Finding the Center of Rotation on a 5-Axis Head-Head Milling Machine

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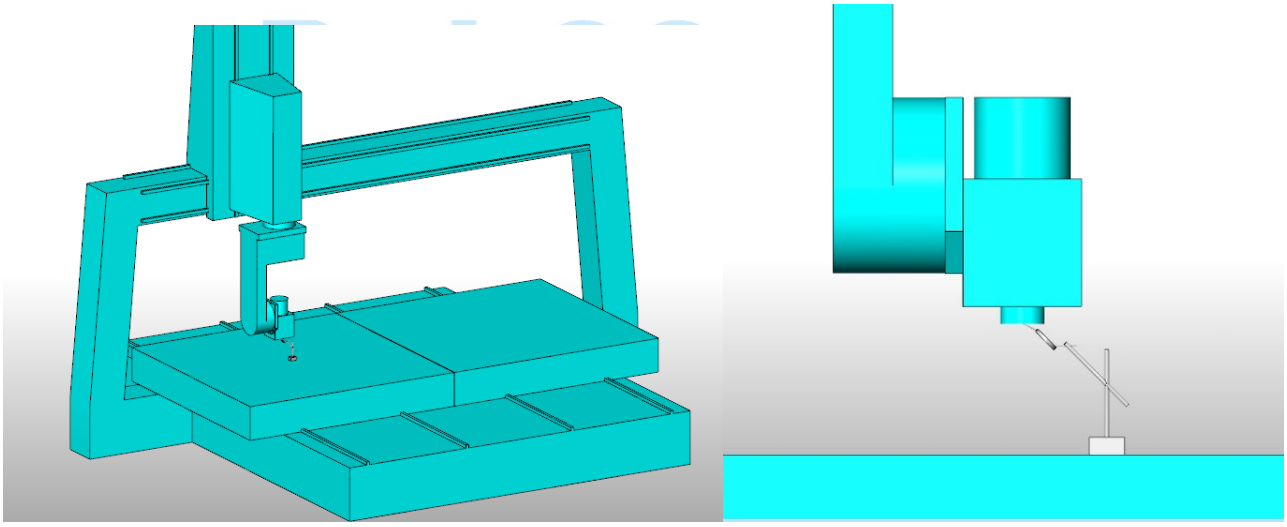
In the BobCAD-CAM system, the physical machine kinematics must be properly defined in the BobCAD machine definition file to create the working G-Code programs for the multi-axis features. The calculations that are performed for proper G-Code creation depend on the accurate definition of the machine's kinematics.

In this document, the first four steps walk you through to find the center of rotation (pivot length) value for a Head-Head 5-axis machine. Step 5 & Step 6 are for finding the Center of Rotation Offset value in the X & Y direction.

Step 1 – Locate the Z-axis position with the spindle vertical

As shown in the following image. Setup an indicator on your machine's table. Touch the end of the indicator with the face of the spindle, and then Zero the reading on the indicator.



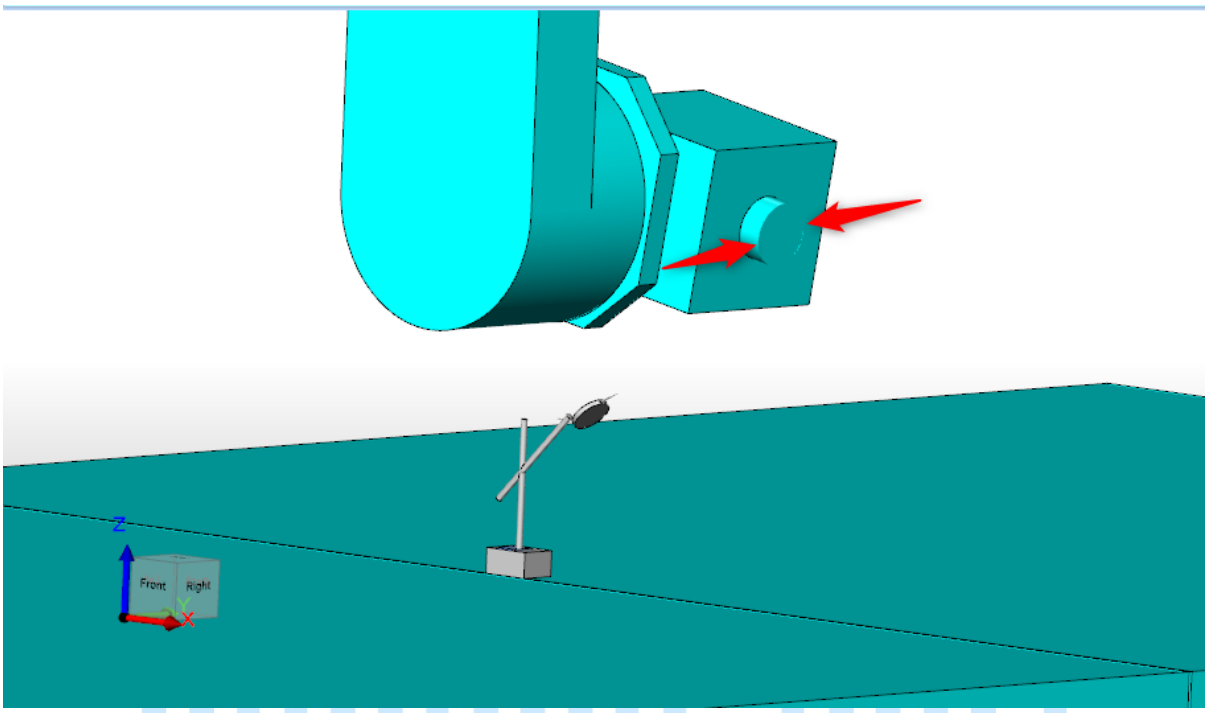
Note the Z-axis position read on the machine controller for this location.

Z_1 = _____

Important Note: Do not move the indicator set up as we need this exact position for later measurements.

Step 2 – Measure the Diameter of the Spindle Ring

The spindle ring is the round outer portion of the spindle that protrudes out of the spindle assembly. We need to know the accurate diameter of this as this value is used in the next step. The following image shows the spindle ring for this example machine.



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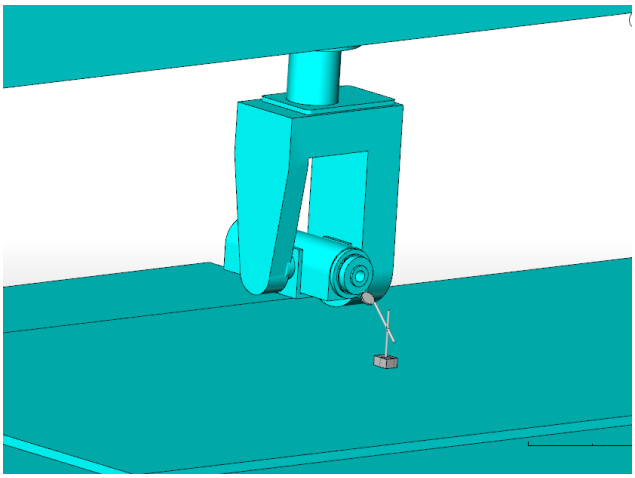
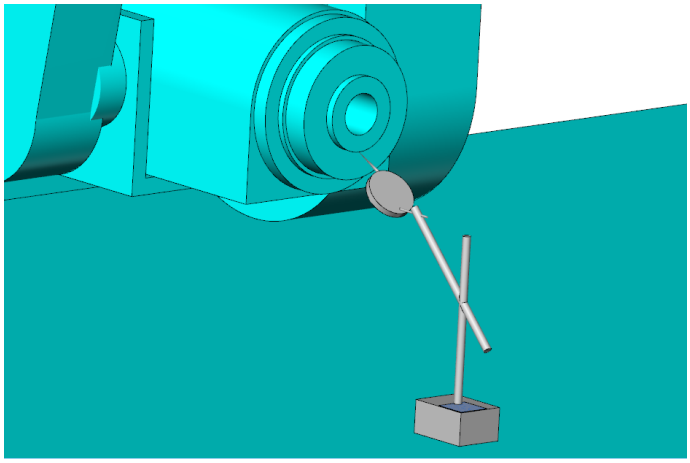
Spindle Diameter Measurement (SDM) = _____

Note: We will be using the Radius of the spindle in the next step

Step 3 – Read the Z-axis position with spindle rotated Up 90 Degrees

For the next reading, you need to rotate the spindle axis 90 degrees so that it is facing horizontally. Take a reading from the lowest portion of the outside diameter of the ground spindle ring. Once you have this value add the Radius of the spindle to get the final Z-axis reading.





The Z_2 value is the reading from the machine's control to the location shown and takes your indicator back to zero. The Z_3 value is the adjusted Z value to let us know where the center of the spindle axis is in this position. To get the Z_3 value just subtract the Spindle Radius found in the previous step to the Z_2 value from this step.

Z_2 = _____

$Z_3 = Z_2 – (SDM/2)$ = _____

Step 4 – Measure the Z-Component of the Center of Rotation (Z_P)

To calculate Z_P, you simply subtract Z_3 from Z_1. This tells us the difference in Z for the two points. Z_P value will be used in your machine setup to determine the center of rotation for your spindle axis.

$Z_P = Z_1 – Z_3$ = _____

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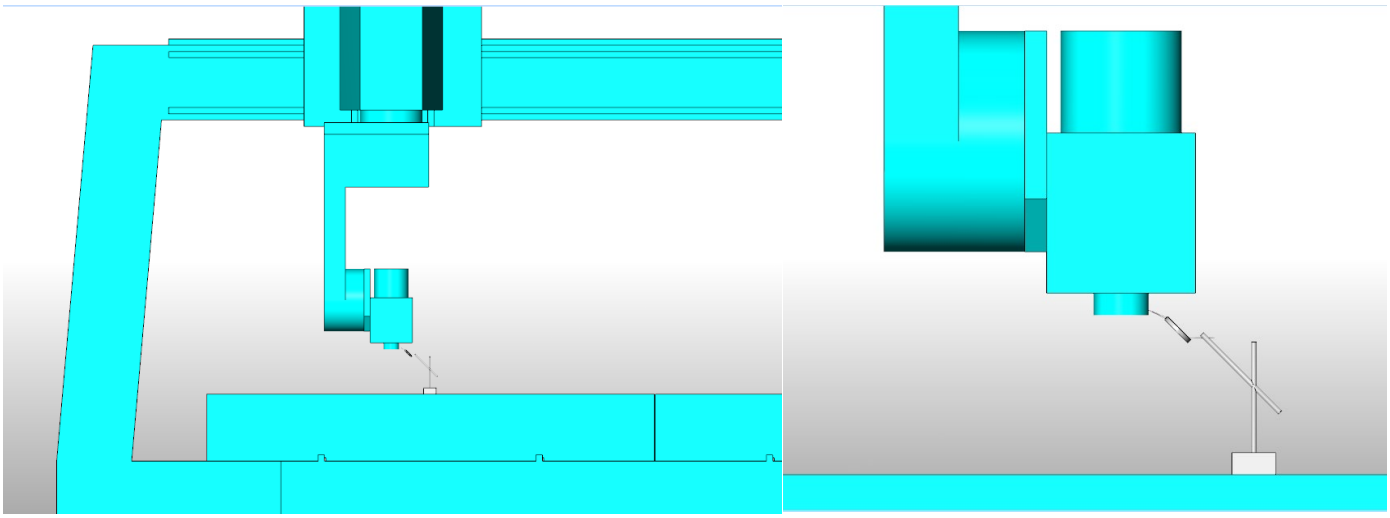
Step 5 – Measure the Center of Rotation point Offset in the X-axis.

In this step, we will be finding the offset between the machine Z-axis and the Center of the Rotation axis in the X-axis direction.

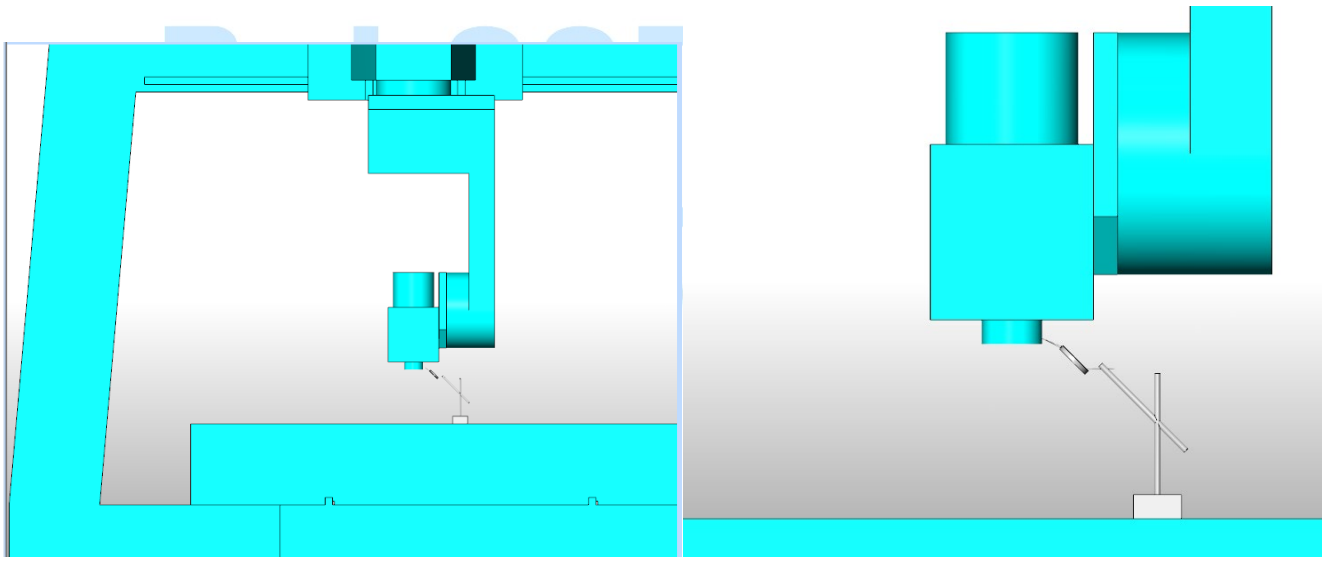
1. Jog the machine to a safe position and then set both rotary axes of the machine to 0 degrees.
2. Place a dial indicator on the machine table and jog the machine in X-direction until the outer face (lip) of the spindle touches the dial indicator tip as shown in the below pictures. Now, zero the reading on the dial indicator.



3. Note the X-axis value displayed on the controller screen.

   X_1 = _____

4. Now, rotate the machine C-axis to 180 degrees. After rotating C-axis, jog the machine only on X-axis until the outer face of the spindle touches the dial indicator and make sure to zero the reading on the dial indicator.



5. Note this X-axis value displayed on the machine controller screen.

   X_2 = _____

6. Finally, from the above two recorded X values, the offset distance between the machine Z-axis and the Center of the Rotation axis can be calculated.

Xp= $(X_2-X_1)/2$=_____

Step 6 – Measure the Center of Rotation point Offset in the Y-axis.

In this step, we will be finding the offset between the machine Z-axis and the Center of the Rotation axis in the Y-axis. The procedure is similar to the earlier step, except that instead of jogging the machine X-axis, we would be jogging the machine Y-axis.

1. Jog the machine to a safe position and then set both rotary axes of the machine to 0 degrees.
2. Place a dial indicator on the machine table and jog the machine in Y-direction until the outer face (lip) of the spindle touches the dial indicator tip. Now, zero the reading on the dial indicator.
3. Note the Y-axis value displayed on the controller screen.

   Y_1 = _____

4. Now, rotate the machine C-axis to 180 degrees. After rotating C-axis, jog the machine only on Y-axis until the outer face of the spindle touches the dial indicator and make sure to zero the reading on the dial indicator.
5. Note this Y-axis value displayed on the machine controller screen.

   Y_2 = _____

6. Finally, from the above two recorded Y values, the offset distance between the machine Z-axis and the Center of the Rotation axis can be calculated.

   Yp= $(Y_2-Y_1)/2$=_____

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