

Week 06: Viewing and Projection Part 1

CS-537: Interactive Computer Graphics

Dr. Chloe LeGendre

Department of Computer Science

For academic use only.

Some materials from the companion slides of Angel and Shreiner, “Interactive Computer Graphics, A Top-Down Approach with WebGL.”



Objectives

- Introduce classical viewing
- Introduce a few standard types of views:
 - Parallel vs. Perspective Projection
 - Orthographic, Axonometric, and Oblique Parallel Projections
 - One, Two, and Three-point Perspective Projections



Classical Viewing

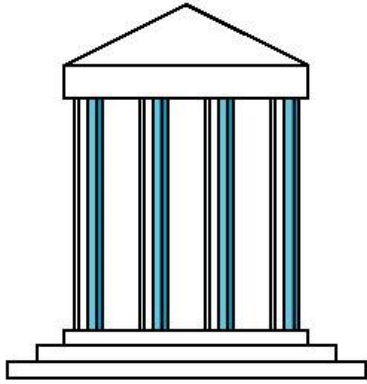
- Viewing requires three basic elements
 - One or more objects
 - A viewer with a projection surface
 - Projectors that go from the object(s) to the projection surface
- Classical views are based on the relationship among these elements
 - The viewer picks up the object and orients it how she would like to see it
- Each object is assumed to be constructed from flat *principal faces*
 - Buildings, polyhedra, manufactured objects



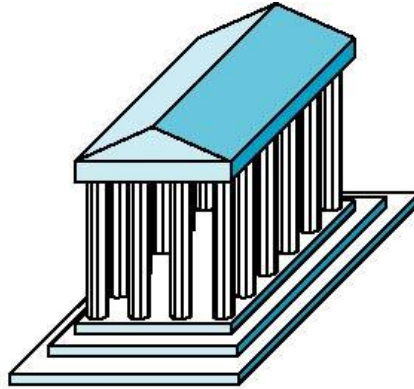
Planar Geometric Projections

- Standard projections project onto a plane (image plane)
- Projectors are lines that either
 - converge at a center of projection (COP)
 - are parallel
- Such projections preserve lines but not necessarily angles
 - Lines in 3D projected onto image plane as lines in 2D
 - The measured angle between two 3D lines is not the same as the angle measured between their projections onto the image plane
- However, nonplanar projections are needed for applications such as map construction

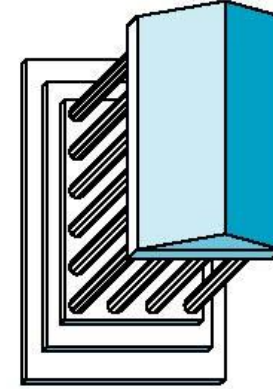
Classical Projections



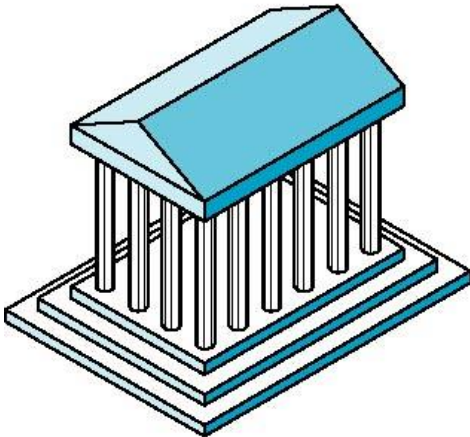
Front elevation



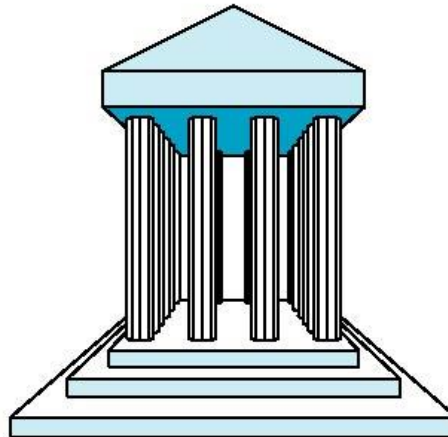
Elevation oblique



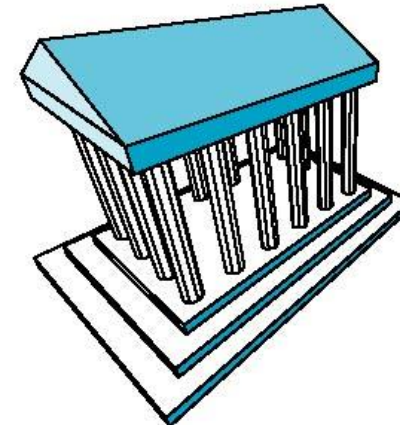
Plan oblique



Isometric



One-point perspective



Three-point perspective

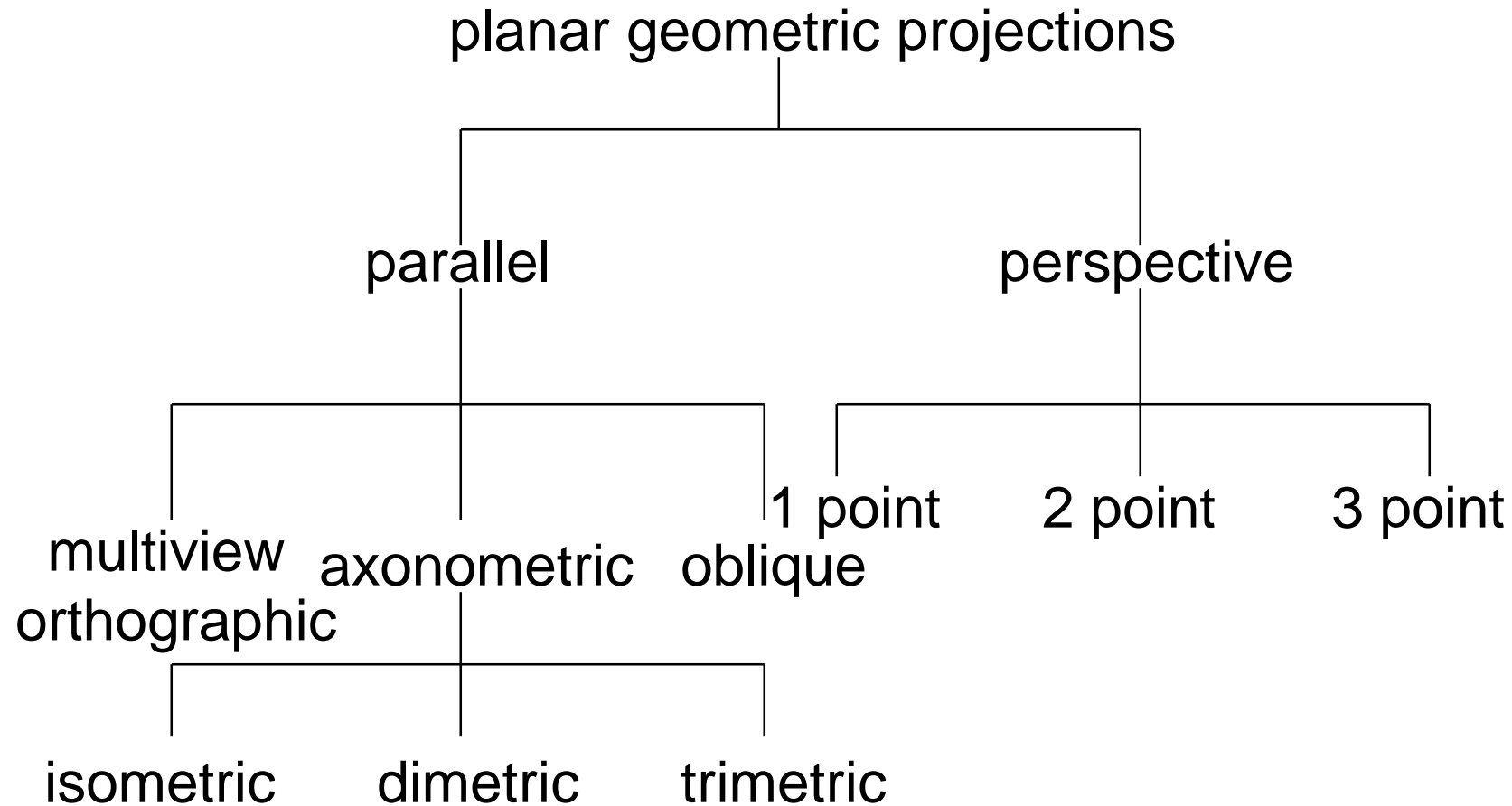


Perspective vs. Parallel

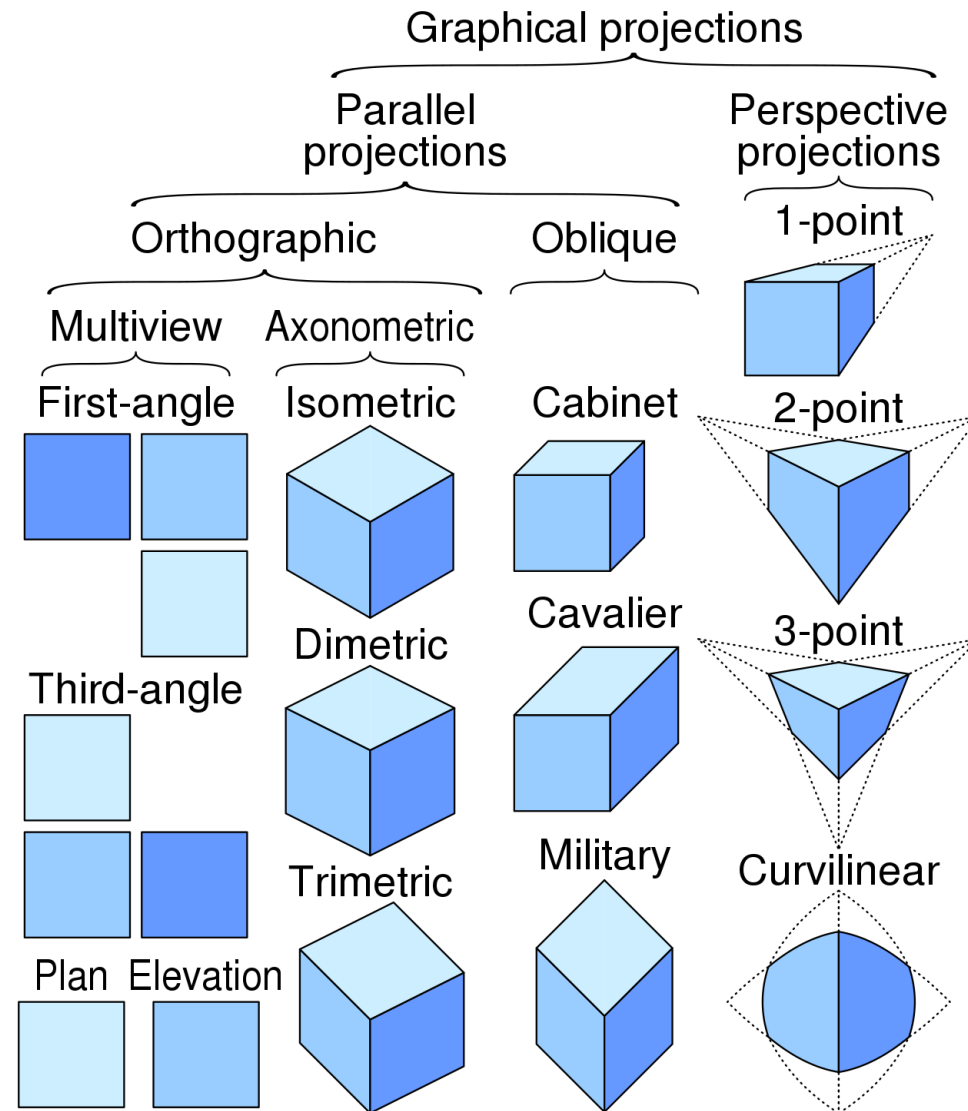
- Computer graphics treats all projections the same and implements them with a single pipeline
- Classical viewing developed different techniques for drawing each type of projection
- Fundamental distinction is between parallel and perspective viewing even though mathematically parallel viewing is the limit of perspective viewing



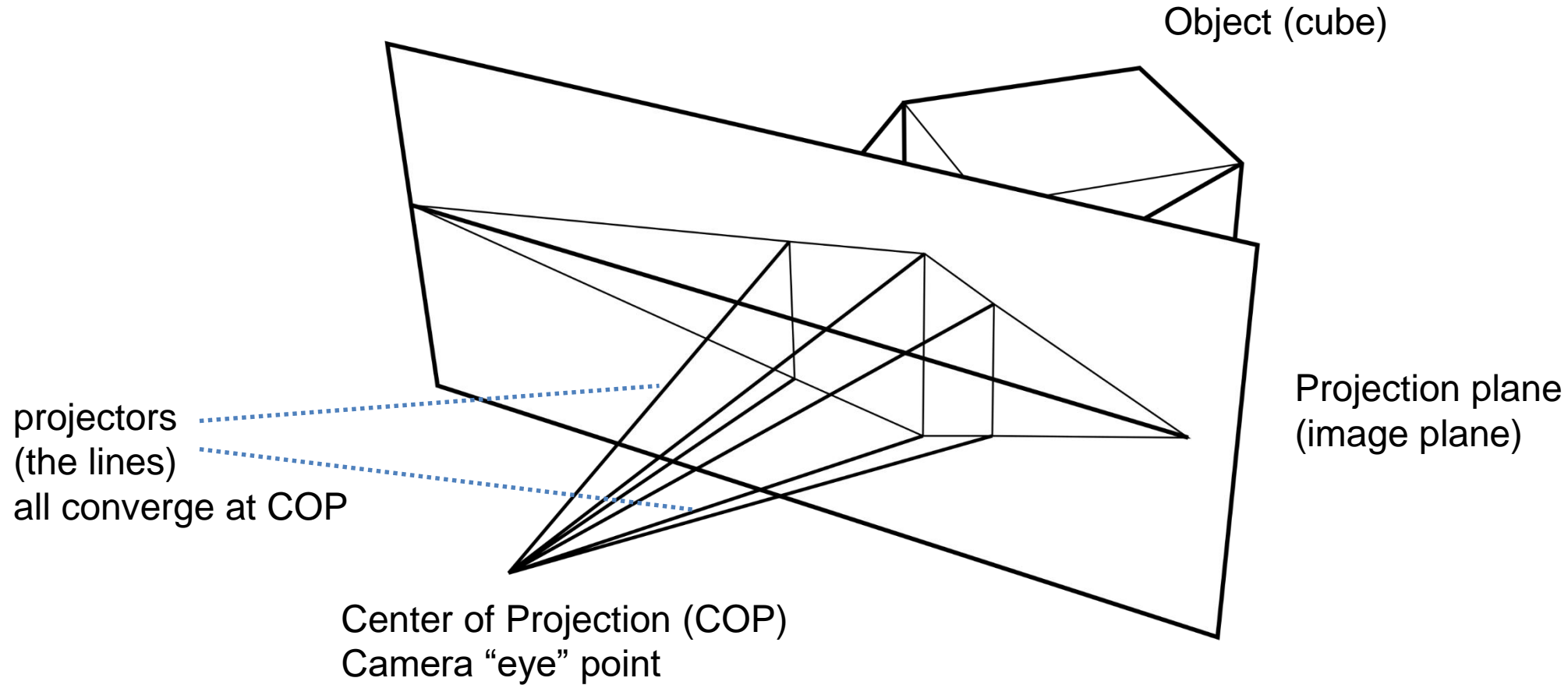
Taxonomy of Planar Geometric Projections



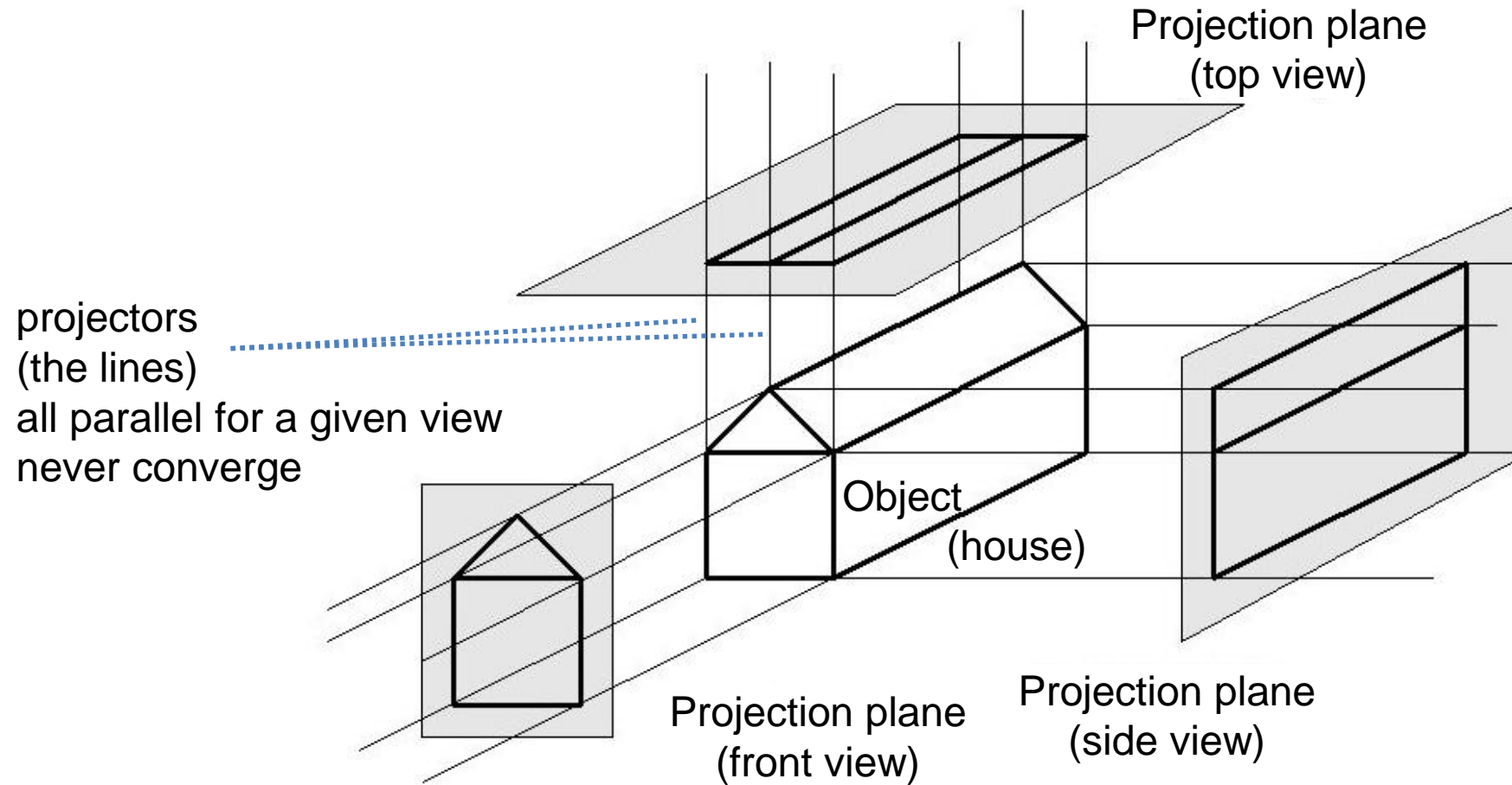
Taxonomy of Planar Geometric Projections (II)



Perspective Projection

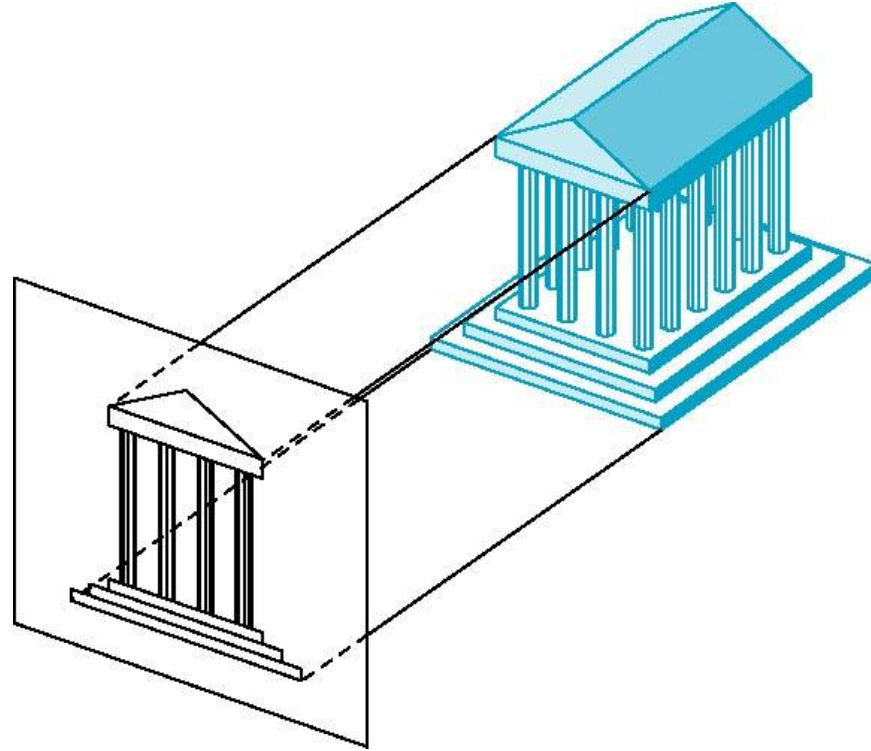


Parallel Projection



A Common Parallel Projection: Orthographic Projection

- Projectors are orthogonal to projection surface
- Note: not all parallel projections are orthographic



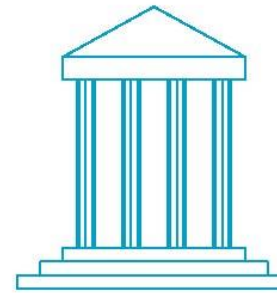
Multiview Orthographic Projection + Isometric

- Projection plane parallel to principal faces, usually forming front, top, side views

isometric (not a multiview orthographic view)

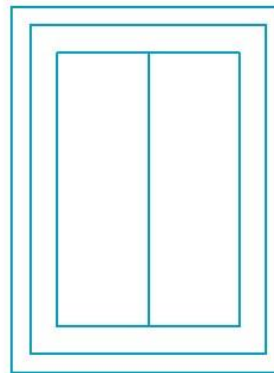


front
view

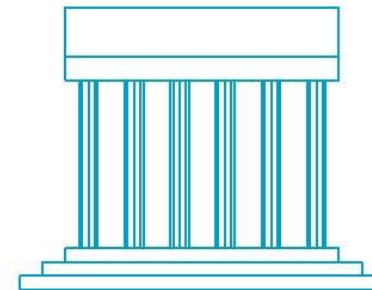


in CAD and architecture programs, three different orthographic projections plus an isometric view are often shown

top
view

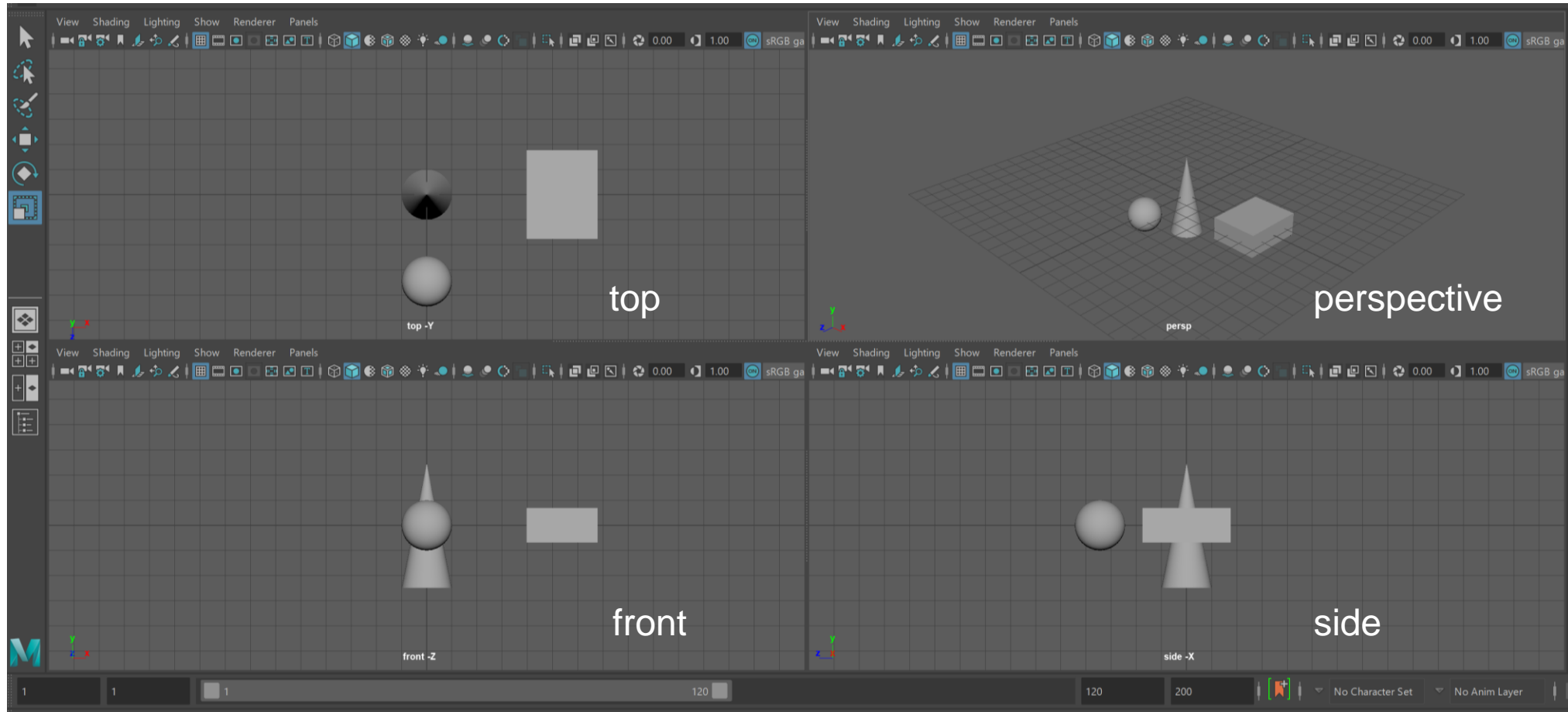


side
view



Multiview Orthographic Projection + Perspective

- Autodesk Maya, one of the more popular geometry modeling programs for CG has a default scene with four camera views: perspective, top, front, and side:





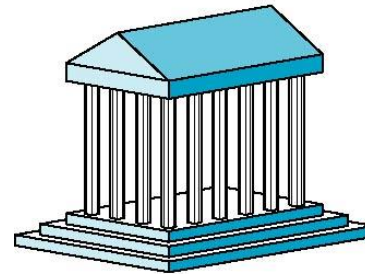
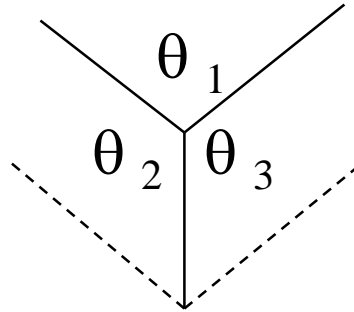
Orthographic Projection – Advantages and Disadvantages

- Preserves both distances and angles when lines are projected
 - Shapes preserved
 - Can be used for measurements
 - Useful for Building plans / instruction manuals
- Cannot see what object really looks like because many surfaces hidden from view
 - Thus isometric is often added to fill in this gap

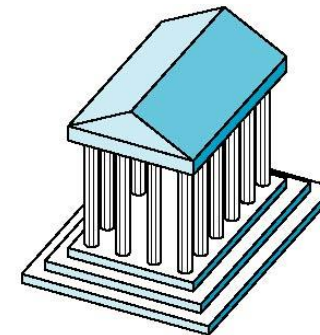
Axonometric Projections

- Allow projection plane to move relative to object
- Still a parallel type projection! (not orthographic)
- Classify by how many angles of a corner of a projected cube are the same:

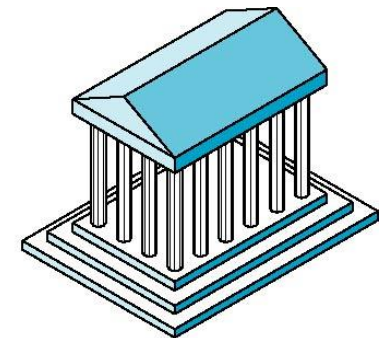
- None: Trimetric
- Two: Dimetric
- Three: Isometric



Dimetric



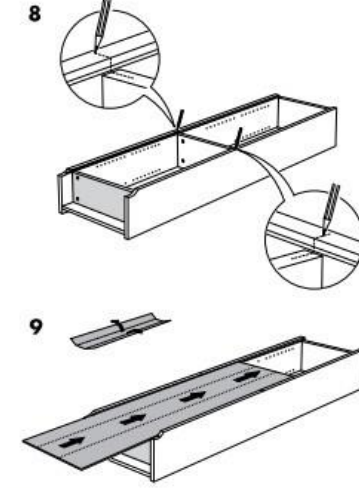
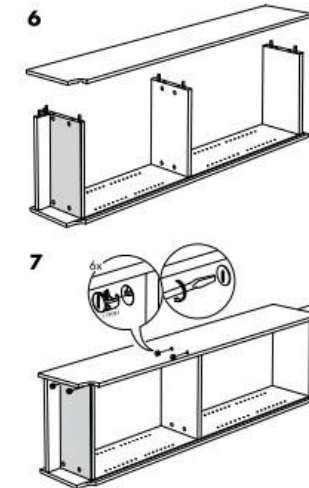
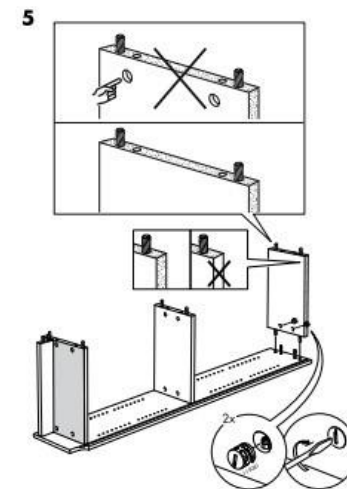
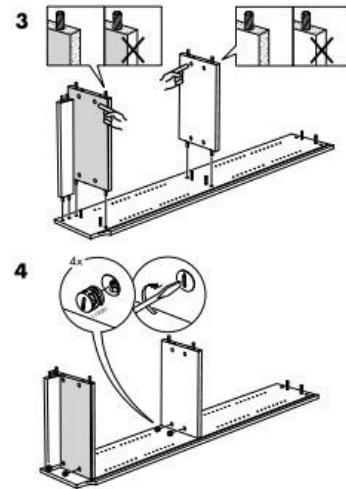
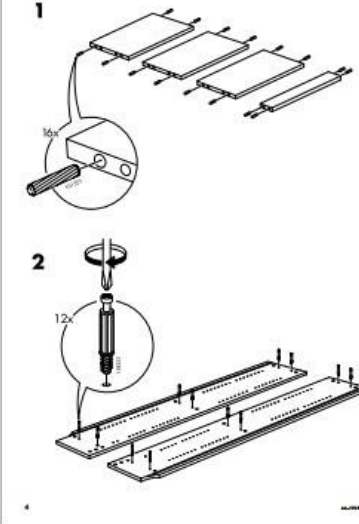
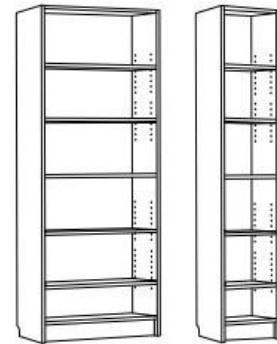
Trimetric



Isometric

Axonometric Projection In Action – DIY Ikea Bookshelf

BILLY



Axonometric Projection In Action – The Sims (original game)



Probably Isometric
(Would need to
measure angles)

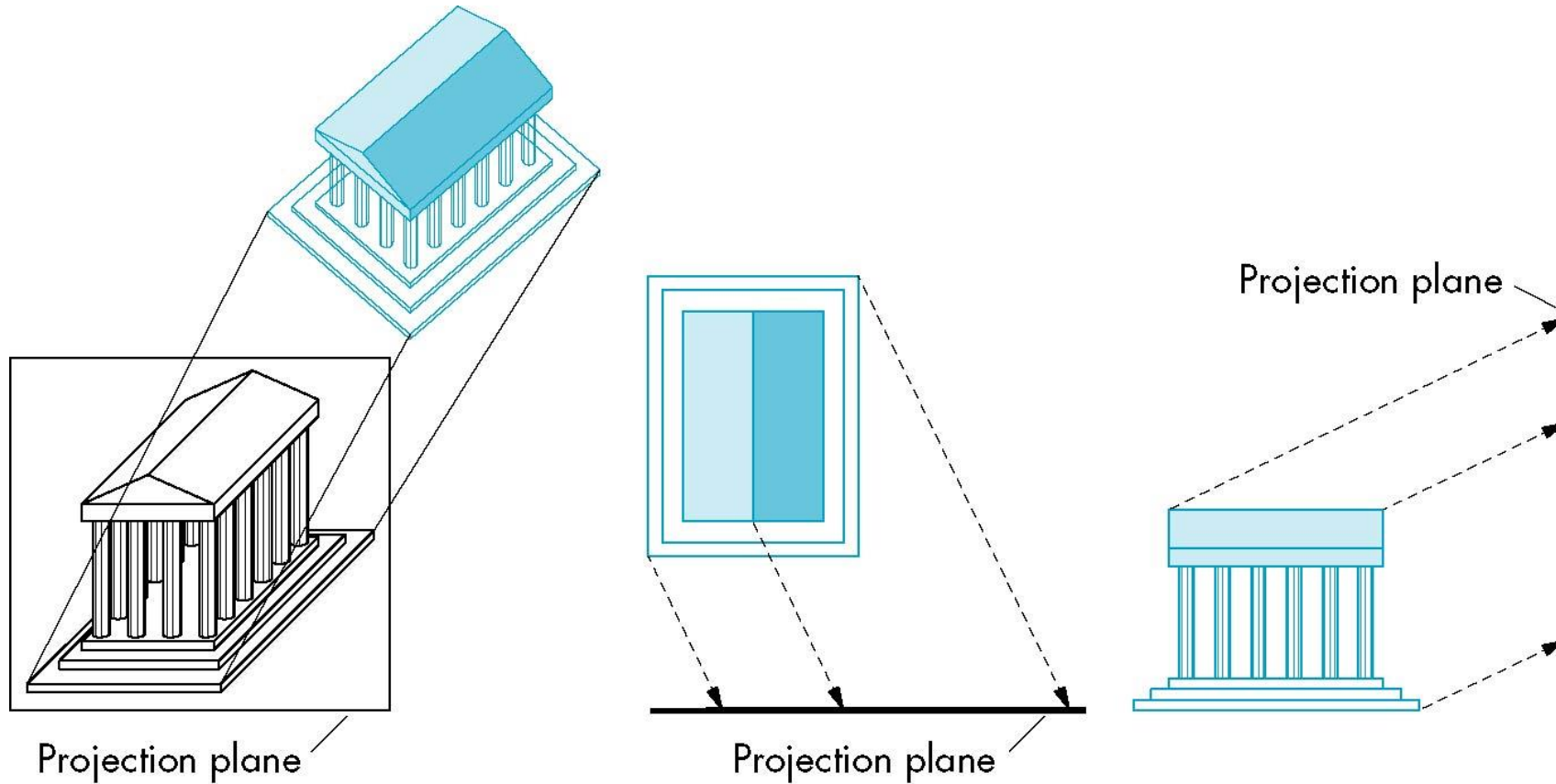


Axonometric Projections – Advantages and Disadvantages

- 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 and modeling applications, usually in tandem with other views.

Oblique Projection

- Arbitrary relationship between projectors and projection plane.





Oblique Projection: 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 or top
- In physical world, cannot create with simple camera
 - Possible with bellows camera or special lens (architectural)

Oblique Projection In Action – Stardew Valley (game)



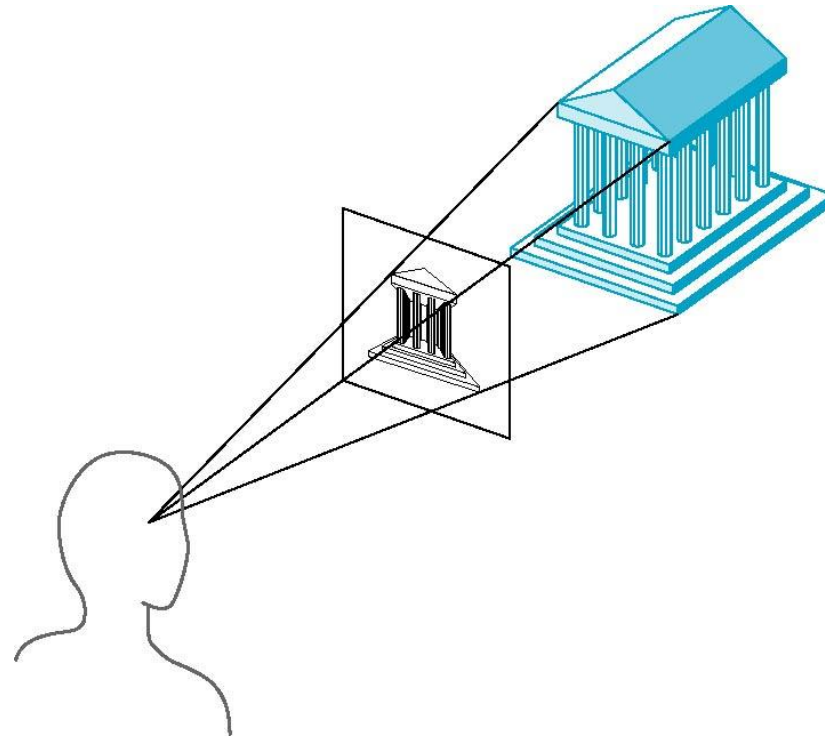
Top-Down Oblique Projection

We see the full front face with correct proportions.

We can't see around the sides, but we can see the top faces.

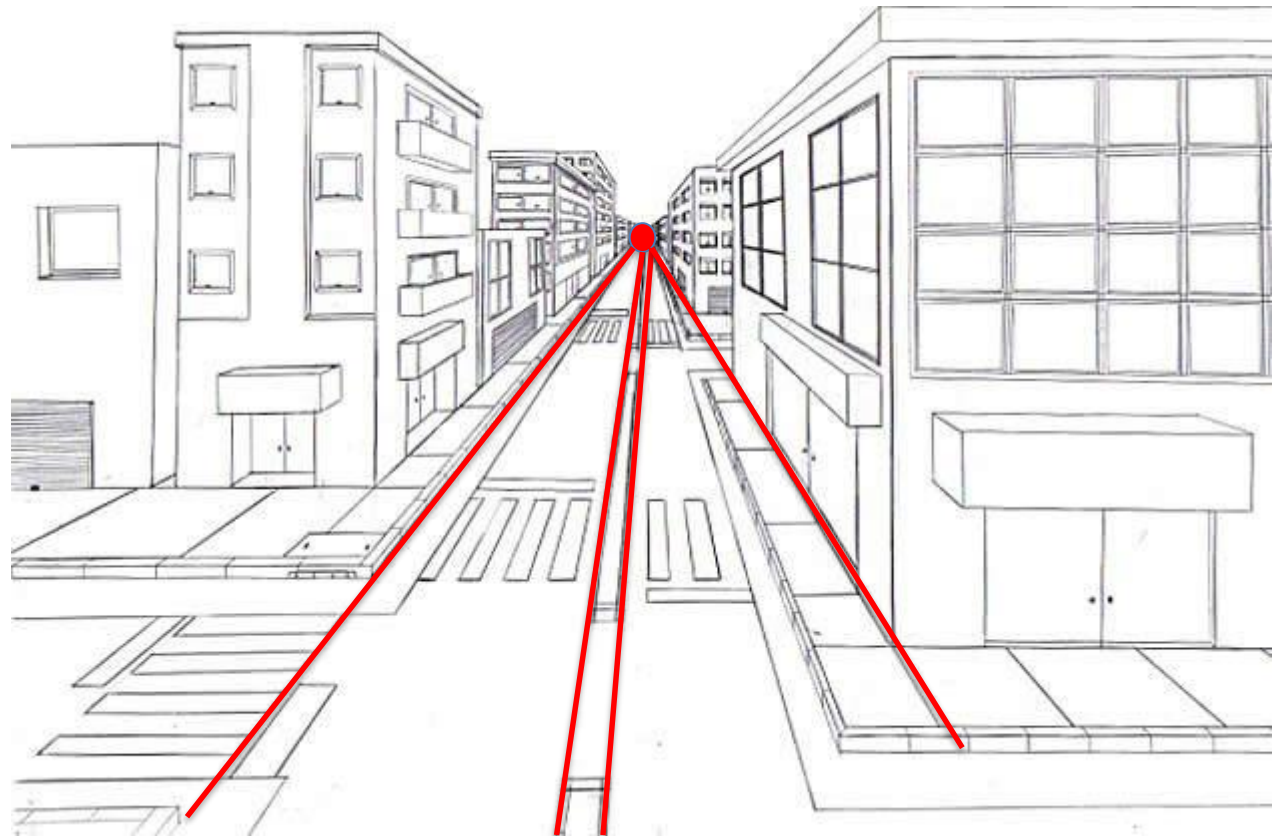
Perspective Projection (II)

- Projectors converge at center of 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)



Three-Point Perspective

- No principal face parallel to projection plane
- Three vanishing points for cube

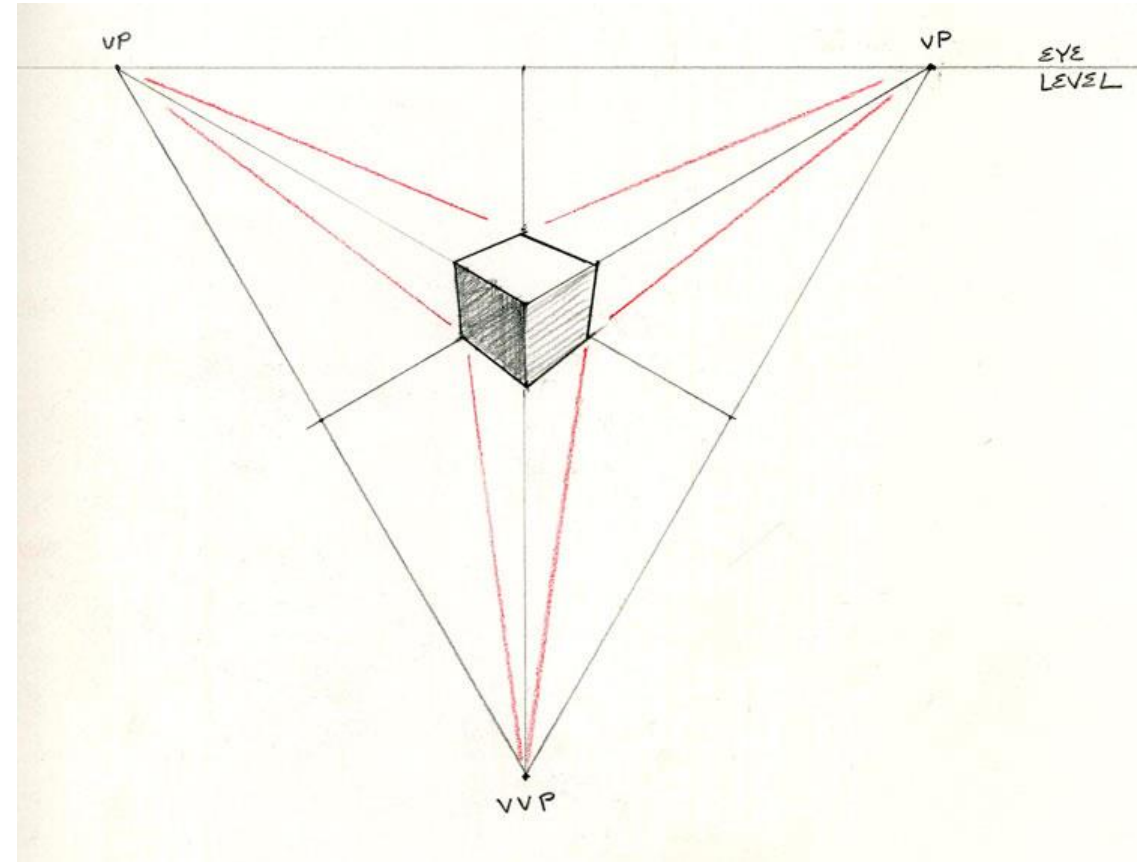
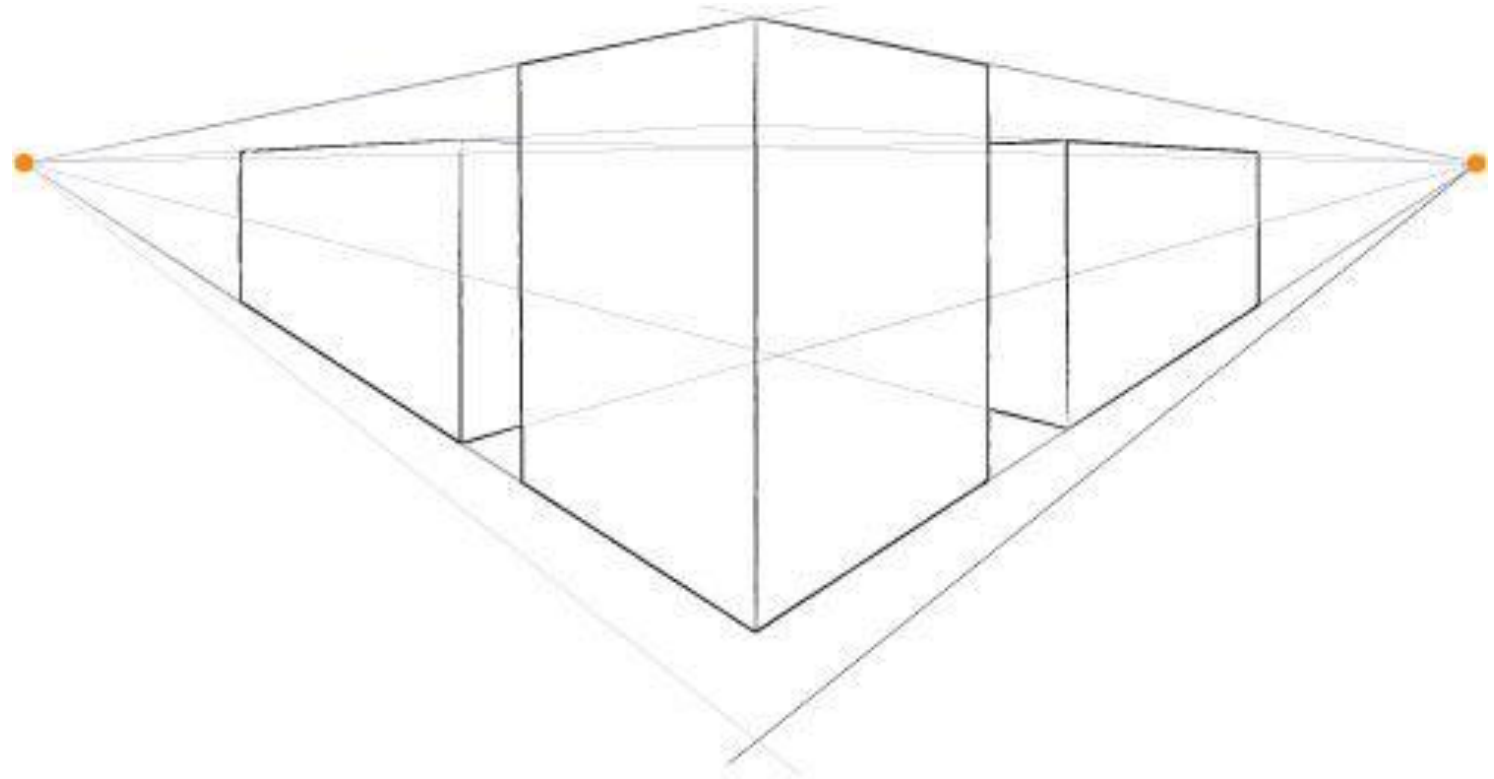


image: Alvalyn Lundgren

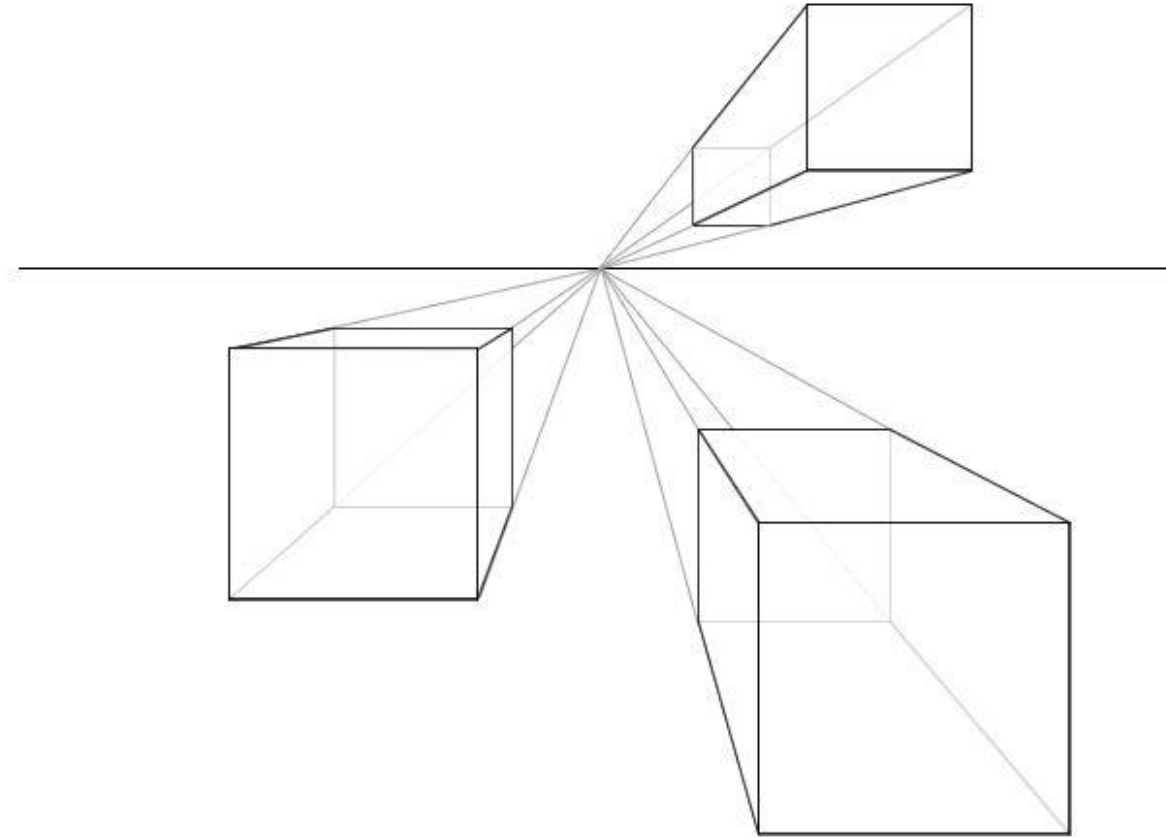
Two-Point Perspective

- One principal direction parallel to projection plane (up/down in this image)
- Two vanishing points for cube



One-Point Perspective

- One principal face parallel to projection plane
- One vanishing point for cube

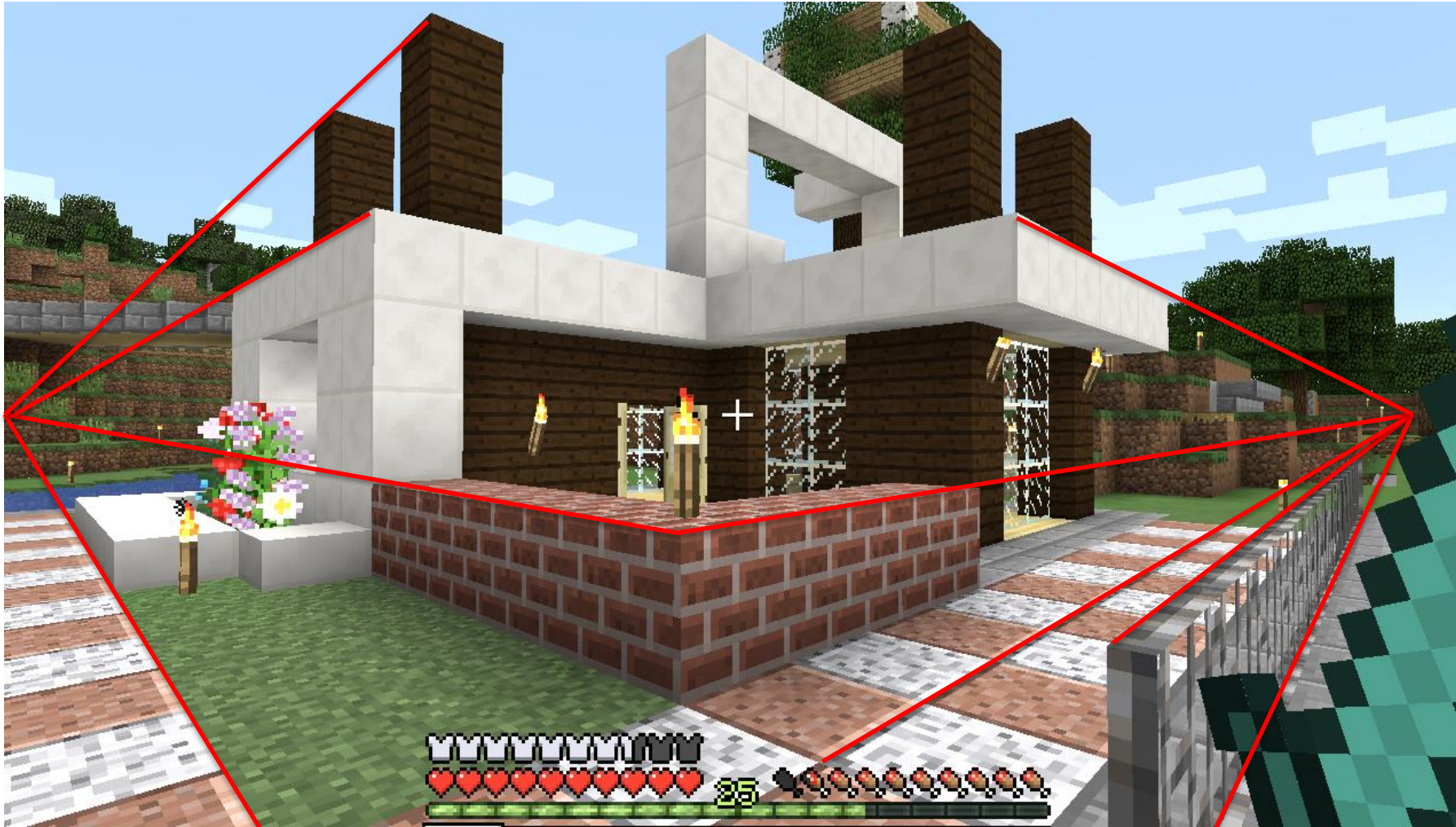




Perspective Projection: Advantages and Disadvantages

- 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 than parallel projections (but not more difficult for computer)

Perspective Projection in Action: Minecraft (game)



This screenshot looks like two-point perspective

Note the up/down axis is parallel to the projection plane

I added the real-world parallel lines in red