To build the sinvle transformation matrix we wil take the matrix product of individual transformation matrices. Based on the work back from earlier chapters, we know that a pixel point can be mapped into the viewport using and equation like.

Px = Wxmin + (x - xmin)(Vxmax - Vxmin)/(xmax - xmin)

Where Wmin refers to the minimum x pixel point in the Graphics Window Minimum, Vxmin and Vxmax refer to the minimum and maximum x pixel positions in the Viewport window, xmin and xmax are the domain of the function and x is the independent variable x in the domain.

In a similar manner,

Py = Wymin + (y - ymin)(Vymax - Vymin)/(ymax - ymin)

where ymin and ymax refer to the range of the function.

Using this defination, we can construct the transformation matrices.

```
In[2]:= T1 = {{1, 0, -xmin}, {0, 1, -ymin}, {0, 0, 1}}
Out[2]= {{1, 0, -xmin}, {0, 1, -ymin}, {0, 0, 1}}

In[3]:= {{1, 0, -xmin}, {0, 1, -ymin}, {0, 0, 1}}
Out[3]= {{1, 0, -xmin}, {0, 1, -ymin}, {0, 0, 1}}

In[4]:= S1 = {{(Vxmax - Vxmin) / (xmax - xmin), 0, 0},
          {0, (Vymax - Vymin) / (ymax - ymin), 0}, {0, 0, 1}}
```

Out[4]= $\left\{\left\{\frac{\text{Vxmax} - \text{Vxmin}}{\text{xmax} - \text{xmin}}, 0, 0\right\}, \left\{0, \frac{\text{Vymax} - \text{Vymin}}{\text{ymax} - \text{ymin}}, 0\right\}, \{0, 0, 1\}\right\}$

```
In[5]:= T2 = {{1, 0, Wxmin}, {0, 1, Wymin}, {0, 0, 1}}
Out[5]= {{1, 0, Wxmin}, {0, 1, Wymin}, {0, 0, 1}}

In[6]:= MatrixForm[T1]
```

Out[6]//MatrixForm=

$$\begin{pmatrix} 1 & 0 & -\text{xmin} \\ 0 & 1 & -\text{ymin} \\ 0 & 0 & 1 \end{pmatrix}$$

```
In[7]:= MatrixForm[S1]
```

Out[7]//MatrixForm=

$$\begin{pmatrix} \frac{\text{Vxmax}-\text{Vxmin}}{\text{xmax}-\text{xmin}} & 0 & 0 \\ 0 & \frac{\text{Vymax}-\text{Vymin}}{\text{ymax}-\text{ymin}} & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

In[8]:= `MatrixForm[T2]`

Out[8]//MatrixForm=

$$\begin{pmatrix} 1 & 0 & Wxmin \\ 0 & 1 & Wymin \\ 0 & 0 & 1 \end{pmatrix}$$

And now to build to matrix product of these...

In[9]:= `P = T2.(S1.T1)`

Out[9]= $$\left\{\left\{\frac{Vxmax - Vxmin}{xmax - xmin}, 0, Wxmin - \frac{(Vxmax - Vxmin)\ xmin}{xmax - xmin}\right\}, \left\{0, \frac{Vymax - Vymin}{ymax - ymin}, Wymin - \frac{(Vymax - Vymin)\ ymin}{ymax - ymin}\right\}, \{0, 0, 1\}\right\}$$

In[10]:= `MatrixForm[P]`

Out[10]//MatrixForm=

$$\begin{pmatrix} \frac{Vxmax-Vxmin}{xmax-xmin} & 0 & Wxmin - \frac{(Vxmax-Vxmin)\ xmin}{xmax-xmin} \\ 0 & \frac{Vymax-Vymin}{ymax-ymin} & Wymin - \frac{(Vymax-Vymin)\ ymin}{ymax-ymin} \\ 0 & 0 & 1 \end{pmatrix}$$

In[11]:= `Vec = {{x}, {y}, {1}}`

Out[11]= {{x}, {y}, {1}}

In[12]:= `MatrixForm[P.Vec]`

Out[12]//MatrixForm=

$$\begin{pmatrix} Wxmin + \frac{(Vxmax-Vxmin)\ x}{xmax-xmin} - \frac{(Vxmax-Vxmin)\ xmin}{xmax-xmin} \\ Wymin + \frac{(Vymax-Vymin)\ y}{ymax-ymin} - \frac{(Vymax-Vymin)\ ymin}{ymax-ymin} \\ 1 \end{pmatrix}$$

Comparing the last matrix with our initial equations, we see that the individual equations for the x and y pixel mapping agree with the initial equations.

In[13]:=
```
Wxmin = 0;
Wxmax = 700;
Wymin = 0;
Wymax = 700;
Vxmin = 100;
Vxmax = 600;
Vymin = 100;
Vymax = 600;
xmin = -70;
xmax = 50;
ymin = 20;
ymax = 125;
x = -25;
y = 100;
```

```
In[27]:= N[P.Vec]

Out[27]= {{187.5}, {380.952}, {1.}}
```