(1) A - Viewport transformation matrix

it transforms window to viewport

$$M_{vp} = \begin{bmatrix} \frac{n_x}{2} & 0 & 0 & \frac{n_x - 1}{2} \\ 0 & \frac{n_y}{2} & 0 & \frac{n_y - 1}{2} \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

n_x = number pixels in x

n_y = number pixels in y

B - Orthogonal Projection matrix

changes projection to be orthogonal

$$M_{ort} = \begin{bmatrix} 2/r-l & 0 & 0 & -r+l/r-l \\ 0 & 2/t-b & 0 & -t+b/t-b \\ 0 & 0 & 2/n-f & -n+f/n-f \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

r = right b = bottom

l = left t = top

n = near

f = far

C - Perspective matrix

converts $P(X_v, Y_v, Z_v) \rightarrow P(X_s, Y_s)$

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

n = near

f = far

D - Camera transform Matrix

converts world to view coordinates

$$M_{cam} = \begin{bmatrix} r_{11} & r_{12} & r_{13} & t_x \\ r_{21} & r_{22} & r_{23} & t_y \\ r_{31} & r_{32} & r_{33} & t_z \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

r = rotations

t = translation

E - Modeling transform Matrix

tran. into world coordinates

$$M_m = \begin{bmatrix} Sr_{11} & r_{12} & r_{13} & t_x \\ r_{21} & Sr_{22} & r_{23} & t_y \\ r_{31} & r_{32} & Sr_{33} & t_z \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

r = rotations from model to world

t = translation from model to world

s = scaling from model to world