

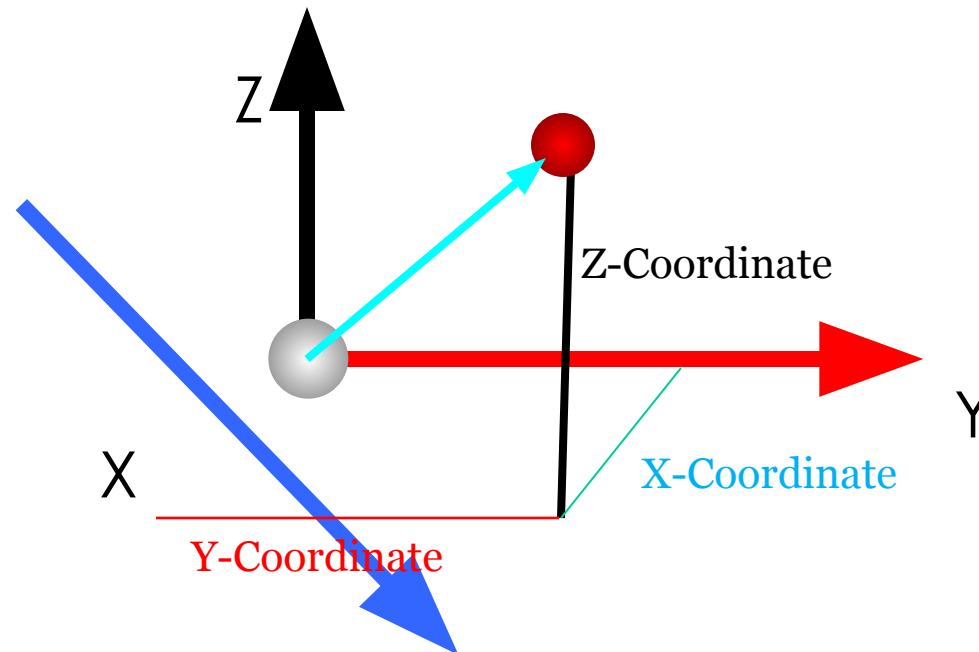


CSE- 4105

Lecturer-09
Projection-I

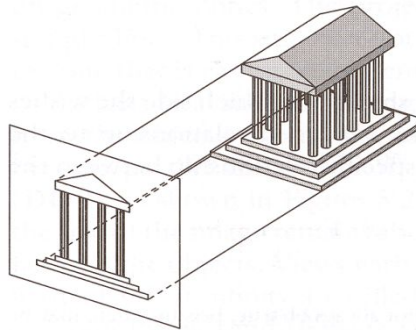
Three dimension

- **Three-dimensional** space is a geometric 3-parameters model of the physical universe (without considering time) in which all known matter exists.



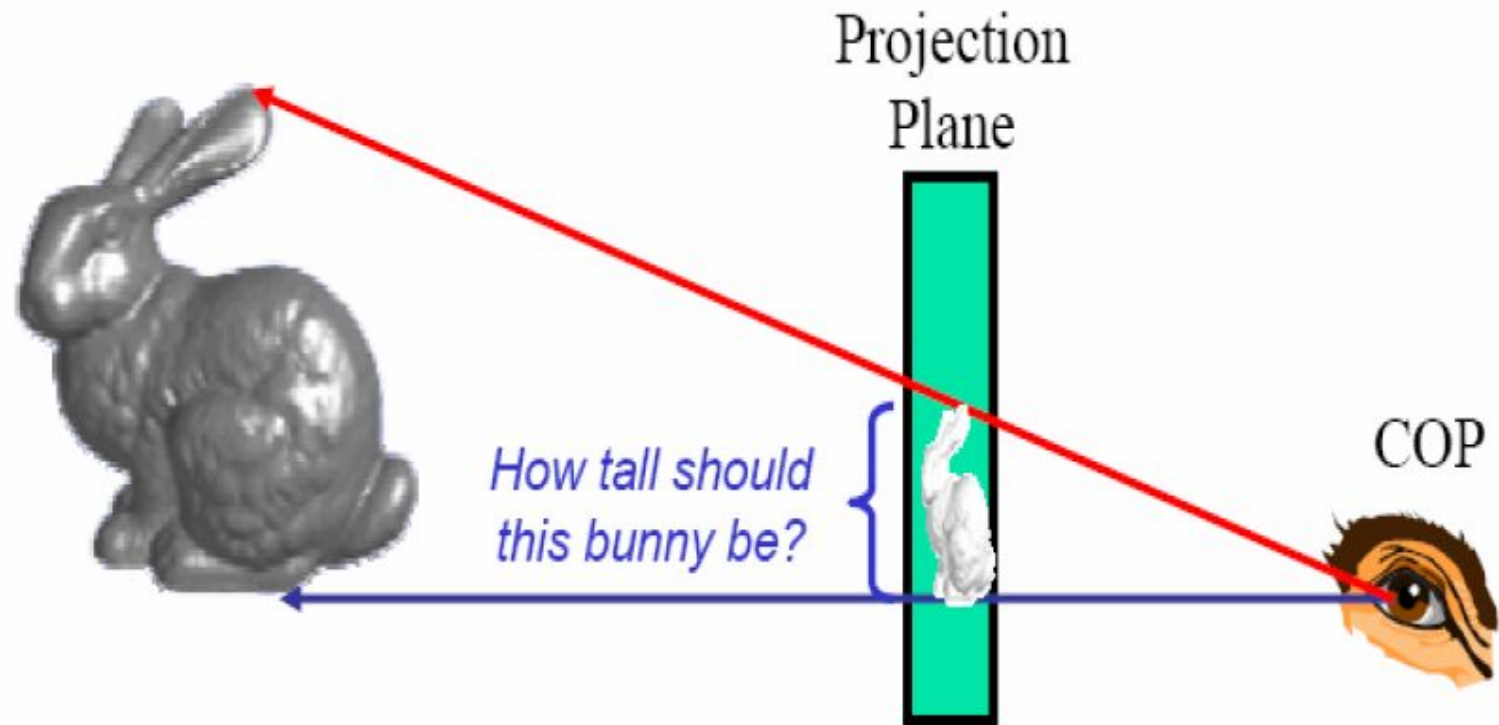
Three dimension

- **3 Dimensional Object** : An object that has height, width and depth, like any object in the real world is a 3 dimensional object.
- **3D Graphics** : In computers graphics, 3-D (three dimensions or three-dimensional) describes an image that provides the perception of depth/height/width.



Projection

Projections



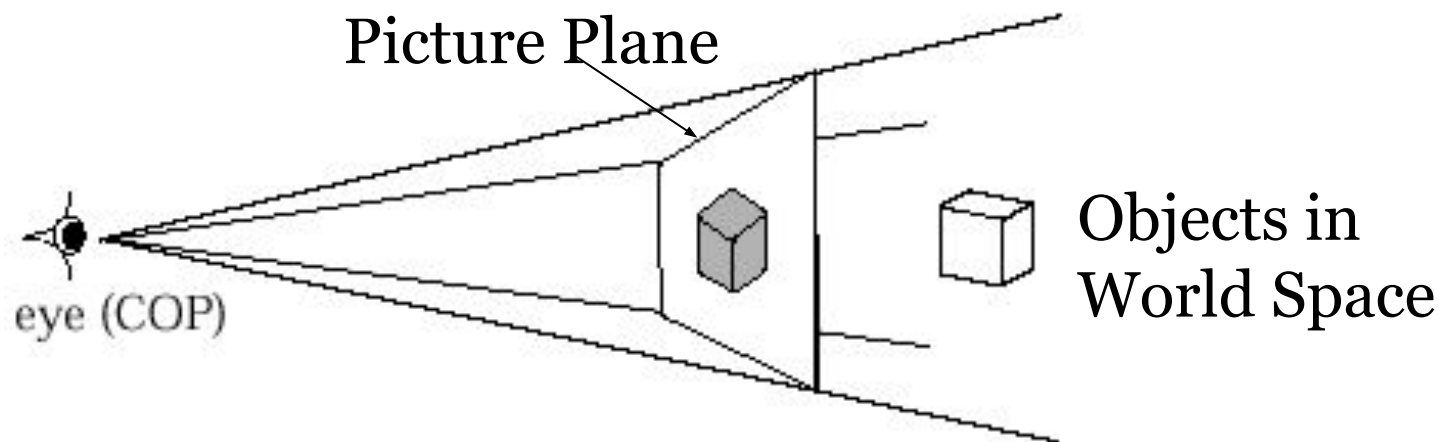
Projection

- Projection
 - Transformation from n -D coordinate system to m -D coordinate system, where $m < n$
- Our concern
 - $n = 3$ and $m = 2$
 \Rightarrow projection from 3D to 2D



What Are Projections?

- Our 3-D scenes are all specified in 3-D world coordinates
- To display these we need to generate a 2-D image - *project* objects onto a *picture plane*
- So how do we figure out these projections?



Converting From 3-D To 2-D

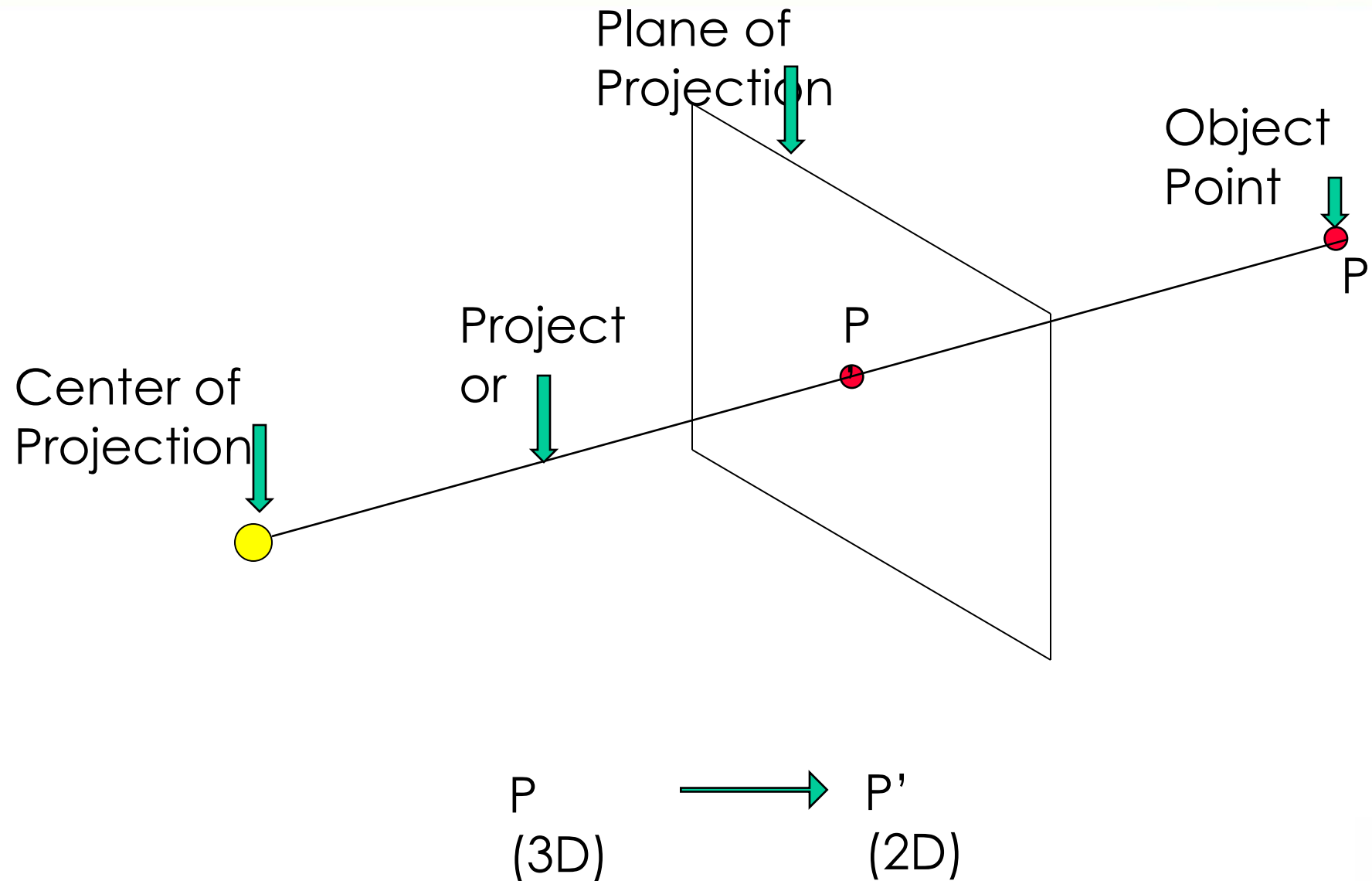
- Projection is just one part of the process of converting from 3-D world coordinates to a 2-D image



Projection

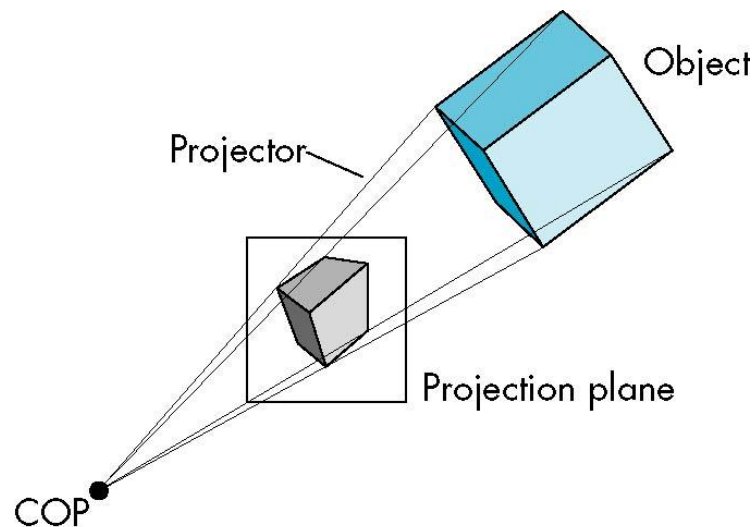


Projection Geometry



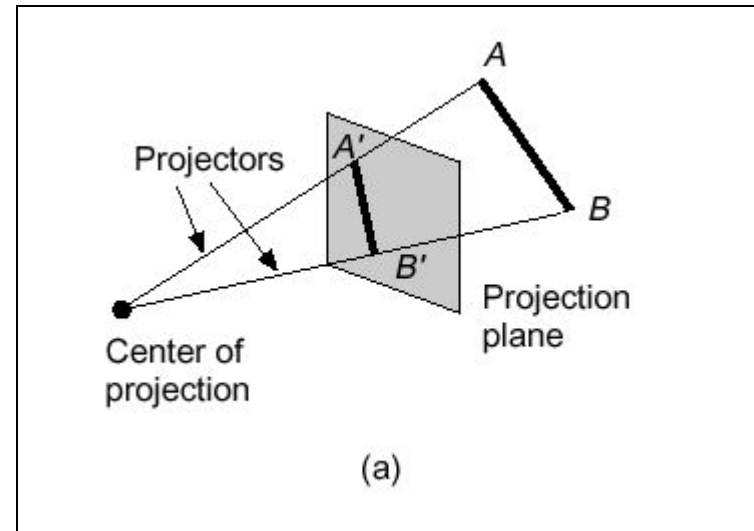
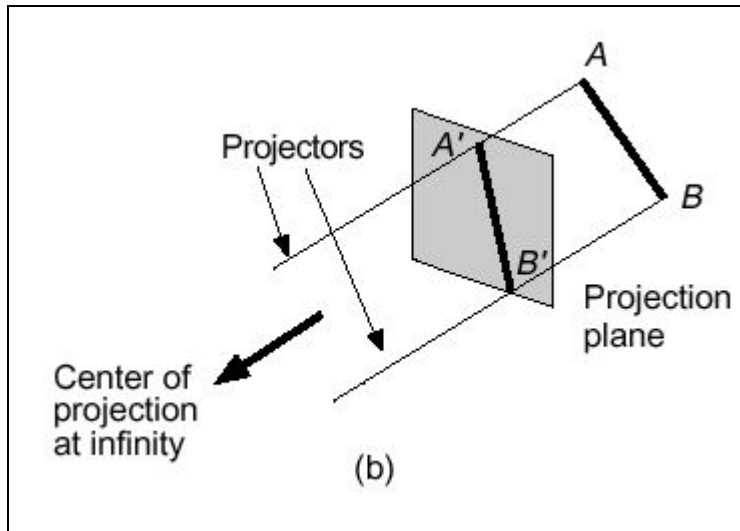
Projections

- Terminology
 - **Projectors:** Straight projection rays
 - **Center of projection:** Where the projectors emanated from
 - **Projection plane:** Where the projection forms



Types Of Projections

- There are two broad classes of projection:
 - **Parallel:** Typically used for architectural and engineering drawings
 - **Perspective:** Realistic looking and used in computer graphics



Perspective

- Perspective is a technique applied in drawing and painting to give a flat surface or imagery a sense of depth.
- Horizon is the line for which the sky meets the land of water below. The height of the horizon will affect the placement of the vanishing point(s) as well as the scene's eye level.



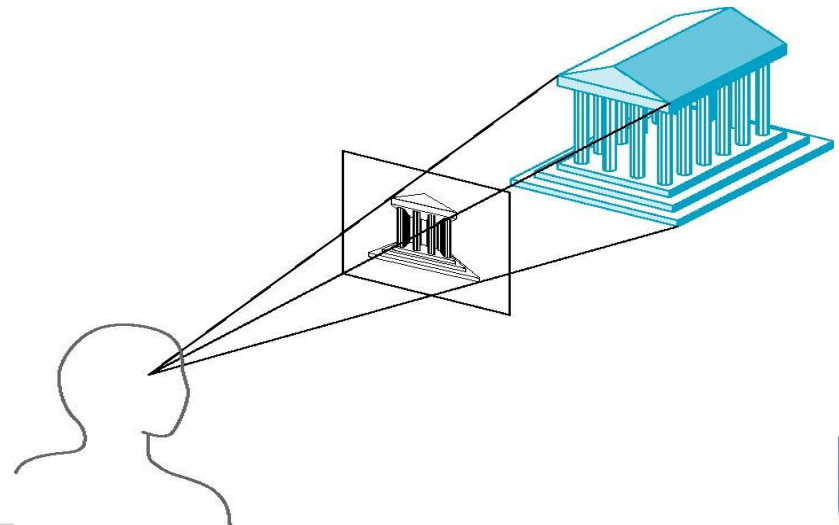
Perspective

- Vanishing point is the point where parallel lines appear to come together in the distance. A scene can have a limitless number of vanishing points.
- The diagonal lines are lines which are directed to a vanishing point.
- The ground plane is the horizontal surface below the horizon. It could be land or water.



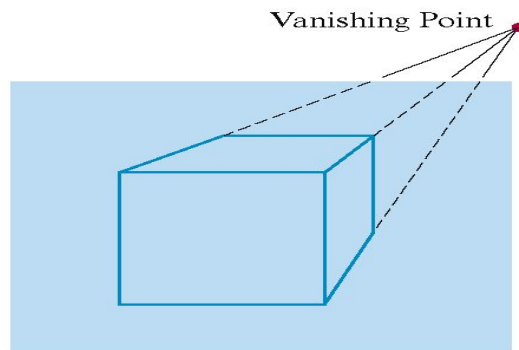
Perspective

- Perspective is all about DEPTH
- Determined by *center of projection*
- Distance between projection plane and COP is *finite*
- Visual effect similar to human visual system
 - Perspective foreshortening:
 - Distance from COP longer, size smaller
 - Exact shape, measurement, parallelism not reserved

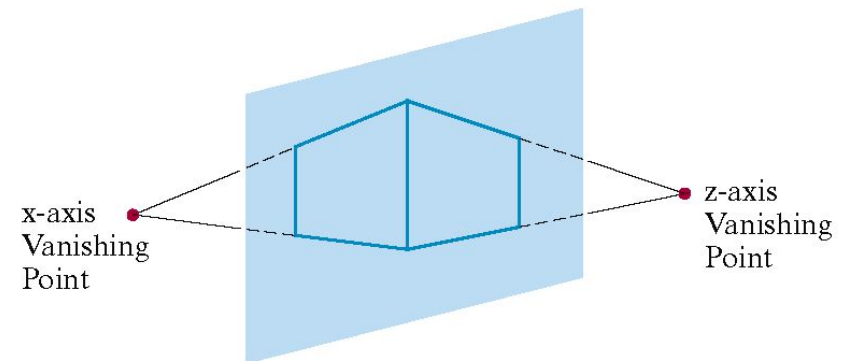


Perspective Projections

- There are a number of different kinds of perspective views
- The most common are one-point and two point perspectives



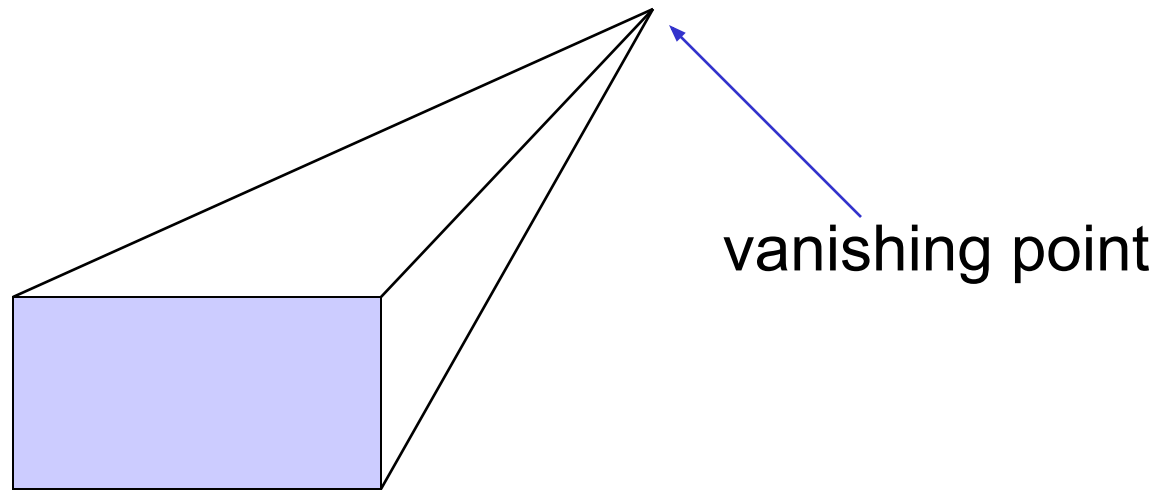
(b)
One-Point
Perspective
Projection



(c)
Two-Point
Perspective
Projection

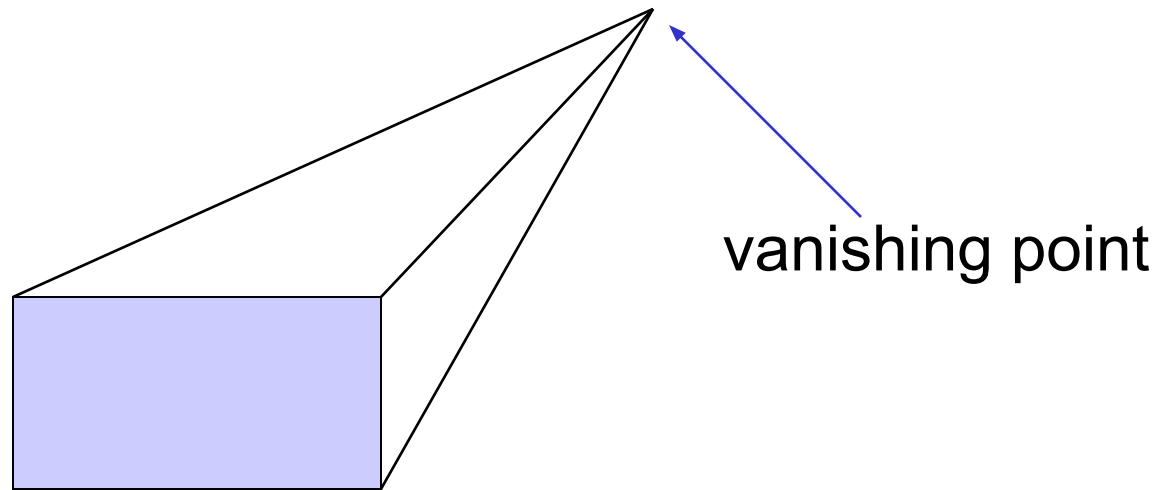
Vanishing Points

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



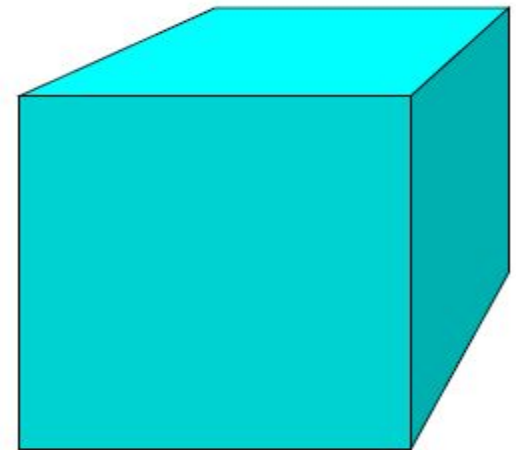
Vanishing Points

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One-Point Perspective

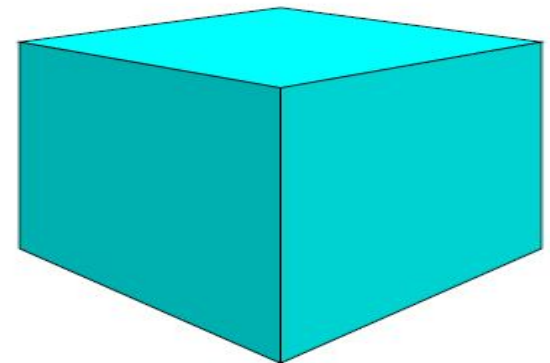
- One point perspective rule applies when your subject is viewed on the front.
- Ex- a side of a cube or a face looking directly at you.
- One principal face parallel to projection plane
- One vanishing point for cube
- Used when drawing rooms, roads and landscape.



One point

Two-Point Perspective

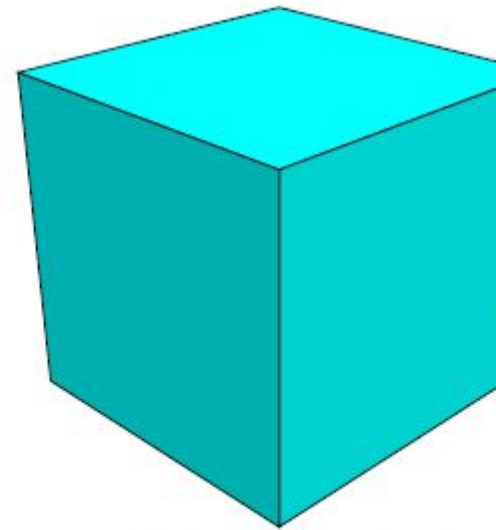
- Two point perspective is a linear perspective that uses two vanishing points, and is associated with DEPTH and WIDTH.
- Senses in this type of perspective have the vanishing points placed at the far left and far right.



Two Point

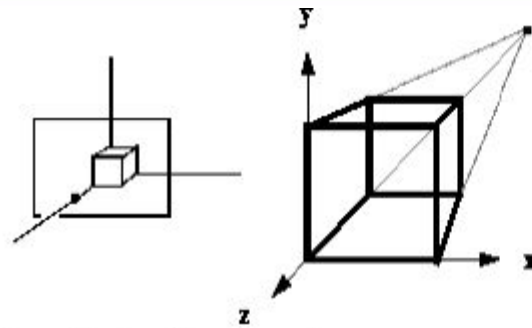
Three-Point Perspective

- Three point perspective is similar to two-point perspective, it has left and right vanishing points on the horizon.
- Additionally, there is a third vanishing point either below or above the horizon.
- Principal face parallel to projection Plane and associated with DEPTH, WIDTH and HEIGHT.

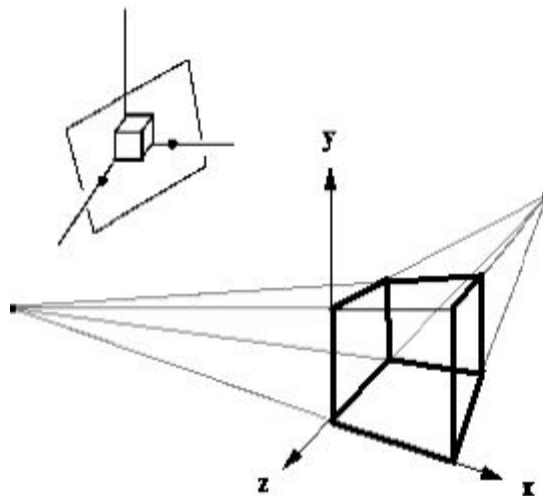


Three point

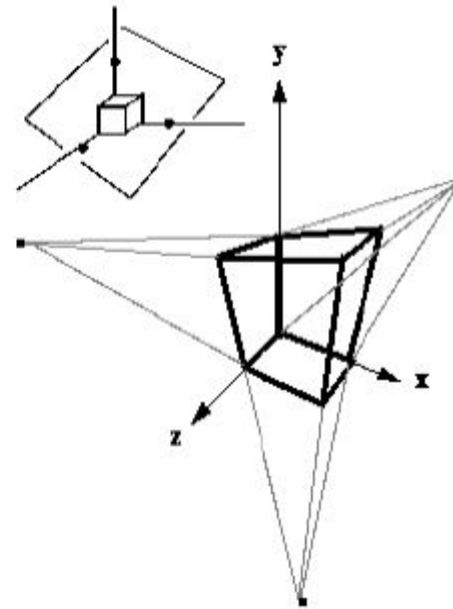
Vanishing points



One Point Perspective
(z-axis vanishing point)



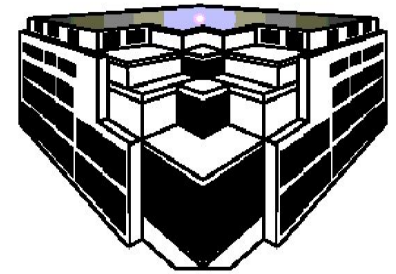
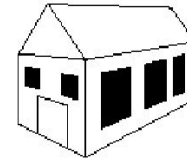
Two Point Perspective
z, and x-axis vanishing points



Three Point Perspective
(z, x, and y-axis
vanishing points)

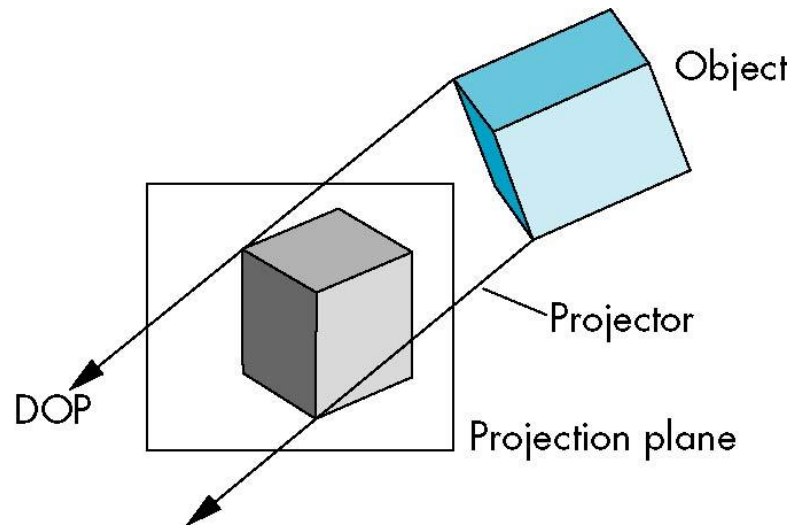
Perspective Projections

- Used for:
 - Fine Art
 - Human visual system...
- Pros:
 - Gives a realistic view and feeling for 3D form of object
- Cons:
 - Does not preserve shape of object or scale (except where object intersects projection plane)



Parallel Projections

- Determined by *direction of projection*
- Distance between projection plane and COP is infinite
- Less realistic view
 - No foreshortening
- Exact measurement and parallelism preserved



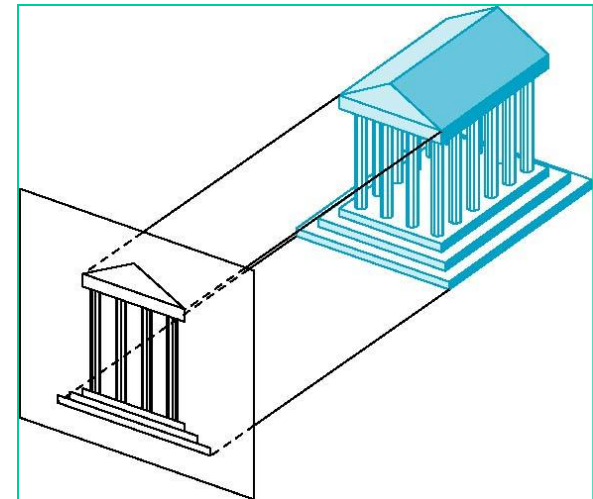
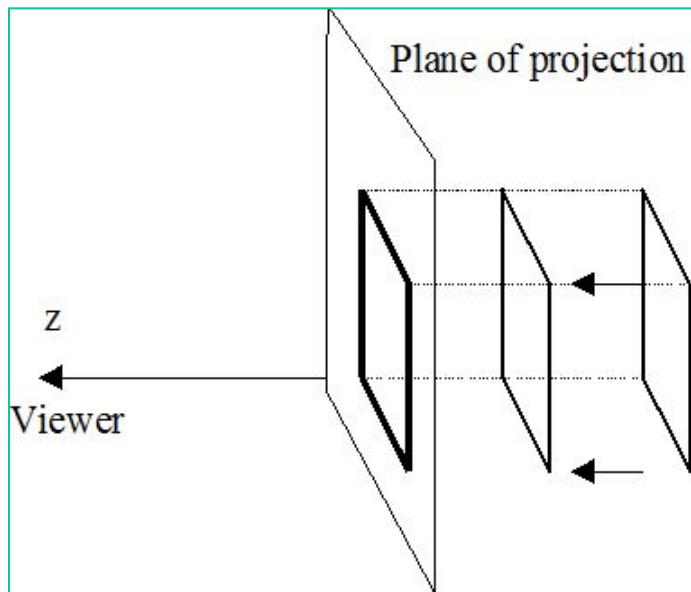
Parallel projections

- For parallel projections, we specify a **direction of projection** (DOP) instead of a COP.
- There are two types of parallel projections:
 - **Orthographic projection** – DOP perpendicular to PP
 - **Oblique projection** --- DOP not perpendicular to PP



Orthographic Projection

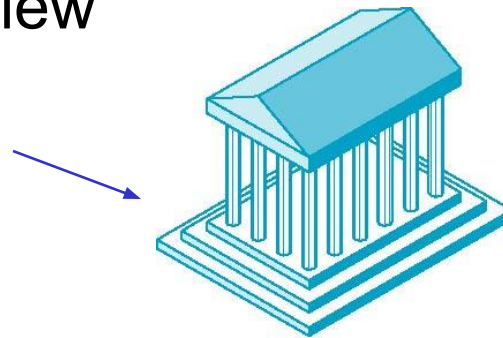
- The lines of projection are parallel, and at the same time orthogonal to the plane of projection.
- Project onto plane by dropping that coordinate;
- All rays are parallel.



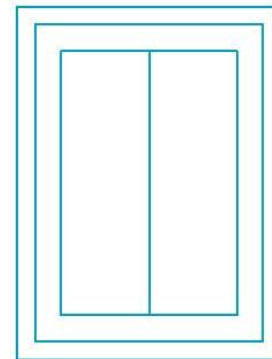
Multiview Orthographic Projection

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

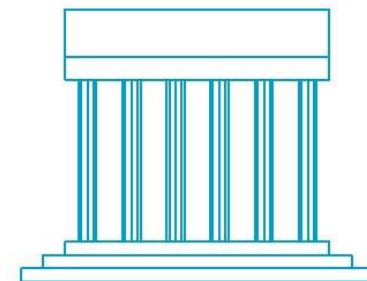
isometric (not multiview orthographic view)



front

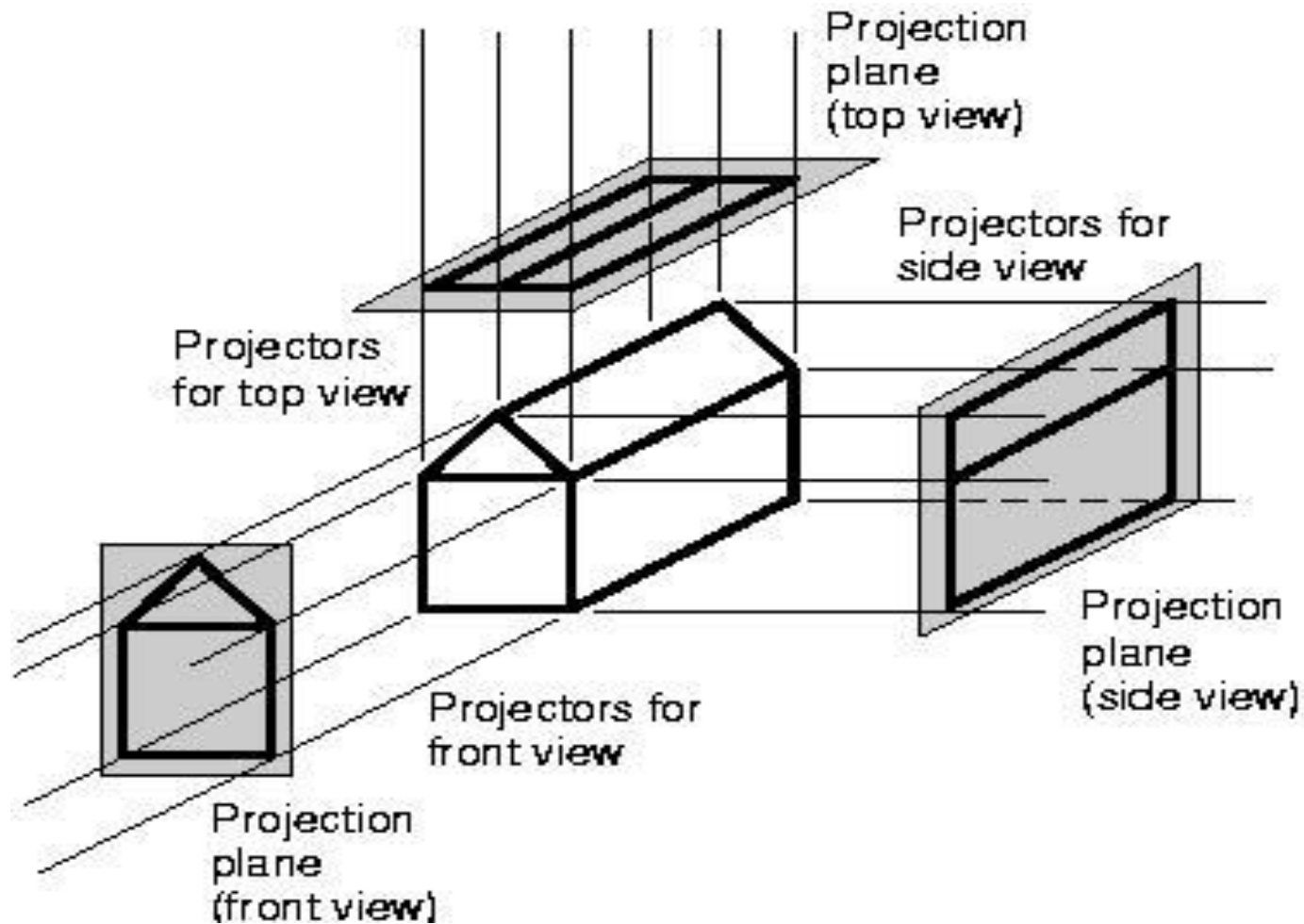


top



side

Orthographic Parallel Projections



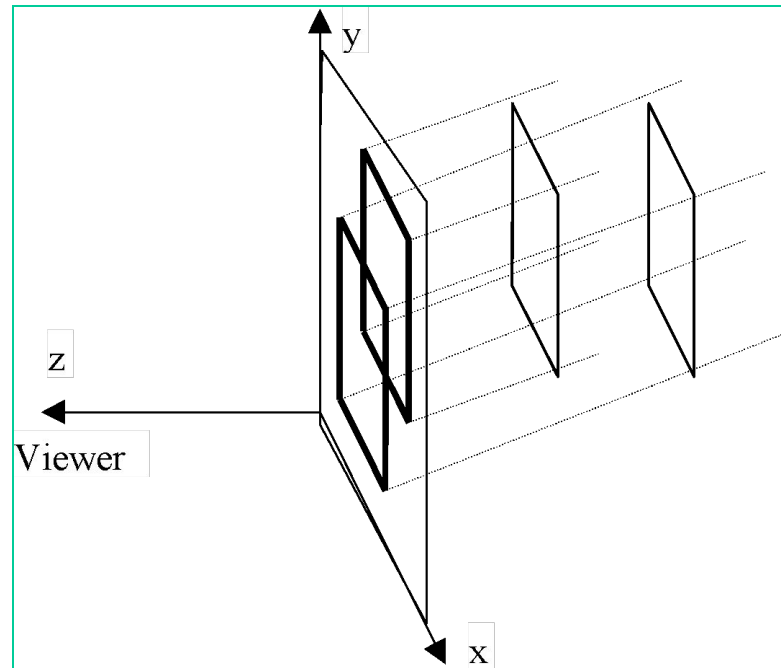
Advantages and Disadvantages

- 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



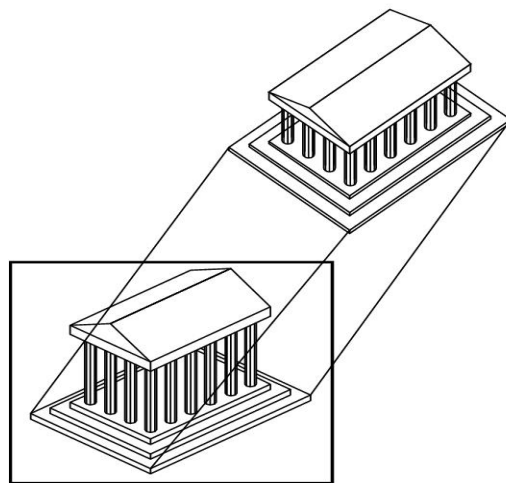
Oblique Projection

- The lines of projection are parallel, but not orthogonal to the plane of projection.



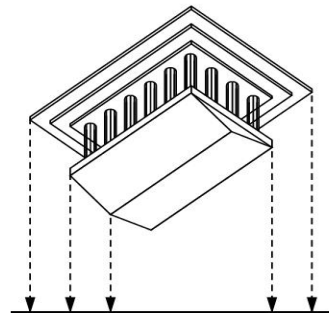
Oblique Projection

- Arbitrary relationship between projectors and projection plane
- The projectors are still orthogonal to the projection plane
- But the projection plane can have any orientation with respect to the object.
- It is used extensively in architectural and mechanical design.



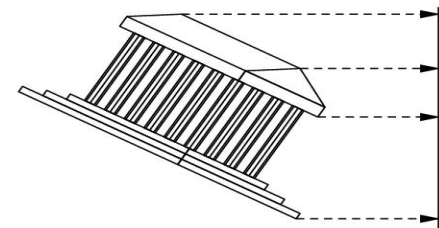
Projection plane

(a)



Projection plane

(b)

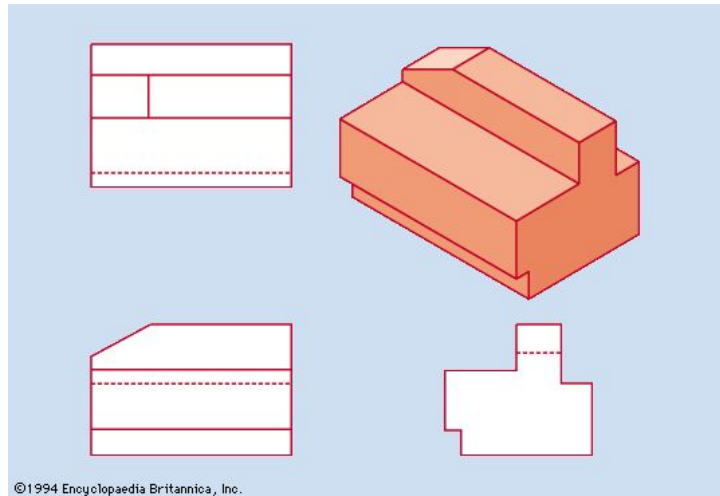


Projection plane

(c)

Advantages and Disadvantages

- Can pick the angles to emphasize a particular face
 - Architecture: plan oblique, elevation oblique
- Angles in faces parallel to projection plane are preserved while we can still see “around” side



Parallel and Perspective

- Parallel Projections:
 - The center of projection is at infinity.
 - The projectors are parallel to each other.
- Perspective Projections:
 - The center of projection is a finite point.
 - The projectors intersect at the center of projection.



Projections: Properties

- Projections map points from one space to another coordinate space of lower dimension, and hence involves loss of information.
- Projections are not invertible. All projection matrices are singular.
- All points on a projector map to the same point on the plane of projection.



For better understanding

- <https://www.youtube.com/watch?v=1miyDqcobsg>





Thank You