Calculating the changes in errors that result from moving the COM from the bottom of the spindle housing to the inline with the spindle shaft.

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$$HTM(\delta,\theta) := \begin{pmatrix} \cos(\theta_1)\cdot\cos(\theta_2) & -\cos(\theta_1)\cdot\sin(\theta_2) & \sin(\theta_1) & \delta_0 \\ \sin(\theta_0)\cdot\sin(\theta_1)\cdot\cos(\theta_2)+\cos(\theta_0)\cdot\sin(\theta_2) & \cos(\theta_0)\cdot\cos(\theta_2)-\sin(\theta_0)\cdot\sin(\theta_1)\cdot\sin(\theta_2) & -\sin(\theta_0)\cdot\cos(\theta_1) & \delta_1 \\ -\cos(\theta_0)\cdot\sin(\theta_1)\cdot\cos(\theta_2)+\sin(\theta_0)\cdot\sin(\theta_2) & \sin(\theta_0)\cdot\cos(\theta_2)+\cos(\theta_0)\cdot\sin(\theta_1)\cdot\sin(\theta_2) & \cos(\theta_0)\cdot\cos(\theta_1) & \delta_2 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

$$Err := \begin{pmatrix} 0 \\ 0 \\ 0.001 \end{pmatrix} \quad noErr := \begin{pmatrix} 0 \\ 0 \\ 0 \end{pmatrix} \quad Points := \begin{pmatrix} 0 & 0 & 190.5 \\ 0 & 228.6 & 0 \\ 0 & 12.8 & 558.7 \end{pmatrix} \quad ref := Points^{\langle 1 \rangle} + Points^{\langle 2 \rangle}$$

$$htm_{ref} := HTM(ref, Err)$$

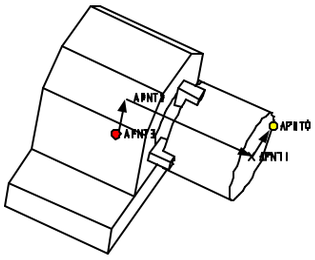

Figure 1: COM (red dot) at bottom of spindle housing.

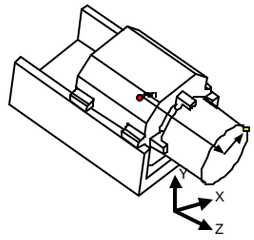

Figure 2: COM (red dot) inline with the spindle shaft.

Columb 1 on of the Points Matrix is the location of the COM at the bottom the housing. Columb 2 is the location of the COM inline with the spindle shaft (wrt columb 1), Columb 3 is the location of the work point (wrt columb 2).

Calculate the errors at the cutting point (yellow dot) if the errors are applied to a point at the bottom of the spinlde housing (red dot in Figure 1)

$$disp_{carriage} := HTM(Points^{\langle 0 \rangle}, Err)\cdot HTM(Points^{\langle 1 \rangle}, noErr)\cdot HTM(Points^{\langle 2 \rangle}, noErr)$$

$$error := disp_{carriage} - htm_{ref} \qquad x_{err} := error_{0,3} \qquad y_{err} := error_{1,3} \qquad z_{err} := error_{2,3}$$

$x_{err} = -0.229$ $y_{err} = 0.19$ $z_{err} = 0$

Calculate the errors at the cutting point (yellow dot) if the errors are applied to a point inline with the spinlde shaft (red dot in Figure 2)

$$disp_{spindle} := HTM(Points^{\langle 0 \rangle}, noErr)\cdot HTM(Points^{\langle 1 \rangle}, Err)\cdot HTM(Points^{\langle 2 \rangle}, noErr)$$

$$error := disp_{spindle} - htm_{ref} \qquad x_{err1} := error_{0,3} \qquad y_{err1} := error_{1,3} \qquad z_{err1} := error_{2,3}$$

$x_{err1} = -9.525 \times 10^{-5}$ $y_{err1} = 0.19$ $z_{err1} = 0$

$\frac{x_{err1}}{x_{err}} = 4.165 \times 10^{-4}$ $\frac{y_{err1}}{y_{err}} = 1.001$ $\frac{z_{err1}}{z_{err}} = 0$