Advanced Viewing: PHIGS

- Two coordinate systems
  - World reference coordinate system (WRC)
  - Viewing reference coordinate system (VRC)

Arbitrary view reference point

- Specify viewplane, view coords (WRC)
  - View Reference Point (VRP)
  - View Plane Normal (VPN)
  - View Up Vector (VUV)

- Specify window on the view plane (VRC)
  - Max and min u,v values (window center (CW))
  - Projection Reference Point (PRP)
    - Ignore VPD from book...
Specifying a view

Normalizing Transformation for Perspective Views

1. Translate VRP to origin
2. Rotate the VRC system so that VPN become z-axis, u become x-axis and v become y-axis
3. Translate so that the CoP given by the PRP is at origin
4. Shear such that the center line of the view volume becomes the z-axis
5. Scale so that the view volume becomes the canonical view volume
1. Translate VRP to origin

\[
\begin{pmatrix}
1 & 0 & 0 & -VRP_x \\
0 & 1 & 0 & -VRP_y \\
0 & 0 & 1 & -VRP_z \\
0 & 0 & 0 & 1
\end{pmatrix} = T(-VRP)
\]

2. Rotate VRC

We want to take 
- u into (1, 0, 0)
- v into (0, 1, 0)
- n into (0, 0, 1)

First derive n, u, and v from user input:
2. Rotate VRC (cont.)

\[
\begin{pmatrix}
    u_x & u_y & u_z & 0 \\
    v_x & v_y & v_z & 0 \\
    n_x & n_y & n_z & 0 \\
    0 & 0 & 0 & 1
\end{pmatrix} = R_{VRC}
\]

3. Translate PRP to the origin

\[
\begin{pmatrix}
    1 & 0 & 0 & -PRP_u \\
    0 & 1 & 0 & -PRP_v \\
    0 & 0 & 1 & -PRP_n \\
    0 & 0 & 0 & 1
\end{pmatrix} = T(-PRP)
\]
4. Shear such that the center line of the view volume becomes the z-axis

Direction of projection (DoP) = CW - PRP
The center line of the view volume is DoP

Shear (cont.)

Multiply DoP with a matrix to get (0,0,DoP_z)

We want \( SH^*DoP = (0,0,DoP_z) \)

\[ \begin{pmatrix} 1 & 0 & SHx & 0 \\ 0 & 1 & SHy & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix} \]

\( SHx = \)
\( SHy = \)
5. Scale

5. Scale (cont.)

Scale is done in two steps:

1. First scale in x and y
   
   \[ \text{xscale} = 2 \frac{\text{PRP}_n}{(\text{umax} - \text{umin})} \]
   \[ \text{yscale} = 2 \frac{\text{PRP}_n}{(\text{vmax} - \text{vmin})} \]

2. Scale everything uniformly such that the back clipping plane becomes \( z = -1 \)
   
   \[ \text{xscale} = 1 / (-\text{PRP}_n + B) \]
   \[ \text{yscale} = 1 / (-\text{PRP}_n + B) \]
   \[ \text{zscale} = 1 / (-\text{PRP}_n + B) \]
Total Composite Transformation

\[ \mathbf{N}_{\text{per}} = \mathbf{S}_{\text{per}} \mathbf{SH}_{\text{per}} \mathbf{T}(-\mathbf{PRP}) \mathbf{R} \mathbf{T}(-\mathbf{VRP}) \]

Use this to transform from the viewing to the world space, then project onto the viewplane.