1. $r = P - E = \begin{pmatrix} 2 \\ 0 \\ -1 \end{pmatrix}$

$$P' = (r \cdot u)\, u + (r \cdot v)\, v + (r \cdot n)\, n$$

$$= \begin{pmatrix} 0 \\ 1 \\ -2 \end{pmatrix} \quad \text{in } (u, v, n) \text{ coordinate system}$$

2. Let Q be a point on the plane
say $Q \begin{pmatrix} 1 \\ 2 \\ 0 \end{pmatrix}$

$\dfrac{OQ \cdot n}{|n|}$ is the distance from the origin with n vector perpendicular to the plane

$$n = \begin{pmatrix} 3 \\ 1 \\ -2 \end{pmatrix} \qquad \frac{OQ \cdot n}{|n|} = \frac{5}{\sqrt{14}}$$

$$n' = \frac{1}{\sqrt{14}} \begin{pmatrix} 3 \\ 1 \\ -2 \end{pmatrix}$$

$$|n'| = 1$$

3. Distance between Q and the plane:

$OQ \bullet n - d$

d distance plane from origin

$$d_{Qplane} = \frac{\begin{pmatrix}3\\4\\2\end{pmatrix} \cdot \begin{pmatrix}3\\1\\-2\end{pmatrix}}{\sqrt{14}} - \frac{5}{\sqrt{14}}$$

$$d = \frac{5}{\sqrt{14}}$$

$$= \frac{4}{\sqrt{14}} = \frac{2\sqrt{2}}{\sqrt{7}}$$

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4. $R_S = S(1, 0.5)\, R = \begin{pmatrix}1 & 0\\0 & \frac{1}{2}\end{pmatrix}\begin{pmatrix}1\\2\end{pmatrix} = \begin{pmatrix}1\\1\end{pmatrix}$

$R_t = R_S + t(0,4) = \begin{pmatrix}1\\1\end{pmatrix} + \begin{pmatrix}0\\4\end{pmatrix} = \begin{pmatrix}1\\5\end{pmatrix}$

$R_{shear} = Shear(0,2) R_t = \begin{pmatrix}1 & 0\\2 & 1\end{pmatrix}\begin{pmatrix}1\\5\end{pmatrix} = \begin{pmatrix}1\\7\end{pmatrix}$

$R' = R_{Shear} = \begin{pmatrix}1\\7\end{pmatrix}$