Faculty of German Engineering and Industrial Management Education - FDIBA

Introduction to Computer Graphics

Viewing Transformation

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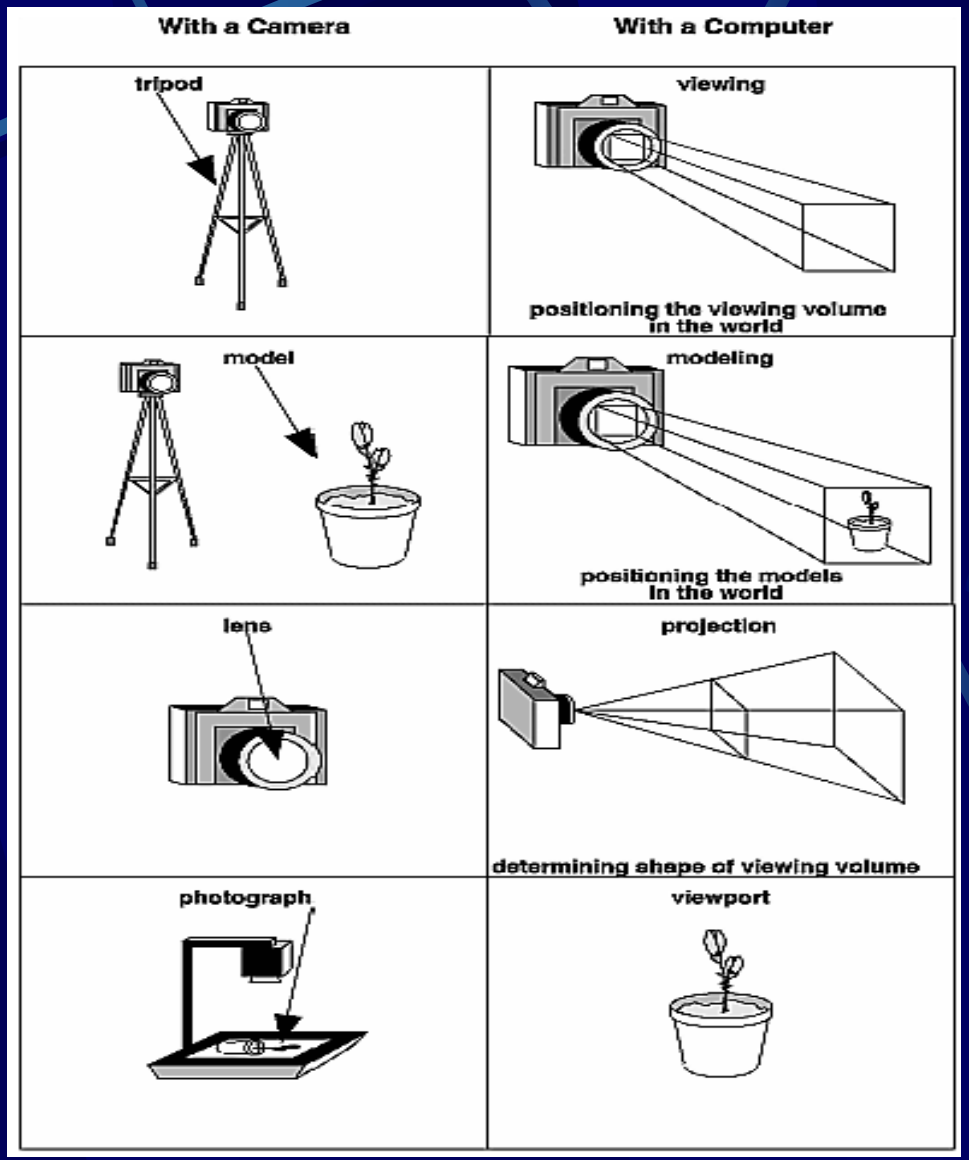
Specifying a View

- Define how the observer is watching the scene
- Analogy: take a picture with a camera
  - Where is the camera positioned?
  - Where is the camera pointed at?
  - Additional adjustments

Camera Analogy

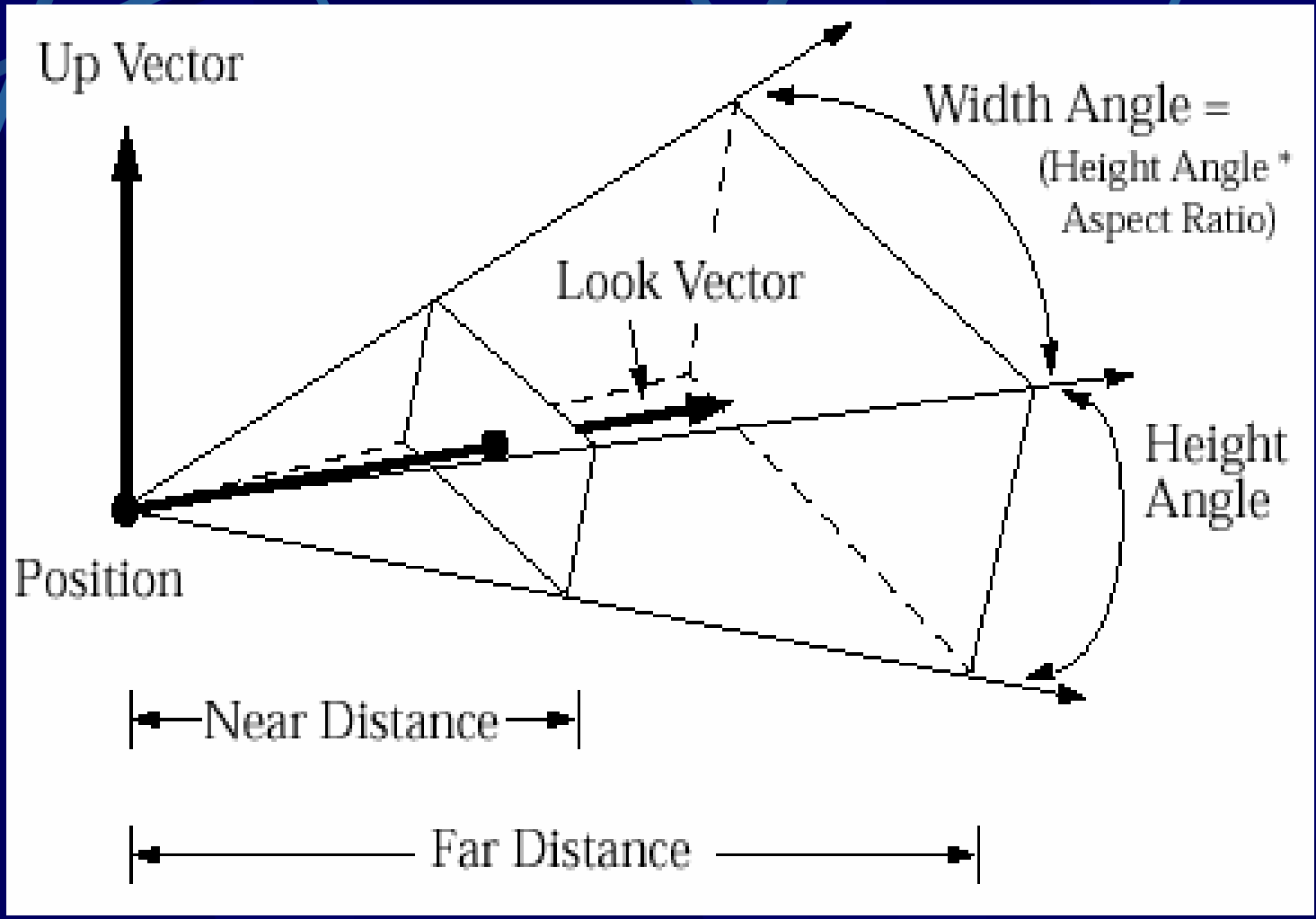


Specifying a View

- **Five steps to specifying view**
  - position the camera (and view/film plane)
  - point it at what you want to see, with the camera in the orientation you want
  - define the field of view
    - for a perspective projection: view volume, aspect ratio of film and angle of view: wide angle, normal, angle, narrow angle;
    - for a parallel projection: view volume, width and height
  - choose perspective or parallel projection
  - determine the focal distance

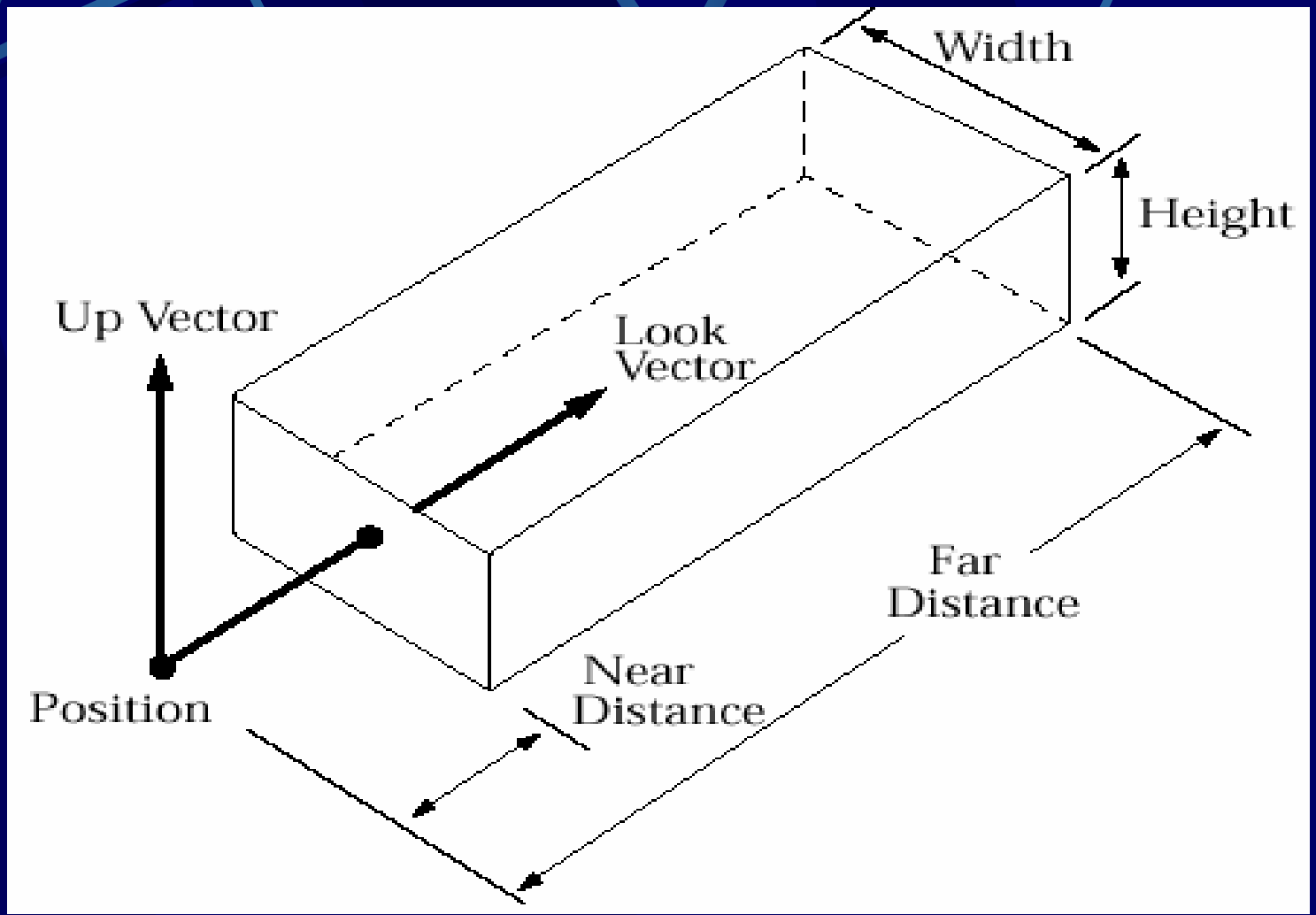
View Volume

Perspective Projection:



View Volume

Parallel Projection:

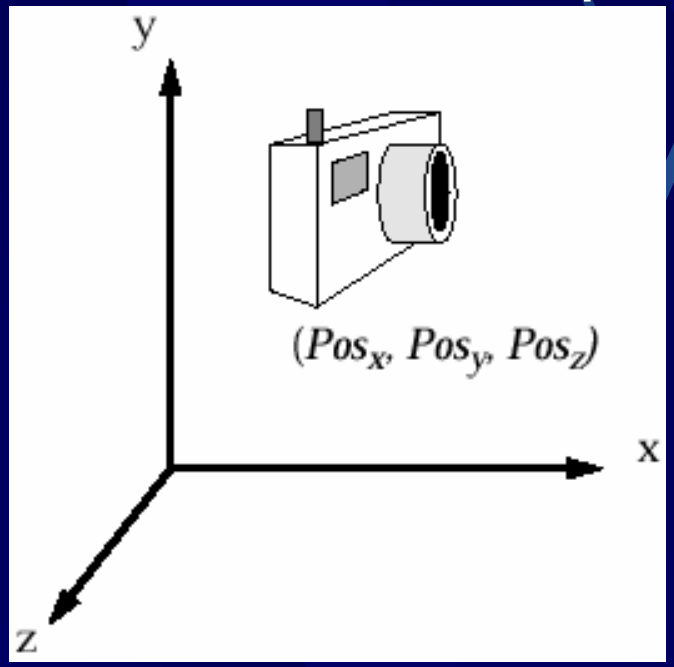


Specifying Arbitrary 3D Views

- Placement of View Volume (visible part of world) specified by
  - *position*
  - *orientation (axis of rotation* (3D vector*), rotation angle* derived from *Look* and *Up* direction vectors)
- Shape of View Volume specified by
  - *view angles*, horizontal and vertical
  - *near clipping plane* and *far clipping plane*

Position

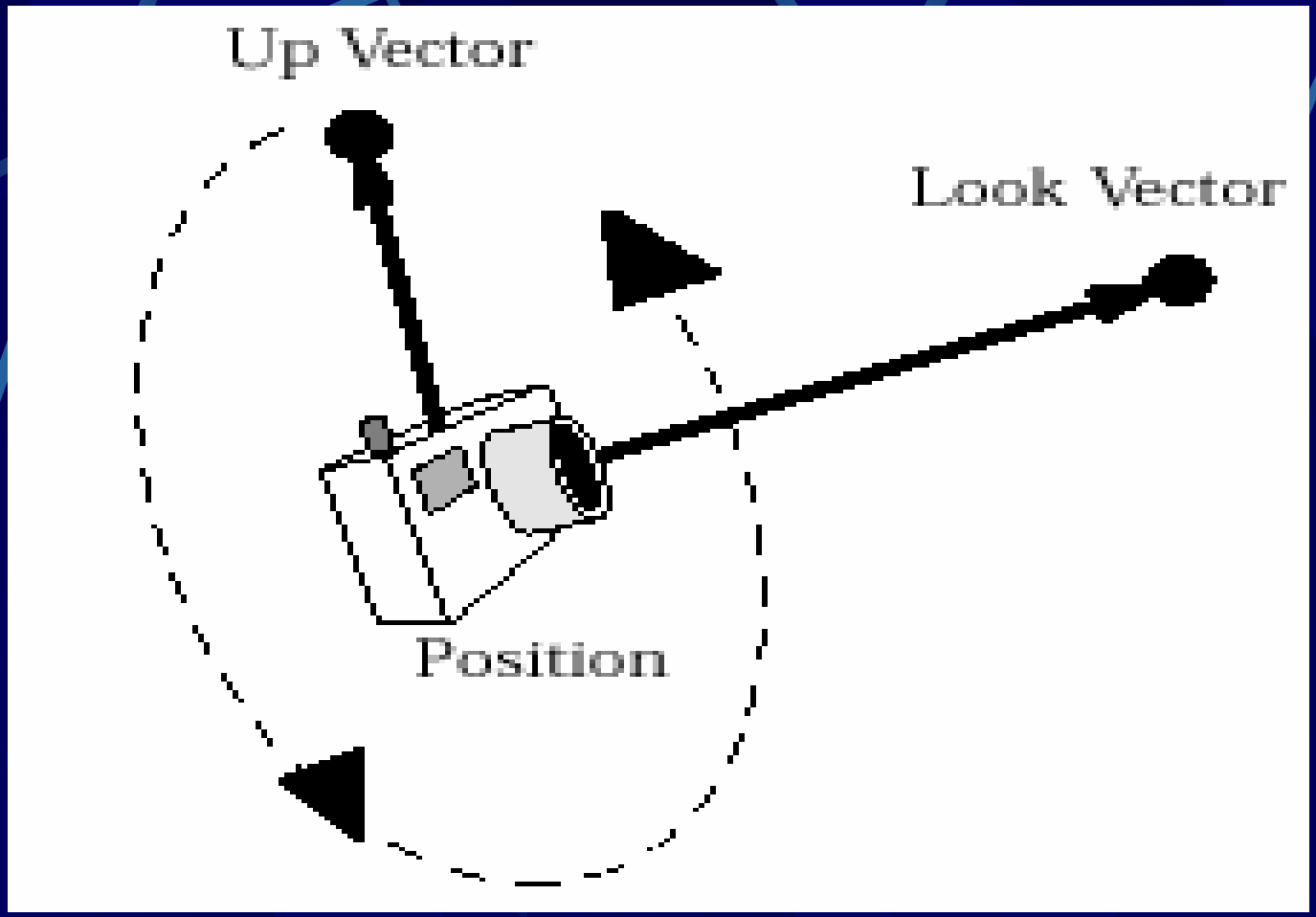
- Determining the *Position* is analogous to a photographer deciding the vantage point from which to shoot a photo
- Three degrees of freedom: *x*, *y*, and *z* coordinates in 3-space



Orientation

- • Look Vector
  - the direction the camera is looking
  - three degrees of freedom; can be any vector in 3-space
- Up Vector
  - determines how the camera is rotated around the look vector
  - for example, whether you're holding the camera horizontally or vertically (or in between)
  - projection of up vector must be in the plane perpendicular to the look vector

Orientation



Aspect Ratio

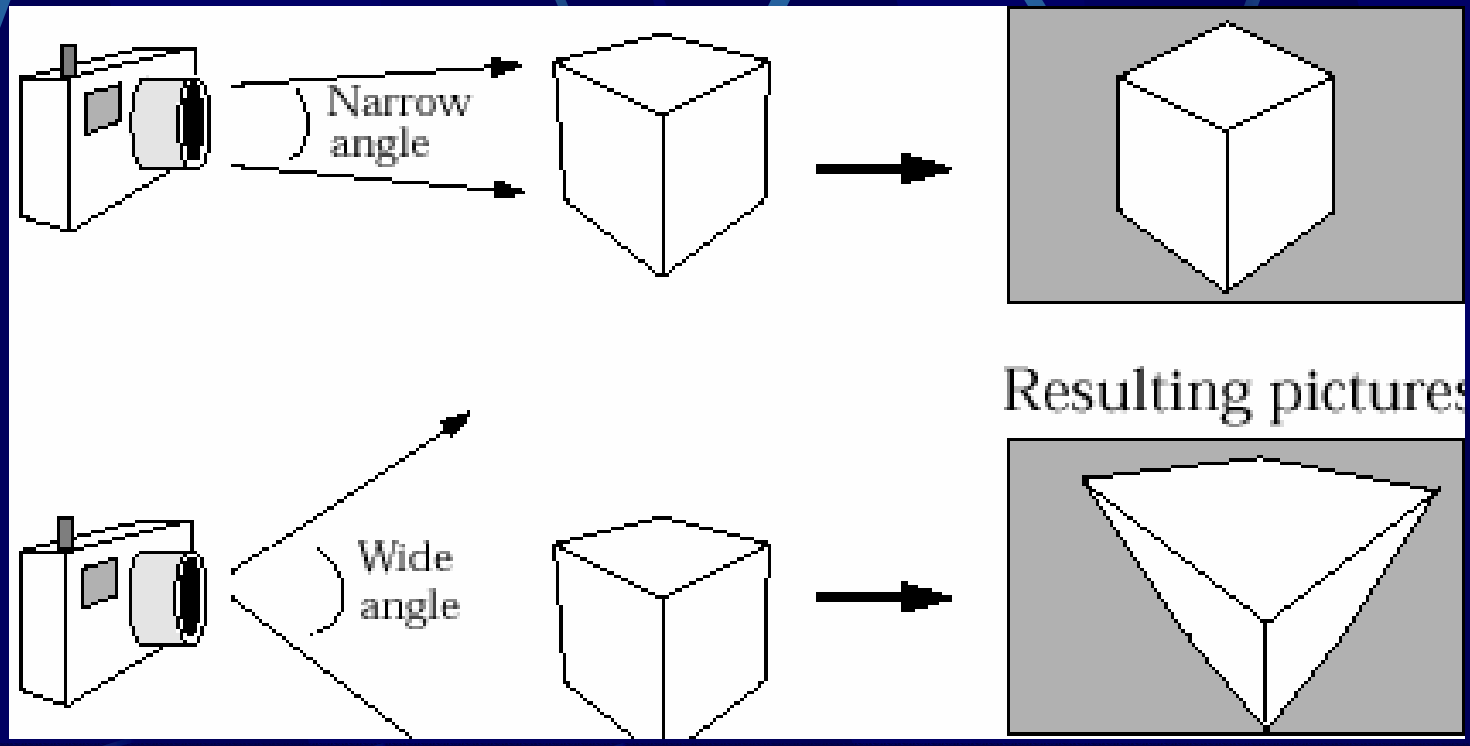
- Analogous to the size of film used in a camera
- Proportion of width to height
- Determines aspect ratio of image displayed on screen
- Square viewing window has aspect ratio of 1:1

View Angle

- Determines amount of perspective distortion in picture, from none (parallel projection) to a lot (wide-angle lens)
- In a frustum we have two viewing angles: width and height angles.
- We specify Height Angle, and get the Width Angle from (Aspect Ratio * Height Angle)
- Choosing view angle analogous to photographer choosing a specific type of lens (e.g., a wide angle or telephoto lens)

View Angle

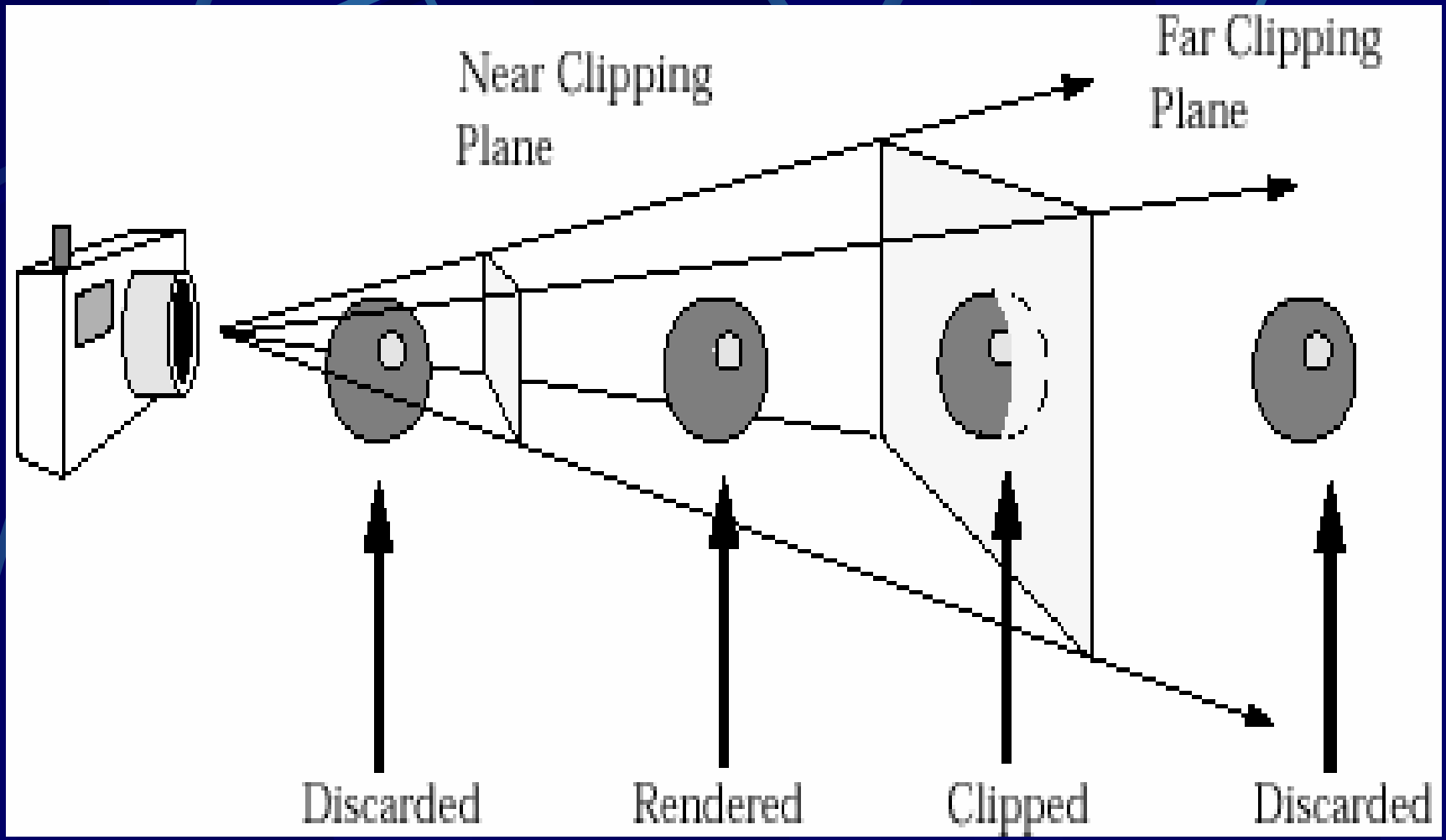
- Lenses made for distance shots often have a nearly parallel viewing angle and cause little perspective distortion, though they foreshorten depth
- Wide-angle lenses cause a lot of perspective distortion



Front and Back Clipping Plane

- Volume of space between front and back clipping planes defines what camera can see
- Position of planes defined by distance along *Look Vector*
- Objects appearing outside of view volume don’t get drawn
- Objects intersecting view volume get clipped

Front and Back Clipping Plane



Front and Back Clipping Plane

- Reasons for *Front* (near) *Clipping Plane:*
- Don’t want to draw things too close to camera
  - would block view of rest of scene
  - objects would be prone to distortion
- Don’t want to draw things behind camera
  - wouldn’t expect to see things behind the camera

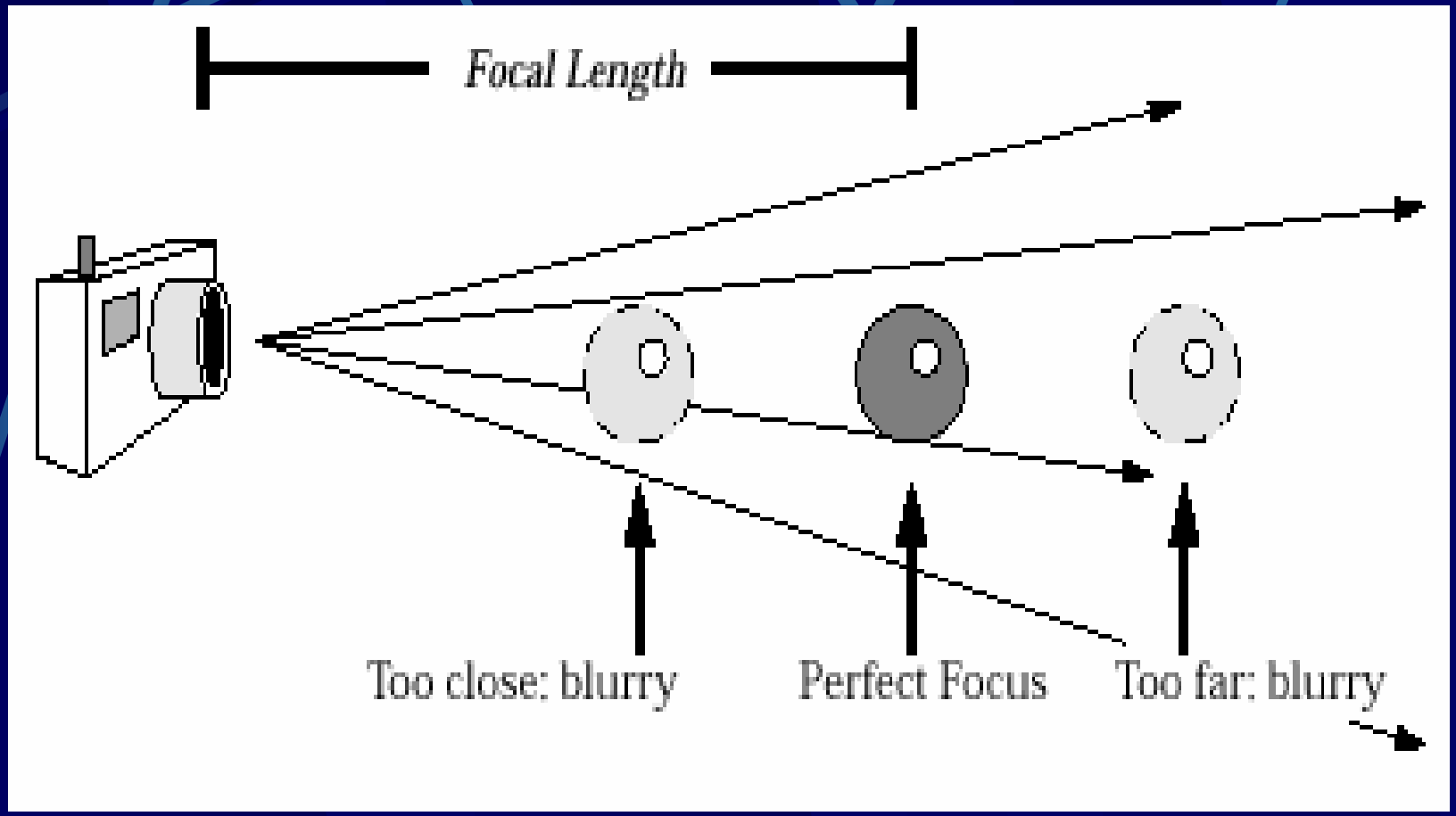
Front and Back Clipping Plane

- Reasons for *Back* (far) *Clipping Plane:*
- Don’t want to draw objects too far away from camera
  - distant objects may appear too small to be visually significant, but still take long time to render
  - by discarding them we lose a small amount of detail but reclaim a lot of rendering time

Focal Length

- *Focal Length* is a measure of ideal focusing range.
- Approximates behavior of real camera lens
  - Objects at distance of *Focal Length* from camera are rendered in focus. Objects closer or farther away than *Focal Length* get blurred
  - *Focal Length* used in conjunction with clipping planes

Focal Length



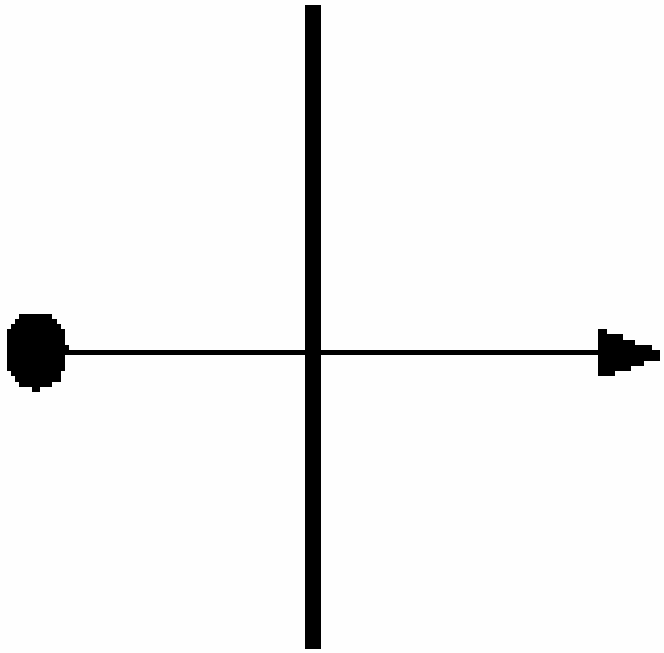
Limitations of the Camera model

- We can create the following view volumes:
  - perspective: positive view angle
  - parallel: zero view angle
- Model *cannot* create oblique view volume

Non-oblique vs. oblique view volumes

Non-oblique view volume:

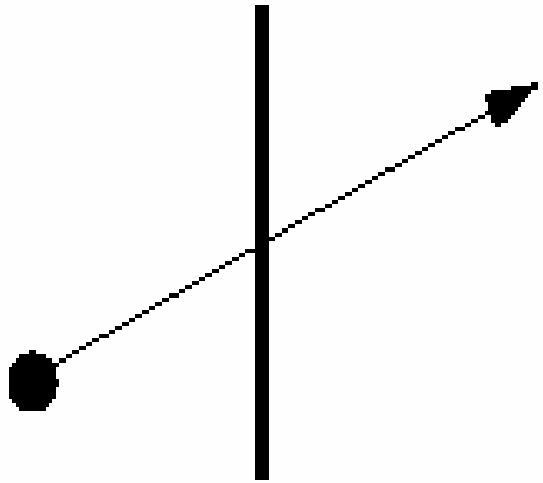
Look Vector is perpendicular to film plane



Non-oblique vs. oblique view volumes

Oblique view volume:

Look Vector is at an angle to the film plane



For example, view cameras with bellows are used to take pictures of (tall) buildings. The film plane is parallel to the facade, while the camera points up. This is an oblique view volume, with the facade undistorted.