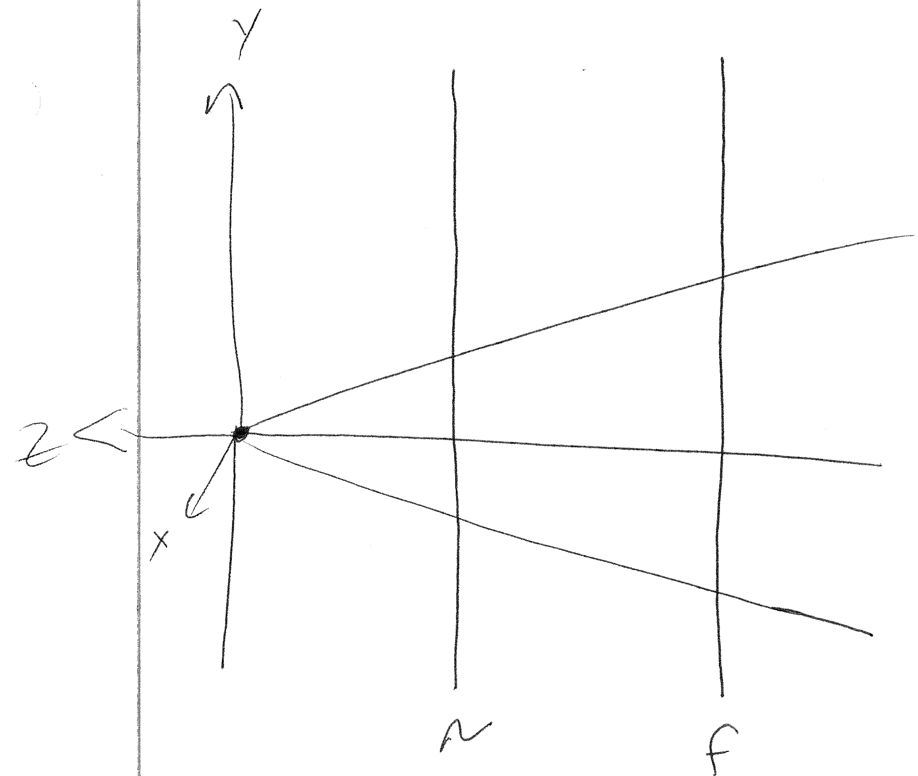
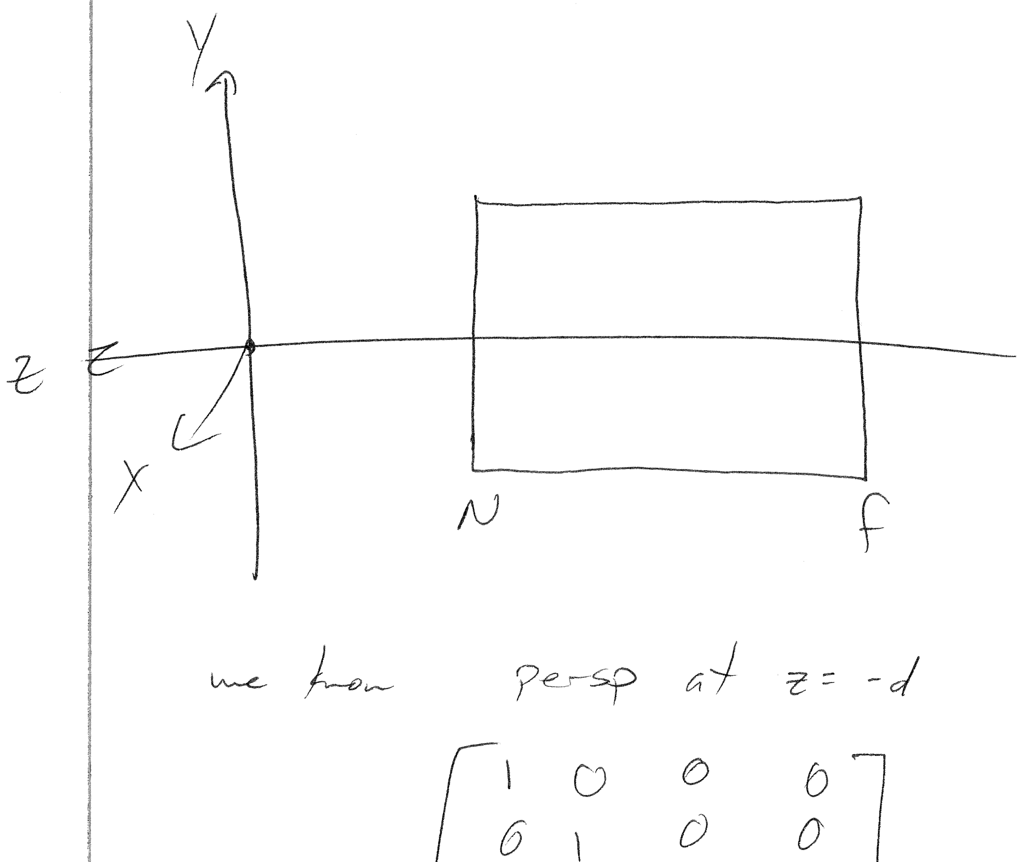




we know persp at $z = -d$

$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & \frac{1}{-d} & 0 \end{bmatrix}$$

but plane is near plane: $-d = n$ so:

$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & \frac{1}{n} & 0 \end{bmatrix}$$ check on Board

we want to have points on the near plane be on the near plane & points on the far plane, be on the far plane

so:

$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & \frac{n+f}{n} & -f \\ 0 & 0 & \frac{1}{n} & 0 \end{bmatrix}$$

check on board

get rid of $\frac{1}{n}$

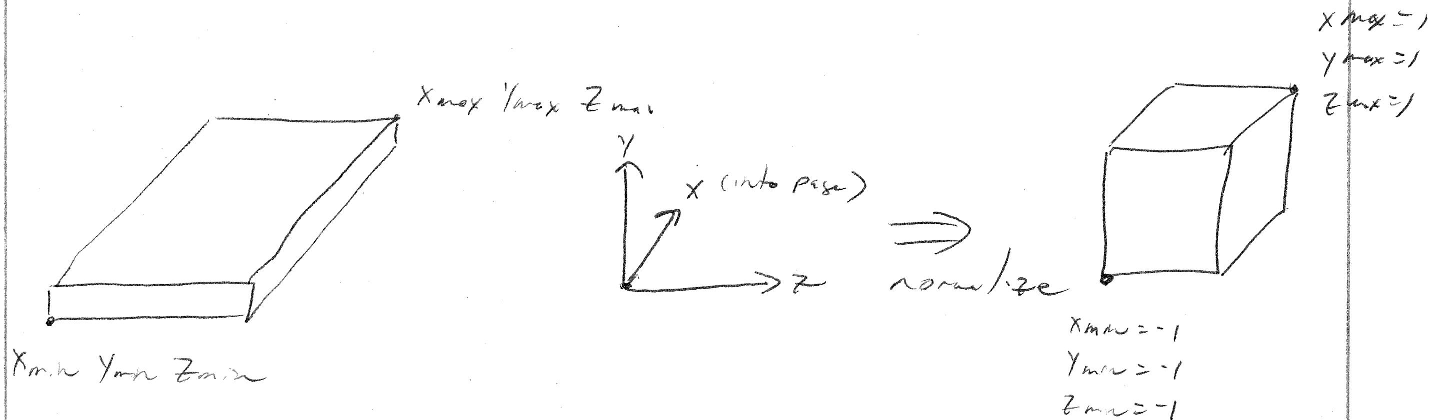
$$\begin{bmatrix} n & 0 & 0 & 0 \\ 0 & n & 0 & 0 \\ 0 & 0 & n+f & -fn \\ 0 & 0 & 1 & 0 \end{bmatrix} = n \cdot \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & \frac{n+f}{n} & -f \\ 0 & 0 & \frac{1}{n} & 0 \end{bmatrix} =$$

Cannonical View Volume

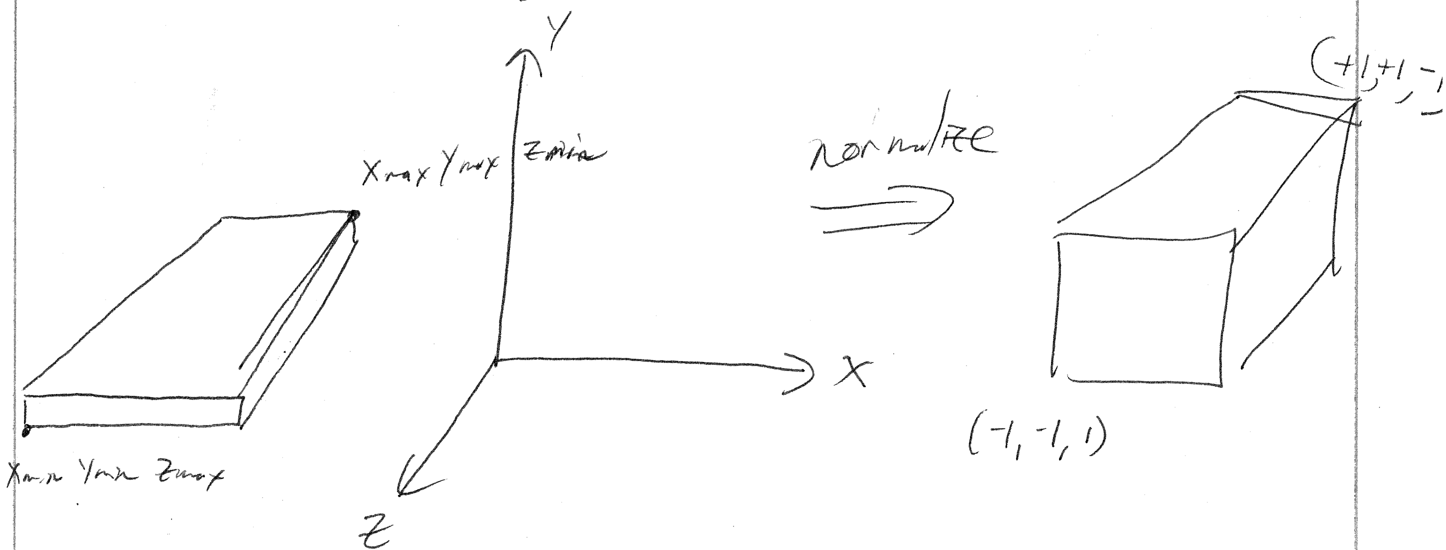
3D: $x = \pm 1$

$y = \pm 1$

$z = \pm 1$



looking down Z



How?

How?

1) translate to the origin

2) scale length 2 in each dim.

Scale $\qquad\qquad$ Trans

$$
\begin{bmatrix}
\frac{2}{X_{max}-X_{min}} & 0 & 0 & 0 \\
0 & \frac{2}{Y_{max}-Y_{min}} & 0 & 0 \\
0 & 0 & \frac{2}{Z_{max}-Z_{min}} & 0 \\
0 & 0 & 0 & 1
\end{bmatrix}
\begin{bmatrix}
1 & 0 & 0 & \frac{-(X_{max}+X_{min})}{2} \\
0 & 1 & 0 & \frac{-(Y_{max}+Y_{min})}{2} \\
0 & 0 & 1 & \frac{-(Z_{max}+Z_{min})}{2} \\
0 & 0 & 0 & 1
\end{bmatrix}
$$

what is X_{max} X_{min} (R L)
Y_{max} Y_{min} (T B)
Z_{max} Z_{min}? (N f)

so

$$
\begin{bmatrix}
\frac{2}{r-l} & 0 & 0 & 0 \\
0 & \frac{2}{T-B} & 0 & 0 \\
0 & 0 & \frac{2}{N-f} & 0 \\
0 & 0 & 0 & 1
\end{bmatrix}
\begin{bmatrix}
1 & 0 & 0 & -\frac{l+r}{2} \\
0 & 1 & 0 & -\frac{b+T}{2} \\
0 & 0 & 1 & -\frac{N+f}{2} \\
0 & 0 & 0 & 1
\end{bmatrix}
$$

$$
\begin{bmatrix}
\frac{2}{r-l} & 0 & 0 & \left(\frac{2}{r-L}\right)\left(\frac{L+r}{-2}\right) = -\frac{L+r}{r-L} \\
0 & \frac{2}{t-b} & 0 & \left(\frac{2}{T-B}\right)\left(\frac{B+T}{-2}\right) \quad \frac{B+T}{B-T} \\
0 & 0 & \frac{2}{N-f} & \left(\frac{2}{N-f}\right)\left(\frac{N+f}{-2}\right) \quad \frac{N+f}{f-N} \\
0 & 0 & 0 &
\end{bmatrix}
$$

Mpersp

Mscreen

$$\begin{bmatrix} \frac{Nx}{2} & 0 & 0 & \frac{Nx-1}{2} \\ 0 & \frac{Ny}{2} & 0 & \frac{Ny-1}{2} \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$
\begin{pmatrix} X \\ Y \\ f \\ \frac{f}{N} \end{pmatrix}
\quad
\begin{pmatrix} X \\ Y \\ N \\ 1\left(\frac{N}{N}\right) \end{pmatrix}
\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & \frac{1}{N} & 0 \end{bmatrix}
\begin{pmatrix} X \\ Y \\ N \\ 1 \end{pmatrix}
\quad
\begin{pmatrix} X \\ Y \\ f \\ 1 \end{pmatrix}
$$

$$
\begin{pmatrix} X \\ Y \\ f \\ \frac{f}{N} \end{pmatrix}
\longrightarrow
\begin{pmatrix} \frac{N}{f} X \\ \frac{N}{f} Y \\ \frac{N}{\cancel{f}} \cancel{f} \\ 1 \end{pmatrix}
$$

$$
\begin{pmatrix} X \\ Y \\ \frac{f(N+f)}{N} - f \\ \frac{f}{N} \end{pmatrix}
\quad
\begin{pmatrix} X \\ Y \\ \frac{N(N+f)}{N} - f \\ \frac{N}{N} \end{pmatrix}
\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & \frac{N+f}{N} & -f \\ 0 & 0 & \frac{1}{N} & 0 \end{bmatrix}
\begin{pmatrix} X \\ Y \\ N \\ 1 \end{pmatrix}
\quad
\begin{pmatrix} X \\ Y \\ f \\ 1 \end{pmatrix}
$$

$$
\begin{pmatrix} X \\ Y \\ \frac{f(N+f)}{N} - f \\ \frac{f}{N} \end{pmatrix}
\longrightarrow
\begin{pmatrix} \frac{NX}{f} \\ \frac{NY}{f} \\ \frac{N}{f} \cdot \left(\frac{f}{N}(N+f) - f\right) \\ \cancel{N} \end{pmatrix}
$$

$$
\frac{N}{f} \cdot \left(\frac{f}{N}(N+f) - f\right) = \frac{N}{f} \cdot \frac{f}{N} \cdot N+f - \frac{Nf}{f}
$$

$$
= N + f - N
$$

$$
= f
$$