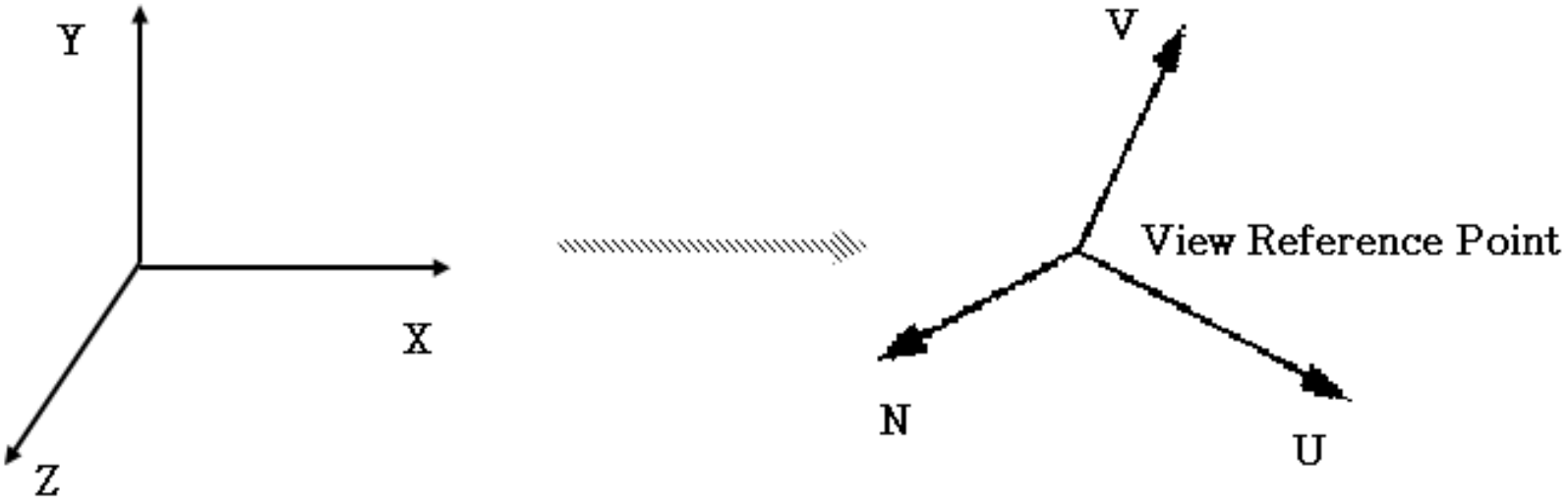
3D Viewing

- 3D Viewing:
  - Coordinate Systems
  - Defining a “View Volume”
  - Benefits of mapping the view volume

3D Viewing Transformations

View Orientation Transformation

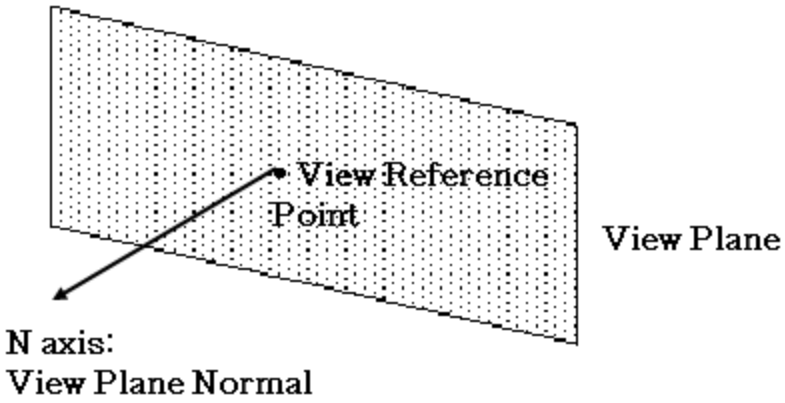
- View orientation transformation...
  - ...defines the location and orientation of view reference coordinates relative to world coordinates
  - ...is specified by a view reference point, which is the origin of VRCs relative to WCs



3D Viewing Transformations

View Orientation Transformation

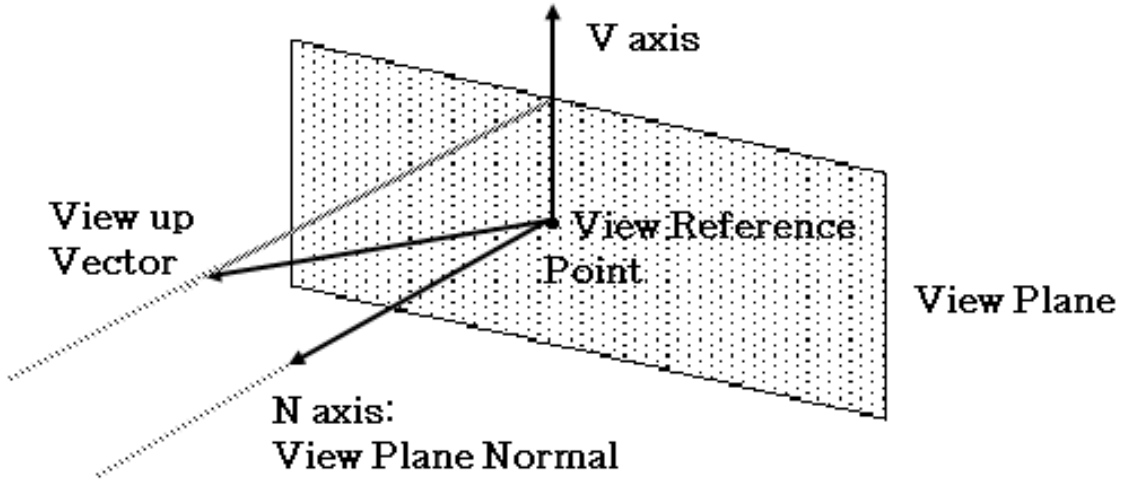
- View orientation transformation...
  - ...is specified by a point (called the view reference point) on a plane that is perpendicular to the N axis and by a vector (called the view plane normal)
  - ...where the view plane normal determines the N axis as a perpendicular distance from the view reference point



3D Viewing Transformations

View Orientation Transformation

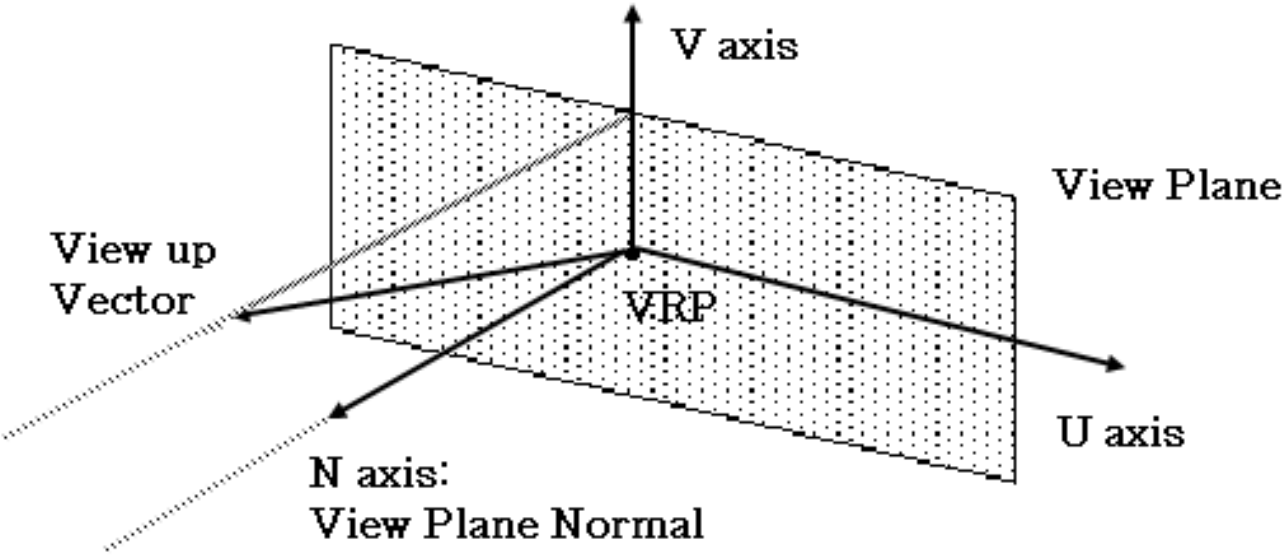
- View orientation transformation...
  - ...is specified by a view up vector whose direction, projected onto the view plane, defines the V axis (specifying the vertical UP direction
  - ...think of it as projecting the view up vector along the view plane normal onto the view plane!



3D Viewing Transformations

View Orientation Transformation

- View orientation transformation...
  - ...defines the U axis as perpendicular to the V and N axes to form a right-handed coordinate system



3D Viewing Transformations

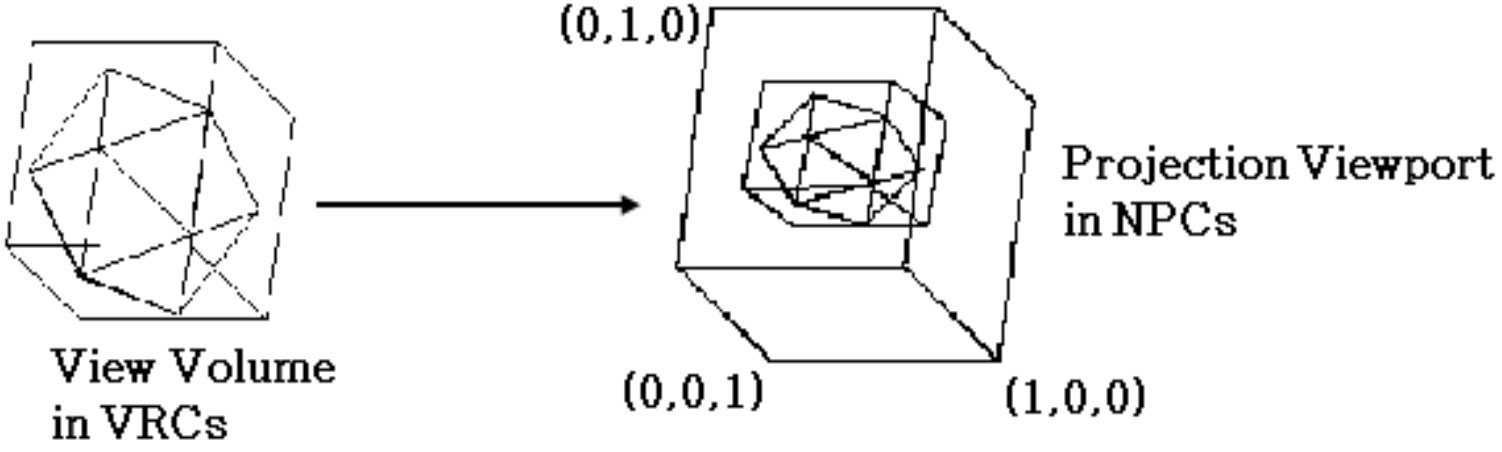
View Mapping Transformation

- View mapping transformation...
  - ...defines the mapping of view reference coordinates to normalized projection coordinates
  - ...specifies a 3D volume of view reference coordinates to be mapped to a 3D volume of normalized projection coordinates (NPC)

3D Viewing Transformations

View Mapping Transformation

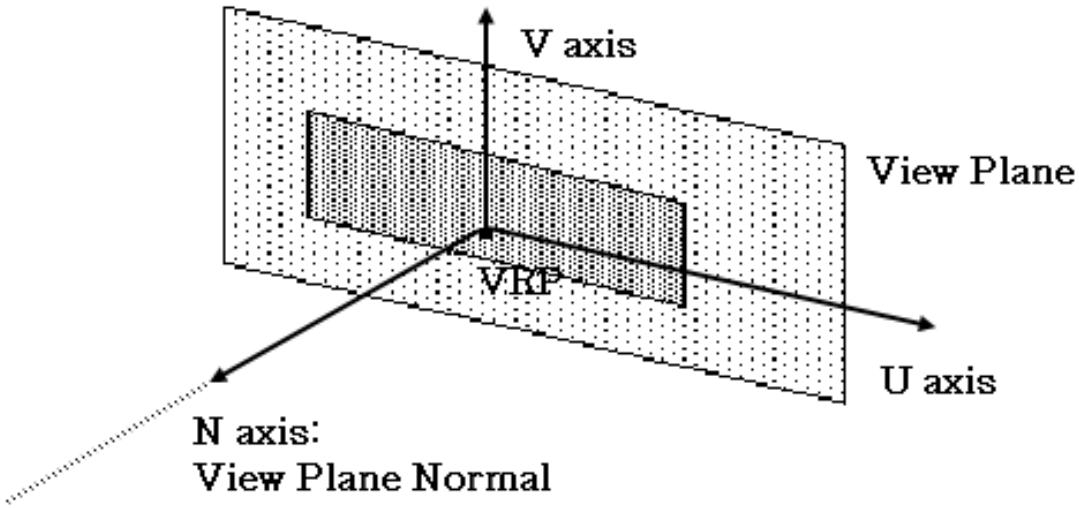
- The 3D volume in VRCs is called the *view volume*
- The 3D volume in NPCs is called the *projection viewport*



3D Viewing Transformations

View Volume

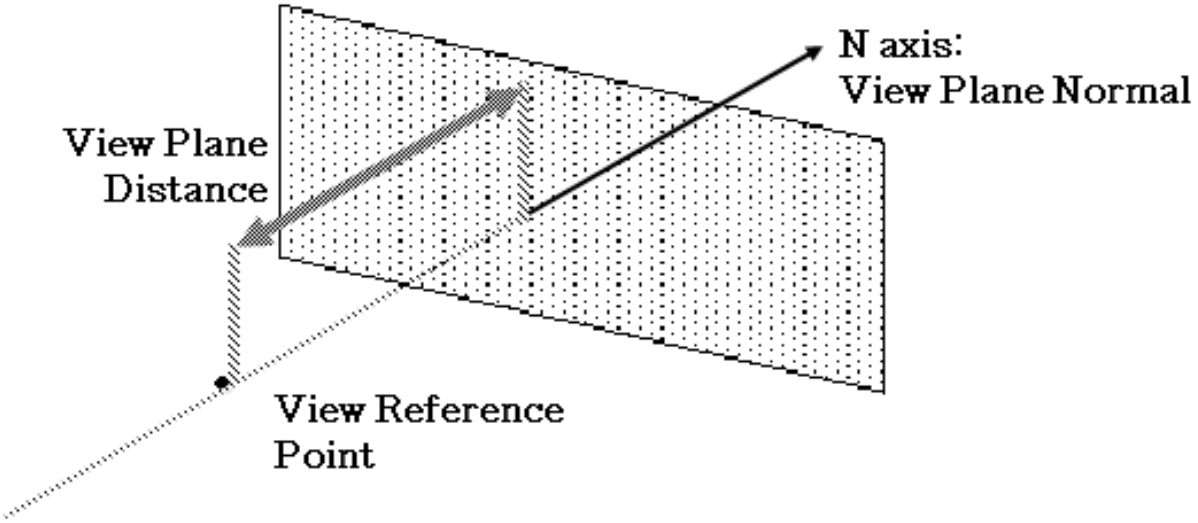
- 3D view volumes are defined by...
  - ...a 2D view *window* that defines your field of view and provides the left and right, bottom and top extents of the view reference coordinates that you can see measured on the view plane



3D Viewing Transformations

View Volume

- 3D view volumes are also defined by...
  - ...a view plane distance specifies where the view plane (an infinite plane perpendicular to the N axis where your picture is projected) intersects the N axis
  - ...the view plane distance displaces the VRP from the view plane



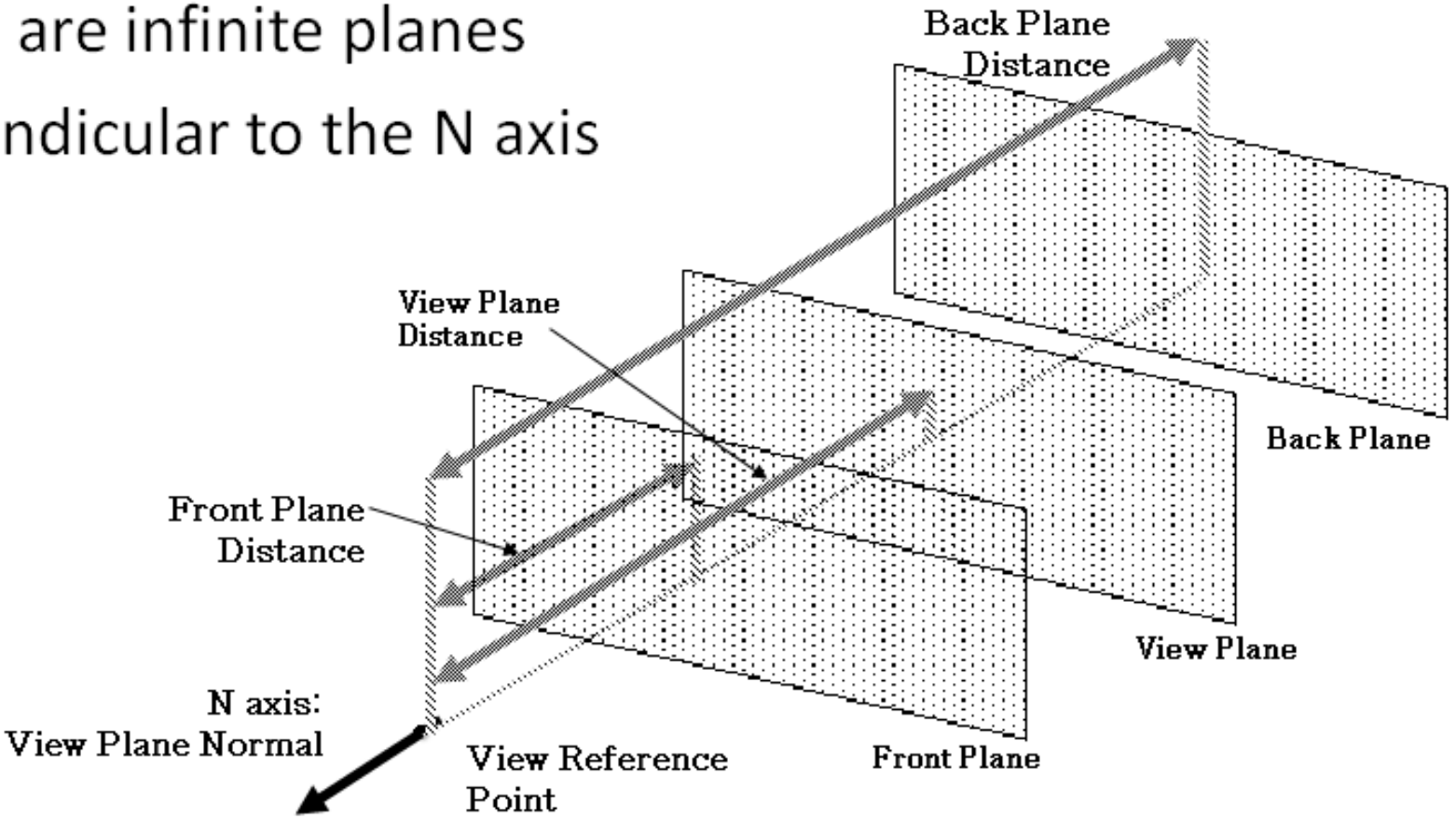
3D Viewing Transformations

View Volume

- 3D view volumes are also defined by...
  - ...front and back plane distances,

  which are infinite planes

  perpendicular to the N axis



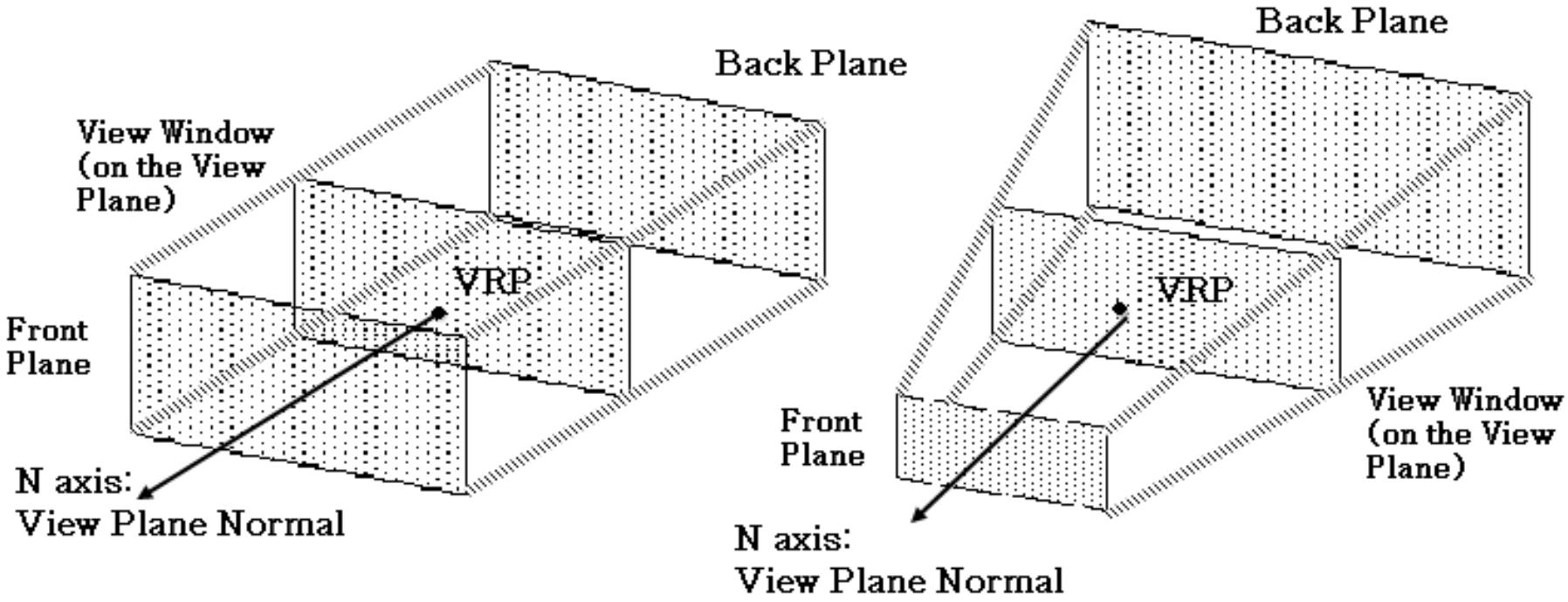
3D Viewing Transformations

View Volume

- 3D view volumes are also defined by the projection type...
  - ...affects the shape of the view volume
  - …parallel or perspective
  - ...for parallel projections, the view volume is a parallelpiped
  - ...for perspective projections, the view volume is a truncated 4-slided pyramid

3D Viewing Transformations

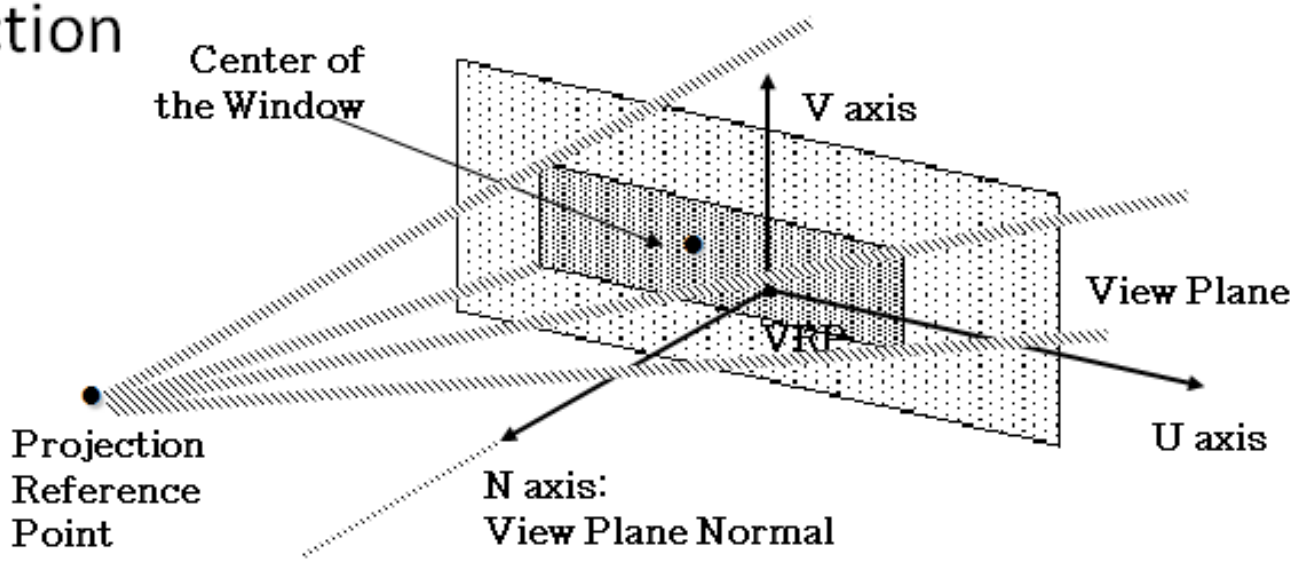
View Volume



3D Viewing Transformations

View Volume

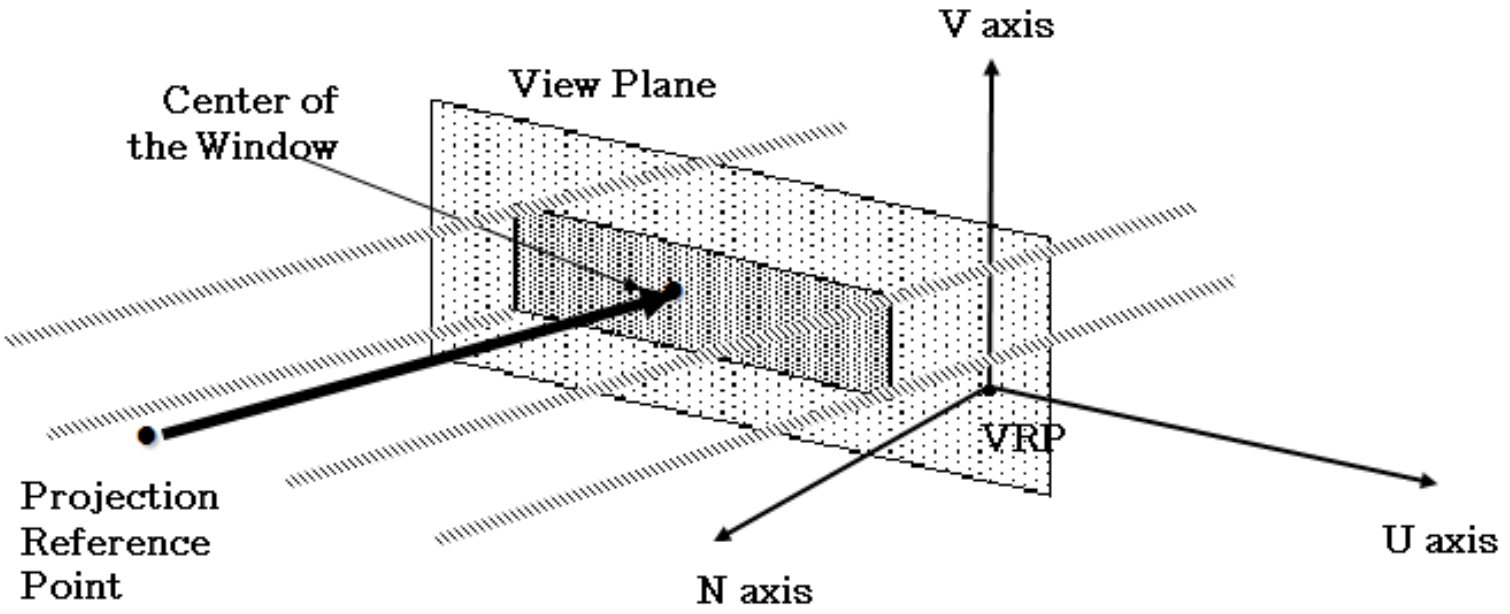
- Lastly, 3D view volumes are also defined by the projection reference point...which
  - ...affects the shape of the view volume
  - ...is the center of projection for perspective projection



3D Viewing Transformations

View Volume

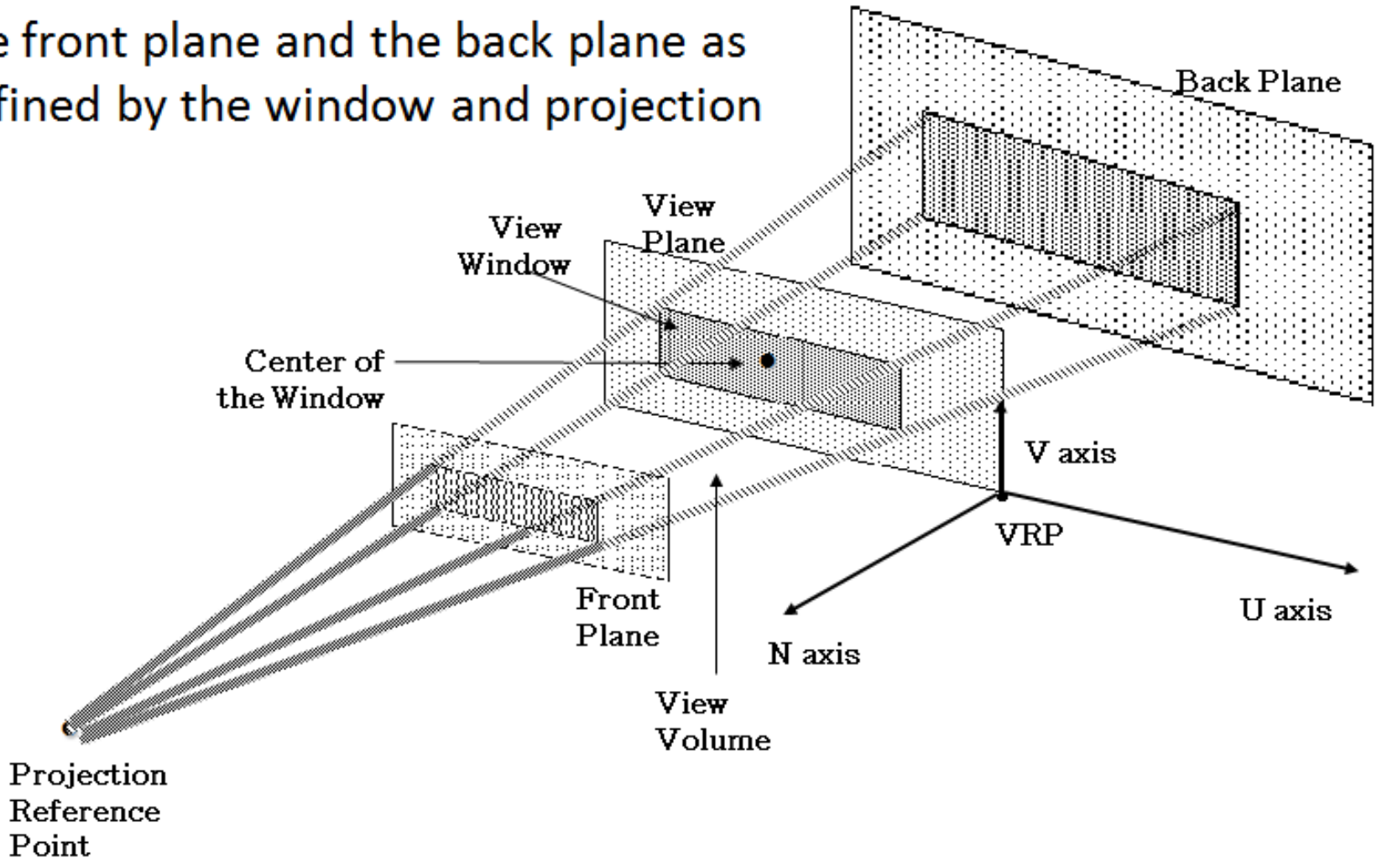
- For parallel projections...the projection reference point...
  - ...specifies the direction of projection to be from the projection reference point to the center of the window



3D Viewing Transformations

View Volume for Perspective Projection

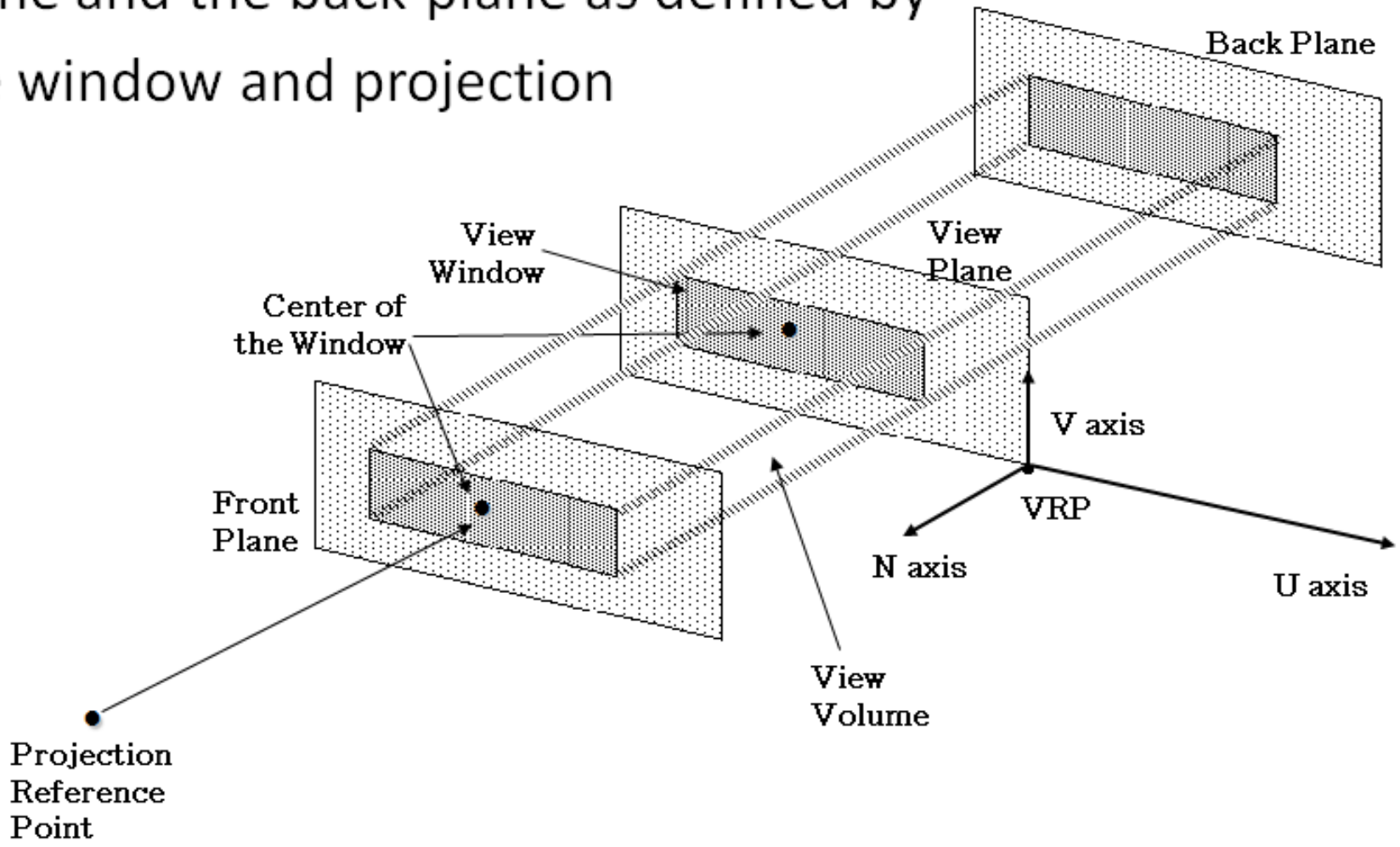
- The view volume is the area between the front plane and the back plane as defined by the window and projection



3D Viewing Transformations

View Volume for Parallel Projection

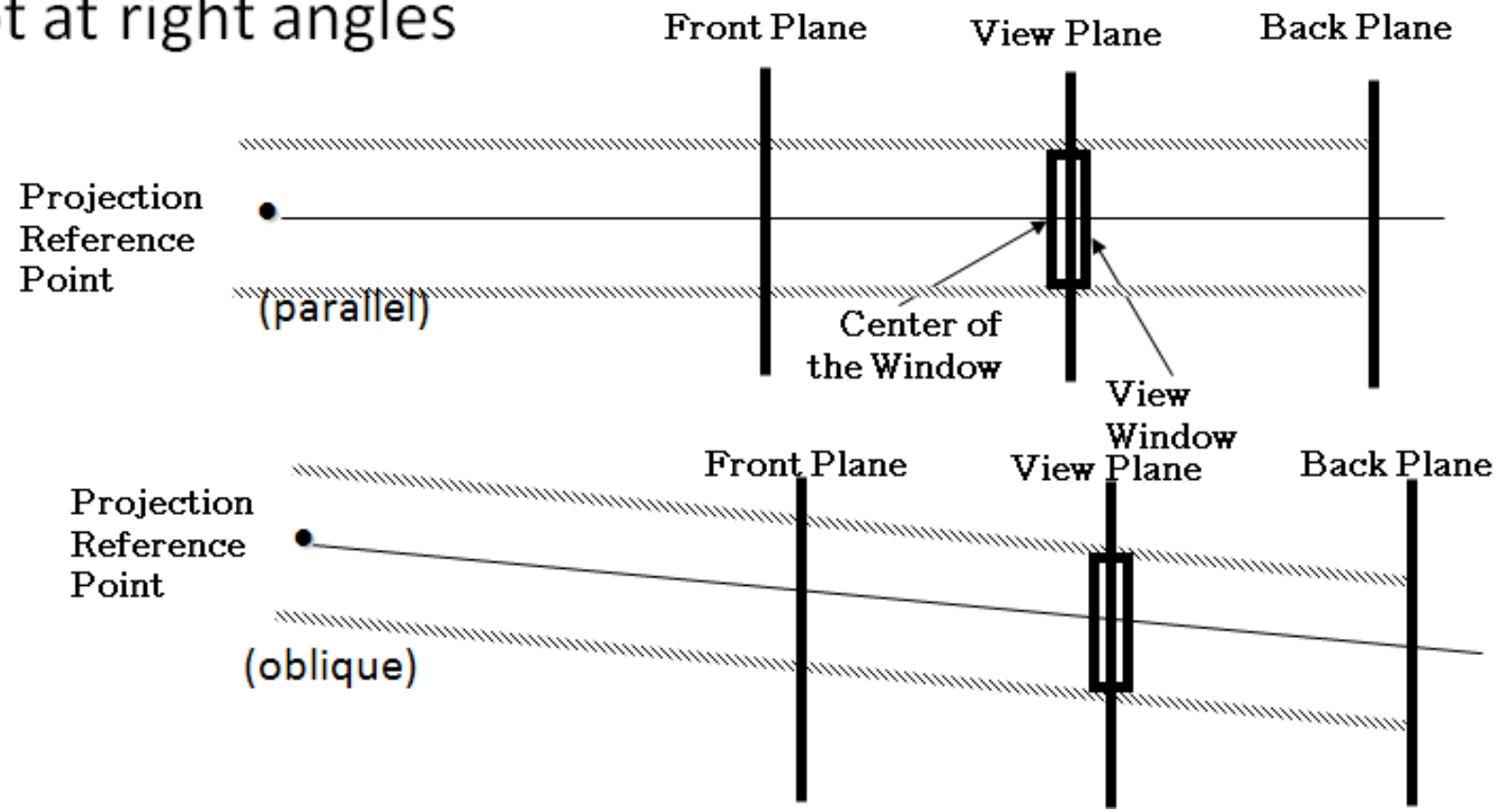
- The view volume is the area between the front plane and the back plane as defined by the window and projection



3D Viewing Transformations

Parallel Projections

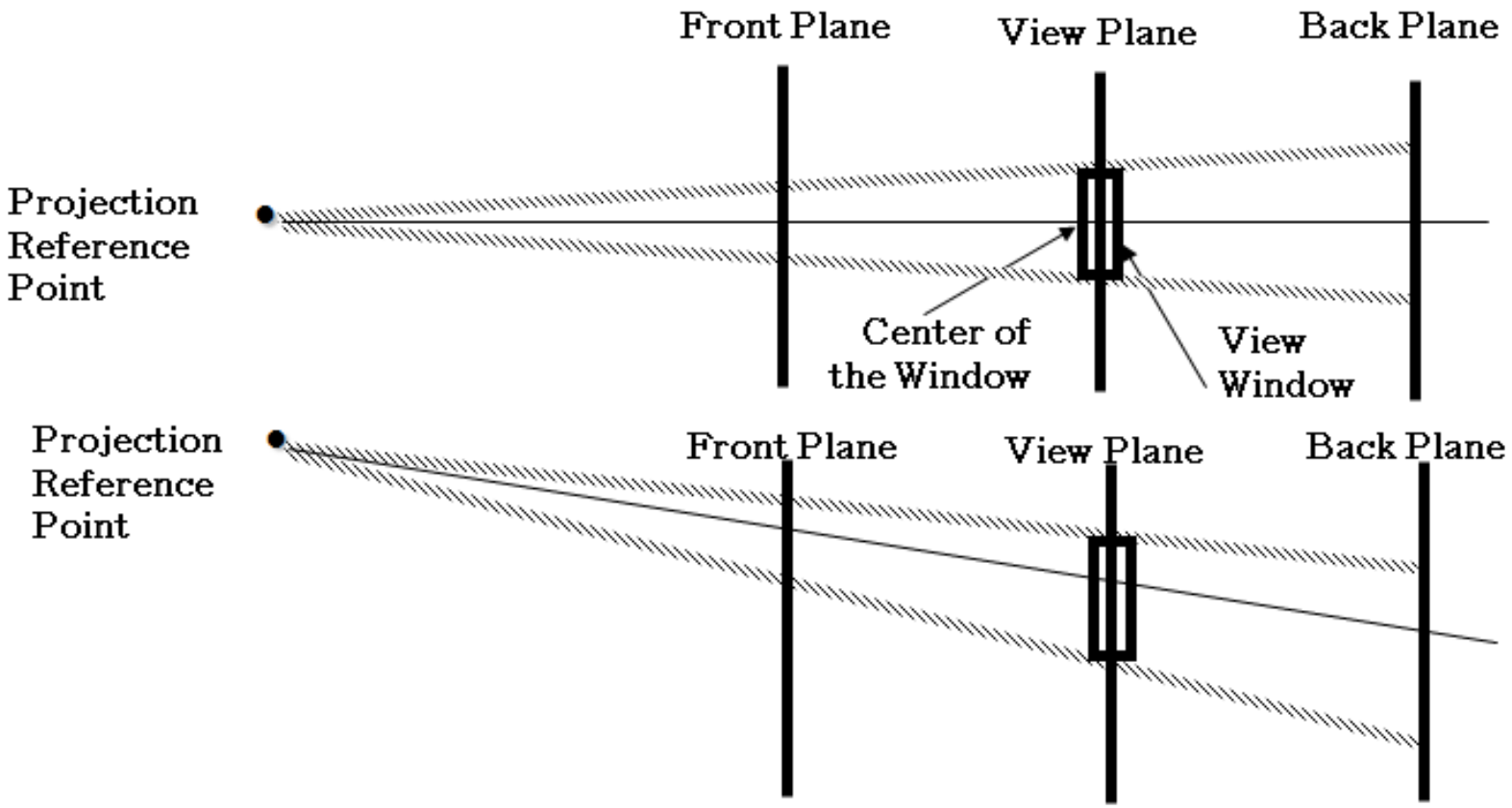
- Oblique Parallel Projection: when the line connecting the projection reference point to the center of the window is not at right angles



3D Viewing Transformations

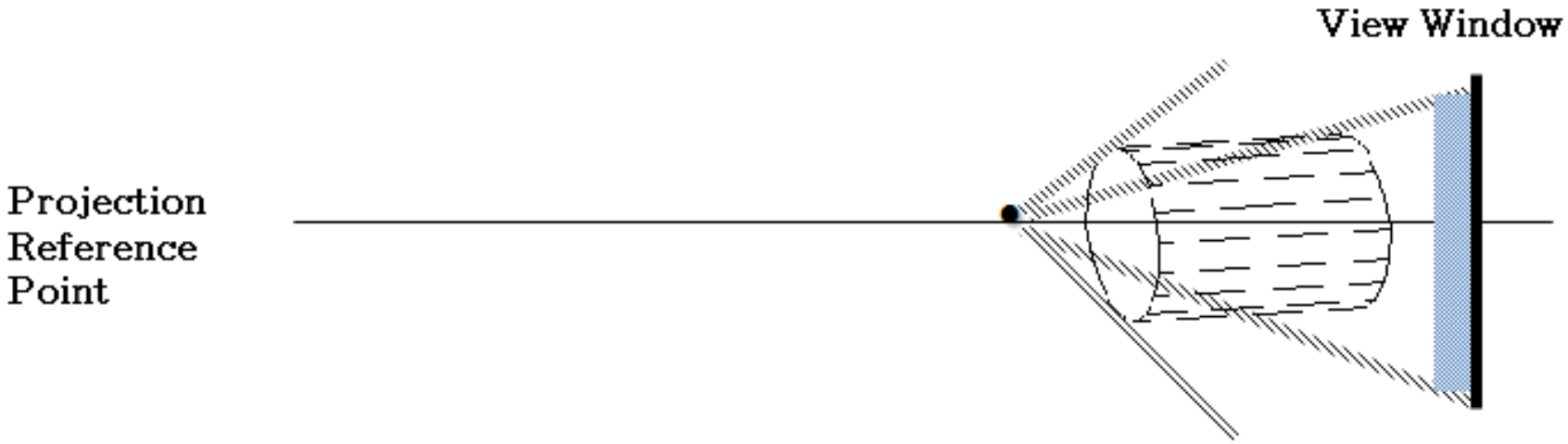
Perspective Projections

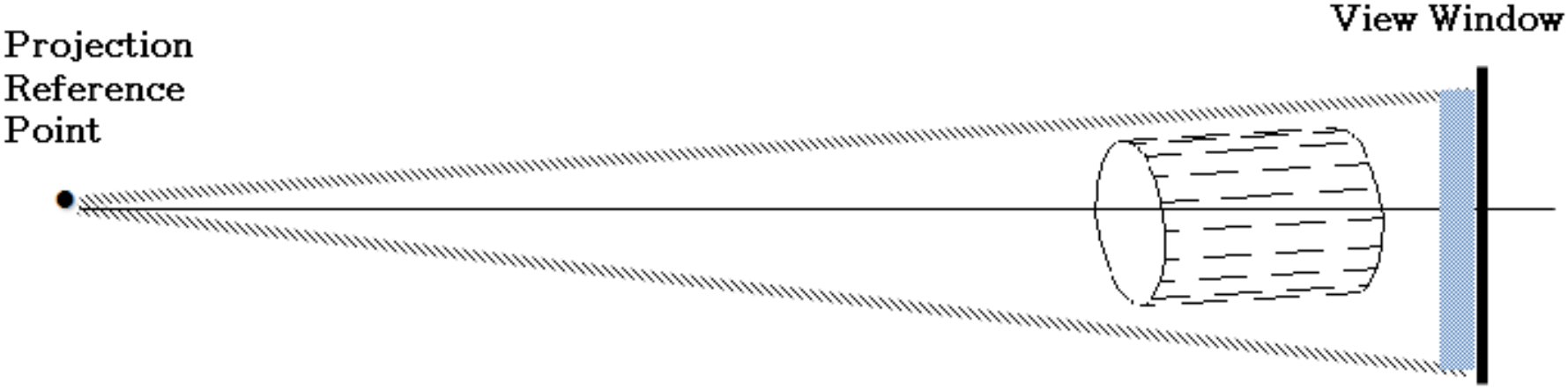
- Oblique Perspective Projection: when the line connecting the projection reference point to the center of the window is not at right angles with the window



3D Viewing Transformations

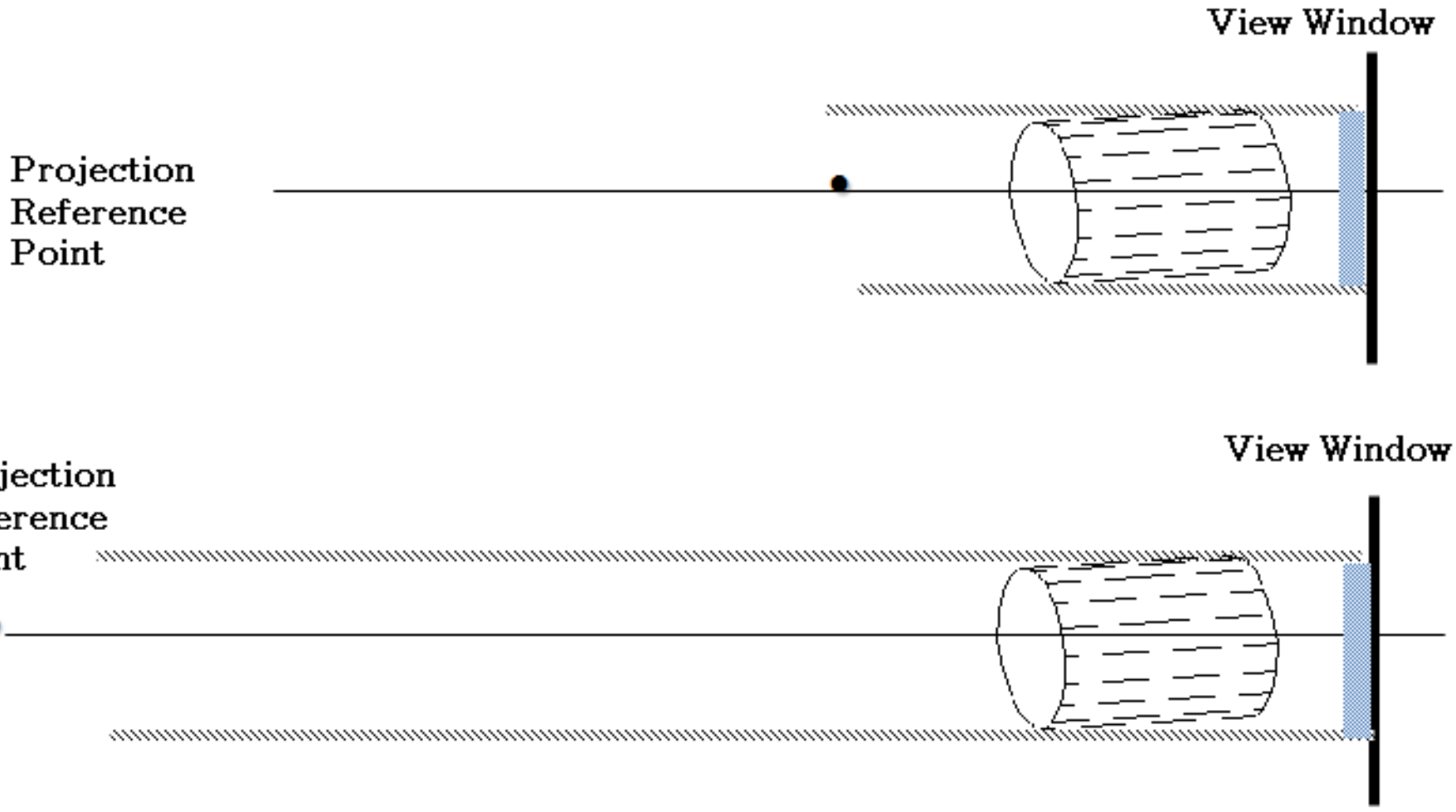
Perspective Projections





3D Viewing Transformations

Parallel Projections



3D Viewing Transformations

Projection Viewport

- Defines a rectangular volume in NPC space into which the view volume is mapped
- Distortion occurs when the view volume and the projection viewport are not the same shape
- In perspective projection, since the view volume is a truncated pyramid, when it is mapped to a rectangular NPC viewport, the pointed end of the pyramid will be expanded relative to the base....causing objects nearer to appear larger! (this is the perspective transformation!)

References

[1] K. S. Fant, CG-Course Slide, Portland State University.

[2] Foley, Van Dam, Feiner, Hughes, Computer Graphics - Principles and Practices 2nd Ed. In C (Chapter 6), Addison Wesley, 1997.