Viewing
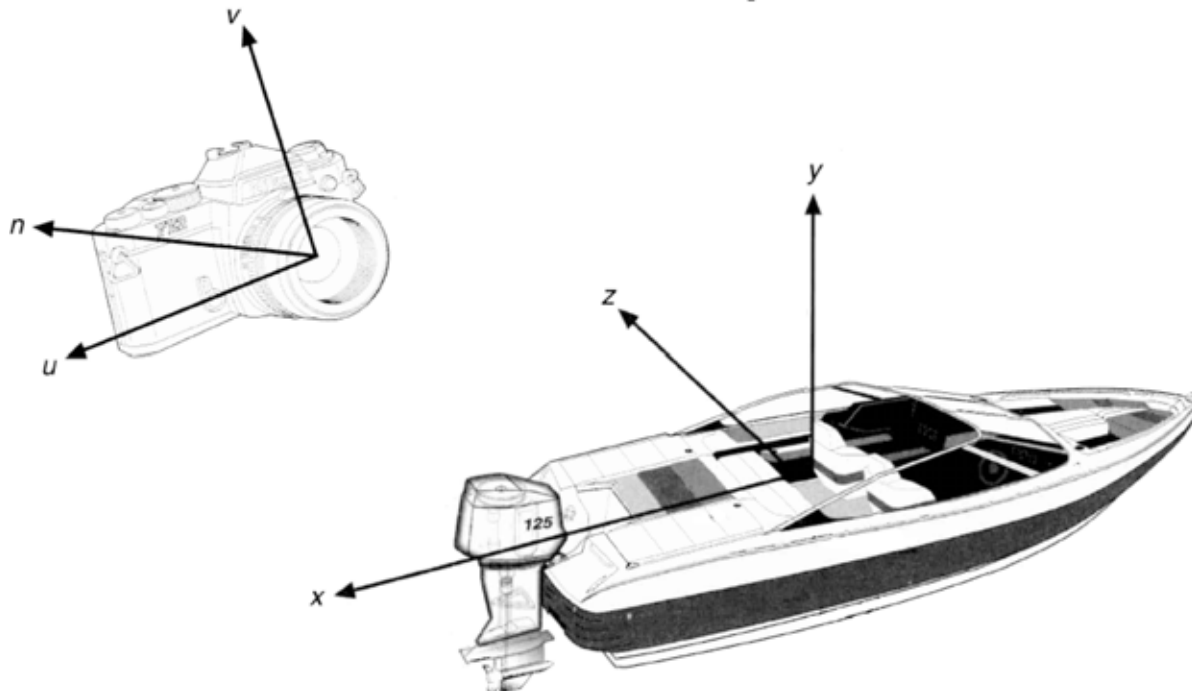
- Often it is helpful to envision viewing in computer graphics using a synthetic camera
- We can move, orient, rotate, and snap the shutter of the camera to capture a 2D image

Reality

- The camera is code which produces an image (either on screen or to file)
  - Object is a 3D model consisting of points, lines, surfaces, etc...
  - Our coordinate system for camera is different than that of the object
    - *u*, *v*, *n* for camera
   - *x*, *y*, *z* for object

Viewing Pipeline

- Of course it's a bit more than just "pushing the button" to capture the image
- Image acquisition requires of a number of steps, usually consisting of...
  - Specification of projection type
  - Specification of viewing parameters
  - Clipping in 3D
  - Projection and Display
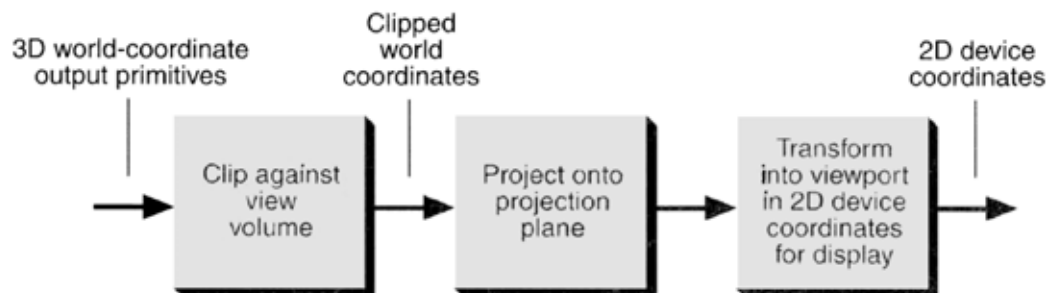
Projection

- In general, projects consist of transforming an n-dimensional system into a system with a dimension less than n
- *We'll focus on the common 3D to 2D projection*

Planar Projection
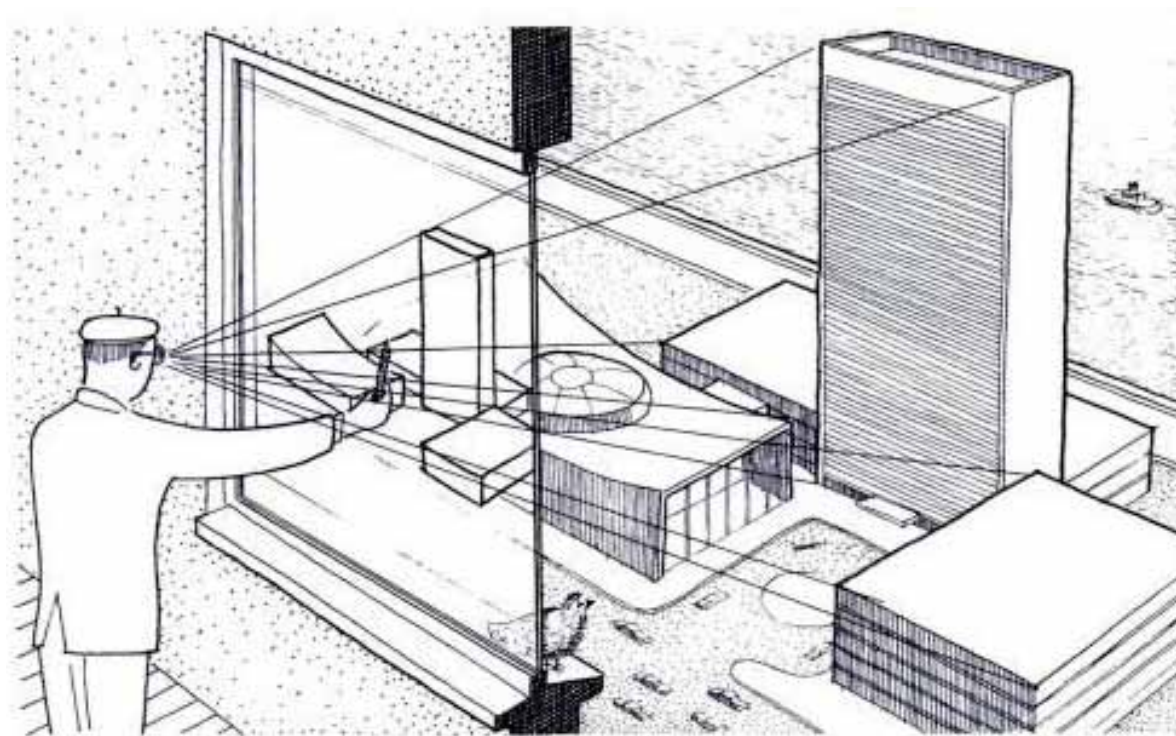
Projection Rays

- Projection of 3D defined by straight projection rays called projectors
- Rays emulate from a center of projection
- Rays pass through each point of an object and intersect a projection plane to form the projection

Center of Projection

- Usually the center of projection is a finite distance away from the projection plane
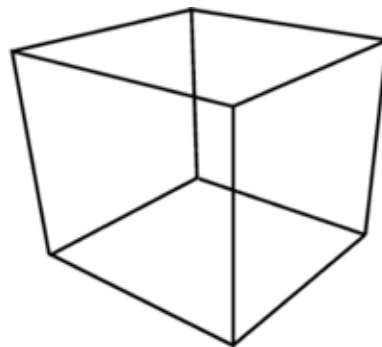- For some projections, it is convenient to think of center of projection as infinitely away
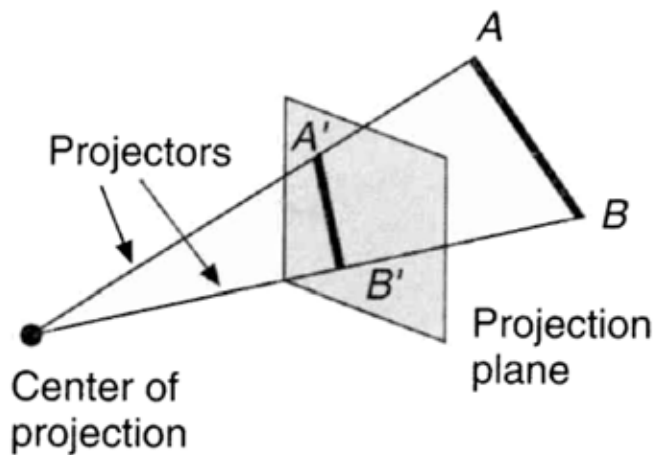

(a)
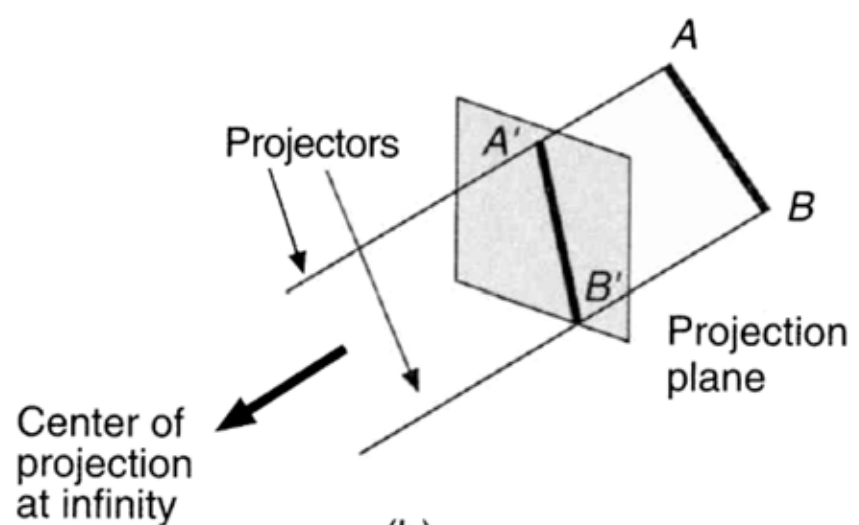
(b)

Perspective Foreshortening

- Size varies inversely with respect to the distance from the center of projection
- Tends to look more realistic
  - Cannot generally measure
    - Shape
    - Object distances
    - Angles (except front faces)
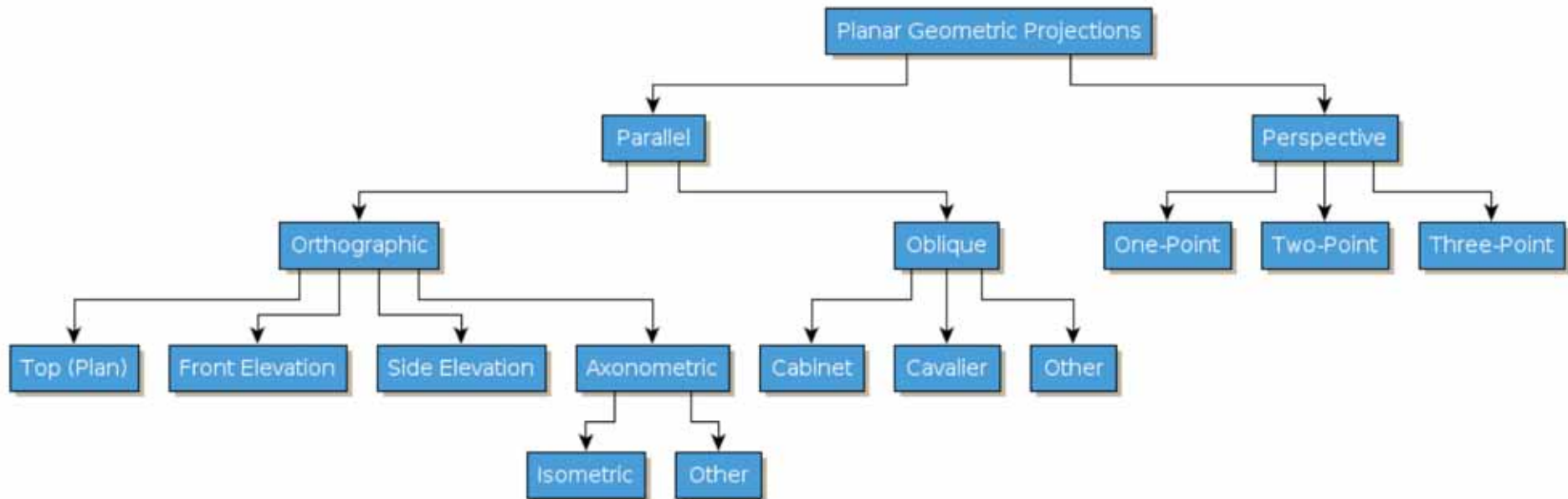 - Parallel lines appear no longer parallel

Parallel Projection

- Less realistic because perspective foreshortening is lacking
- Can however, use for exact measurements
  - Parallel lines remain parallel
  - Angles still only preserved for front faces
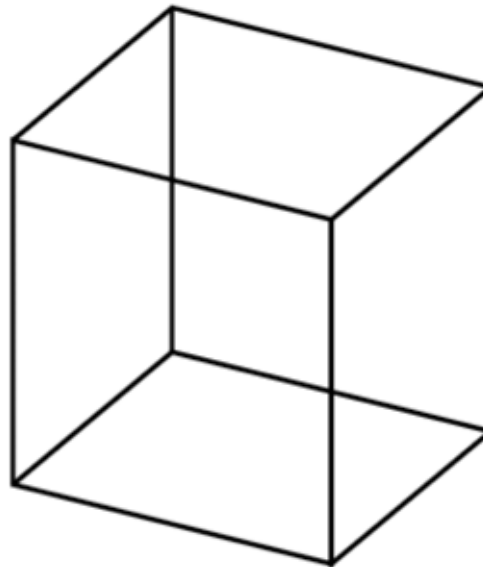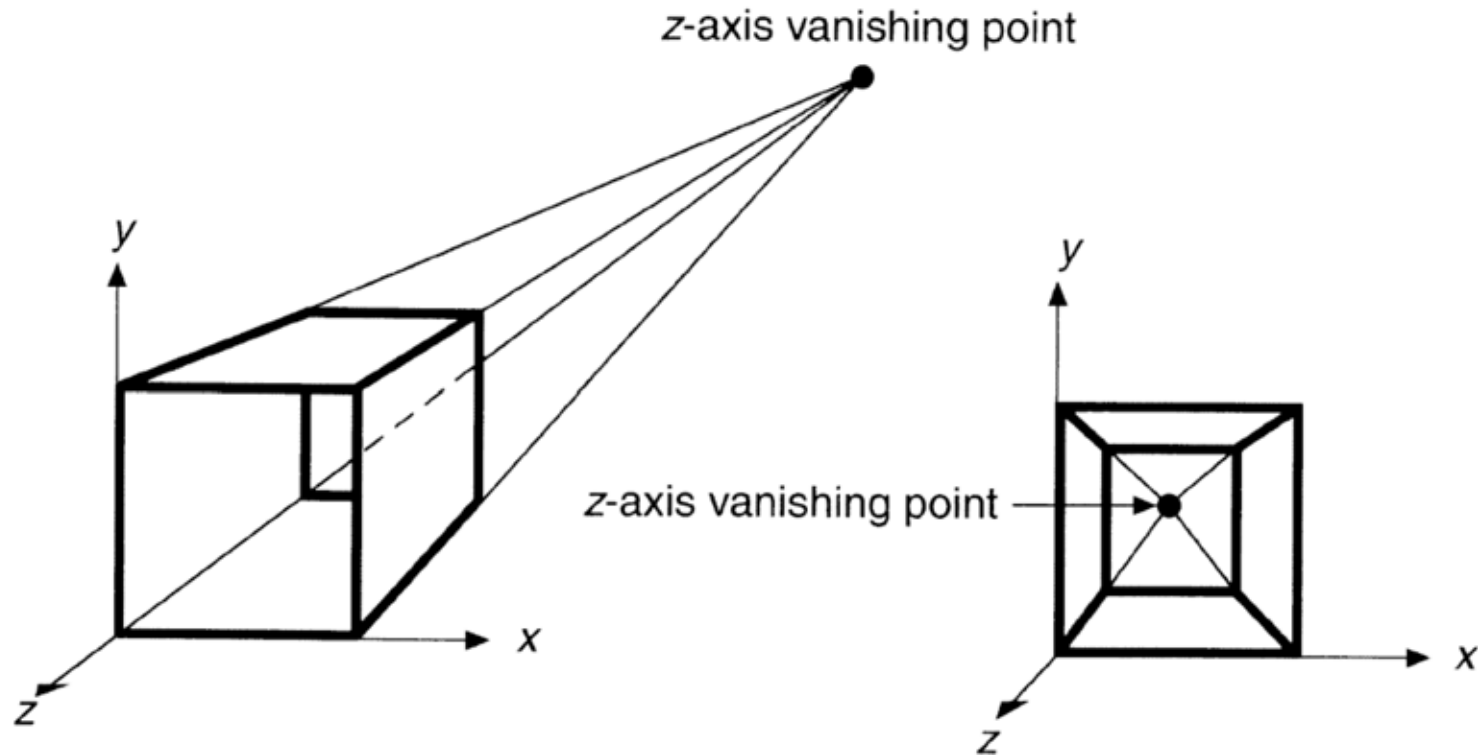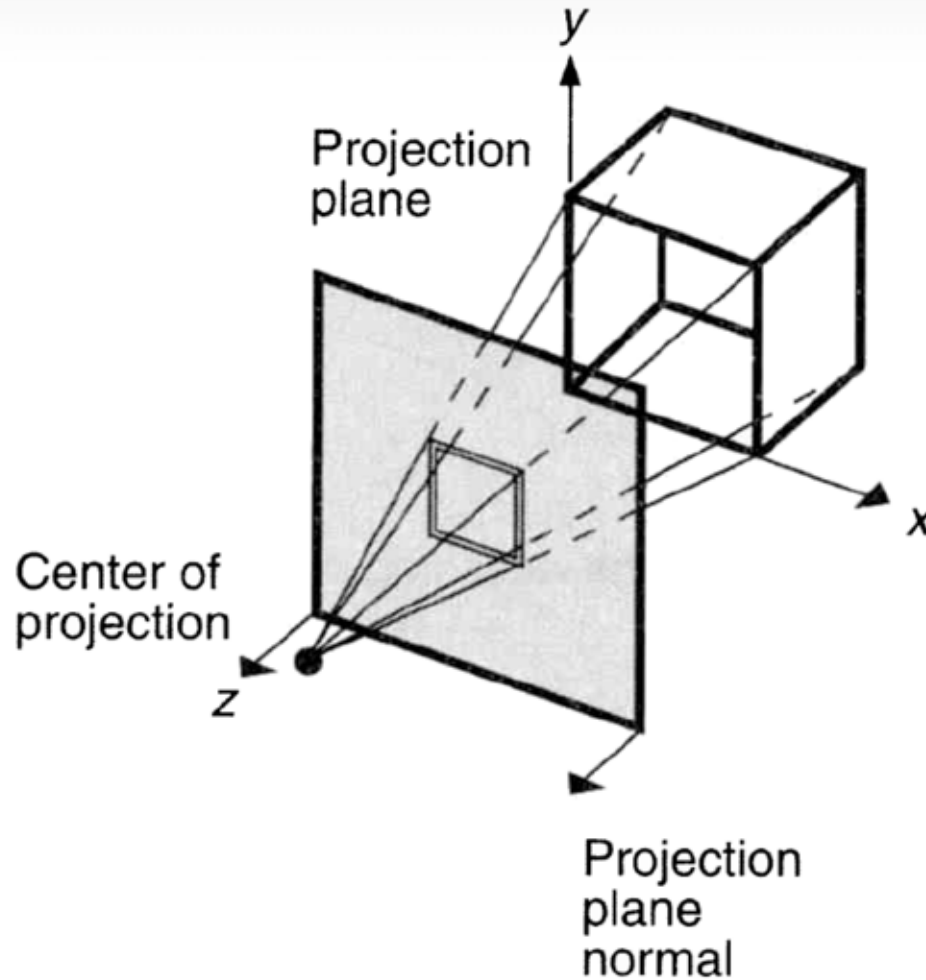
Taxonomy of Projections

Perspective Projections

- Any set of parallel lines not parallel to the projection plane
  - Converge to a vanishing point
- In 3D, parallel lines meet only at infinity

- Lines parallel to x, y do not converge

1 Point Perspective

1 Point Perspective

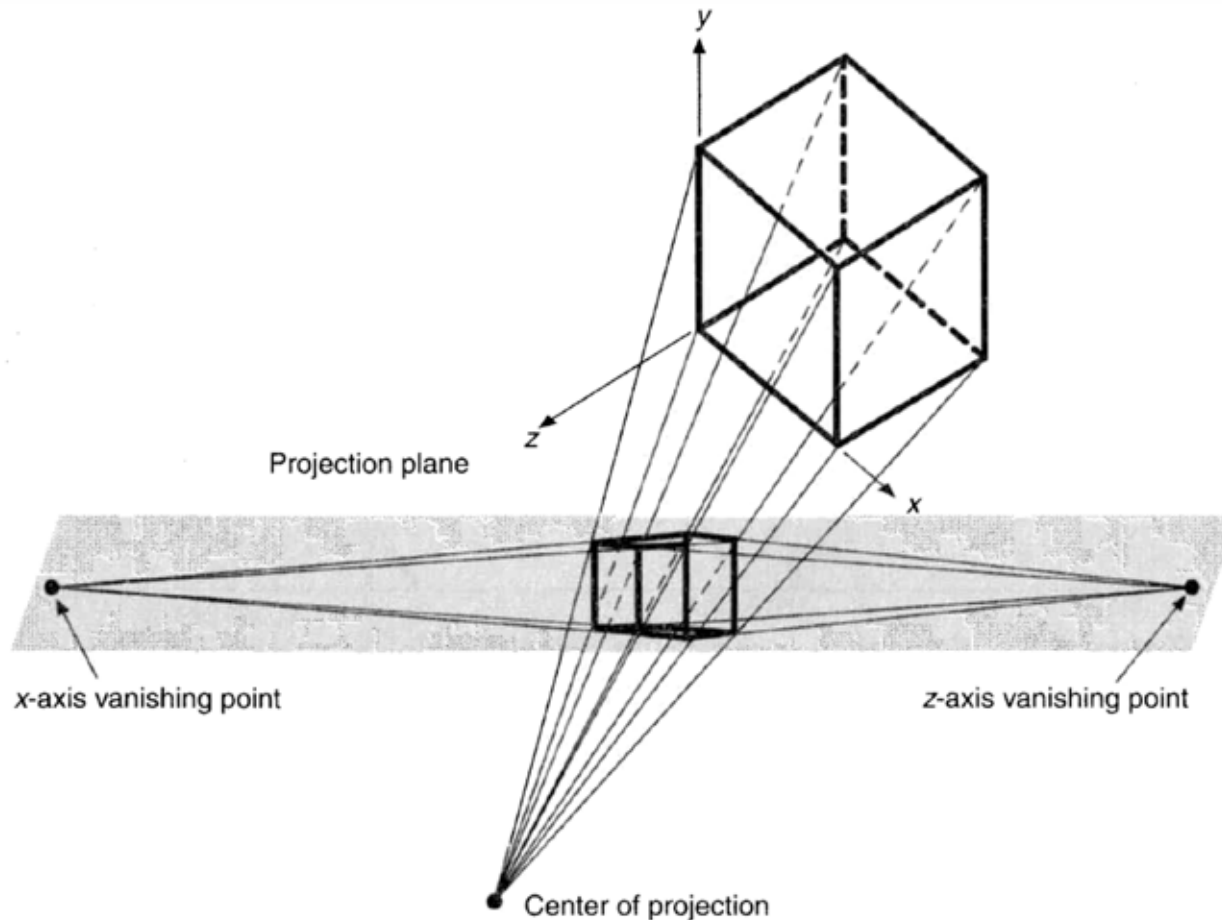
j.ruivivar photography

2 Point Perspective

- Lines parallel to y do not converge

2 Point Perspective

Hillcrest Building - springgrove.com
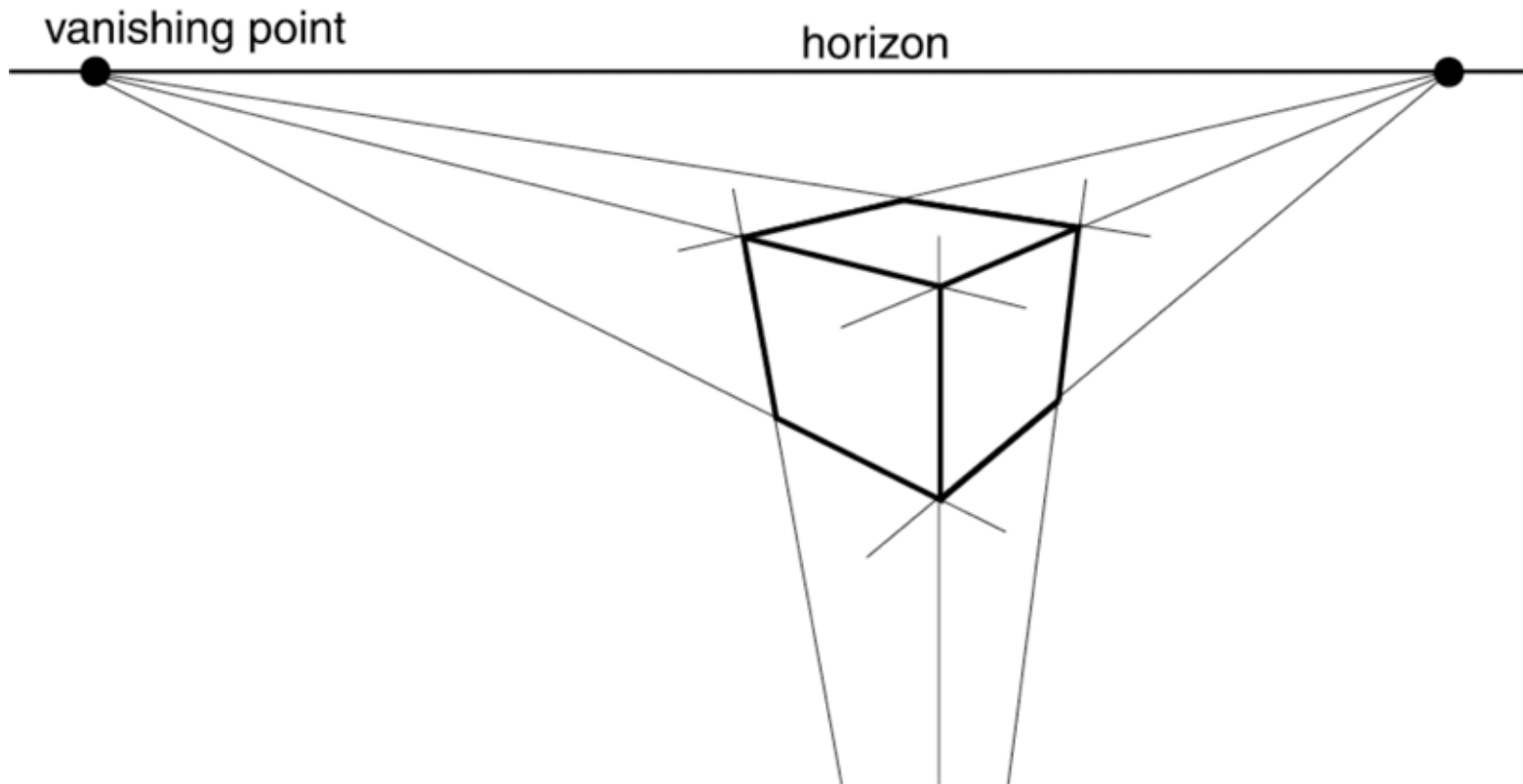
3 Point Perspective

- All lines converge

3 Point Perspective
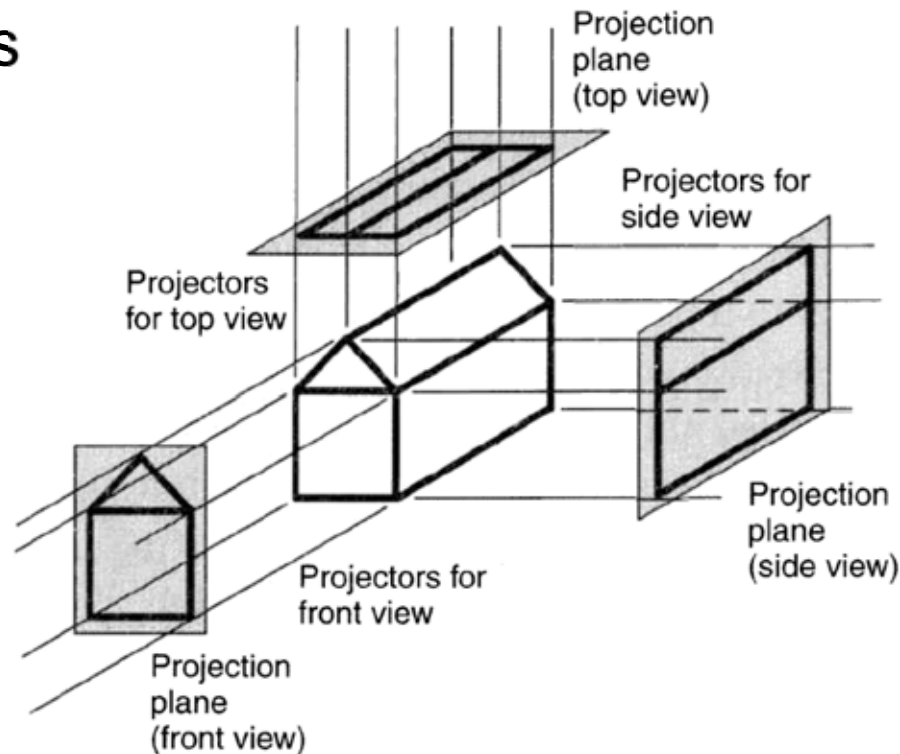
1, 2 & 3 Point Perspectives

Parallel Projections

- Orthographic parallel projections
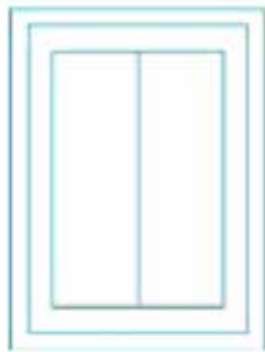 - Direction of projection and normal to projection plane are the same (or reverse)
- Oblique parallel projections
  - If the direction of projection is not normal to projection plane

Orthographic Parallel Projections

- Most common are top/plan, front & side elevations
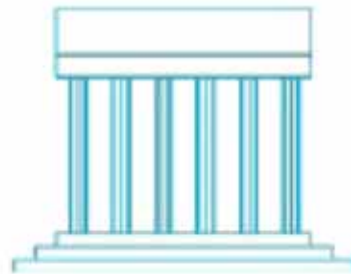 - Frequently found in engineering and architectural drawings

Orthographic Parallel Projections

top

front

side

RenderMan Coordinate Systems

Object (3D)
- At RiSphere, RiPatch, ...

→

Shader (3D)
- At RiShader

→

World (3D)
- At RiWorldBegin

↓

Camera (3D)
- At RiProjection
- Camera at origin
- Axes: →, ↑, Forward

←

Screen (2D)
- 0,0 at center of projection
- Axes: →, ↑

←

Raster (2D)
- 0,0 to width,height
- Axes: →, ↓

↓

NDC (2D)
- 0,0 to 1,1
- Axes: →, ↓
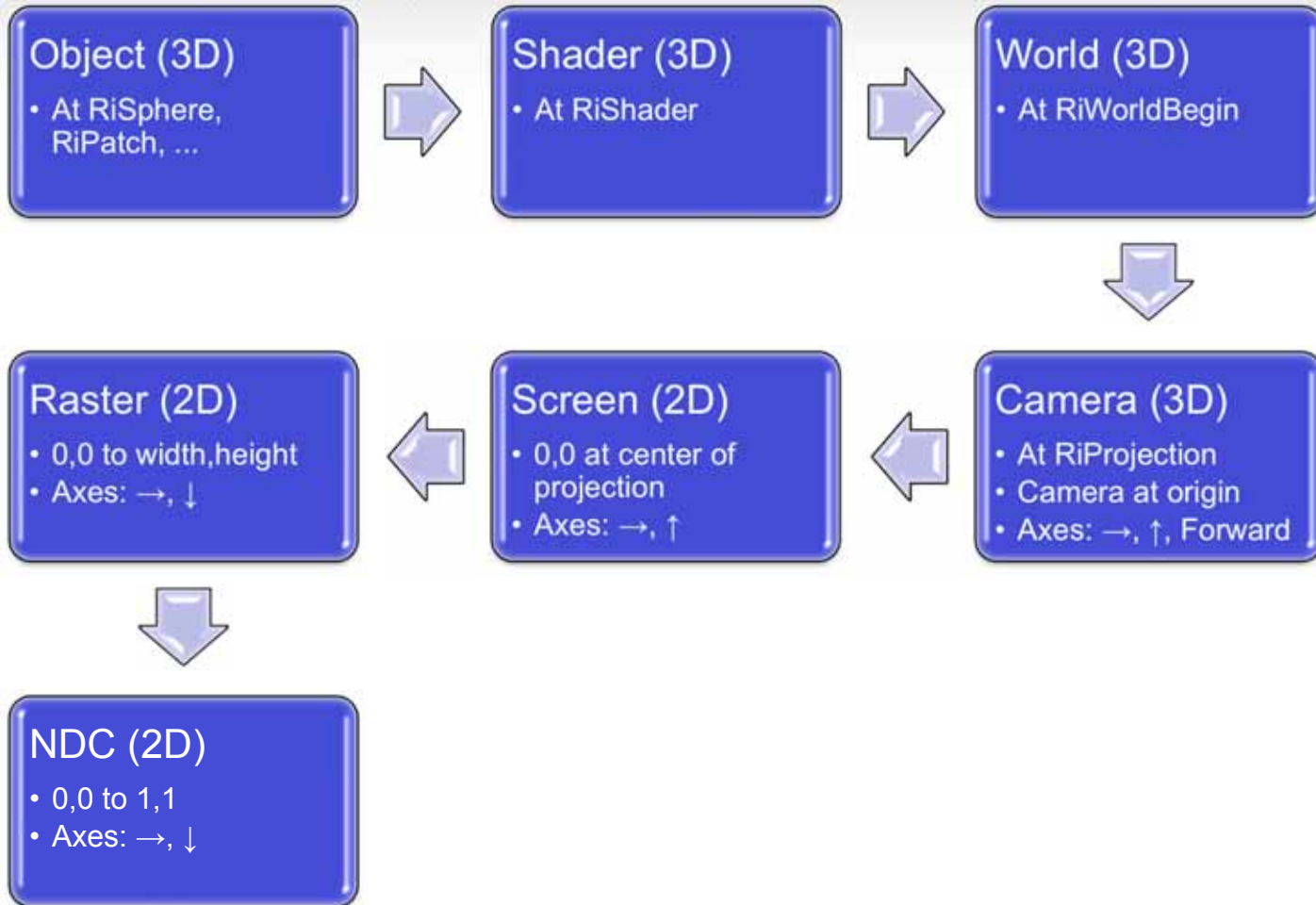
OpenGL Coordinate Systems

MODELVIEW   PROJECTION

Object (3D)
• When rendering

Eye (3D)
• Eye at origin
• Axes: →, ↑, Back

Clip (3D)
• Eye: 0,0,-∞
• Axes: →, ↓, Forward

Window (2D)
• 0,0 to width,height

NDC (3D)
• -1,-1,-1 to 1,1,1

glViewport/glDepthRange