



# Viewing I

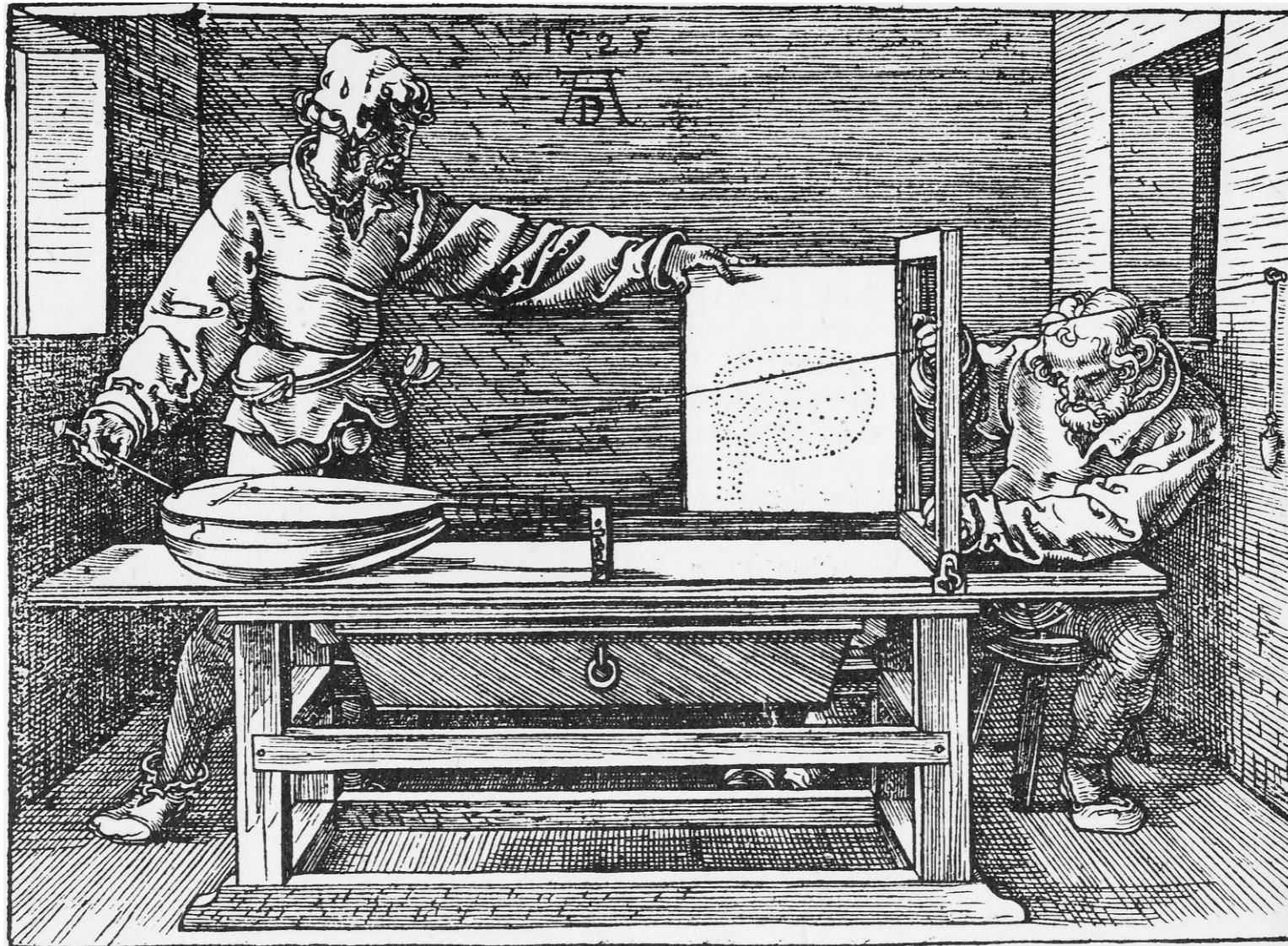
## Overview of Projections

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Introduction to Computer Graphics  
CSE 533/333

# Historical Perspective

- The 2D image is formed by the intersections of converging light rays with a picture plane

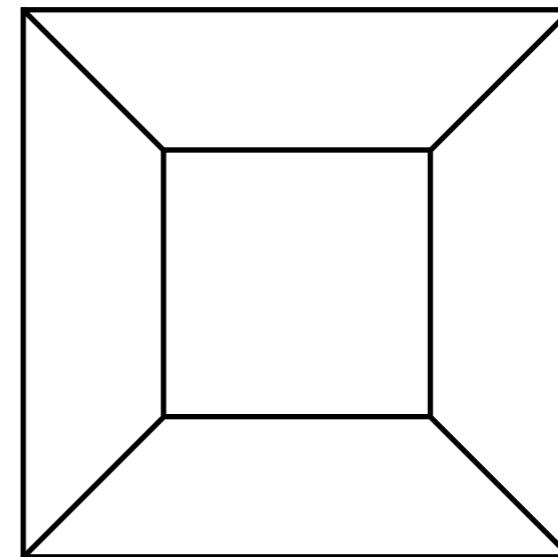


Woodcut from Albrecht Durer's work about art of measurement. "Underweysung der Messung"

# Historical Perspective

## Rules of linear perspective

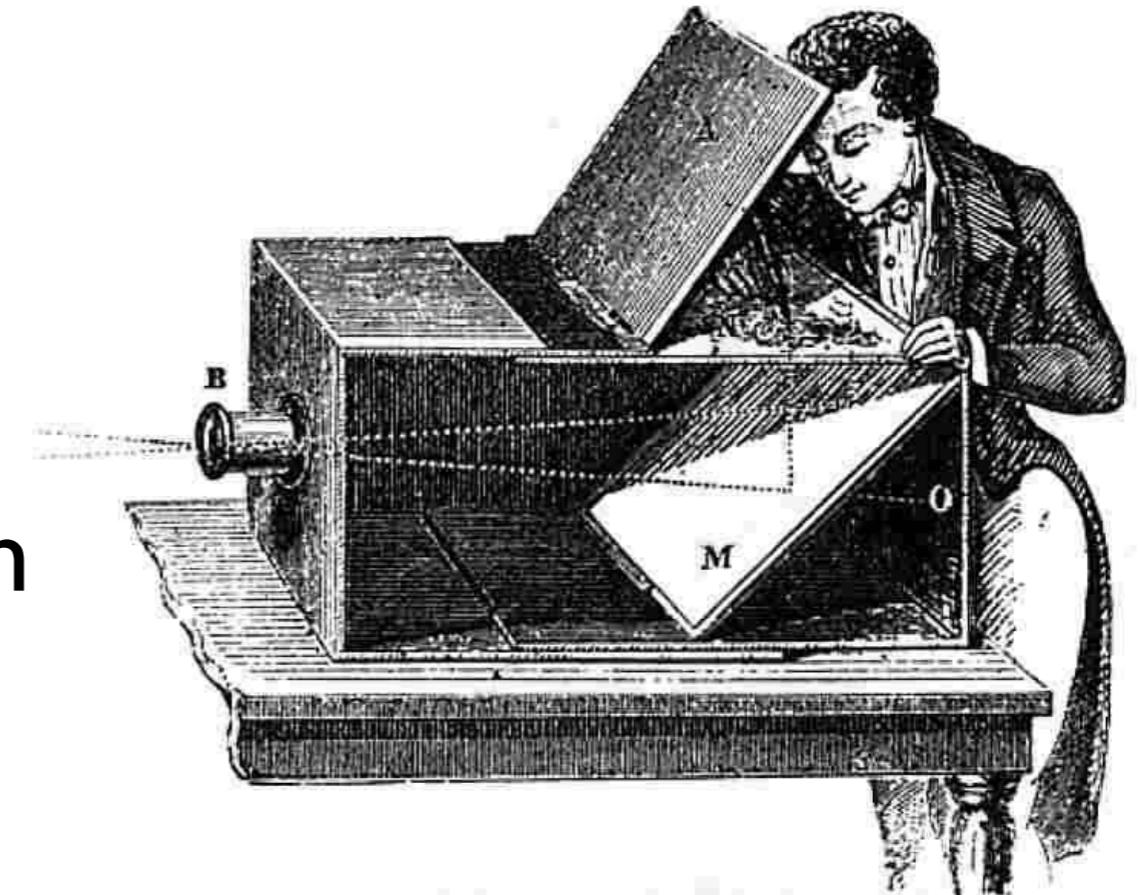
- Parallel lines converge to a vanishing point
- Objects further away are foreshortened than closer ones
- Example:  
Perspective cube



# Historical Perspective

## Camera Obscura

- An optical device that projects an image of its surroundings on a screen
- Artist *David Hockney* proposed that many Renaissance artists might have been aided by camera obscura while painting their masterpieces, raising a big controversy.



# Historical Perspective

## **Masters of Illusion**

Short intro to perspective projections  
discovered during the renaissance period

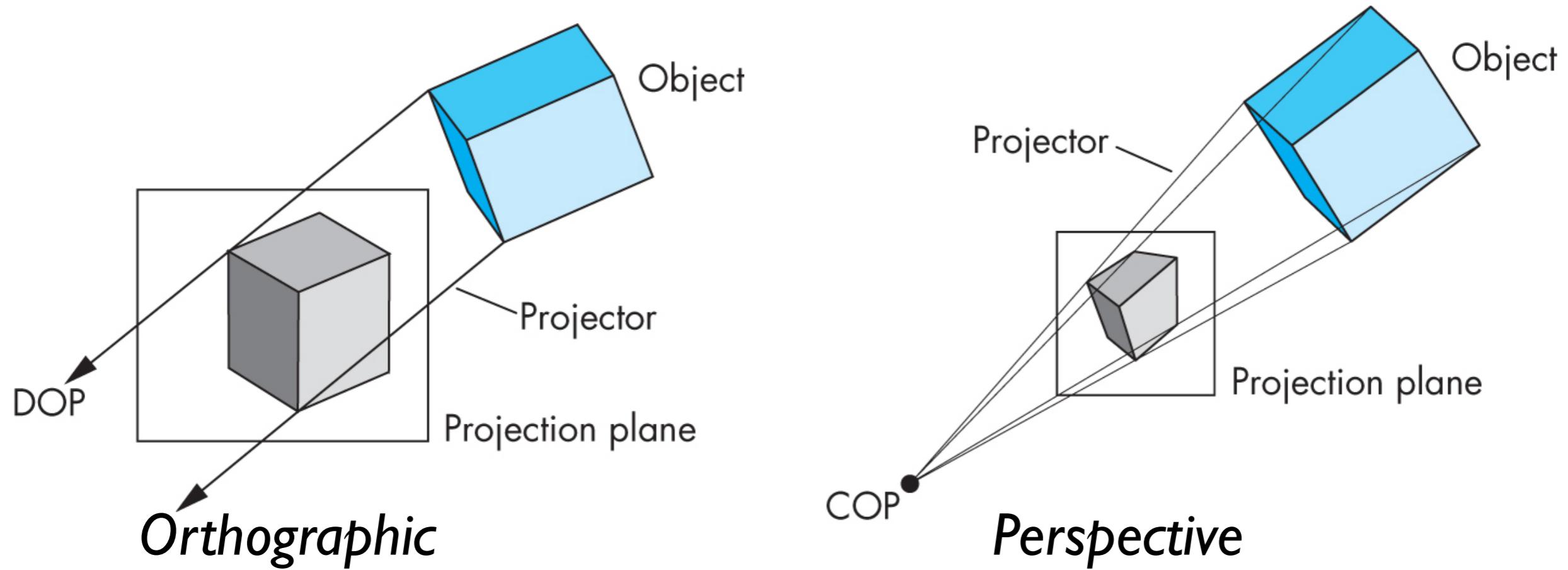
<https://www.youtube.com/watch?v=YU5khzhizNI>

©National Gallery of Art, USA

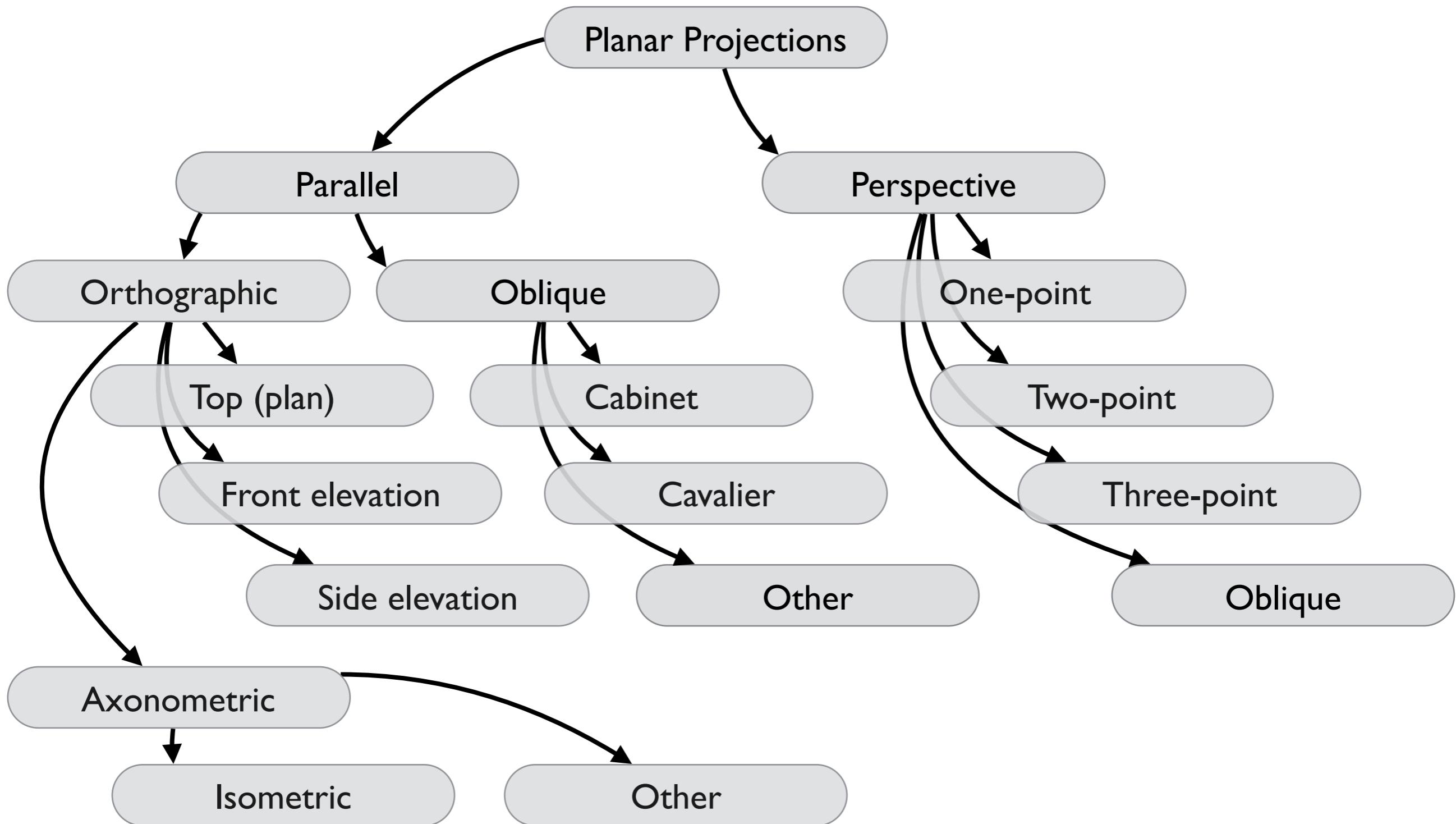
# Types of Projections

**Orthographic:** determined by *direction of projection*

**Perspective:** determined by *centre of projection*

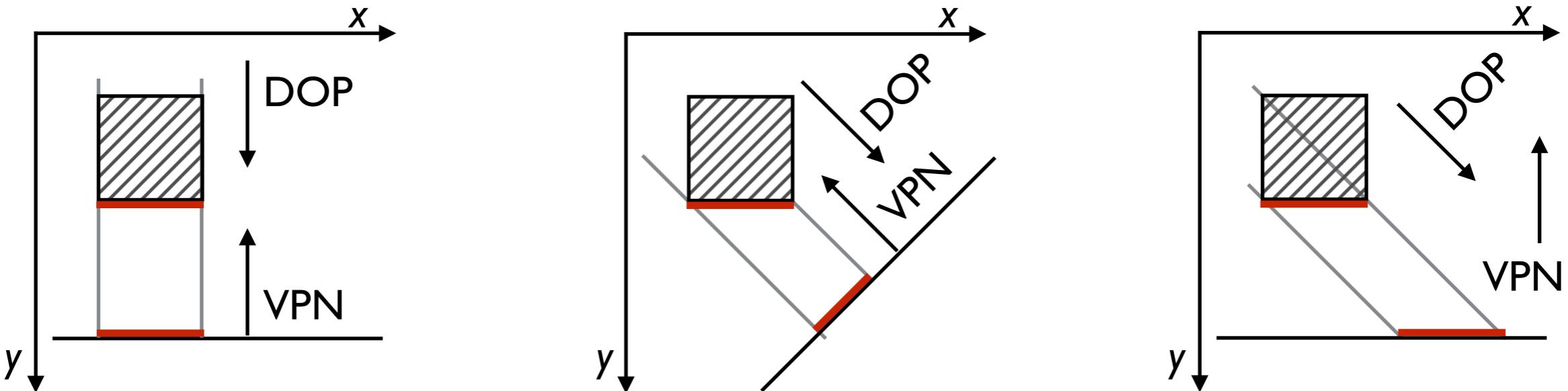


# Types of Projections



# Parallel Projections

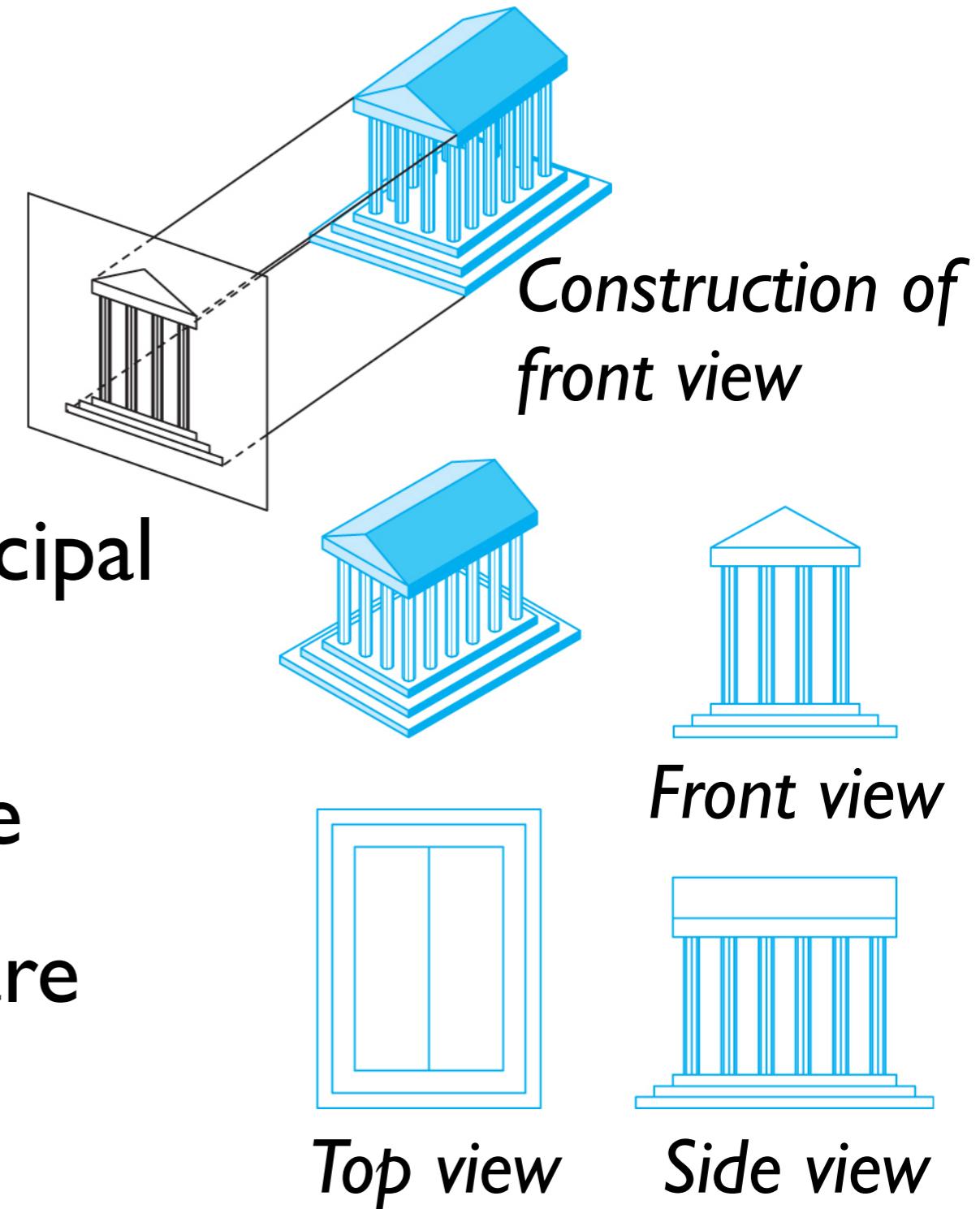
Assume object face of interest lies in principal plane  
(DOP: direction of projection, VPN: view plane normal)



Multiview Orthographic	Axonometric	Oblique
<ul style="list-style-type: none"><li>• <math>\text{VPN} \parallel</math> a principal axis</li><li>• <math>\text{DOP} \parallel \text{VPN}</math></li><li>• Shows a single face, <b>exact</b> measurements</li></ul>	<ul style="list-style-type: none"><li>• <math>\text{VPN} \nparallel</math> a principal axis</li><li>• <math>\text{DOP} \parallel \text{VPN}</math></li><li>• Adjacent faces, <b>none exact</b>, uniformly foreshortened</li></ul>	<ul style="list-style-type: none"><li>• <math>\text{VPN} \parallel</math> a principal axis</li><li>• <math>\text{DOP} \nparallel \text{VPN}</math></li><li>• adjacent faces, <b>one exact</b>, others uniformly foreshortened</li></ul>

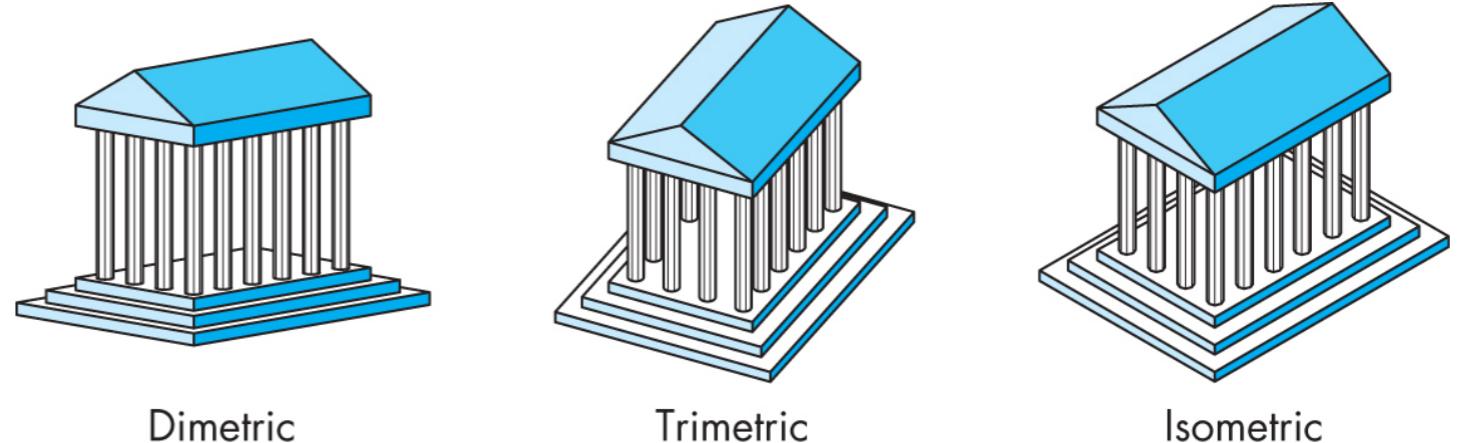
# Multiview Orthographic

- Projectors are orthogonal to the projection plane
- Projection plane is parallel to one of the principal planes (XY, YZ, or ZX)
- All views are at same scale
- Accurate measurements are possible



# Axonometric

- Projectors are orthogonal to the projection plane
- Projection plane is **not** parallel to one of the principal planes



- Parallel lines are equally foreshortened

## Dimetric

- Angles between two of the principal axes equal
- Need two scale ratios

## Trimetric

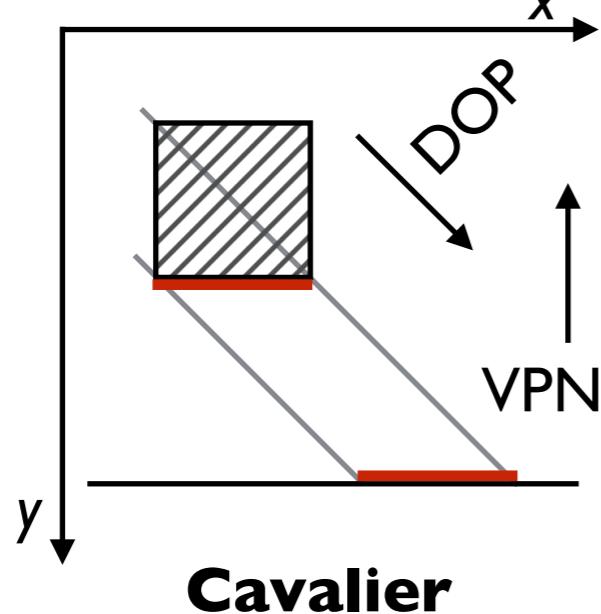
- Angles between all three principal axes different
- Need three scale ratios

## Isometric

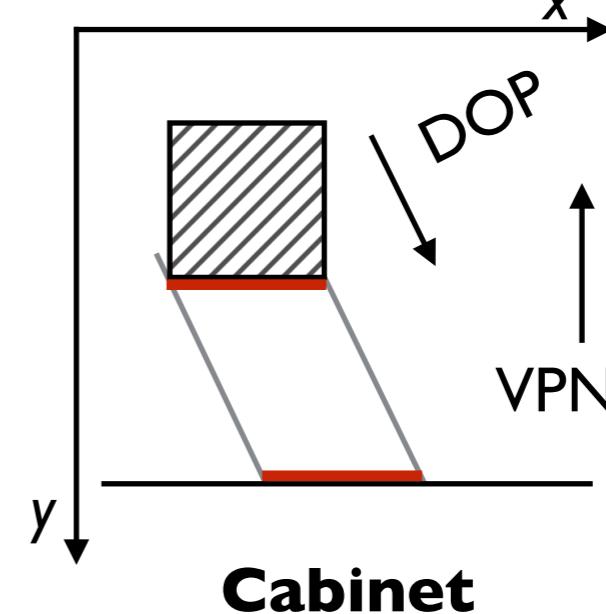
- Angles between all three principal axes equal ( $120^\circ$ )
- Same scale ratio applies along each axis

# Oblique

- Projectors at oblique angle to projection plane
- Can represent exact shape of one of the faces
- Can be used to emphasize a particular face



**Cavalier**



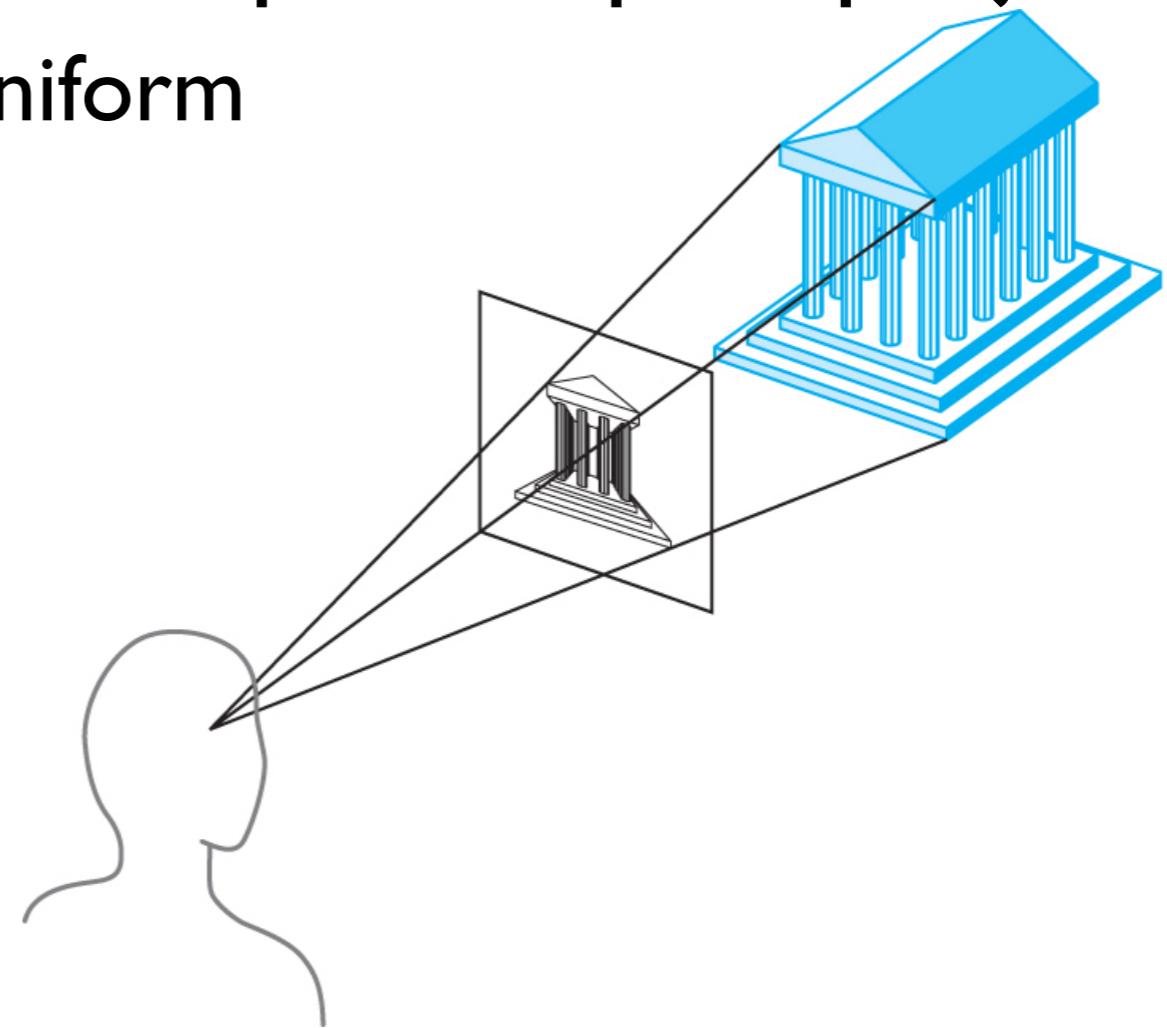
**Cabinet**

- Angle between projectors and projection plane is  $45^\circ$
- Perpendicular faces projected at full scale

- Angle between projectors and projection plane is  $\tan^{-1}(2) = 63.4^\circ$
- Perpendicular faces projected at 50% scale

# Perspective Projections

- Depicts the way we see objects in nature
- Parallel lines do not remain parallel post projection
  - Foreshortening is not uniform
- Two concepts:  
**Vanishing point**, and  
**View Point**



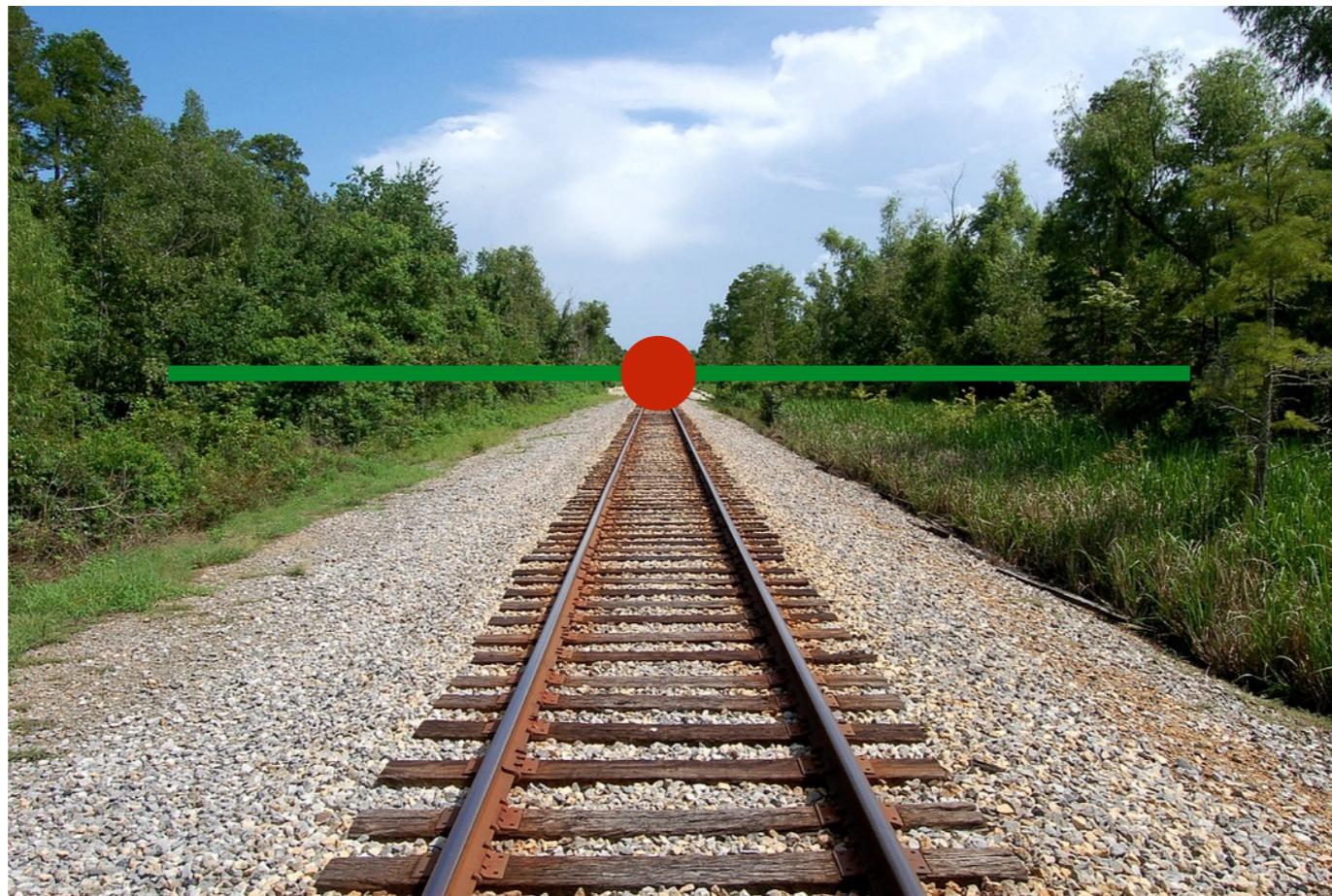
# Perspective Projections



Source: <http://orthographic.weebly.com/single-point-perspective.html>

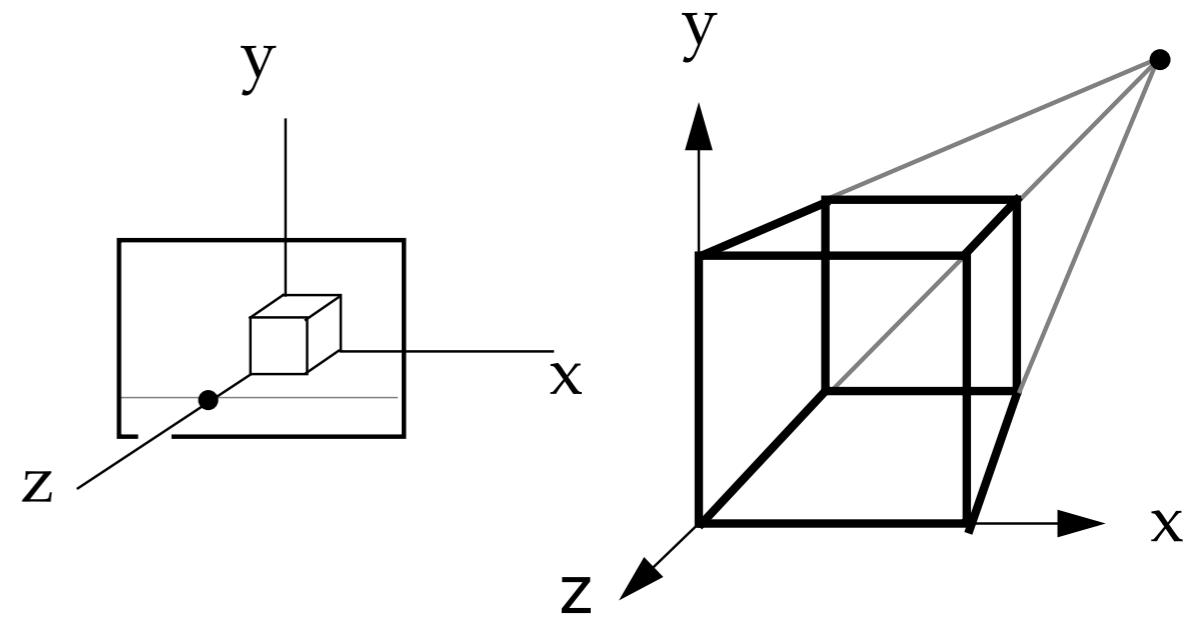
# Vanishing Points

- Point of intersection (in the image plane) of projections of a set of parallel lines in space



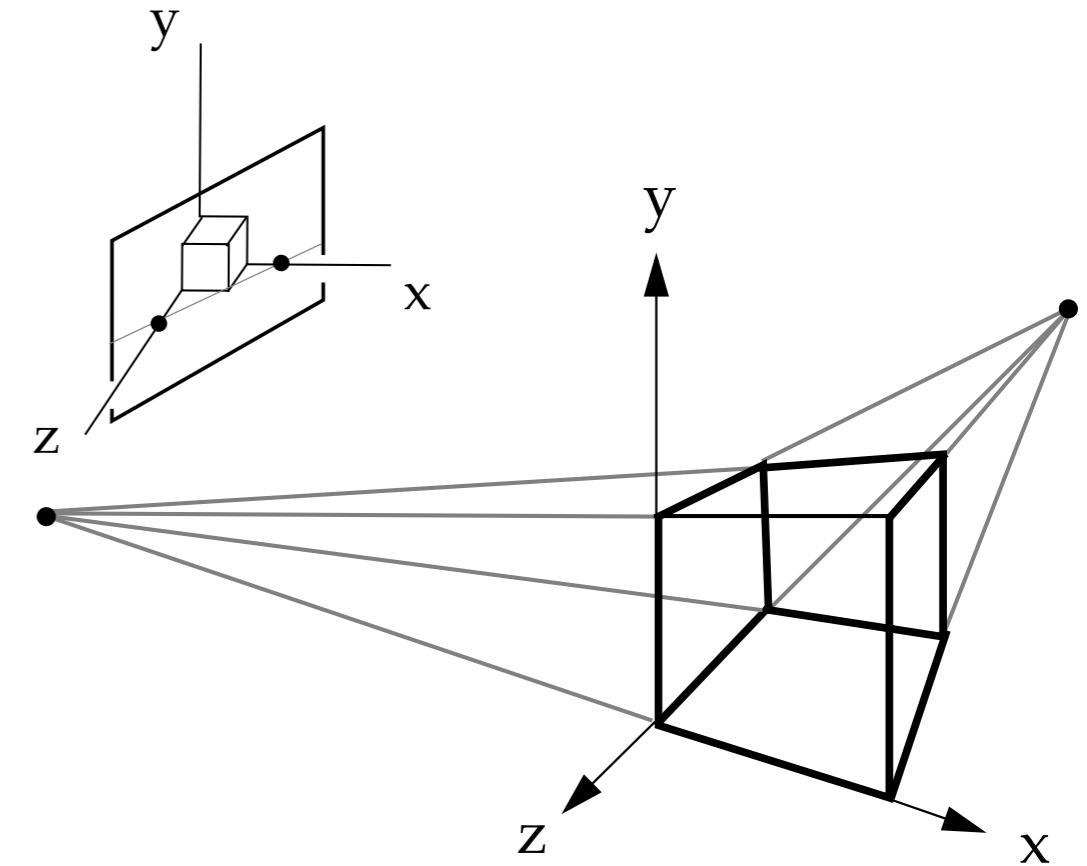
# One-Point Perspective

- Verticals and horizontals are parallel
- All lines of perspective meet at a single vanishing point on the horizon



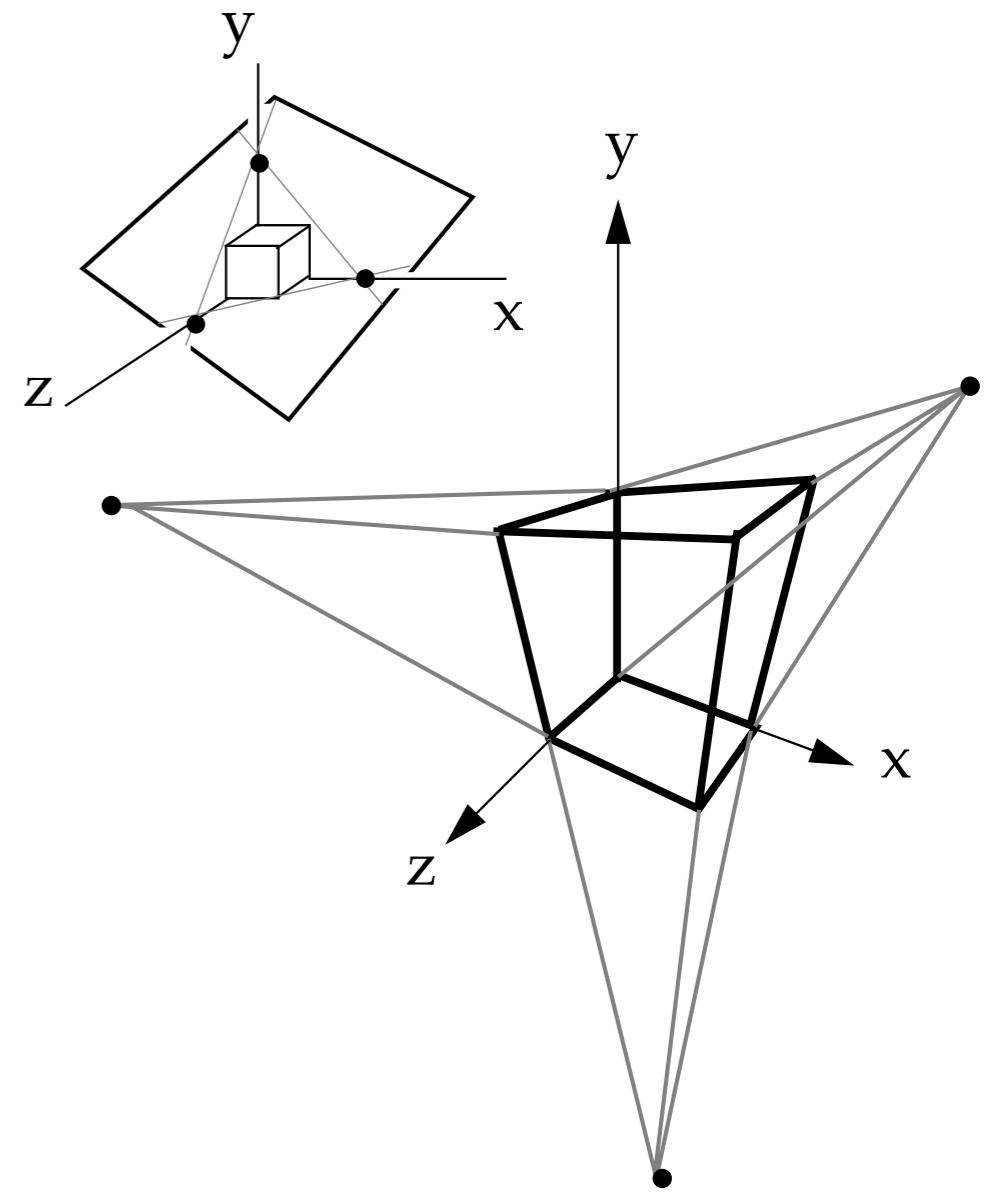
# Two-Point Perspective

- Verticals are parallel
- Contains two vanishing points on the horizon

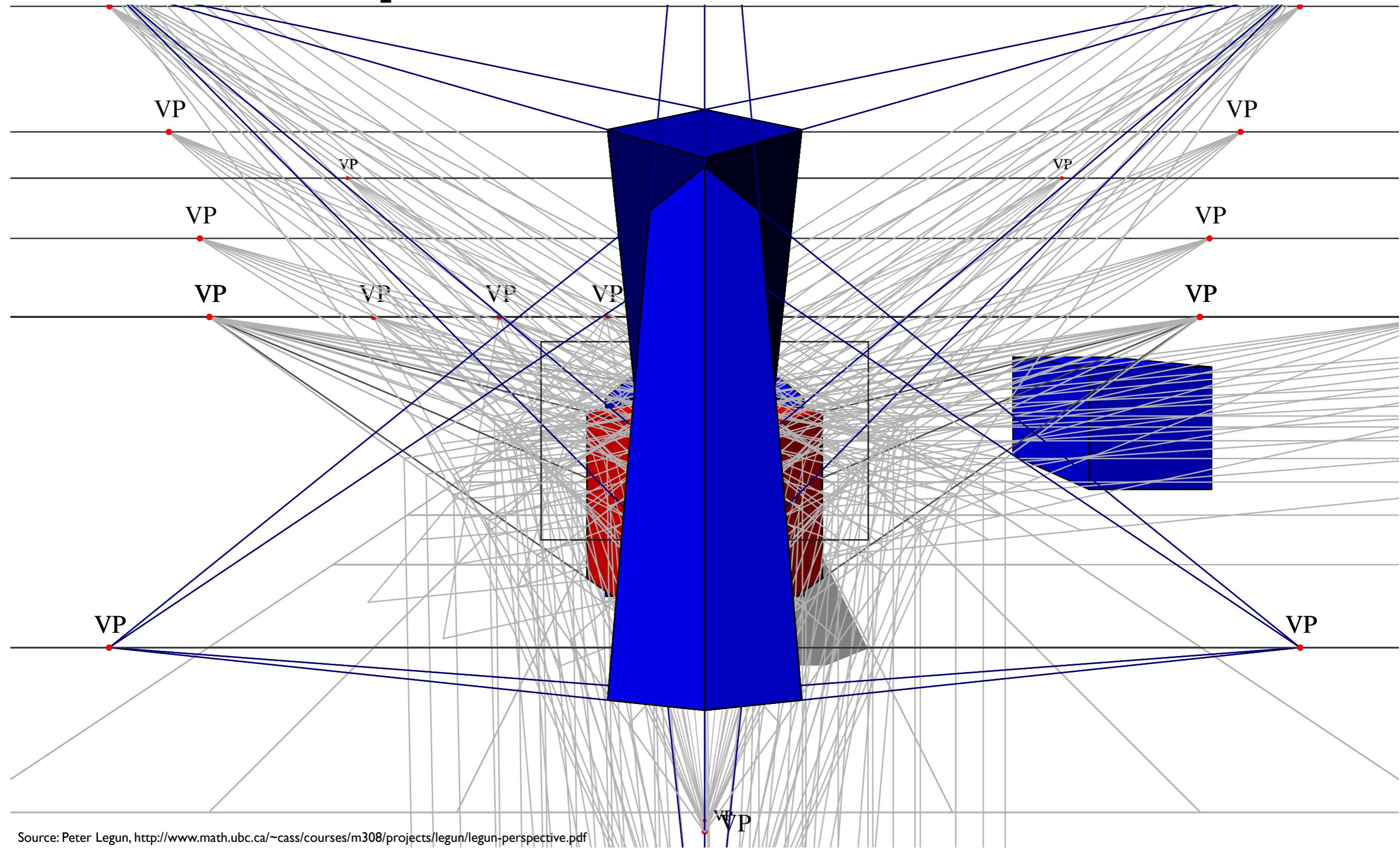


# Three-Point Perspective

- No parallel sides
- Contains three vanishing points



# Perspective Illustration



Source: Peter Legun, <http://www.math.ubc.ca/~cass/courses/m308/projects/legun/legun-perspective.pdf>

# Reading

- ICG: 4.1, 4.2 (see [Viewing\\_I\\_Notes.pdf](#))
- History of perspective (see [History of perspective.pdf](#))

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ICG: Interactive Computer Graphics, E. Angel, and D. Shreiner, 6th ed.

FCG: Fundamentals of Computer Graphics, P. Shirley, M. Ashikhmin, and S. Marschner, 3rd ed.