Finding the Center of Rotation on a 5-Axis Table-Table Machine with a 45-degree Nutating Table

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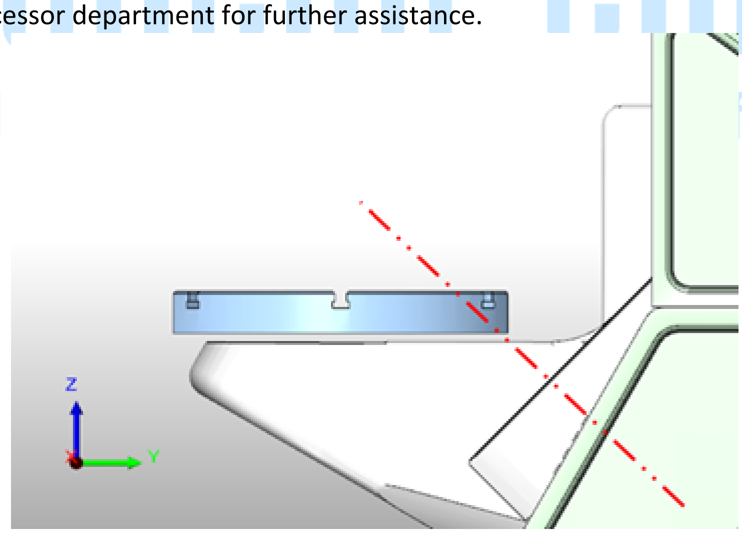
In the BobCAD-CAM system, when using the multi-axis features your machine must be properly defined. The calculations that must be performed for proper G-code creation depends on an accurate definition of your machine's kinematics. The location of the center of rotation on machines with nutating axis is usually measured by the machine tool manufacturer and available in machine's technical documents. However, the following is a simple step by step procedure that you can follow to find the center of rotation in case you don't have access to your machine's technical documents.

This document is prepared for a machine with 45-degree nutating axis located on one of the two main Cartesian planes (also known as plane of rotation for the nutating axis) : YZ or XZ. If the configuration of your machine doesn't quite match the above-mentioned criteria, contact the post-processor department and we will be more than happy to assist you with finding the center of rotation on your machine.

Finding the Vertical Component of the Center of Rotation

Step 1 – Find the Plane of Rotation (PoR)

On most 5-axis table-table machines with nutating axis, the PoR is either of the YZ plane or the XZ plane when both rotary angles are at zero degrees. The first step is to find the PoR as it is shown in the image below. If the nutating axis on your machine is not located on any of these two main planes, please contact the post-processor department for further assistance.



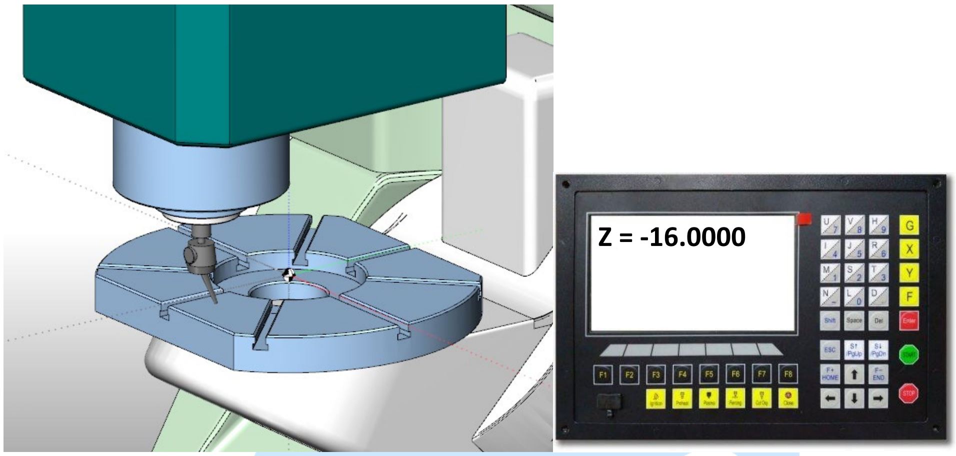
Example of a YZ plane of rotation

Note the plane of rotation and the vertical axis.

Plane of Rotation: ☐ YZ ☐ XZ

Step 2 – Measure the First Vertical Distance (Z_1)

As it is shown in the image below, load an indicator into the machine's spindle. Rotate the machine's table to the position where both rotary axes are at zero degrees. Lower down the spindle in the Z-axis direction until the indicator touches the surface of the platter/table . Zero the indicator's dial and read the Z-axis coordinate of this point from controller's screen.



Measuring Z_1 on a machine with nutating axis located on YZ plane

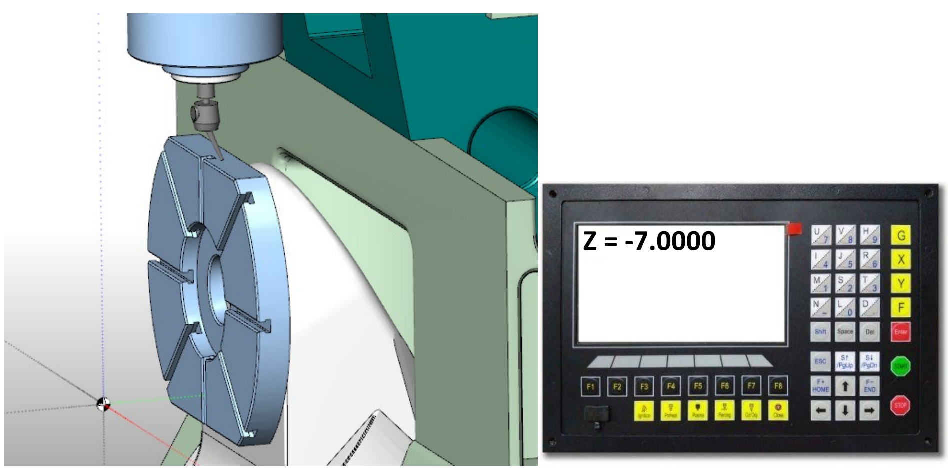
Note the value for this location.

Z_1 = ______________________________

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

Step 3 – Measure the Second Vertical Distance (Z_2)

Move up the spindle to clear the table rotation area. While the platter/table is still at zero degrees, rotate the tilting axis 180 degrees (see image below). Lower down the spindle in Z-axis direction until the indicator touches the outer diameter/surface of the platter/table and the reading on indicator is back to zero. Read the Z-axis coordinate of this point from controller's screen.



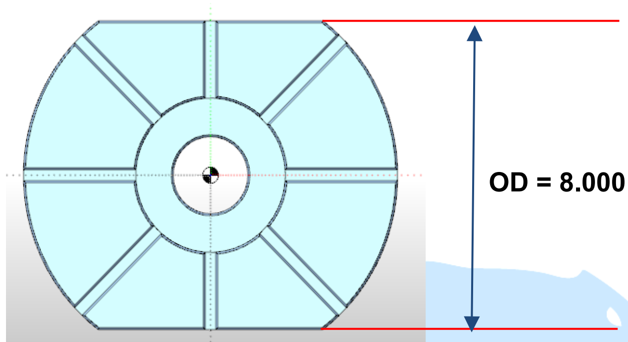
Measuring Z_2 on a machine with nutating axis located on YZ plane

Note the value for this location.

Z_2 = ______________________________

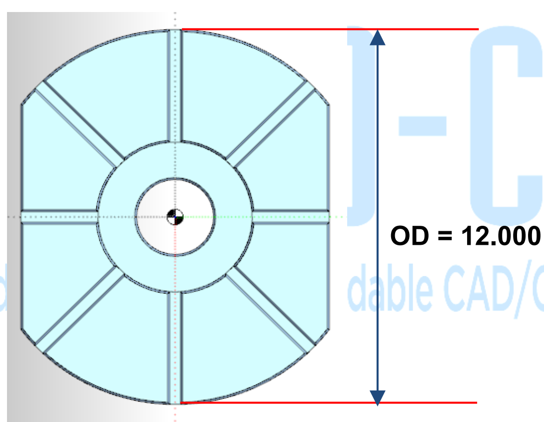
Step 4 – Measure the Outer Diameter of the Table/Platter (OD)

We use table's/platter's outer diameter (OD) to find the axis of rotation when the machine is at step 3 configuration (tilting axis is at 180 degrees). The OD is measured from the point that the indicator touched the OD in step 3.



Platter's OD when the indictor touches the flat side if the platter

So, if the indicator touches the round side of platter when the machine is at step 3 configuration, the OD is measured from the round side as it is shown in the figure below.



If your rotary platter doesn't have flat sides, measure the diameter from the highest point on OD's surface.

OD = ______________________________

Important Note: We will be using the radius instead of the diameter in the next steps

Step 5 – Calculate the Adjusted Vertical Distance (Z_3)

We need to subtract the radius of the table's OD measured in step 4 from the second vertical distance we measured in step 3 (Z_2) in order to calculate the adjusted vertical distance (Z_3).

$Z_3 = Z_2 - (OD/2)$ = ______________________________

Step 6 – Calculate the Vertical Component of the Center of Rotation (Z_p)

To calculate Z_p, simply subtract the Z_1 from the Z_3. This tells us the vertical difference between Z_1 and Z_3 which is in fact the Z-axis component of the center of rotation. The Z_p then will be entered in the machine definition file.

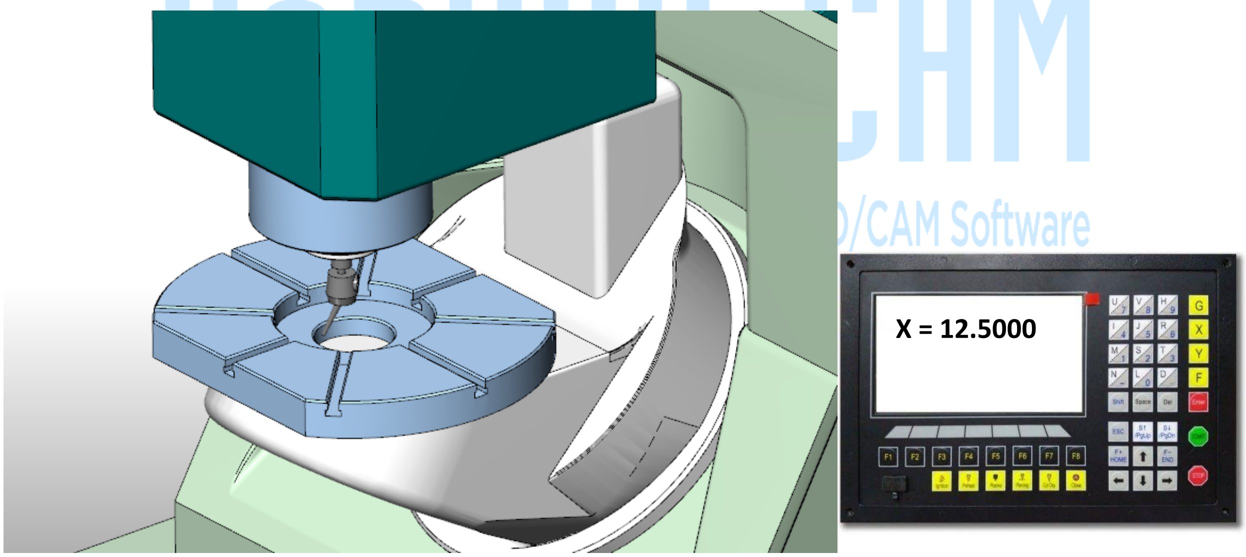
$Z_P = Z_3 - Z_1$ = ______________________________

Finding the Horizontal Component of the Center of Rotation

Depending on whether PoR is YZ plane or XZ plane, you need to measure either the X-axis component or the Y-axis component of the center of rotation. Here, we assume YZ is the PoR so we will show how you can measure the X-axis component (X_P) of the center of rotation. Please note the same logic applies when XZ is the PoR and you need to find the Y-axis component (Y_P) of the center of rotation.

Step 1 – Center the Machine Spindle and Measure the First Horizontal Distance (X_1 / Y_1)

While the indicator is still installed, jog both rotary axes to their zero-degree position. Sweep the indicator around either the outer diameter of the rotary platter (if the outer diameter of the platter is circular) or the inner diameter of platter's central cavity (if the outer diameter of the platter has flat surfaces) to center the machine spindle on the rotary axis. Read the X-axis coordinate (Y-axis coordinate if PoR is XZ) of this point from controller's screen.

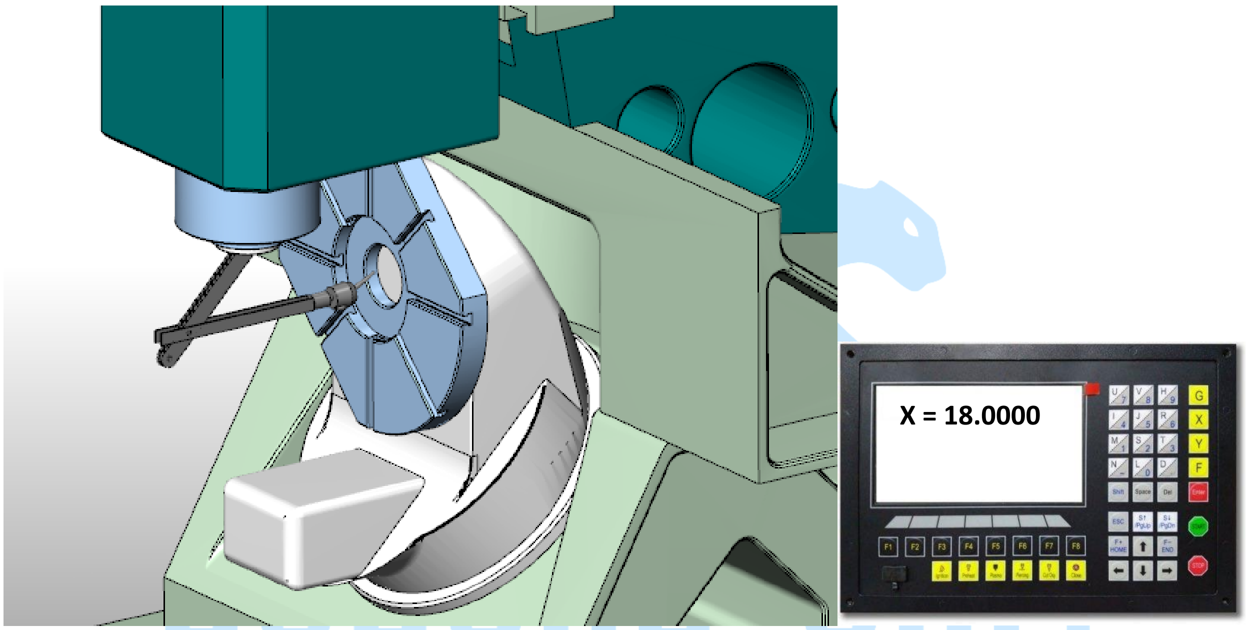


Note the value for this location with the axis identification letter (X or Y).

$_1$ = ______________________________

Step 2 – Center the Machine Spindle and Measure the Second Horizontal Distance (X_2 or Y_2)

Move up the spindle to clear the table rotation area. While the rotary platter is still at zero degrees, rotate the tilting axis 180 degrees (see image below). Move the spindle in Z-axis, Y-axis, and X-axis directions until the indicator touches either the outer diameter of the rotary platter (if the outer diameter of the platter is circular) or the inner diameter of platter's central cavity (if the outer diameter of the platter has flat surfaces). Make sure no collision happens during this process. Sweep the indicator (or rotate the rotary platter) to center the machine spindle on the rotary axis. Read the X-axis coordinate (Y-axis coordinate if PoR is XZ) of this point from controller's screen.



Note the value for this location with the axis identification letter (X or Y).

$_2$ = ______________________________

Step 3 – Calculate the Horizontal Component of the Center of Rotation (X_p / Y_P)

To calculate X_p (Y_p if XZ PoR), simply subtract the X_2 (Y_2 if PoR is XZ) from the X_1 (Y_1 if PoR is XZ) and then divide the result by two. This gives us the horizontal component of the center of rotation. The X_p (Y_p iif PoR is XZ) then will be entered in the machine definition file.

Note the axis identification letter (X or Y).

$_P$ = ($_1$ – $_2$) / 2 = ______________________________