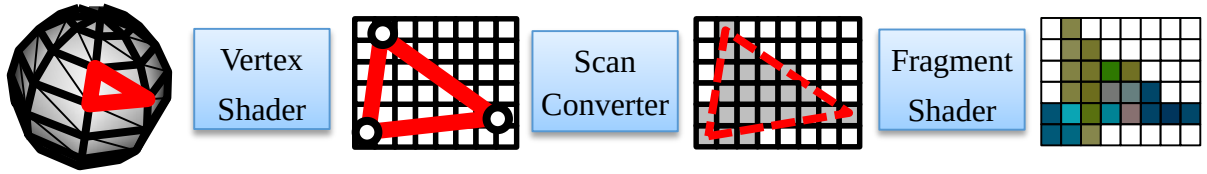
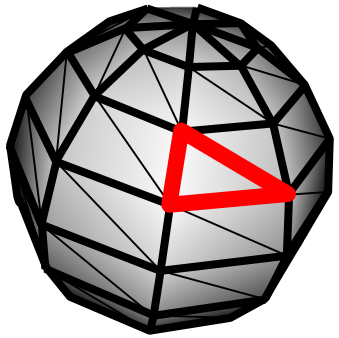
Projections

CS418 Computer Graphics

John C. Hart

Vertex Pipeline





Model Coords

Model Xform

World Coords

Viewing Xform

Viewing Coords

Projection

Clip Coords.

Clipping

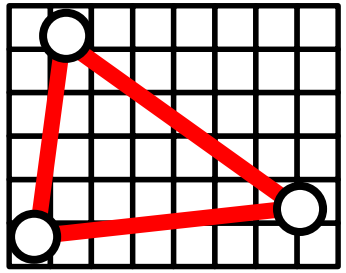
Still Clip Coords.

Homogeneous Divide

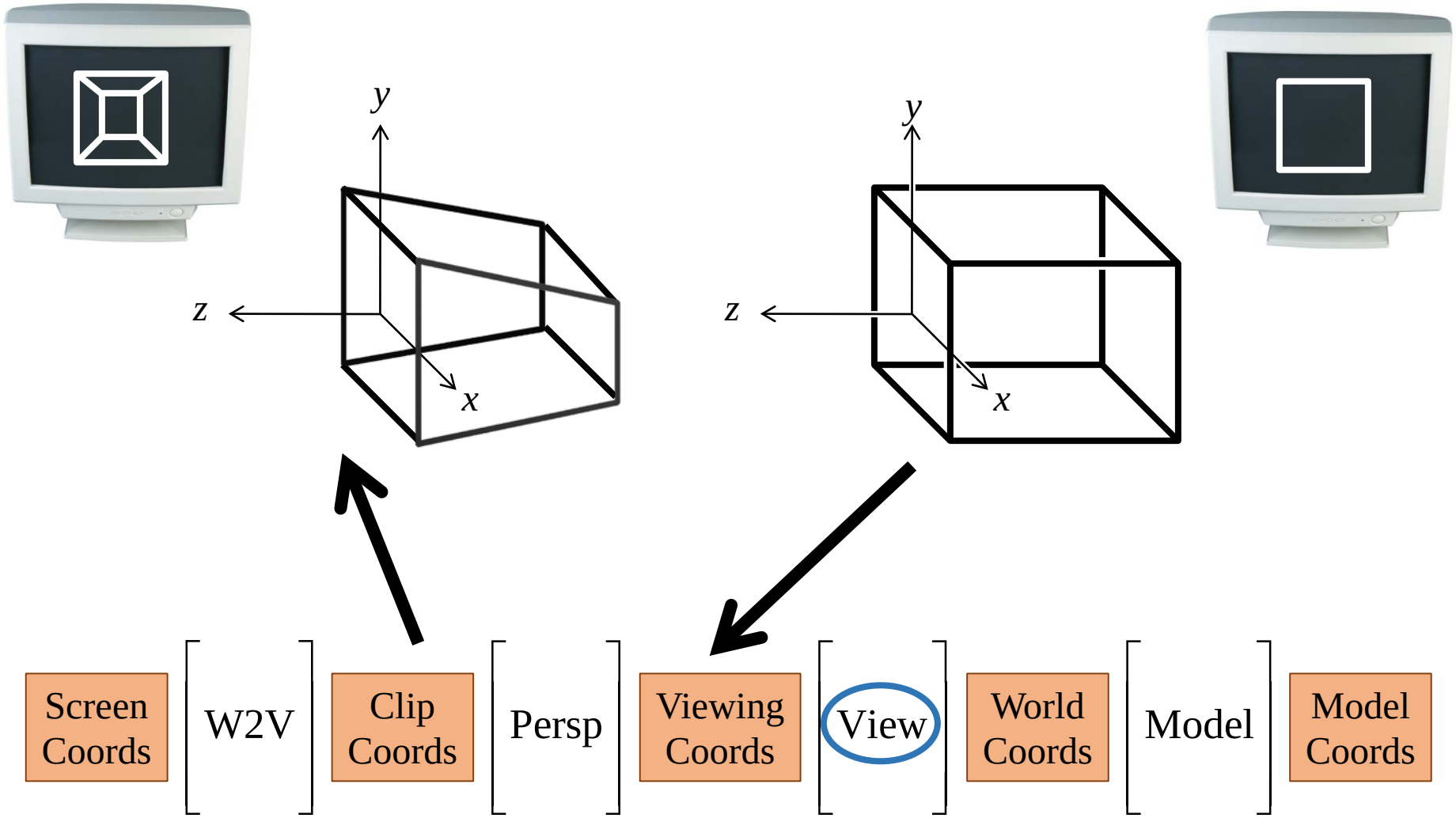
Window Coordinates

Window to Viewport

Viewport Coordinates



Vertex Pipeline



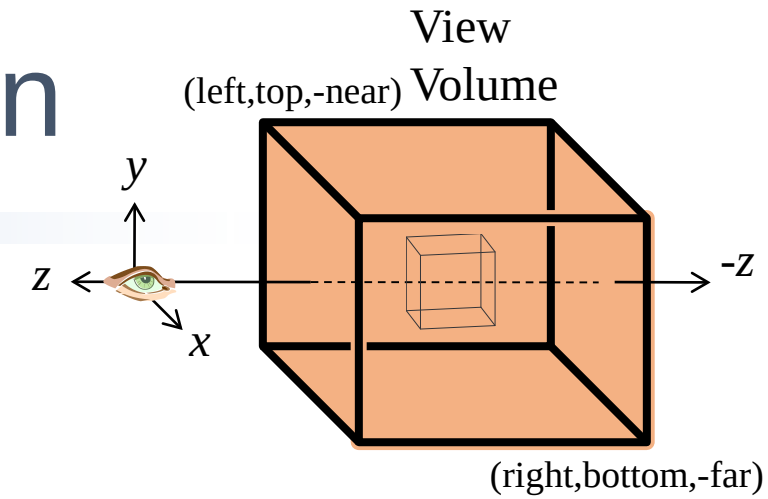
Foreshortening

Projections
squash
receding
surfaces

Andrea Mantegna
The Lamentation over
the Dead Christ

Orthographic Projection

- Foreshortens
- No change in size by depth
- Projection matrix simply zeros the z-coordinate
- (We don't really zero out the z-coordinate)

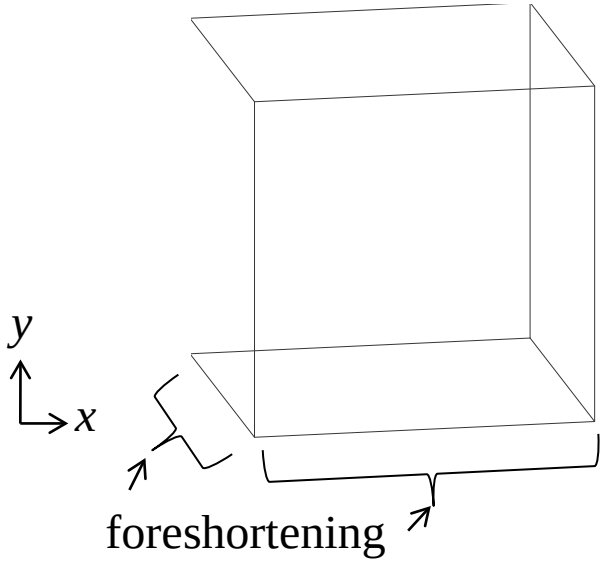


Viewing Coordinates

Ortho

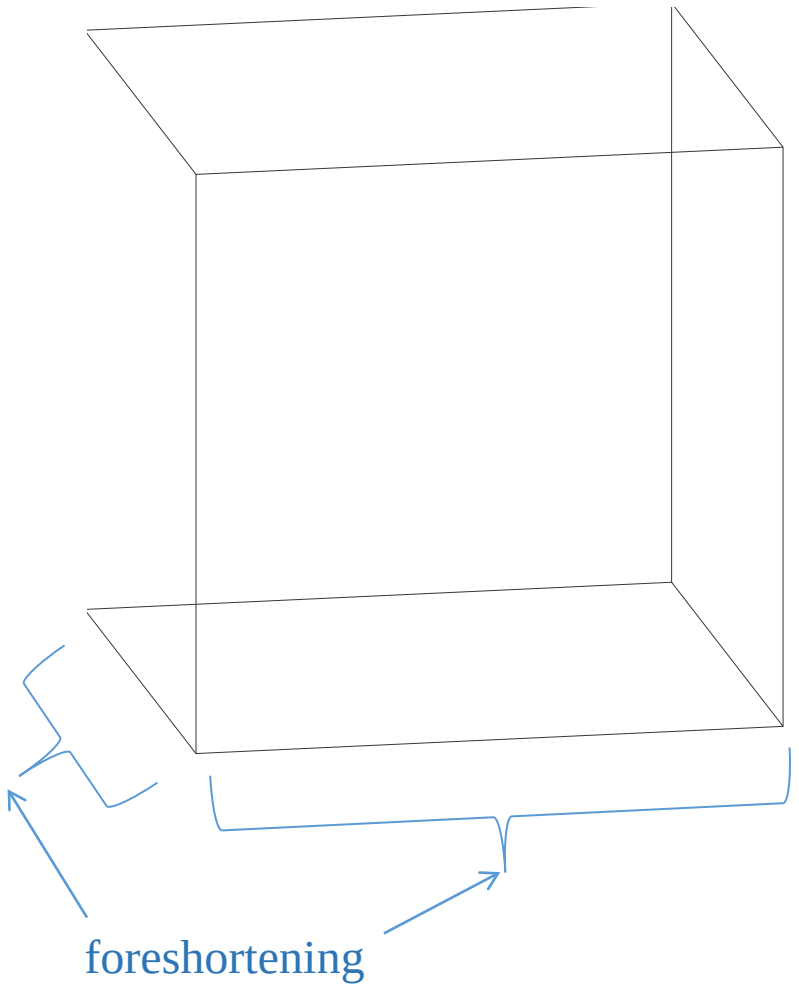
Clip Coordinates

$$\begin{bmatrix} \text{W2V} \end{bmatrix} \begin{bmatrix} 1 & & & \\ & 1 & & \\ & & 0 & \\ & & & 1 \end{bmatrix} \begin{bmatrix} \text{View} \end{bmatrix} \begin{bmatrix} \text{Model} \end{bmatrix}$$

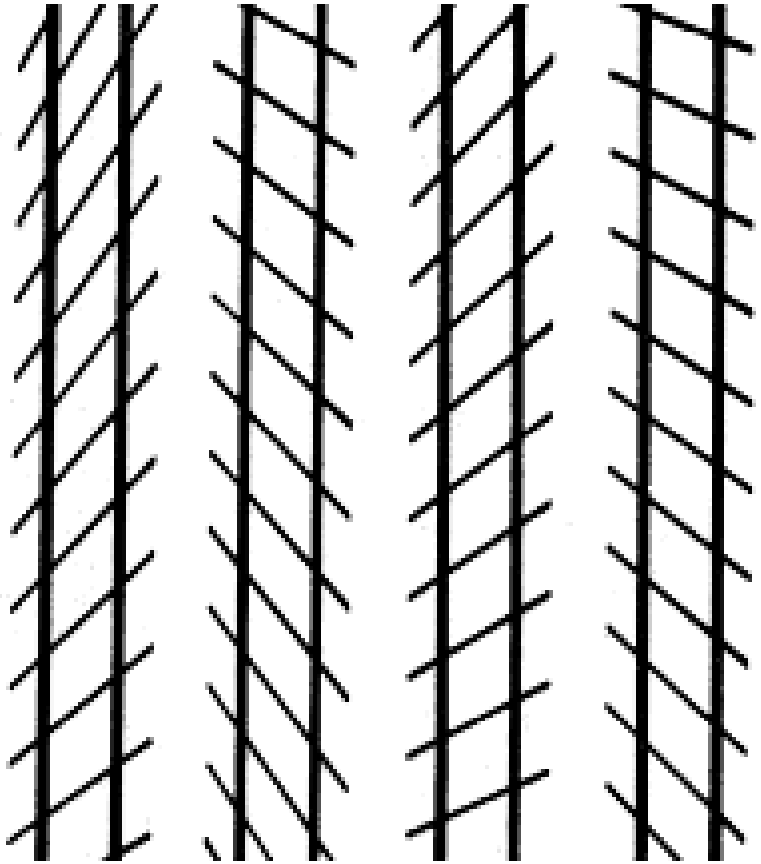


Orthographic Projection

- Foreshortening turns rectangles into parallelograms
- We visually expect right-angle junctions
- When we see an angled junction, we try to perceive it as a right-angle junction

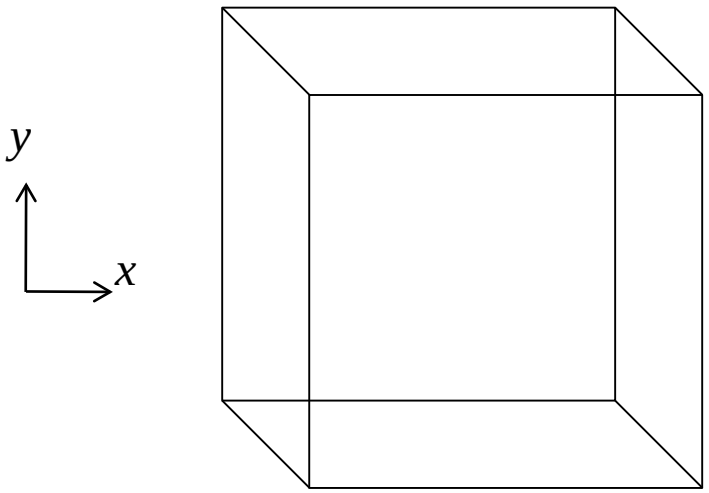


Zollner Illusion



Isometric Projection

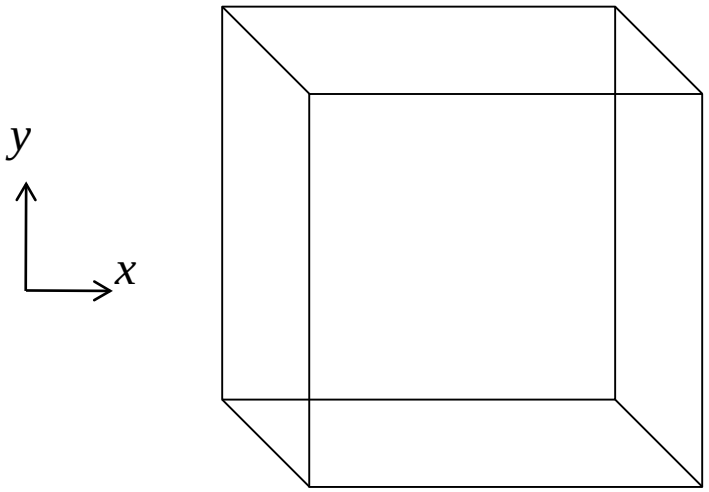
- Foreshortens by using *z*-coord to shear *x* and *y* coordinates



$$x_{\text{clip}} = x_{\text{view}} + z_{\text{view}}$$
$$y_{\text{clip}} = y_{\text{view}} - z_{\text{view}}$$

Isometric Projection

- Foreshortens by using *z*-coord to shear *x* and *y* coordinates

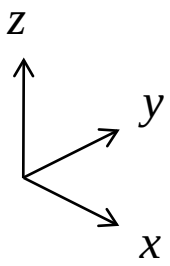


$$x_{\text{clip}} = x_{\text{view}} + z_{\text{view}}$$
$$y_{\text{clip}} = y_{\text{view}} - z_{\text{view}}$$

$$\begin{bmatrix} x_{\text{clip}} \\ y_{\text{clip}} \\ 0 \\ 1 \end{bmatrix} = \begin{bmatrix} 1 & & 1 & \\ & 1 & -1 & \\ & & 0 & \\ & & & 1 \end{bmatrix} \begin{bmatrix} x_{\text{view}} \\ y_{\text{view}} \\ z_{\text{view}} \\ 1 \end{bmatrix}$$

Isometric Projection

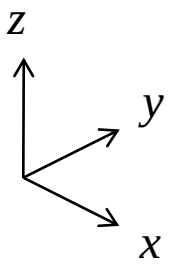
- Used in videogames to place sprites



$$x_{clip} = x_{view} + y_{view}$$
$$y_{clip} = -x_{view} + y_{view} + 2z_{view}$$

Isometric Projection

- Used in videogames to place sprites



$$x_{clip} = x_{view} + y_{view}$$
$$y_{clip} = -x_{view} + y_{view} + 2z_{view}$$

$$\begin{bmatrix} x_{clip} \\ y_{clip} \\ 0 \\ 1 \end{bmatrix} = \begin{bmatrix} 1 & 1 & & \\ -1 & 1 & 2 & \\ & & 0 & \\ & & & 1 \end{bmatrix} \begin{bmatrix} x_{view} \\ y_{view} \\ z_{view} \\ 1 \end{bmatrix}$$