

Finding the Center of Rotation on a 5-Axis Table-Table Milling Machine with a Trunnion Unit

(For Machines with Limited Tilting Axis Rotation in One Direction)

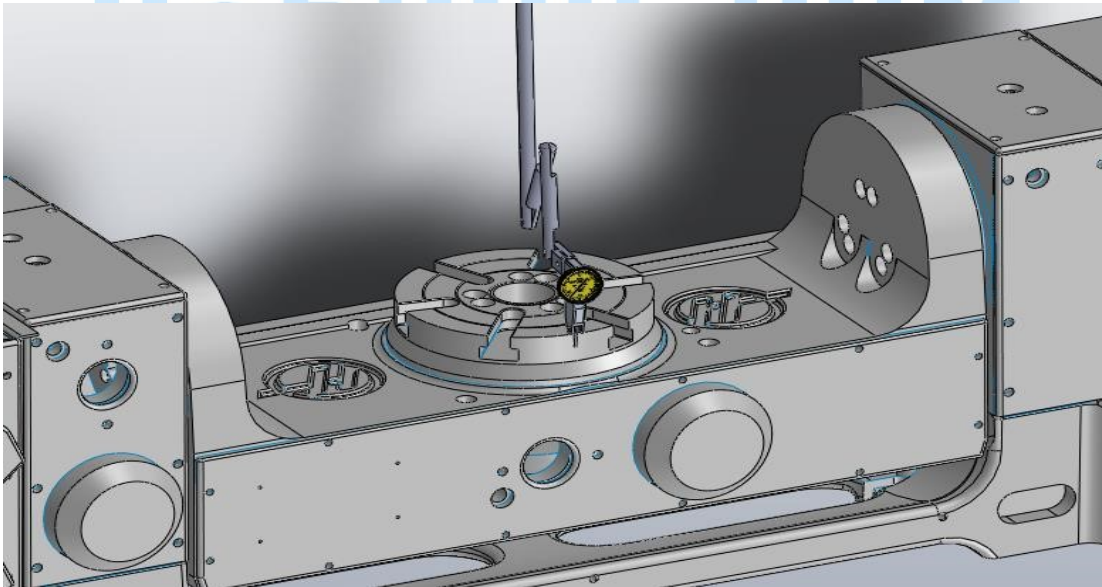


In the BobCAD-CAM system when using the multi-axis features your machine must be properly defined. The calculations that must be performed for proper G-Code creation depends on an accurate definition of your machine's kinematics. This document covers how to find the center of rotation for a 5-axis Table-Table machine with a trunnion unit so the machine parameters can be correctly defined.

There is a simple test you can use to find the necessary values and we will walk you through this process here in this document. This document is prepared for a machine with A and C axes, but the same logic applies to a machine with B and C axes. You just need to replace every X measurements with Y and vice versa. Please make sure to keep the sign of the reading at each step and carry those signs to next steps.

Step 1 - Locate the Y-Axis Position of the 1st Point (Y₁)

Make sure machine is in the configuration as shown below. Using an indicator locate the Y-axis location of the 1st point by sweeping an indicator around the OD of the rotary platter to center the machine spindle on the rotary axis.

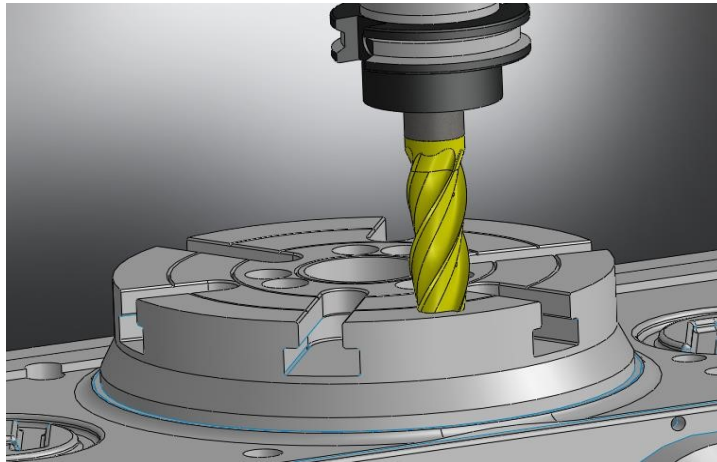


Note the Y-axis values for this location.

Y₁ = _____

Step 2 – Locate the Z-Axis Positions of the 1st Point (Z₁)

While the machine is in its previous configuration, use the indicator (or a tool) to locate the Z-axis location of the 1st point by touching off the surface of the rotary platter as shown in the image below.



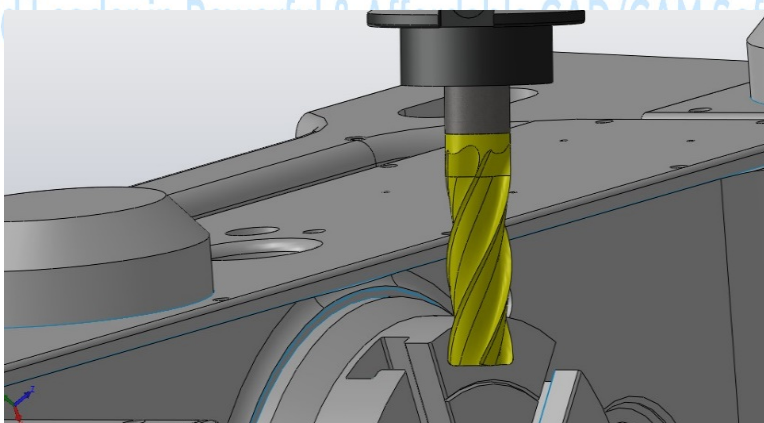
Note the Z axis position for this location.

Z₁ = _____

Step 3 – Locate the Y-Axis and Z-Axis Positions of the 2nd Point (Y₂ & Z₂)

To locate the Y-axis location of the 2nd point, you need to position the tilting in a vertical orientation as shown in the image below using the indicator. Below are the steps and reference image to complete this task.

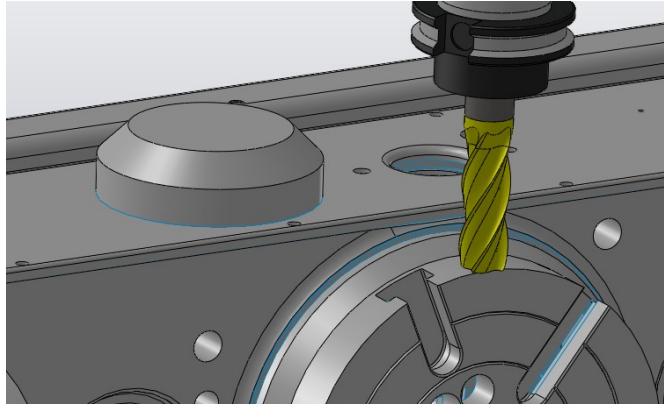
- a) Tilt the saddle assembly to a vertical orientation (+90 or -90 degree position)
- b) Using the indicator (or a tool) touch of the face of the rotary platter as shown in the image below to locate the Y-Axis (Y₂) location of the 2nd point



Note the Y-Axis position for this location.

Y₂ = _____ (Y-axis value at +90 or -90 Deg Tilt)

- c) Using the indicator (or a tool) touch of highest point on the outer diameter of the rotary platter as shown in the image below to locate the Z-Axis (Z_2) location of the 2nd point

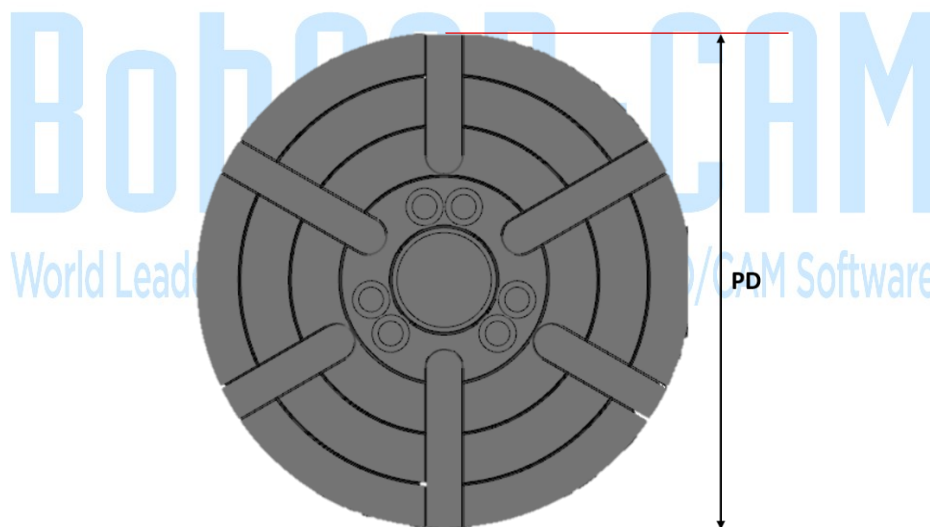


Note the Z-Axis position of this location.

$Z_2 =$ _____ (Z-axis value at +90 or -90 Deg Tilt)

Step 4 – Locate the Adjusted Z Position of the Second Point (Z_3)

The real Z-axis coordinate we are looking for is the Z position of the tilting axis. To find this position, we need to measure the outer diameter of the rotary platter as it is shown in the image below and then calculate the radius of the rotary platter.



$PD =$ _____ (This is the Platter's Diameter)

$R = (PD / 2) =$ _____ (This is the Platter's radius)

To find Z_3 we need to subtract the radius of the rotary platter from Z_2 .

$Z_3 = Z_2 - R =$ _____

Step 5 – Calculate the Incremental Coordinates of the Second Point (Y' & Z')

For this step, we will calculate the coordinates of the 2nd point relative to the first point and then assume the first point is located at (0, 0, 0). To do this, you need to subtract the values of the two points, so you end up with the difference from the 1st point to the 2nd (Y' and Z').

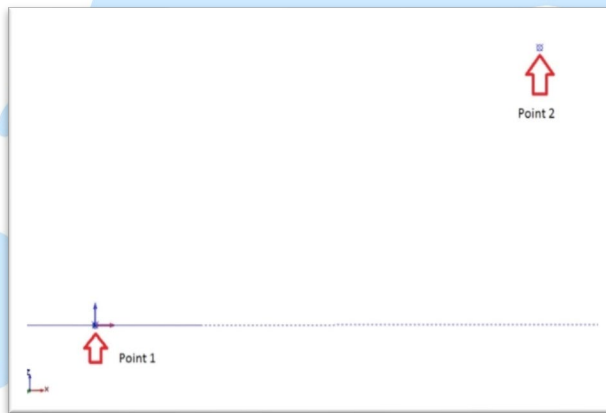
$$Y' = Y_1 - Y_2 = \underline{\hspace{2cm}}$$

$$Z' = Z_1 - Z_3 = \underline{\hspace{2cm}}$$

Step 6 – Locate the Y and Z Positions of the Intersection Point (Y_P & Z_P)

In this step, you need to use BobCAD-CAM (or any other CAD system) to find the location of the rotation center (Y_P and Z_P) for your tilt rotary unit. To do this, you will plot the two points on the screen and construct geometry to locate the center of rotation.

In BobCAD, you need to create the 1st point. Create a point at (X = 0, Y = 0, Z = 0) on the screen. Next create the 2nd point using the coordinates of Y_{2'} and Z_{2'}. These two points represent the 1st point and the 2nd point on your tilt rotary unit when the unit were in the two different orientations. The image below shows an example of what you should have on your screen looking from a SIDE view (YZ plane).



We need to create some reference geometry for the two different orientations. The objective here is to create geometry on the 2nd point that represents the same relative location as it is on the 1st point. The following steps will walk you through this process

- A. Point 1 in the TOP UCS – Create a line from the 1st point location up in Z that is 1.000” long.

Endpoint Data:

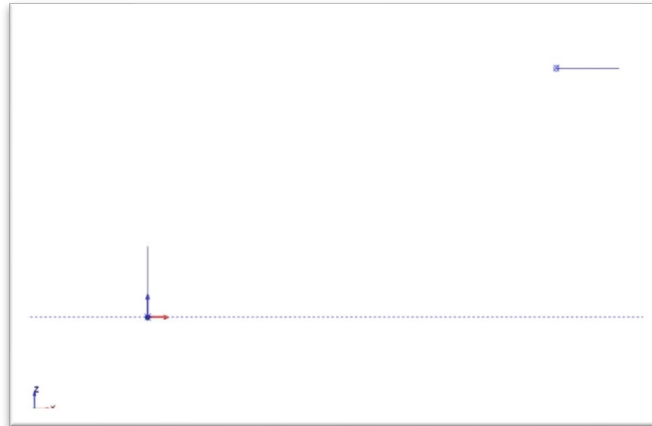
X0. Y0. Z0. (1st Point Location)

to X0. Y0. Z1.

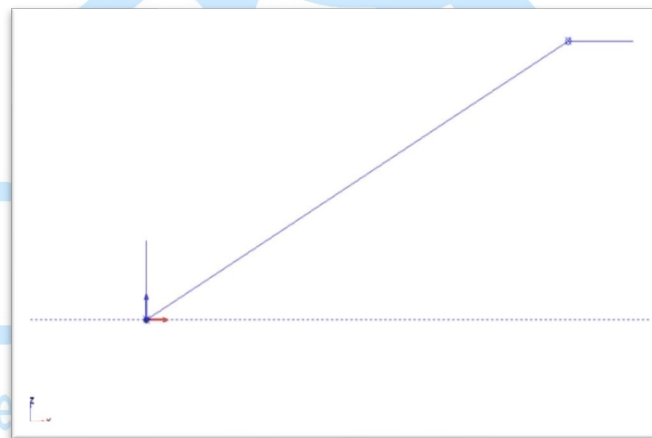
- B. Point 2 In the TOP UCS – Create a line from the 2nd point location over in Y that is 1.000” long.

Use the Create\Line\Angle option to create this line. Set the Angle to 0 and click the 2nd point as the start point.

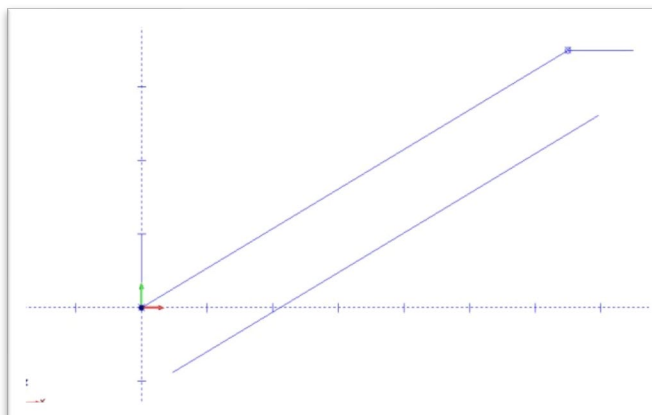
The result of creating this geometry should be two lines. Each line starts on one of the points and the other endpoint represents same point for the tilt rotary in the 2nd position. The following image shows the result of this step.



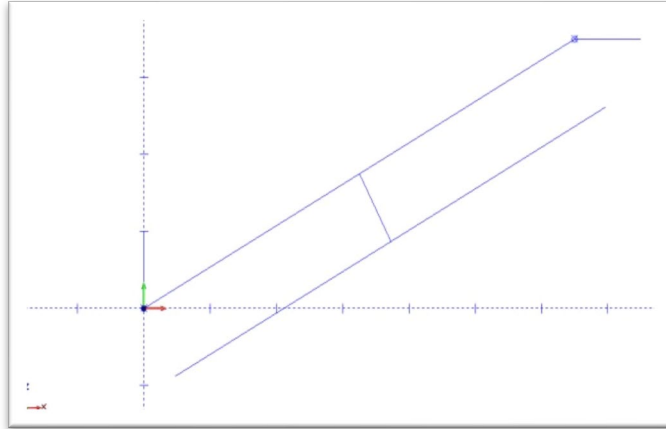
Now we connect the two ends of our reference geometry to each other by connecting the relating endpoints to each other. Use the Create\Line\Continuous command to do this. Next create a perpendicular line in the center of each of the two lines joining the reference geometry. Create reference line from point 1 to point 2 as it is shown in the figure below.



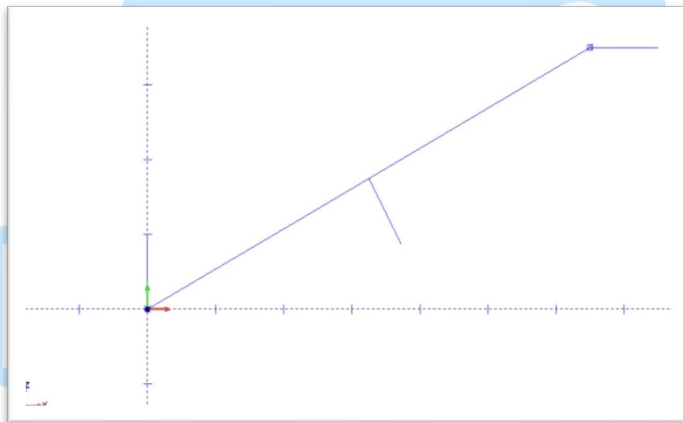
Now we create construction geometry used to construct a perpendicular line. Set the USC to SIDE. Next offset the join line by 1.000 down using the Create\Line\Parallel command. The following image shows the result of this step.



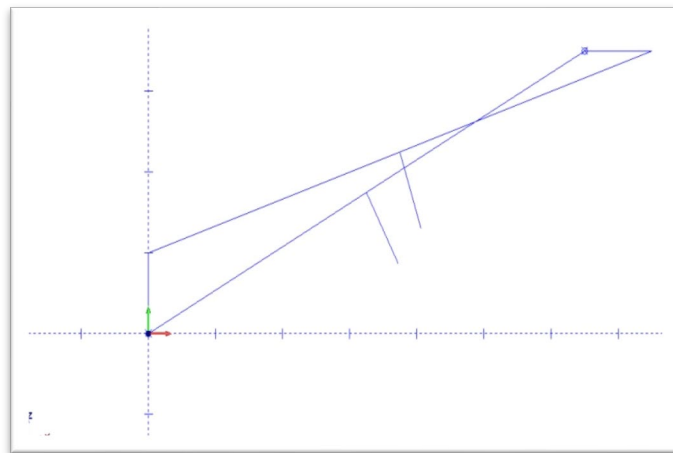
Next create a line from the mid-point of the 1st join line to the construction line just created. The following image shows the result of this step.



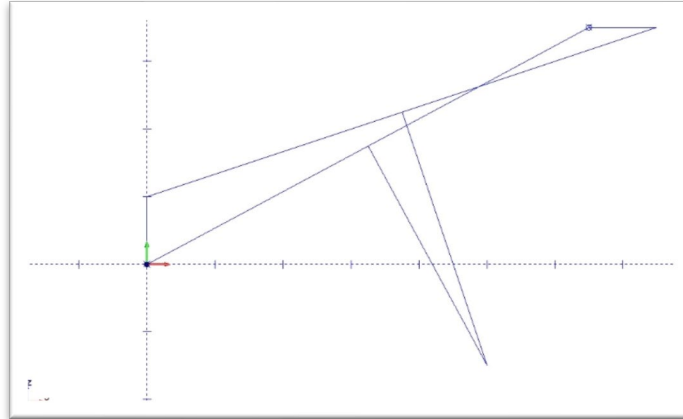
Now Delete the construction line as you no longer need it. The following image shows the result of this step.



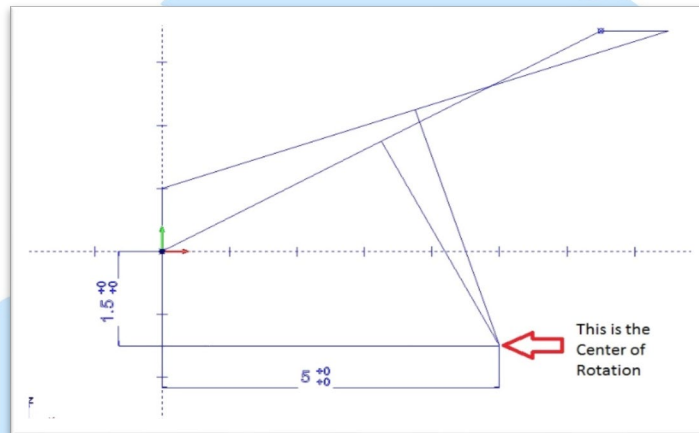
Now repeat the same steps to create the join line and perpendicular center line for the 2nd endpoints of our reference geometry. The following image shows the result of these steps.



Use the Trim Two option to trim the two perpendicular lines to each other. The intersection point of these two lines is the center of rotation. The following image shows the result of these steps.



Using the dimension commands, you can locate the location of the center of rotation relative to the 1st point.



This point represents the Y and Z coordinates of the center of rotation for the tilting axis.

Note these center point values (they are relative to 1st point)

Y_p = _____

Z_p = _____