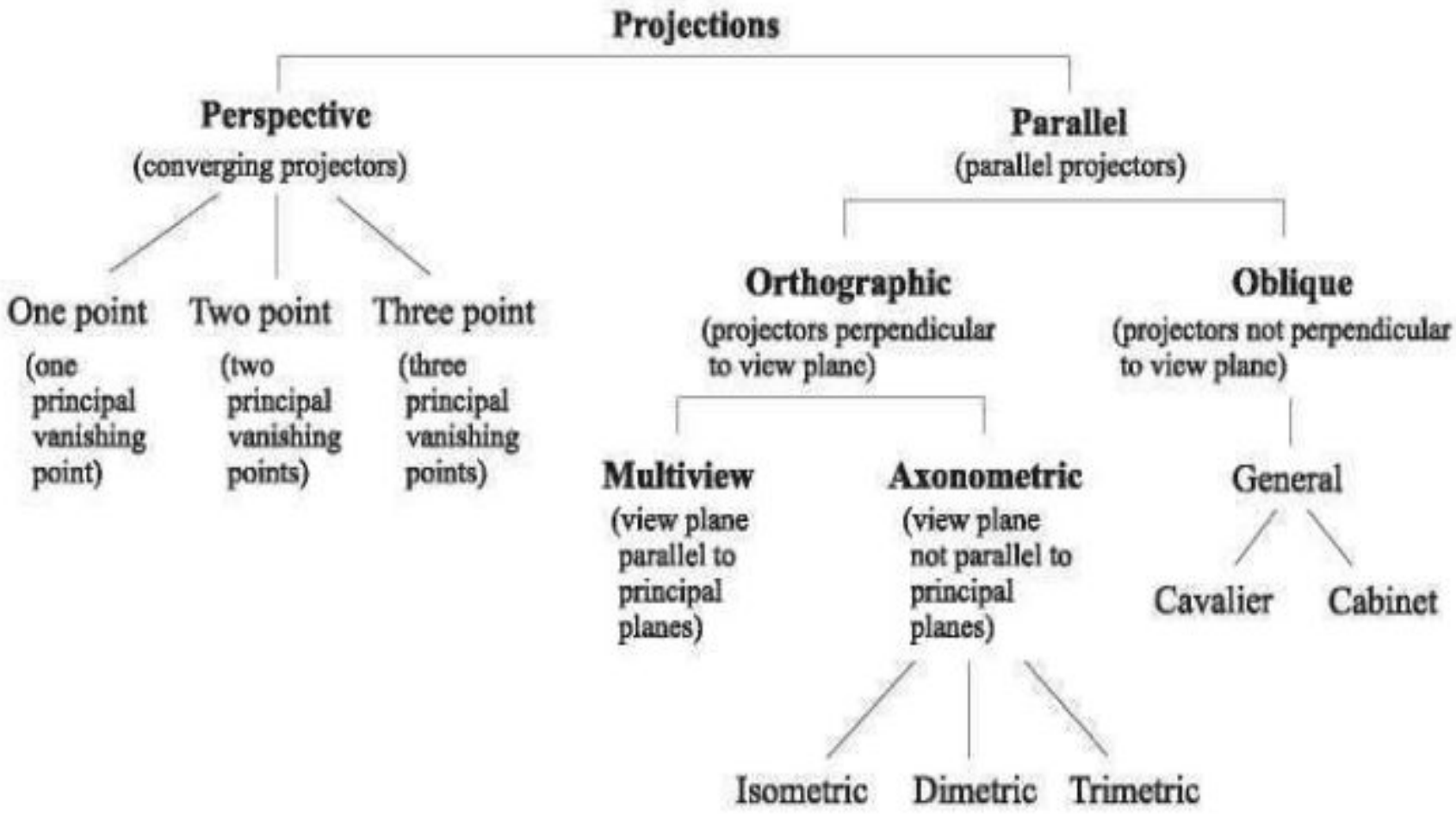
- **Projection** can be defined as a mapping of point P (x, y, z) onto its image P' (x',y', z') in the projection plane or view plane, which constitutes the display surface.
- The mapping is determined by a projection line called the **projector** that passes through P and intersects the view plane. The intersection point is P'.



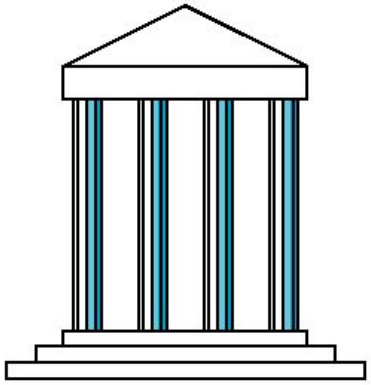
Planar Geometric Projections

- Standard projections project onto a plane
- Projectors are lines that either
  - converge at a center of projection
  - are parallel
- Such projections preserve lines
  - but not necessarily angles

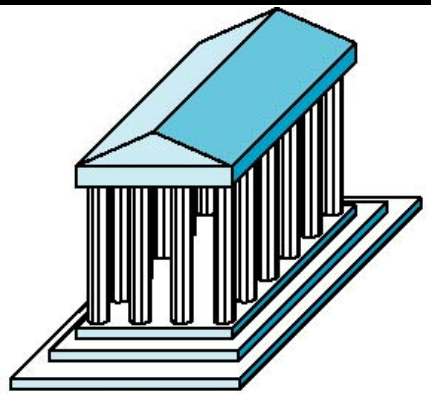
Taxonomy of Planar Geometric Projections



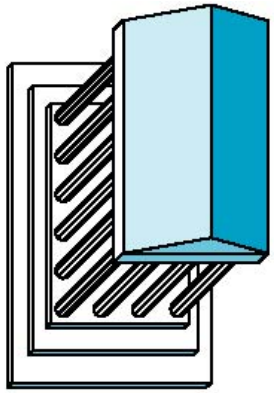
Classical Projections



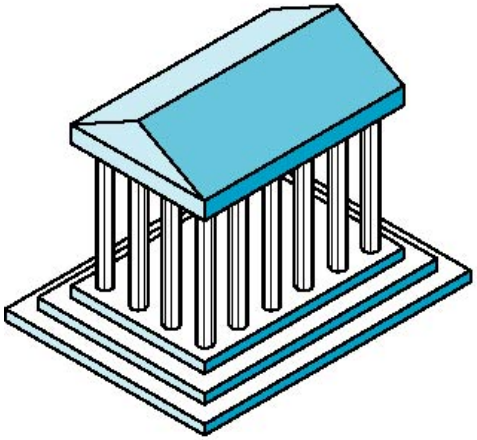
Front elevation



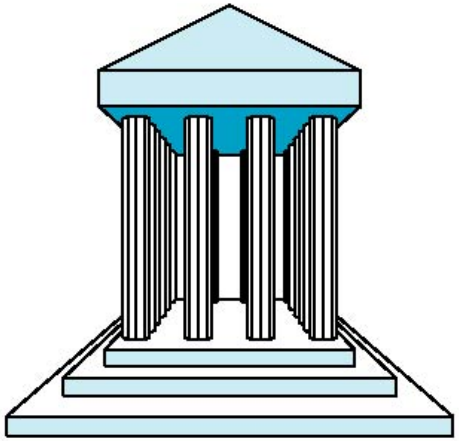
Elevation oblique



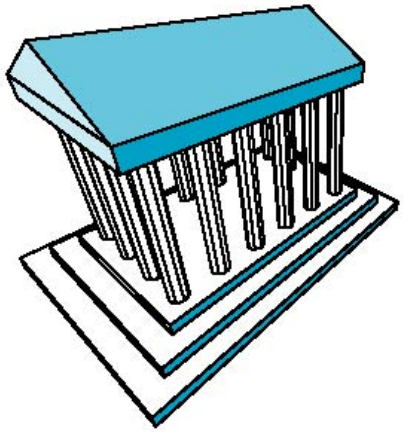
Plan oblique



Isometric

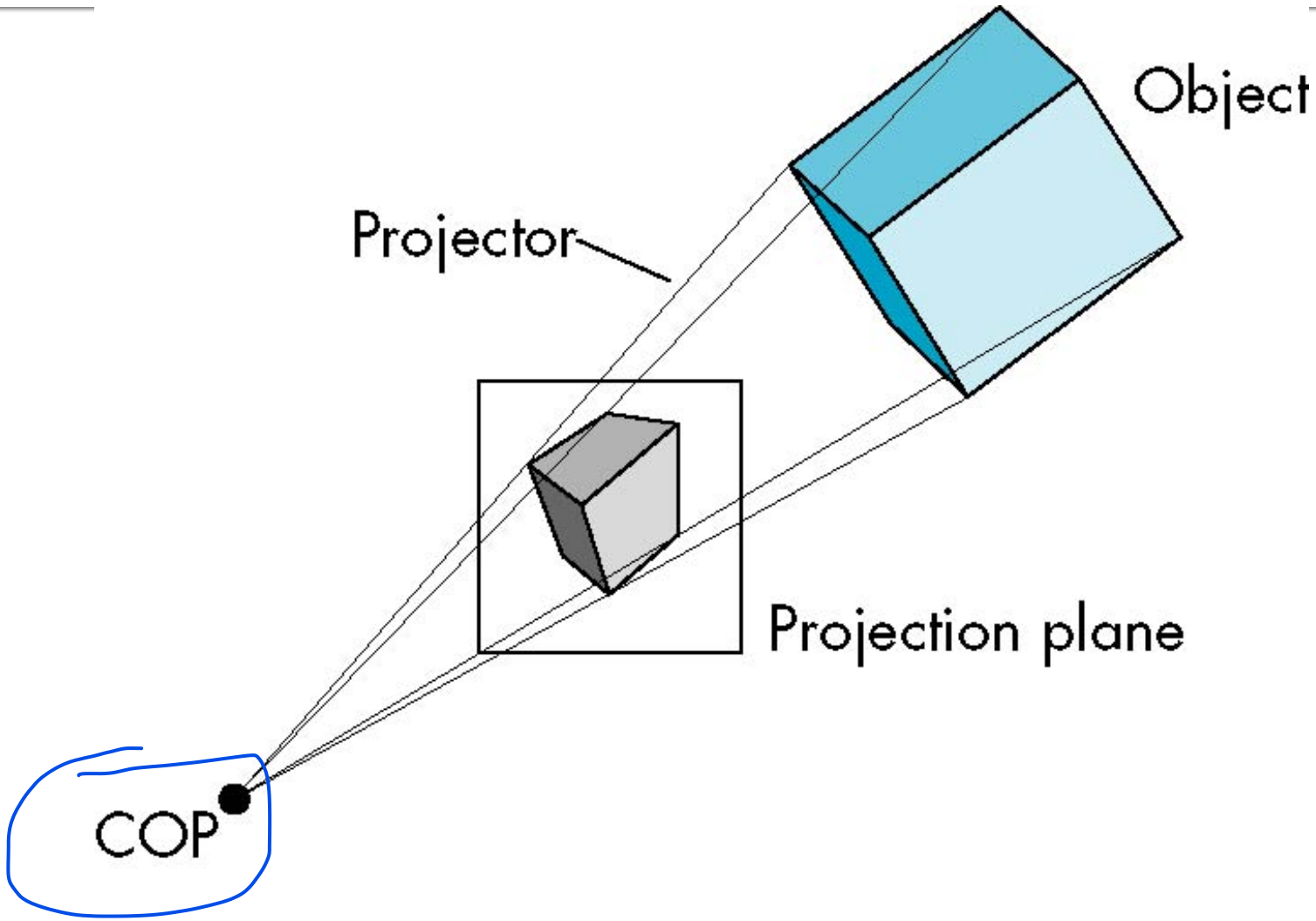


One-point perspective



Three-point perspective

Perspective Projection



Perspective Projection

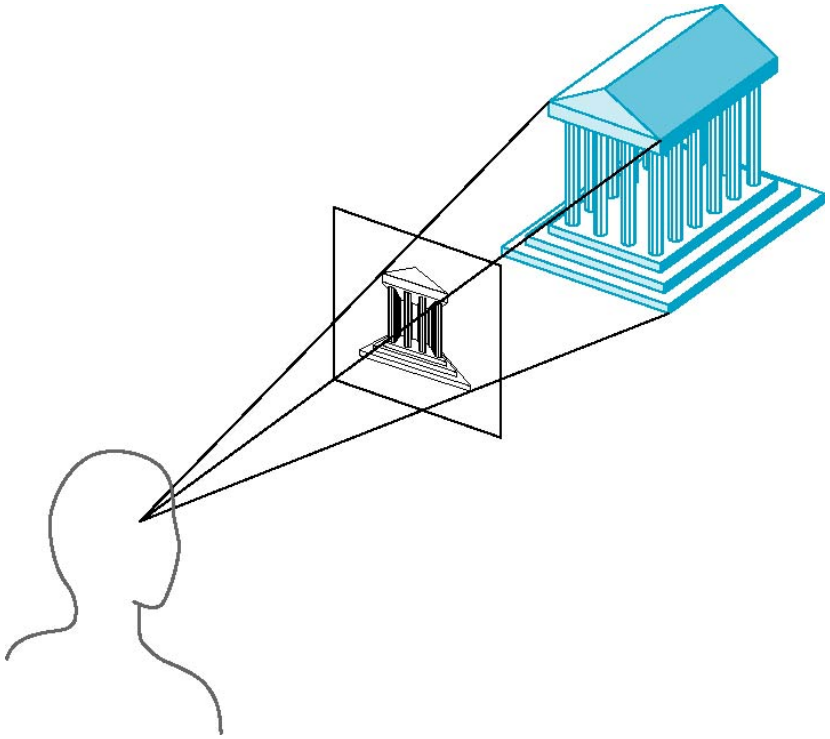
- The techniques of perspective projection are generalizations of the principles used by artists in preparing perspective drawings of three-dimensional objects and scenes.
- The eye of the artist is placed at the center of projection, and the canvas, or more precisely the plane containing the canvas, becomes the view plane.
- An image point is determined by a projector that goes from an object point to the center of projection .

Perspective Projection

- Perspective drawings are characterized by perspective foreshortening and vanishing points.
- **Perspective foreshortening** is the illusion that objects and lengths appear smaller as their distance from the center of projection increases.
- The illusion that certain sets of parallel lines appear to meet at a point is another feature of perspective drawings. These points are called **vanishing points**.
- Principal vanishing points are formed by the apparent intersection of lines parallel to one of the three principal x, y, or z axes.
- The number of principal vanishing points is determined by the number of principal axes intersected by the view plane

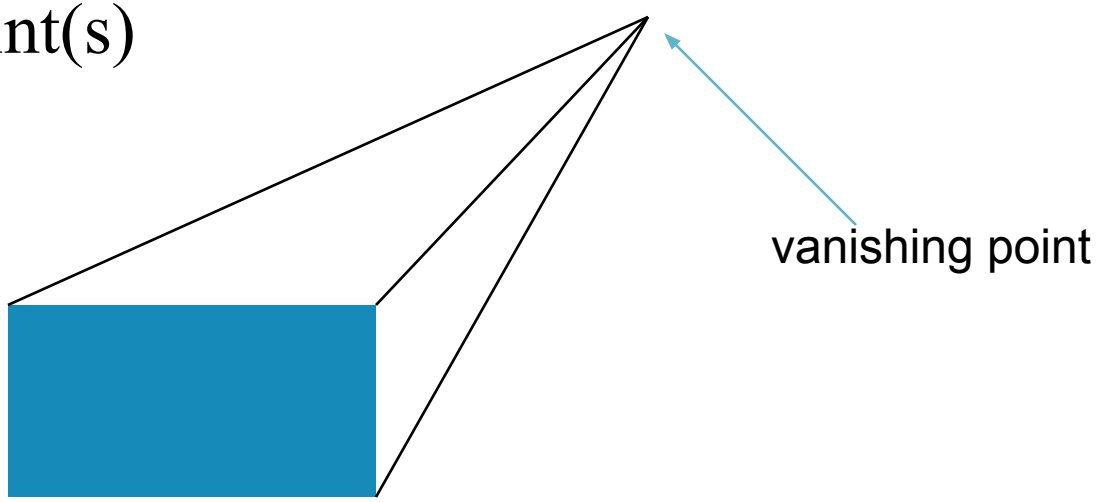
Perspective Foreshortening

Projectors converge at center of projection



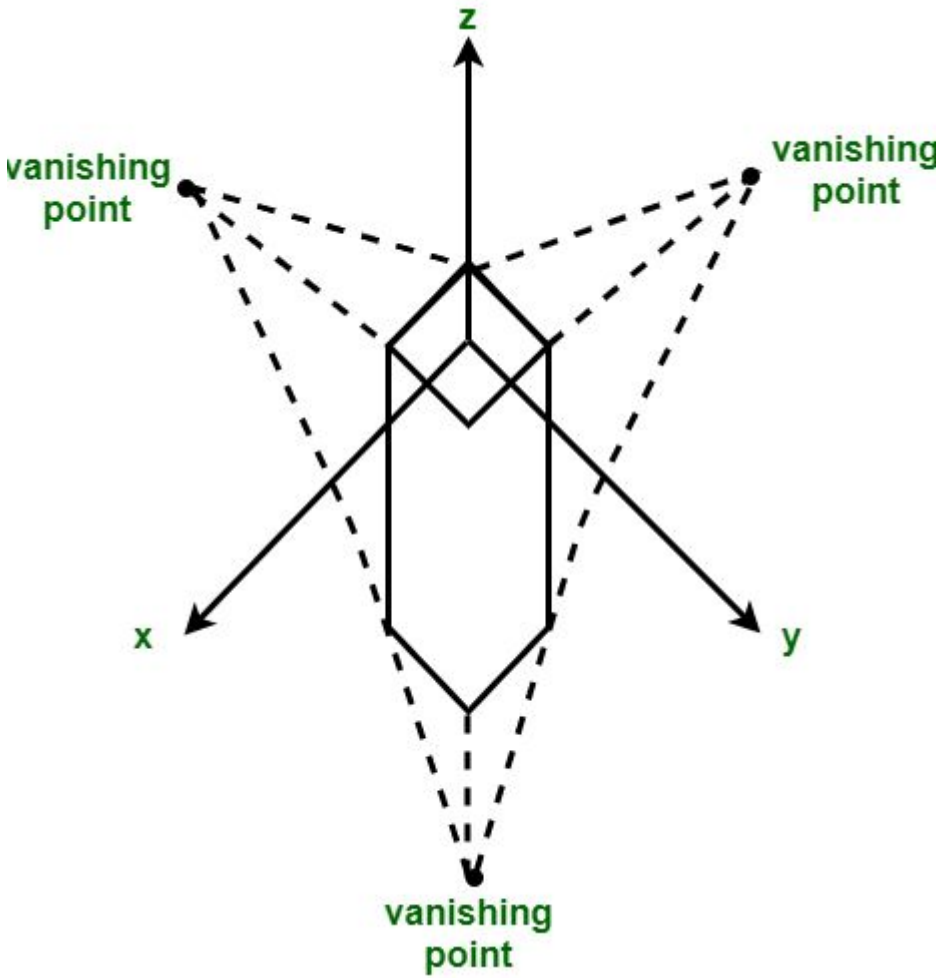
Vanishing Points

- Parallel lines (not parallel to the projection plan) on the object converge at a single point in the projection (the *vanishing point*)
- Drawing simple perspectives by hand uses these vanishing point(s)



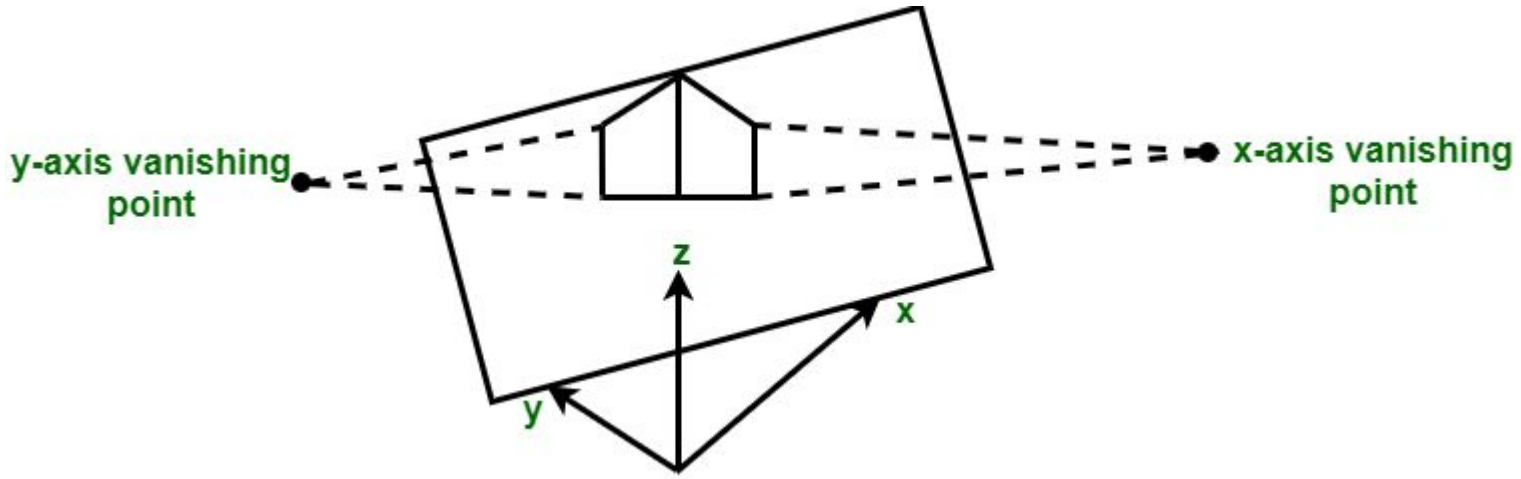
Three-Point Perspective

- Three point perspective projection occurs when all three axis intersects with projection plane. There is no any principle axis which is parallel to projection plane.



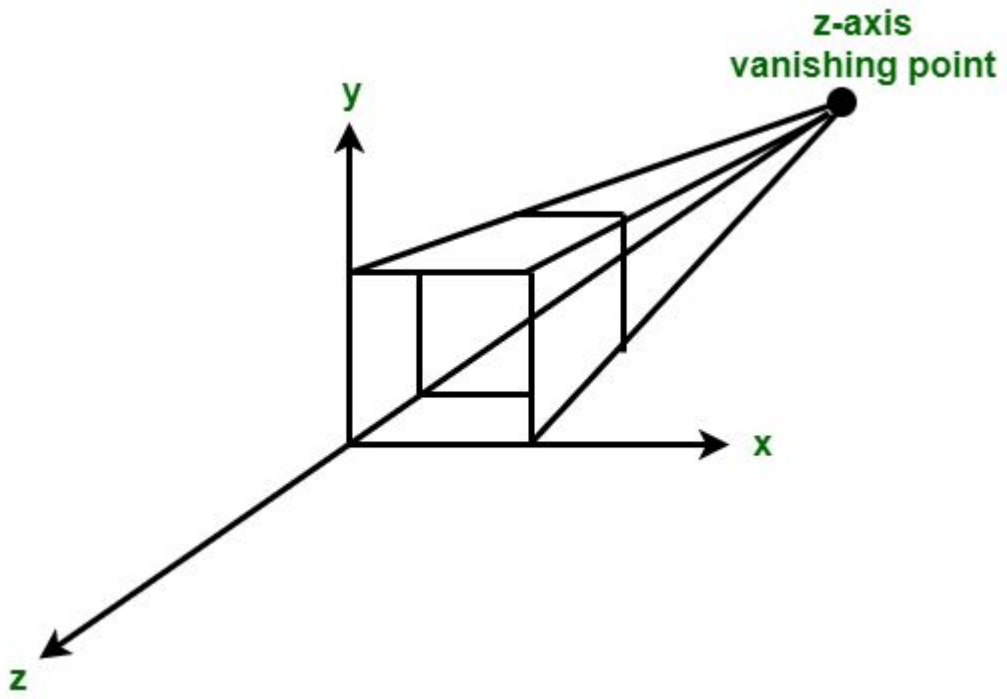
Two-Point Perspective

- Two point perspective projection occurs when projection plane intersects two of principal axis. In the above figure, projection plane intersects x and y axis whereas z axis remains parallel to projection plane.



One-Point Perspective

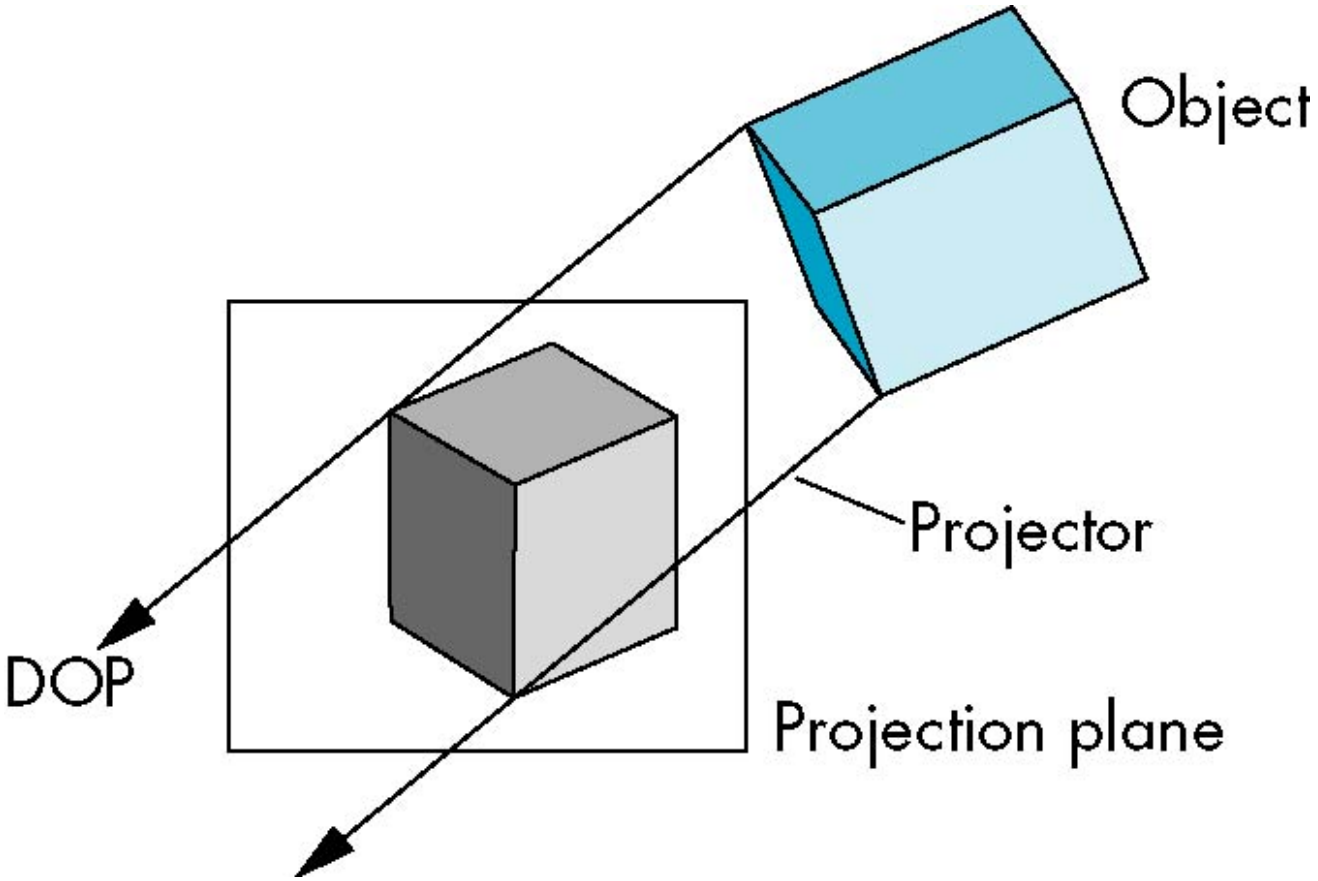
- **One Point Perspective Projection –** One point perspective projection occurs when any of principal axes intersects with projection plane or we can say when projection plane is perpendicular to principal axis.
- above figure, z axis intersects projection plane whereas x and y axis remain parallel to projection plane.



Advantages and Disadvantages

- Objects further from viewer are projected smaller than the same sized objects closer to the viewer (*diminution*)
  - Looks realistic
- Equal distances along a line are not projected into equal distances (*nonuniform foreshortening*)
- Angles preserved only in planes parallel to the projection plane
- More difficult to construct by hand (perspective projection) than parallel projections (but not more difficult by computer)

Parallel Projection

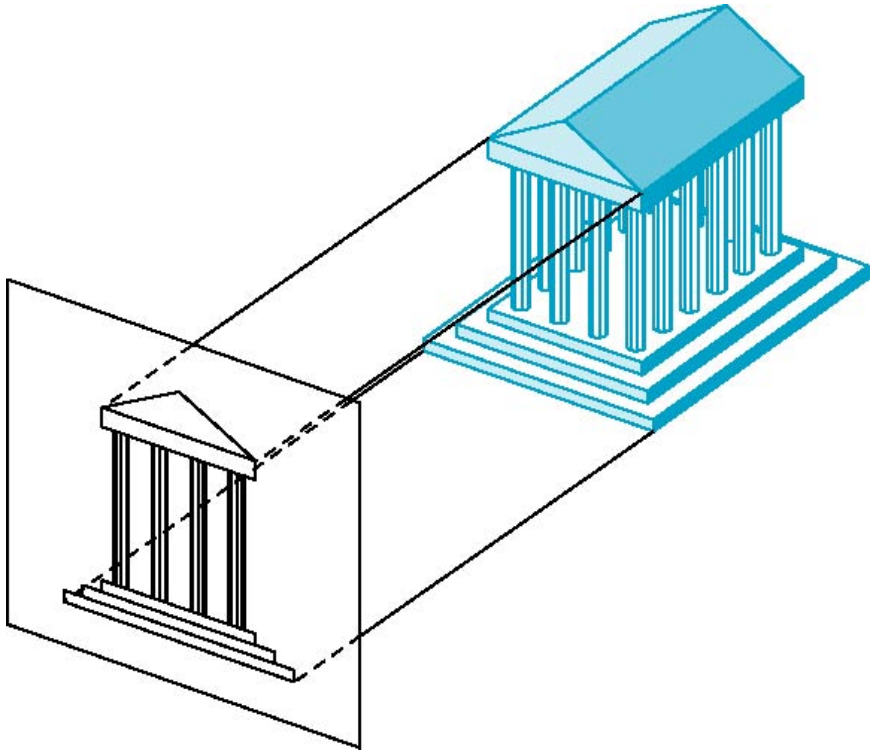


Parallel Projection

- Parallel projection methods are used by drafters and engineers to create working drawings of an object which preserves its scale and shape.
- The complete representation of these details often requires two or more views (projections) of the object onto different view planes
- In parallel projection, image points are found as the intersection of the view plane with a projector drawn from the object point and having a fixed direction (see Fig. 7-9). The direction of projection is the prescribed direction for all projectors.

Orthographic Projection

Projectors are orthogonal to projection surface



Orthographic Projection

- It is a kind of parallel projection where the projecting lines emerge parallelly from the object surface and incident perpendicularly at the projecting plane.
- Orthographic projections are characterized by the fact that the direction of projection is perpendicular to the view plane.
- When the direction of projection is parallel to any of the principal axes, this produces the front, top, and side views of mechanical drawings (also referred to as multiview drawings).

Multiview Orthographic Projection

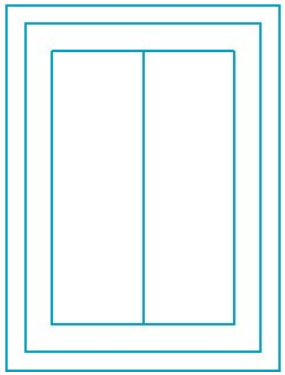
- Projection plane parallel to principal face
- Usually form front, top, side views

isometric (not multiview orthographic view)

front

in CAD and architecture, we often display three multiviews plus isometric

top



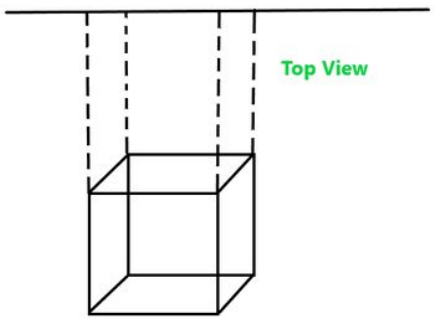
side

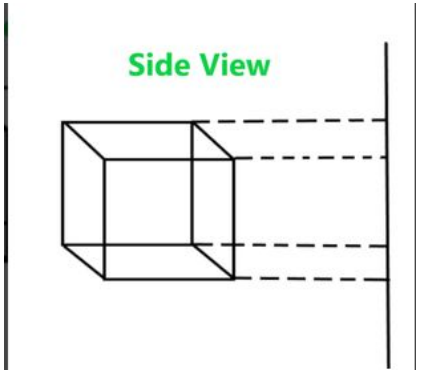
Multiview Orthographic Projection

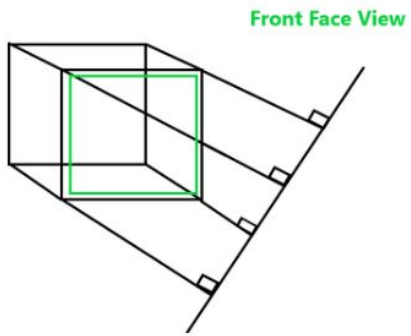
Multiview Projection : It is further divided into three categories –
(1) Top-View : In this projection, the rays that emerge from the top of the polygon surface are observed.

Side-View : It is another type of projection orthographic projection where the side view of the polygon surface is observed.

Front-view : In this orthographic projection front face view of the object is observed.







Advantages and Disadvantages

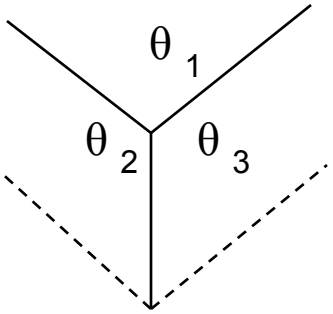
- Preserves both distances and angles
  - Shapes preserved
  - Can be used for measurements
    - Building plans
    - Manuals
- Cannot see what object really looks like because many surfaces hidden from view
  - Often we add the isometric

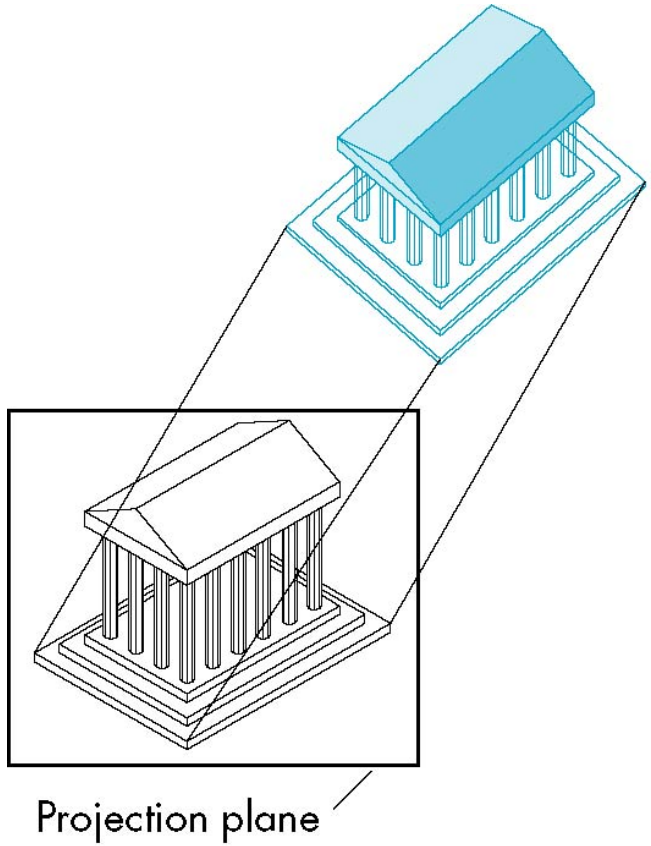
Axonometric Projections

Allow projection plane to move relative to object

classify by how many angles of a corner of a projected cube are the same

none: trimetric
two: dimetric
three: isometric





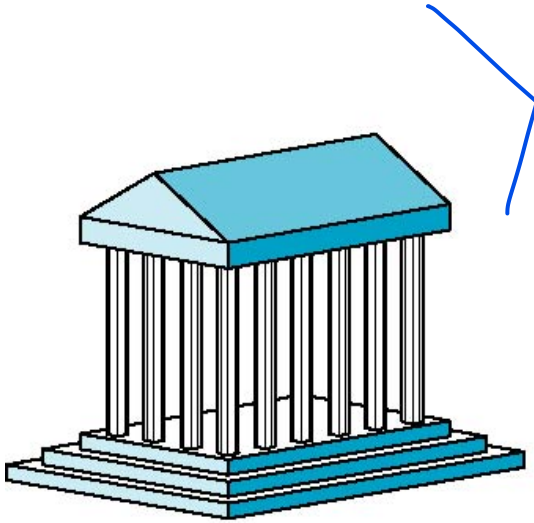
Axonometric Projection

- Axonometric projection is an orthographic projection, where the projection lines are perpendicular to the plane of projection, and the object is rotated around one or more of its axes to show multiple sides.
- It is further divided into three categories :
- **(1) Isometric Projection :** It is a method for visually representing three-dimensional objects in two-dimensional display in technical and engineering drawings. Here in this projection, the three coordinate axes appear equally foreshortened and the angle between any two of them is 120 degrees.
- **Dimetric Projection :** It is a kind of orthographic projection where the visualized object appears to have only two adjacent sides and angles are equal.
-
- **Trimetric Projection :** It is a kind of orthographic projection where the visualized object appears to have all the adjacent sides and angles unequal.

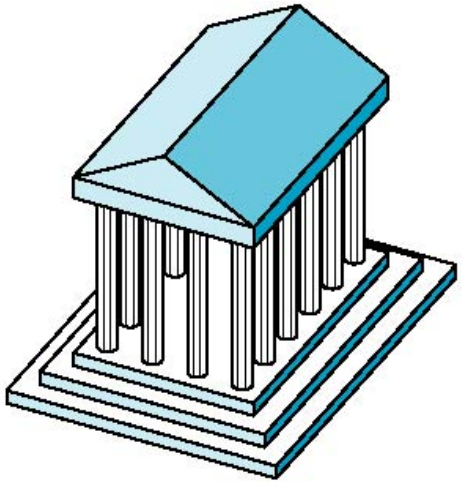
Axonometric Projection

- Axonometric projections are orthographic projections in which the direction of projection is not parallel to any of the three principal axes.

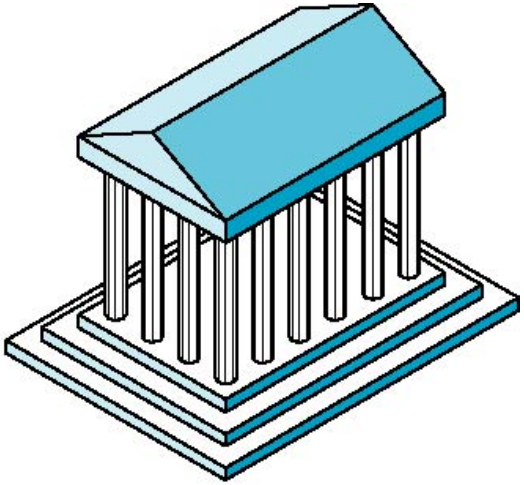
Types of Axonometric Projections



Dimetric



Trimetric



Isometric

Advantages and Disadvantages of Axonometric Projections

- Lines are scaled (*foreshortened*) but can find scaling factors
- Lines preserved but angles are not
  - Projection of a circle in a plane not parallel to the projection plane is an ellipse
- Can see three principal faces of a box-like object
- Some optical illusions possible
  - Parallel lines appear to diverge
- Does not look real because far objects are scaled the same as near objects
- Used in CAD applications

Oblique Projection

Arbitrary relationship between projectors and projection plane