# Penta 4-Axis Lab Guide

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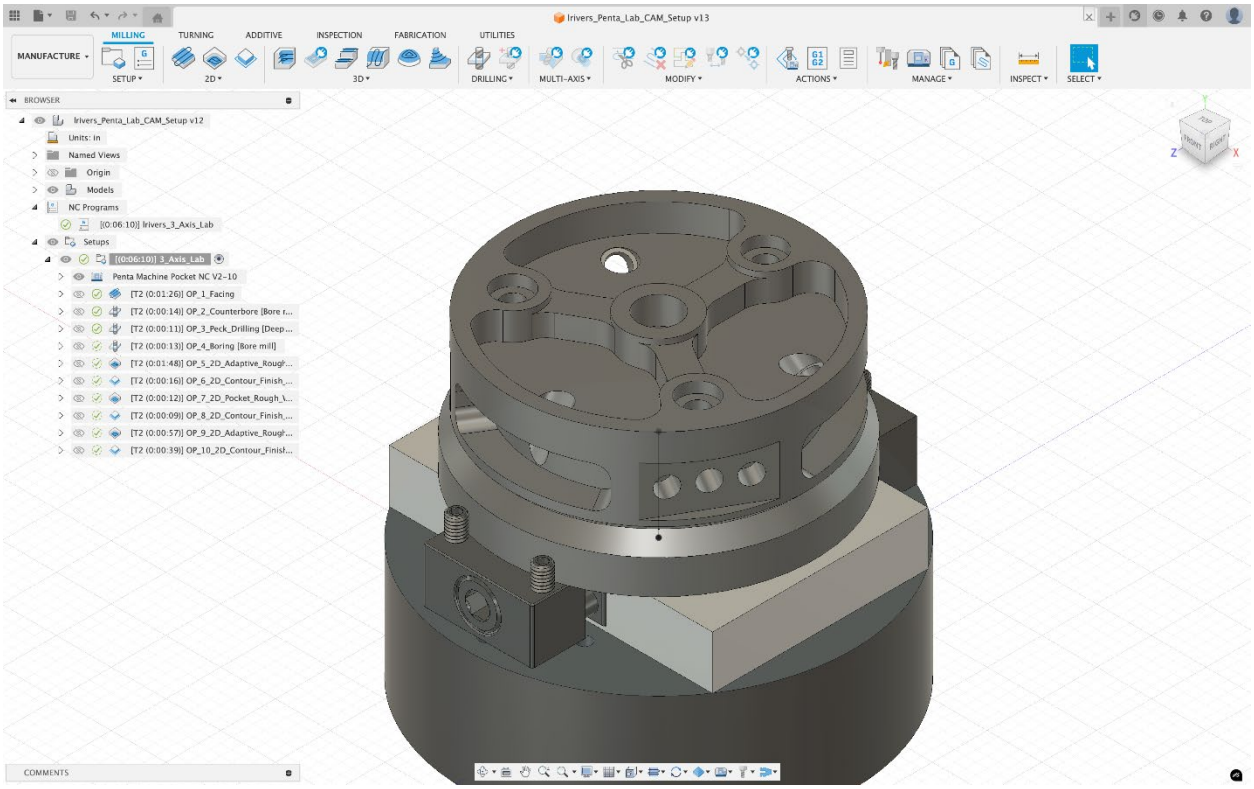
# Required Materials:

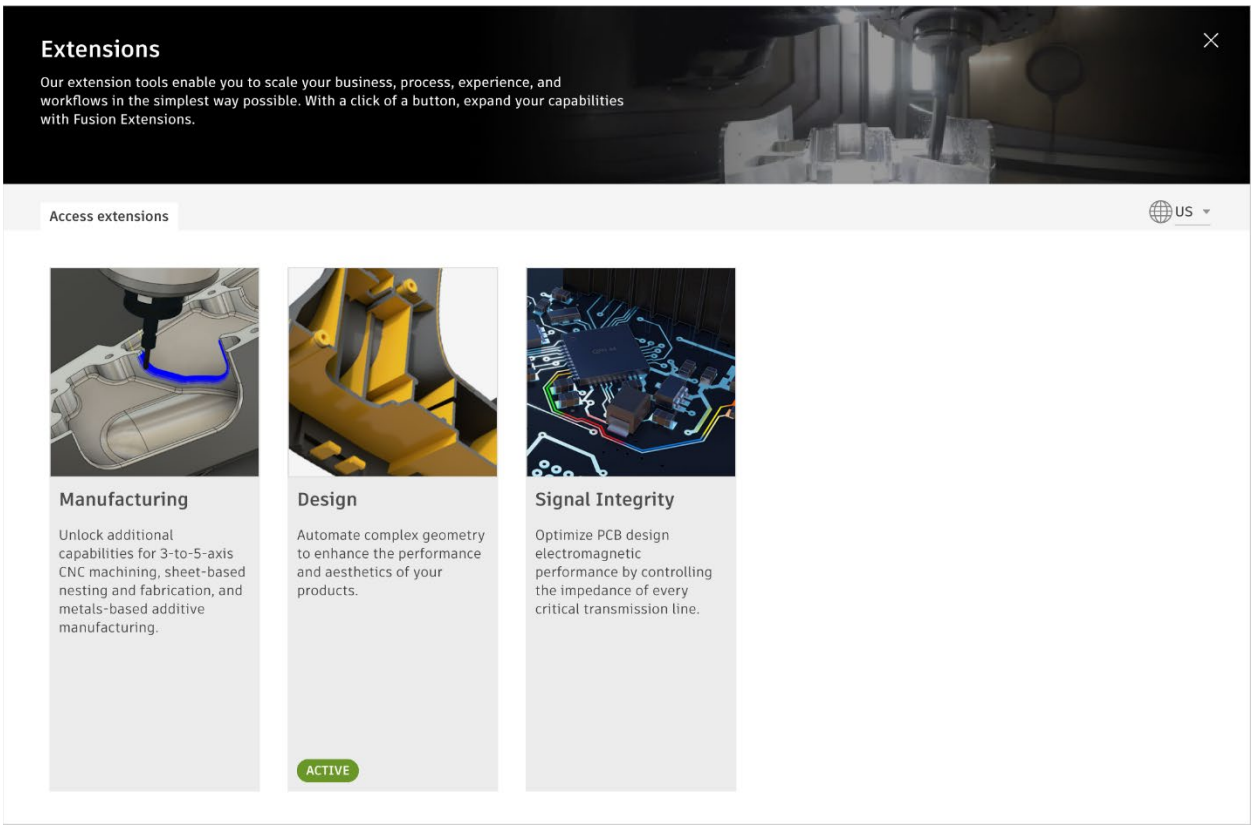
All the files created during the completion of the “Penta Lab Setup Guide” and the “Penta 3-Axis Lab Guide”

# Step 1: Add Extensions to Fusion

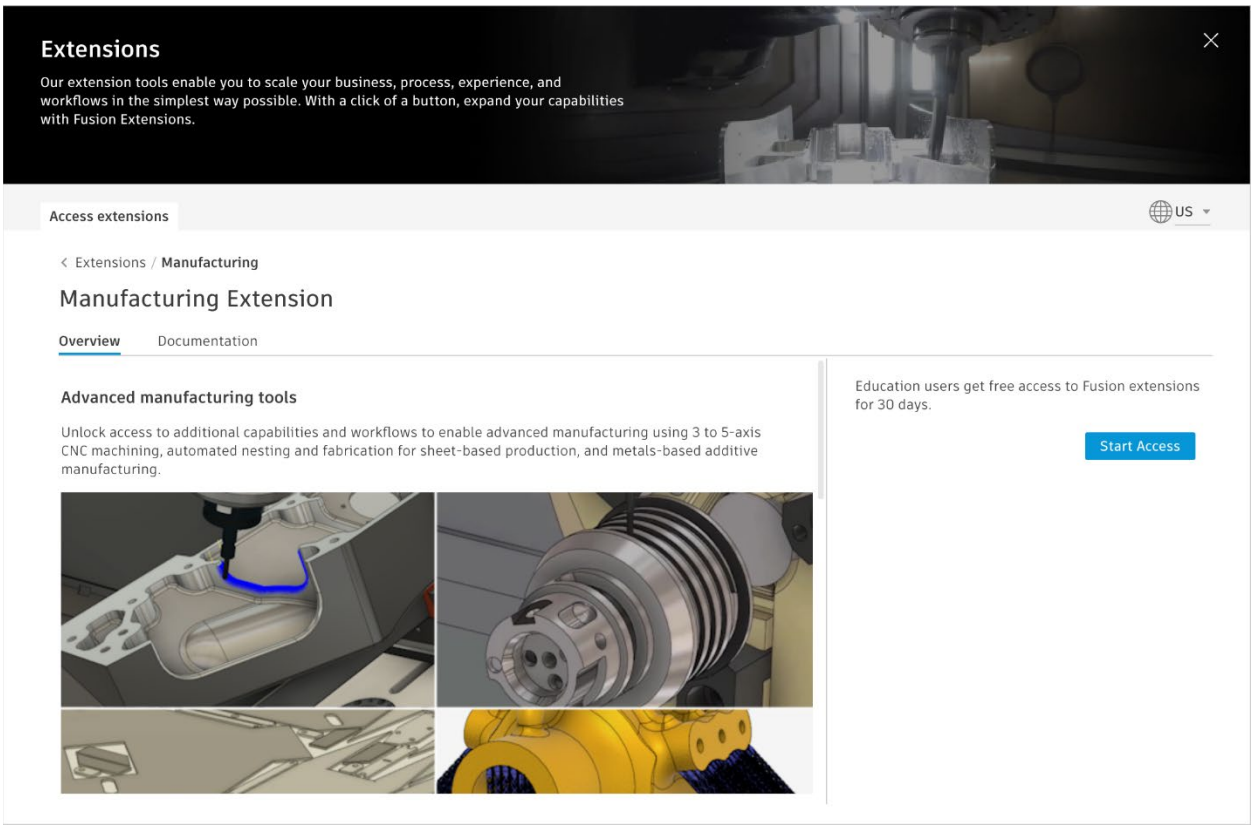



This lab requires the manufacturing extension since there are simultaneous 4-axis movements.

Click on the extensions icon at the top right of the screen.



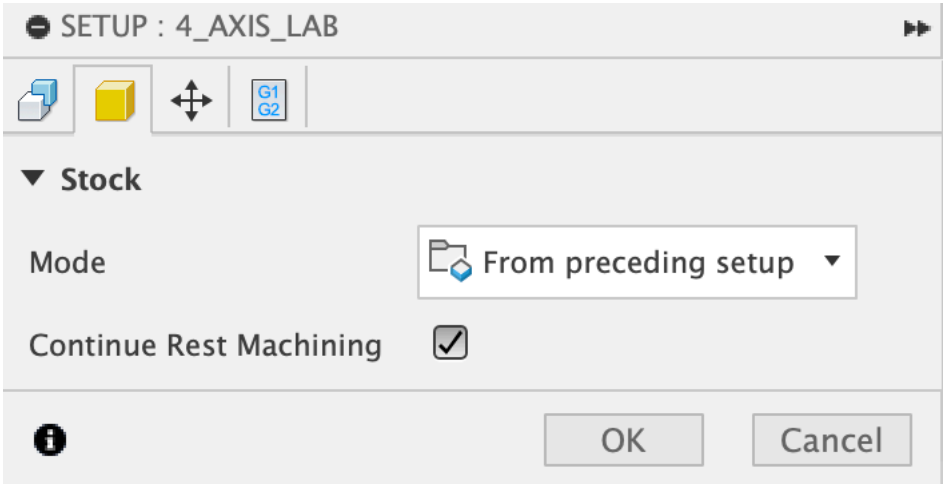

A window will appear with multiple different extension packages to choose from. Select the manufacturing extension.




Now click “Start Access”.

Note: This extension should be free for those with educational Autodesk accounts.

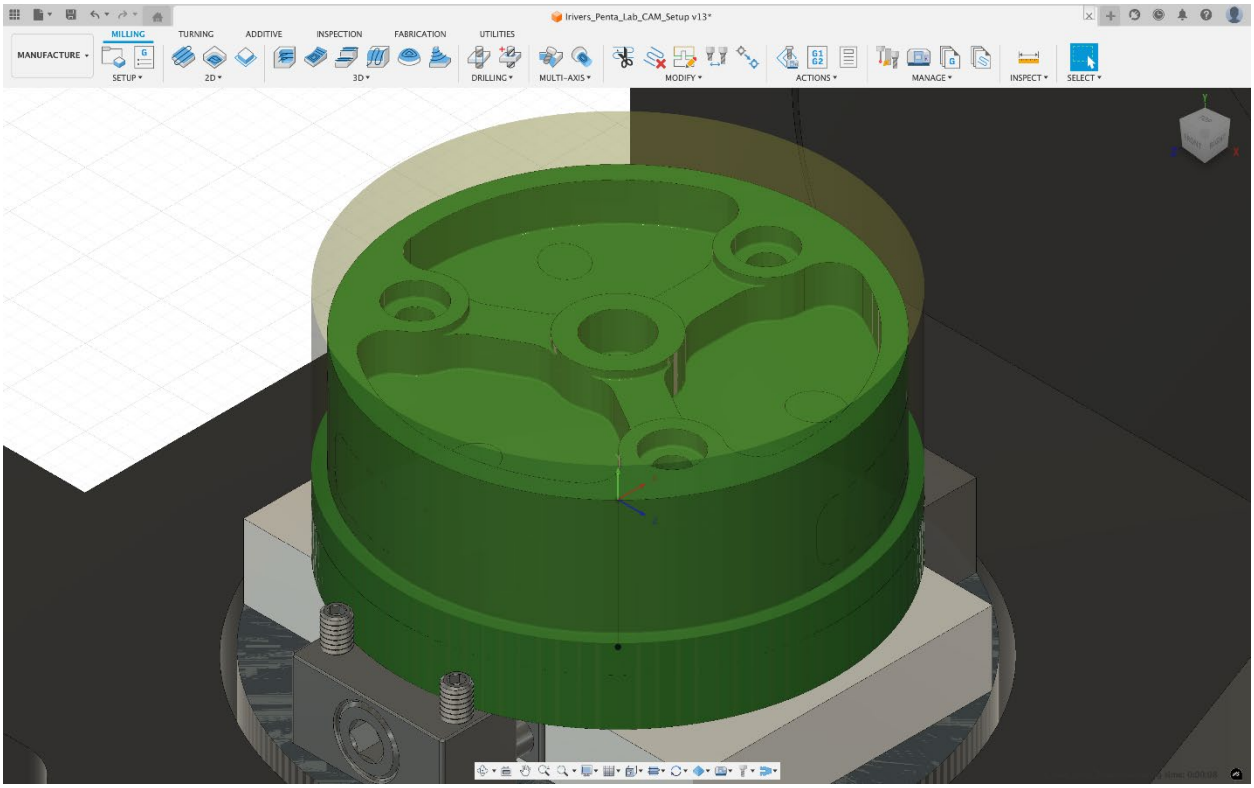
# Step 2: Create a New Setup




Create a new setup and name it appropriately for this lab. Except for the stock tab, the process is exactly the same as in the Lab Setup Guide.

We want the in-process stock from the 3-axis setup to carry over into this 4-axis setup. To do this, change the stock mode to “From preceding setup” and select “Continue Rest Machining”.

Finish creating the setup and click “OK”.




If the setup was done correctly, the stock for the 4-axis setup should look like this. Notice that all of the stock that was removed during the 3-axis lab is also gone in the new 4-axis setup.

# Step 3: Mill Flats

Create 2D pocket operation.

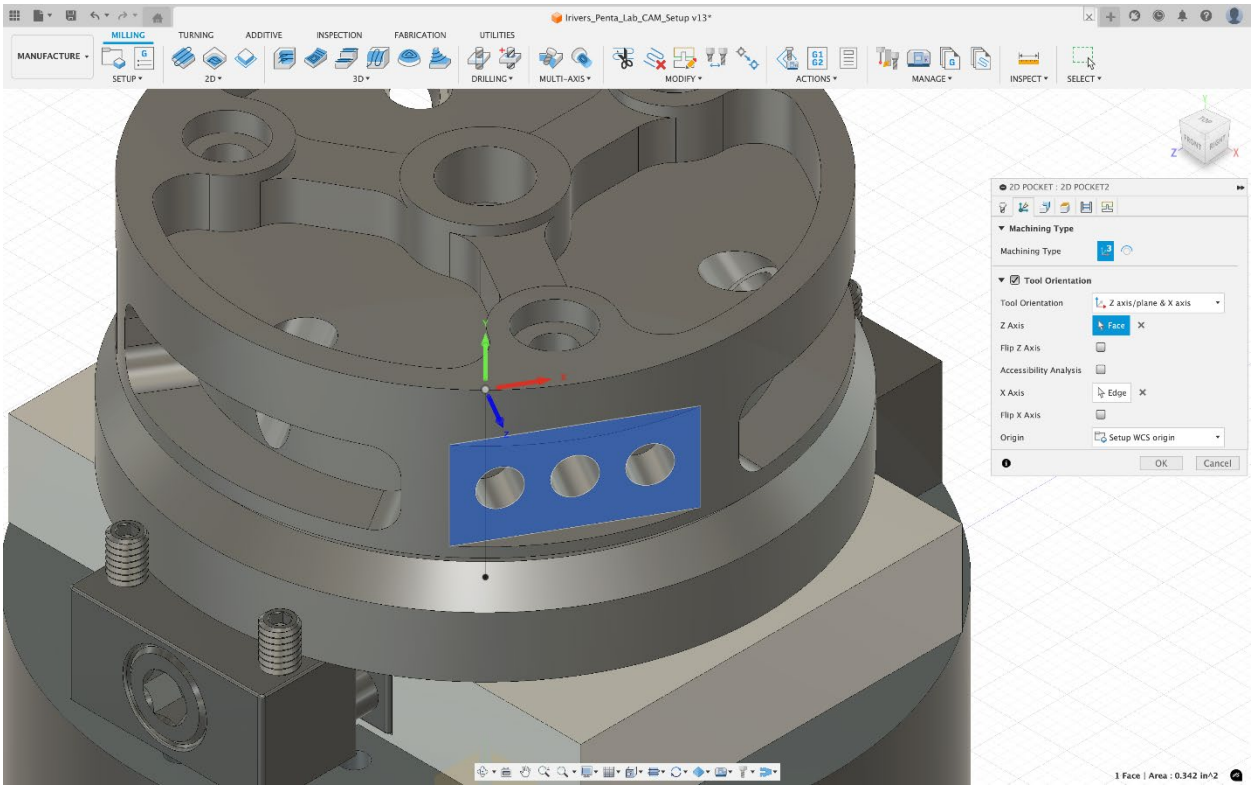
## 3.1: Tool Tab

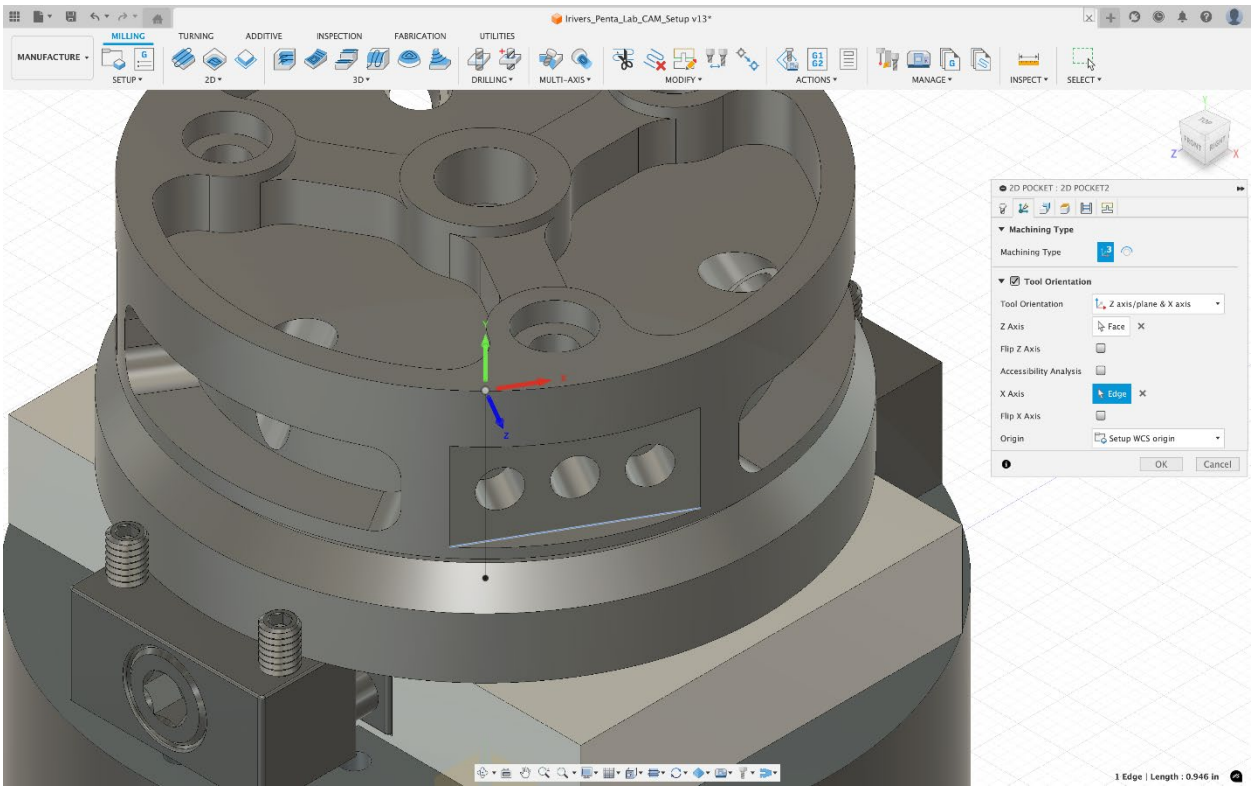
Use the same tool settings as the 3-axis lab.

- Tool #2
- Default feeds and speeds
- 0.005 inch shaft clearance
- 0.05 inch holder clearance

**Note: These tool settings will be used for all operations in this document unless stated otherwise.**

# 3.2: Multi-Axis Tab

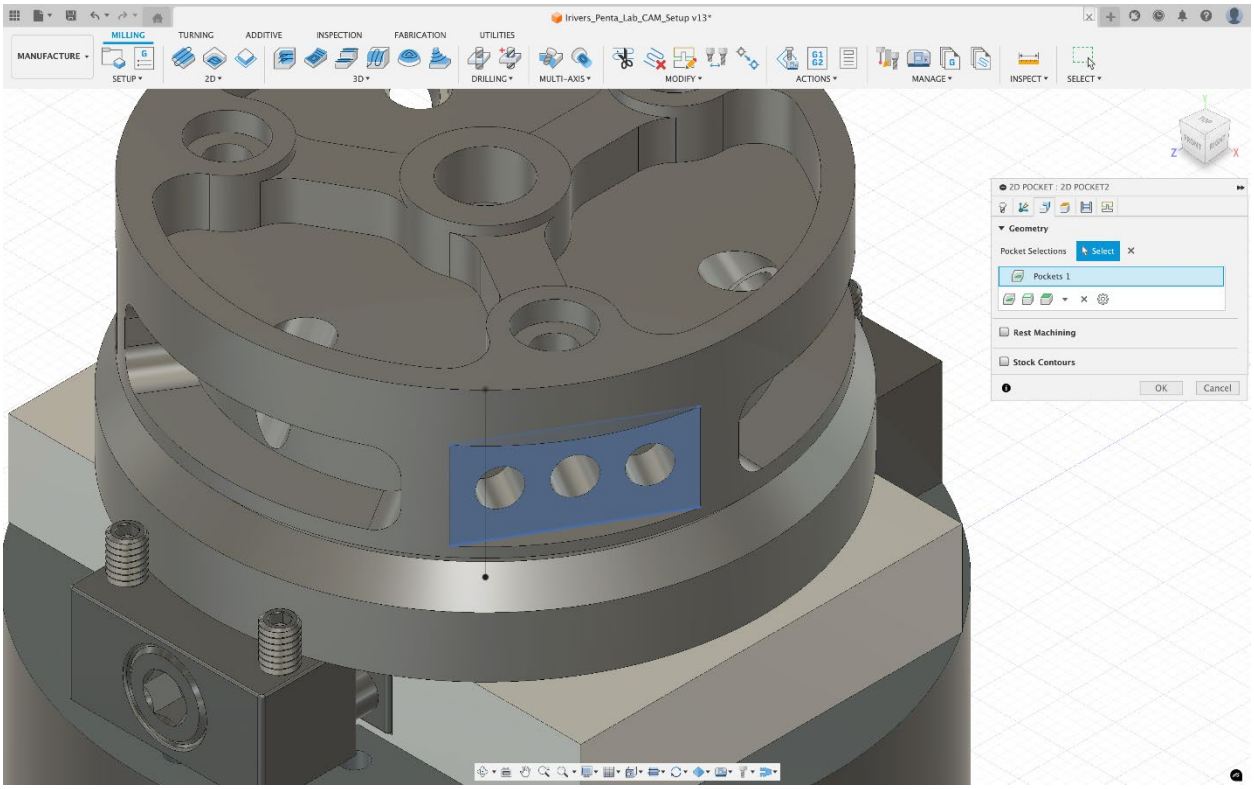


Make selections for the Z and X axes such that the tool will point directly at the flat that you are machining and the X-axis will point towards the back of the machine once the part has been rotated to align with the Z-axis.

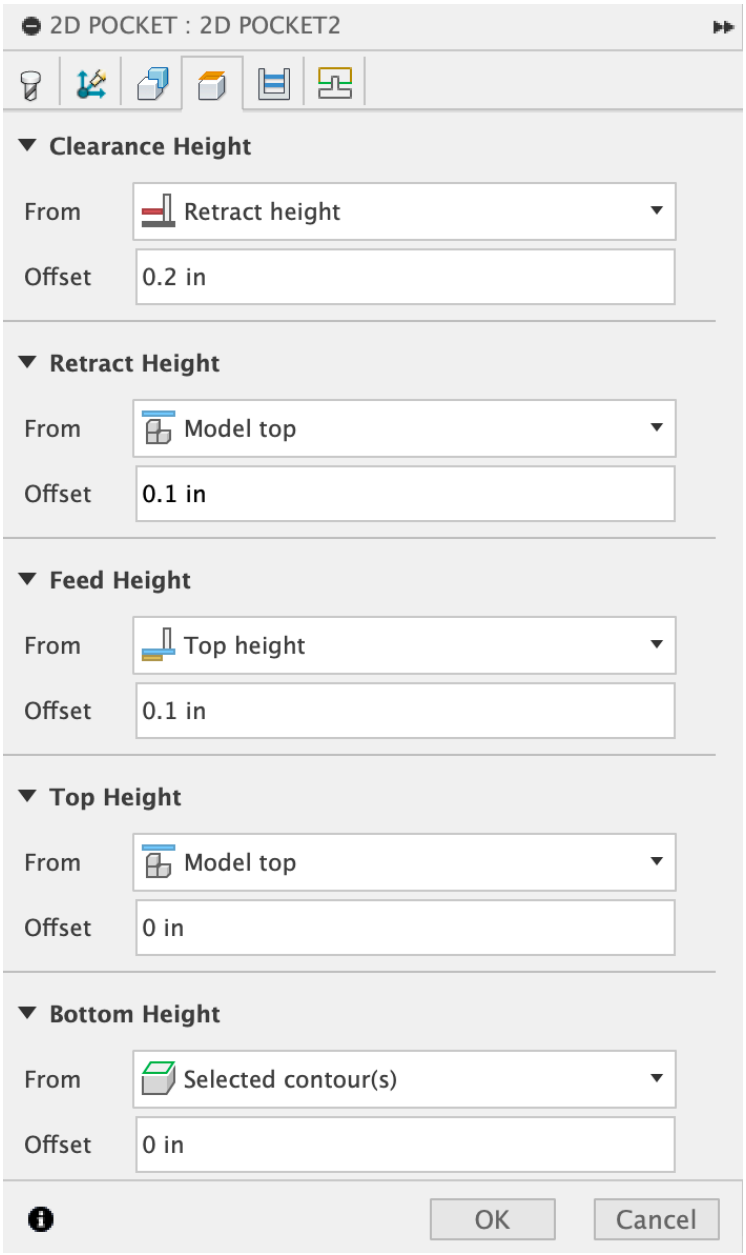
Note: A 2D pocket operation was selected for this since the part geometry does not require an adaptive toolpath.

## 3.3: Geometry Tab




Select the face of the flat for the geometry.

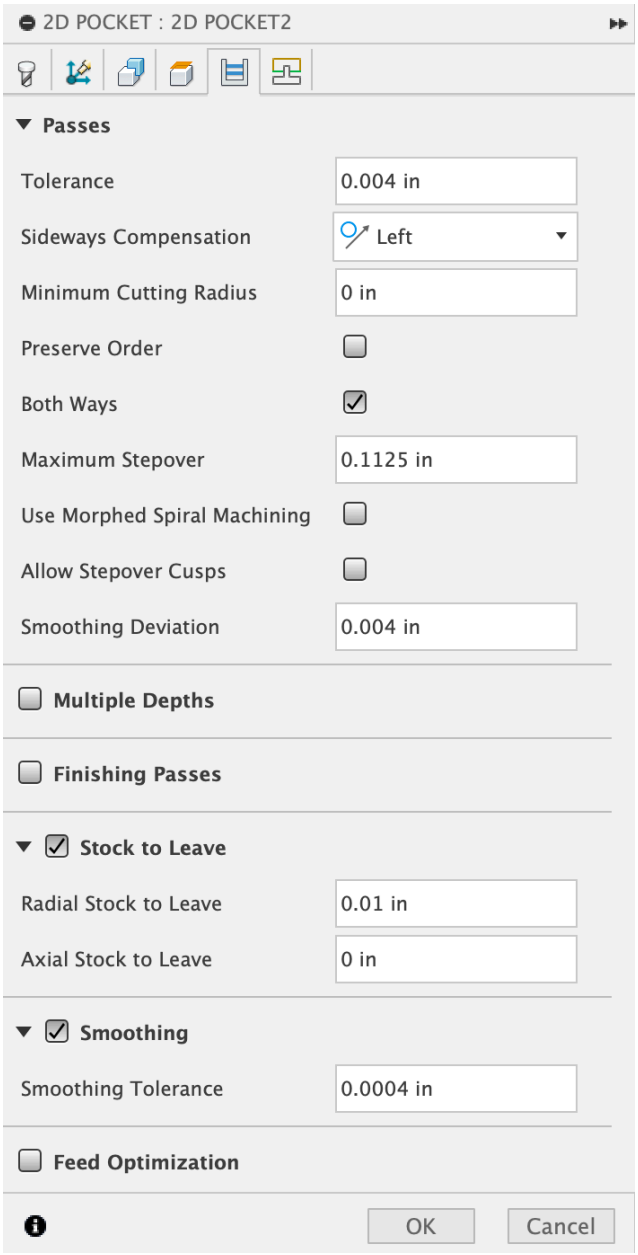
## 3.4: Heights Tab




Adjust the heights tab to the values pictured above.

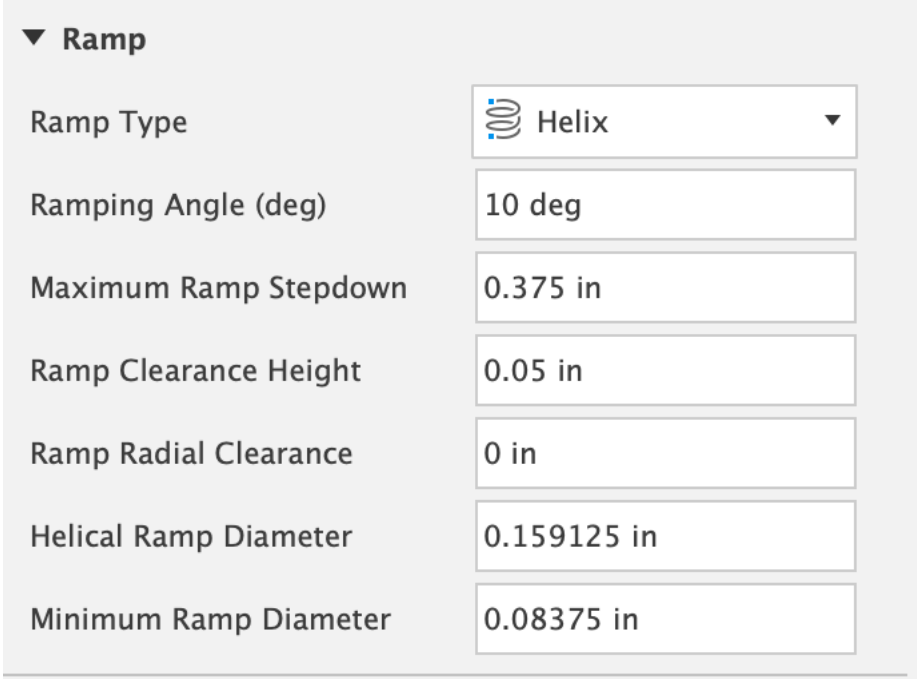
**Note: These values will be used for the remainder of this document unless stated otherwise.**

## 3.5: Passes Tab




Use the settings shown above for the passes tab. These are the same settings as the 2D pocket operation in the 3-axis lab.

## 3.6: Linking Tab




Adjust the “Ramp Clearance Height” to 0.05 inches in the linking tab.

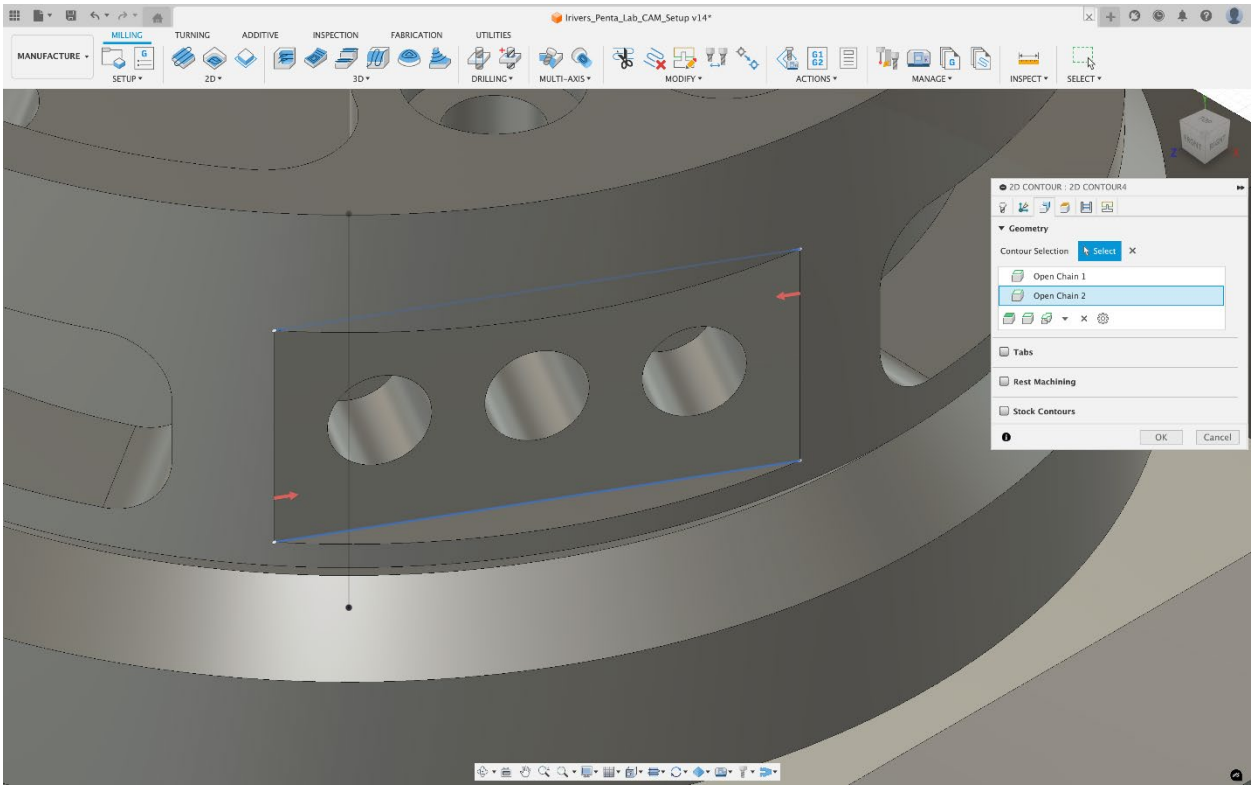
Click OK when finished.

## 3.7: Machine the Other Two Flats

Right click on the operation and duplicate it twice.

Once you have three operations, edit the multi-axis selections for the two new operations so that the second and third flats are machined. This process is exactly the same as before. Simply select an unmachined flat and align the Z-axis so that it points away from the face you want to machine and adjust the X-axis so that it will point towards the back of the machine after the part has been rotated.

# Step 4: Finish Flats



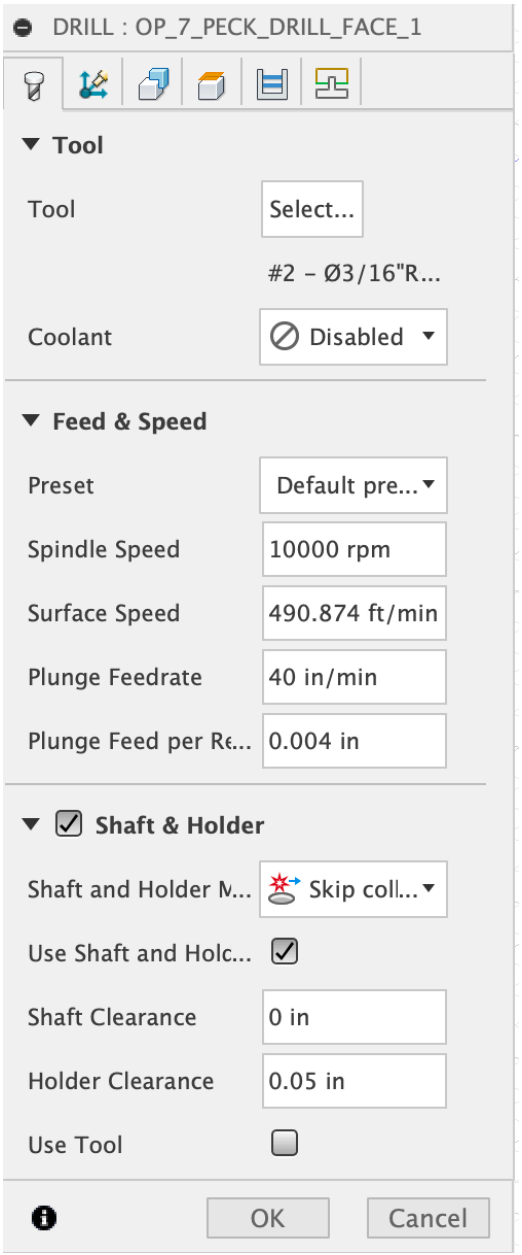

Create a derived 2D contour operation from each of the three 2D pocket operations to finish the part. If Fusion gouges the part when using the geometry from the 2D pocket operation, remove the old geometry from the finishing operation and select the top and bottom edges of the flat as shown in the image above.

Complete this process for all three flats. Remember to verify that the correct values were imported by Fusion and that “Stock to Leave” is disabled.

# Step 5: Drill Holes on Flats

Create a drilling operation for one of the flats.

## 5.1: Tool Tab

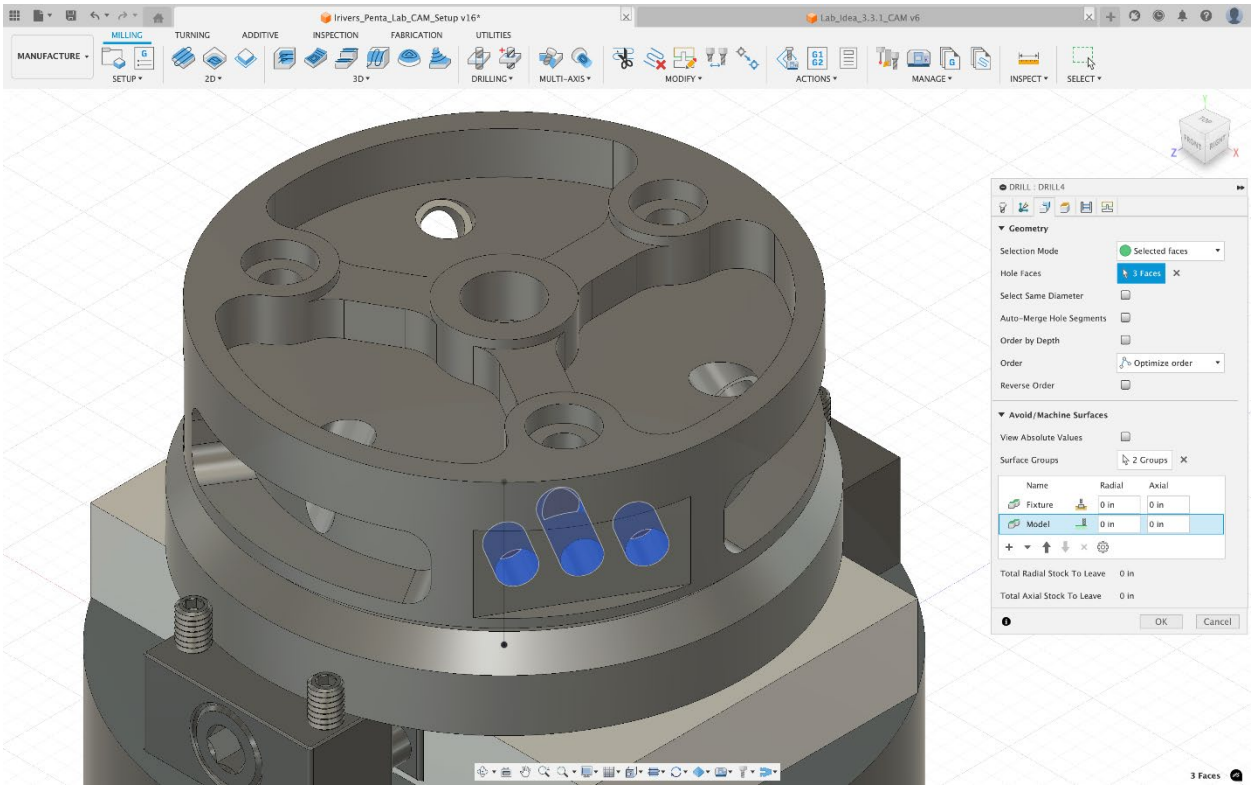



The tool settings are the same as usual except for the shaft clearance. The center hole is deep enough that the shaft clearance must be set to zero. If it is not, the middle hole will be skipped or result in an empty toolpath.

## 5.2: Multi-Axis Tab

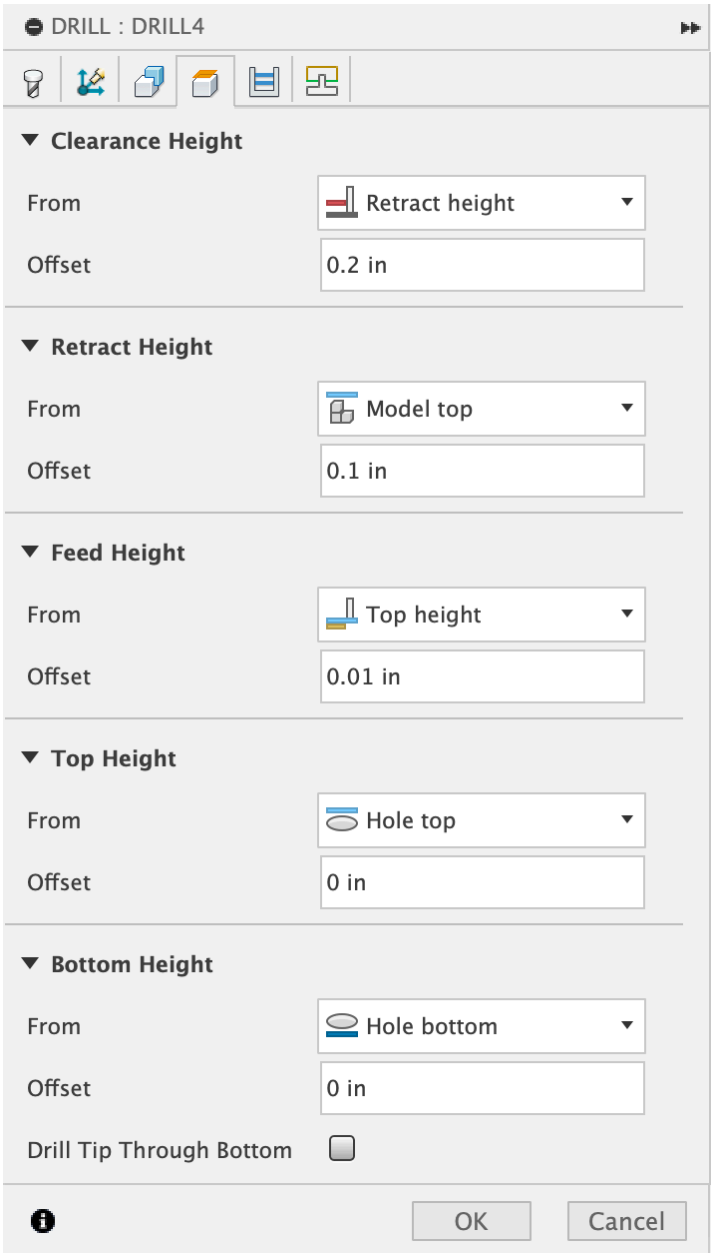
Make the same multi-axis selections as 3.2: Multi-Axis Tab.

## 5.3: Geometry Tab



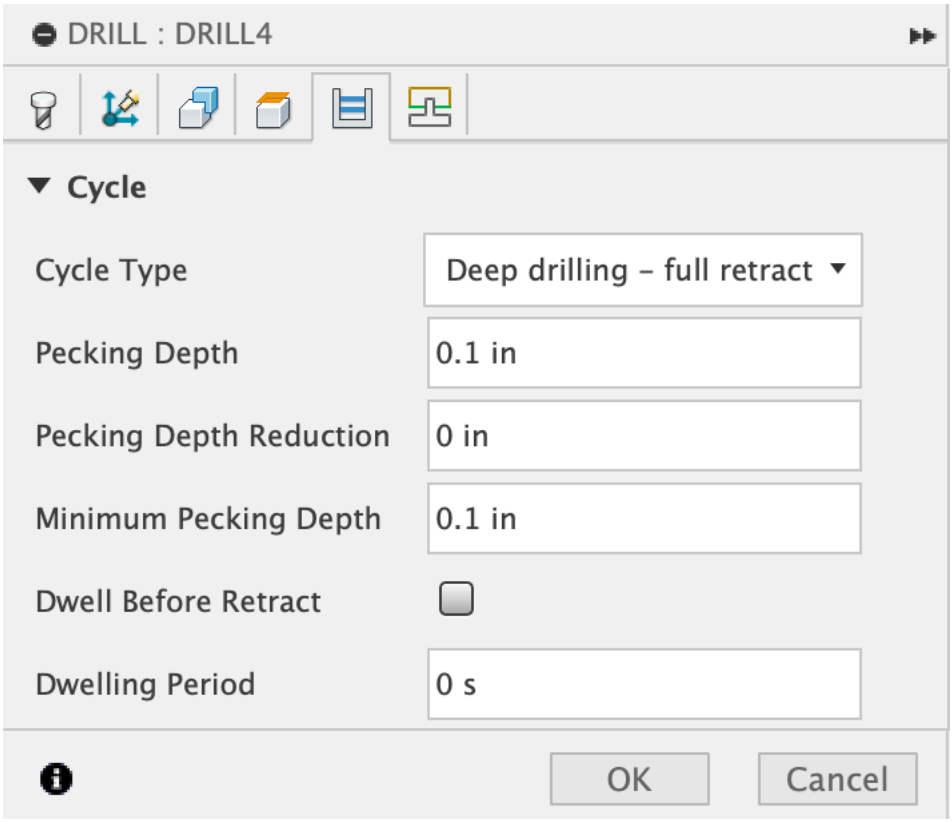

Individually select all three holes on the face that you are working on.

## 5.4: Heights Tab




Adjust the drilling heights to these values.

## 5.5: Cycle Tab




Set the drilling cycle to “Deep drilling – full retract” and adjust the “Pecking Depth” to 0.1 inches.

Click OK to finish creating the operation.

## 5.7: Drill Holes on the Other Three Flats

Duplicate the operation so that the holes on the other two faces can be drilled. Like before, change the multi-axis setup and the geometry for each new operation so that the holes are drilled on the other flats.

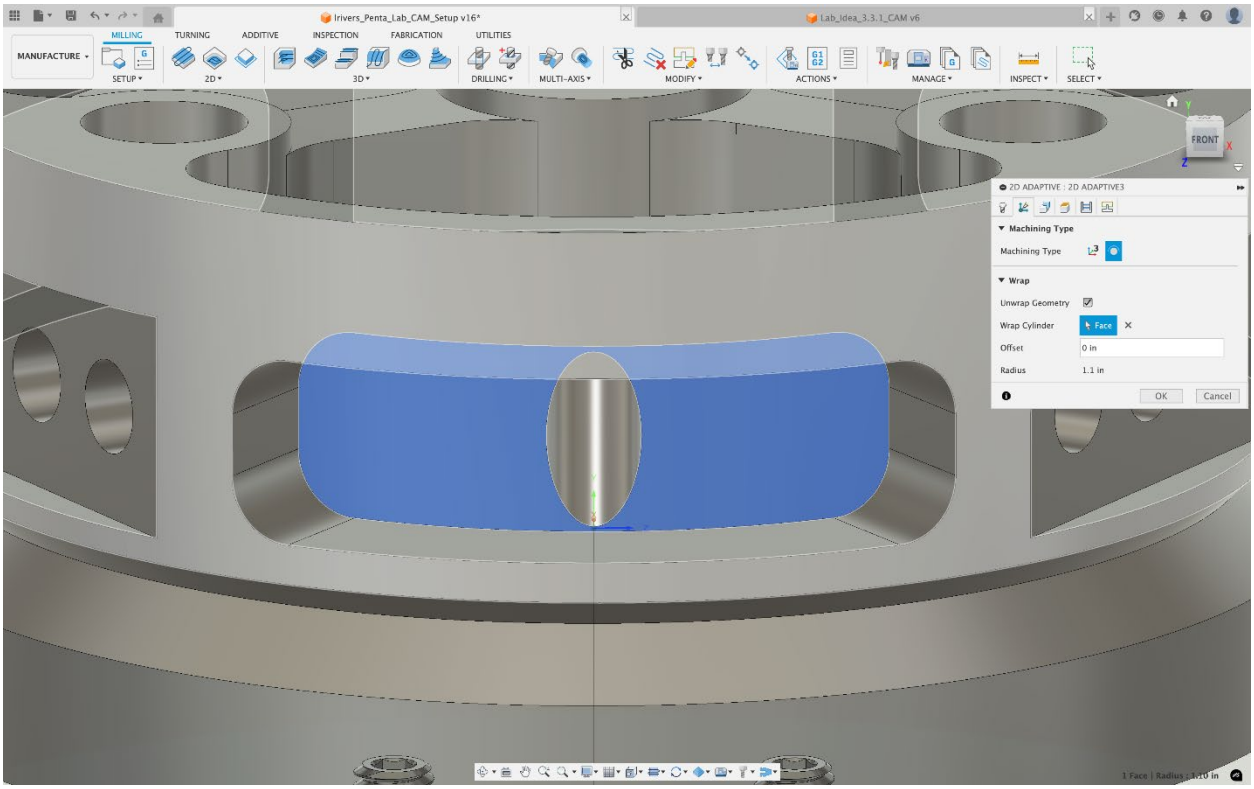
# Step 6: Rough Pockets

Create a 2D adaptive clearing operation.

## 6.1: Tool Tab

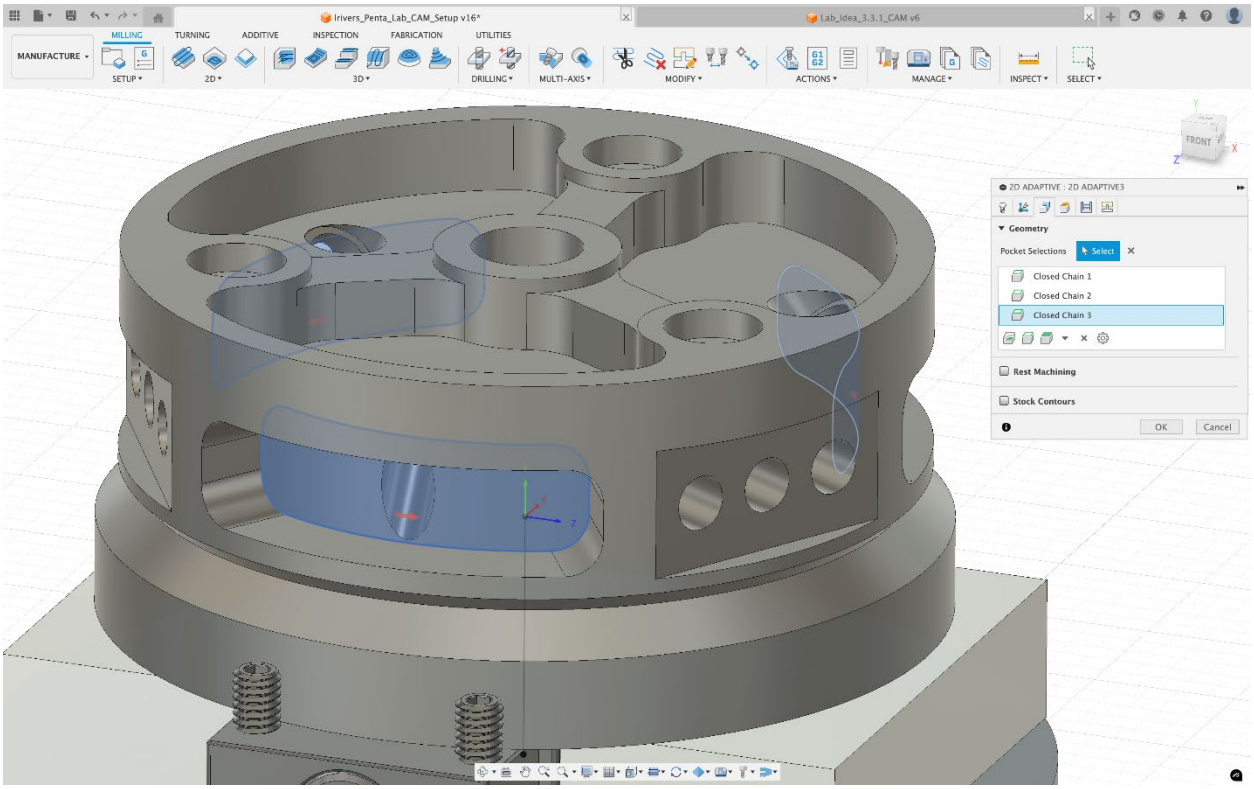
Use the settings and selections from 3.1: Tool Tab.

## 6.2: Multi-Axis Tab




Change the machining type to “Wrapped”. Select the face at the bottom of one of the pockets for the “Wrap Cylinder” selection.

## 6.3: Geometry Tab




Select a closed chain at the bottom edge of one of the pockets. After this has been done, make the same selection for the other two pockets.

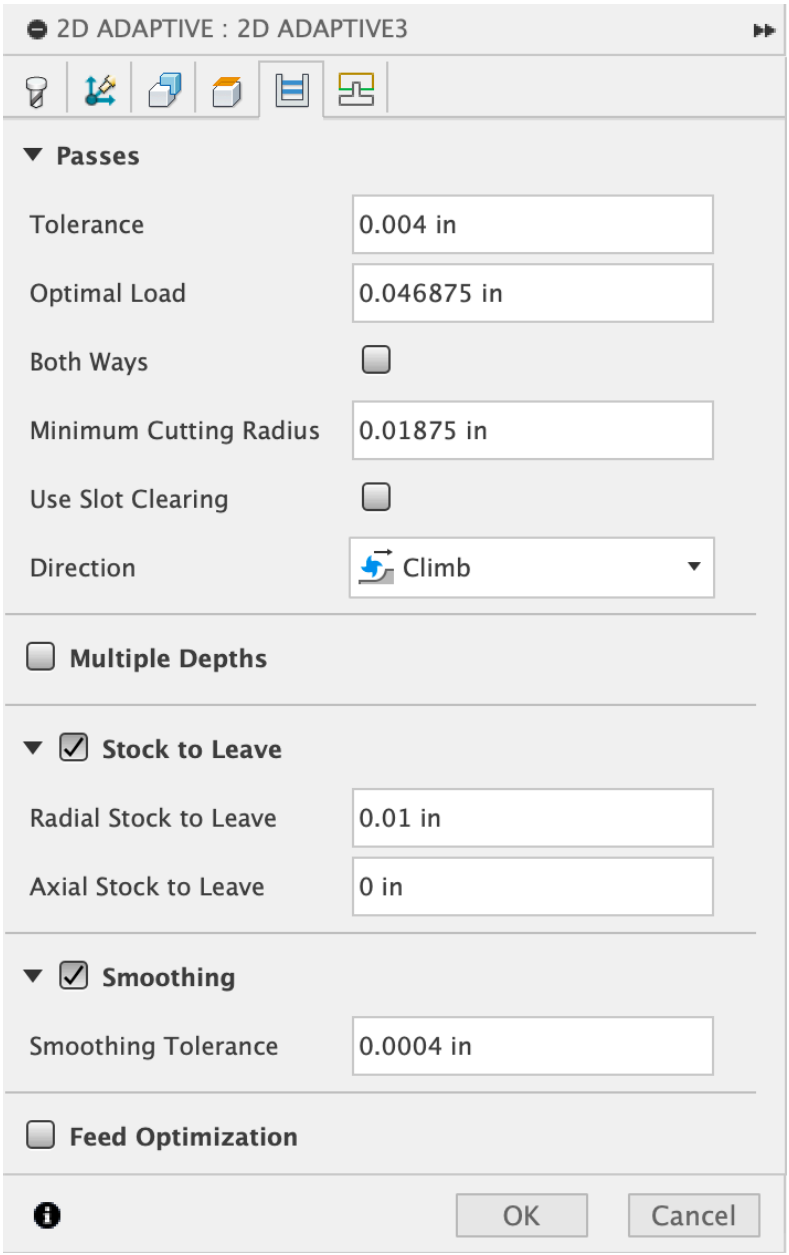
Remember to check that Fusion has placed the arrow on the correct side of the closed chain. If it has not, click the arrow to reverse the side to be machined.

## 6.4: Heights Tab

The wrapped heights tab looks a little different than normal, but it works the same way. Use the same clearance heights as normal.

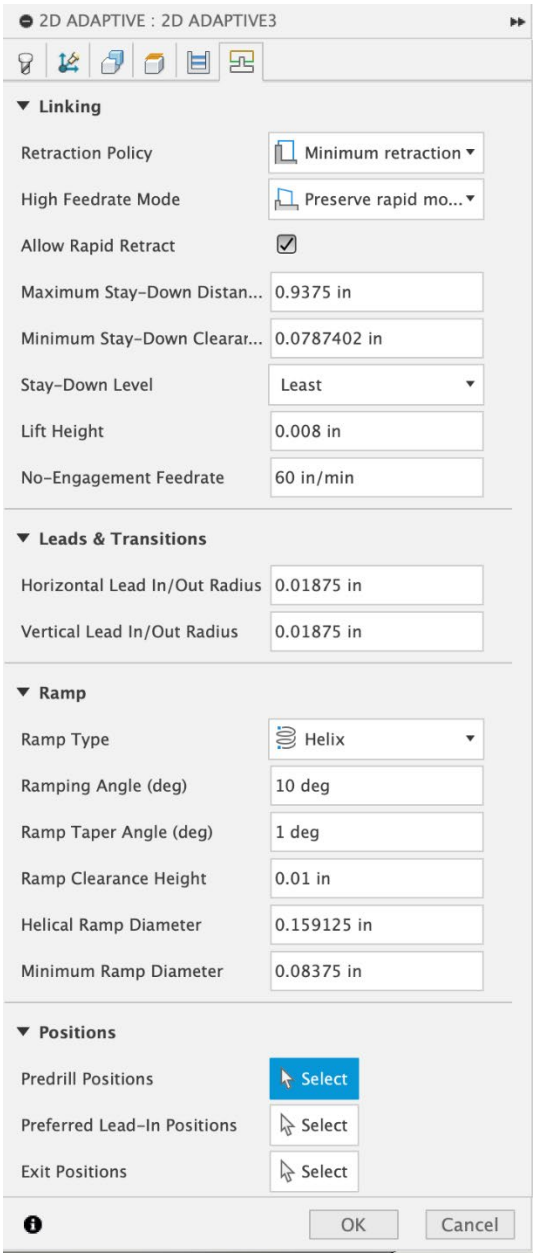
The settings and selections from 3.4: Heights Tab can be used as a reference is you do not remember the values.

## 6.5: Passes Tab




Use the settings shown above for the passes. Remember, since we are making a heavy adaptive roughing cut, it is important to set the optimal load to 25% to avoid overloading the machine.

## 6.6: Linking Tab

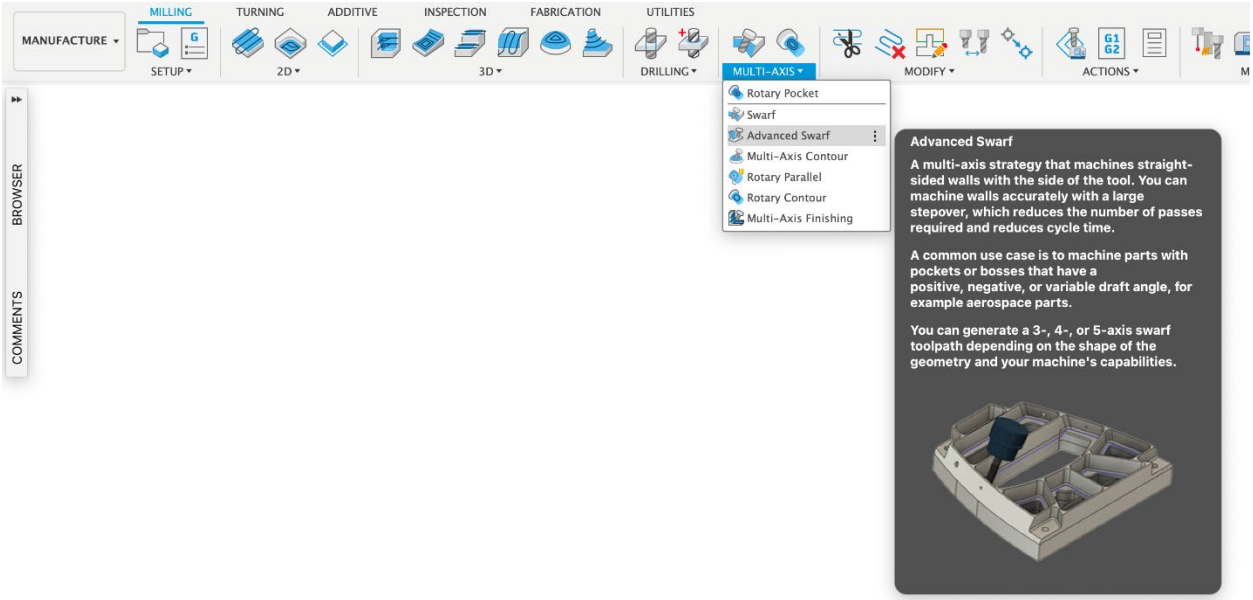



Adjust the linking tab to the settings above and click OK to complete the operation.

# Step 7: Finish Pockets

Unfortunately, there is a limitation in Fusion that keeps us from being able to create a derived 2D contour operation that will finish all the walls of the pocket to the correct dimensions. More can be read about it here: Wrapped 4-Axis Toolpath

## 7.1: Create a New Operation

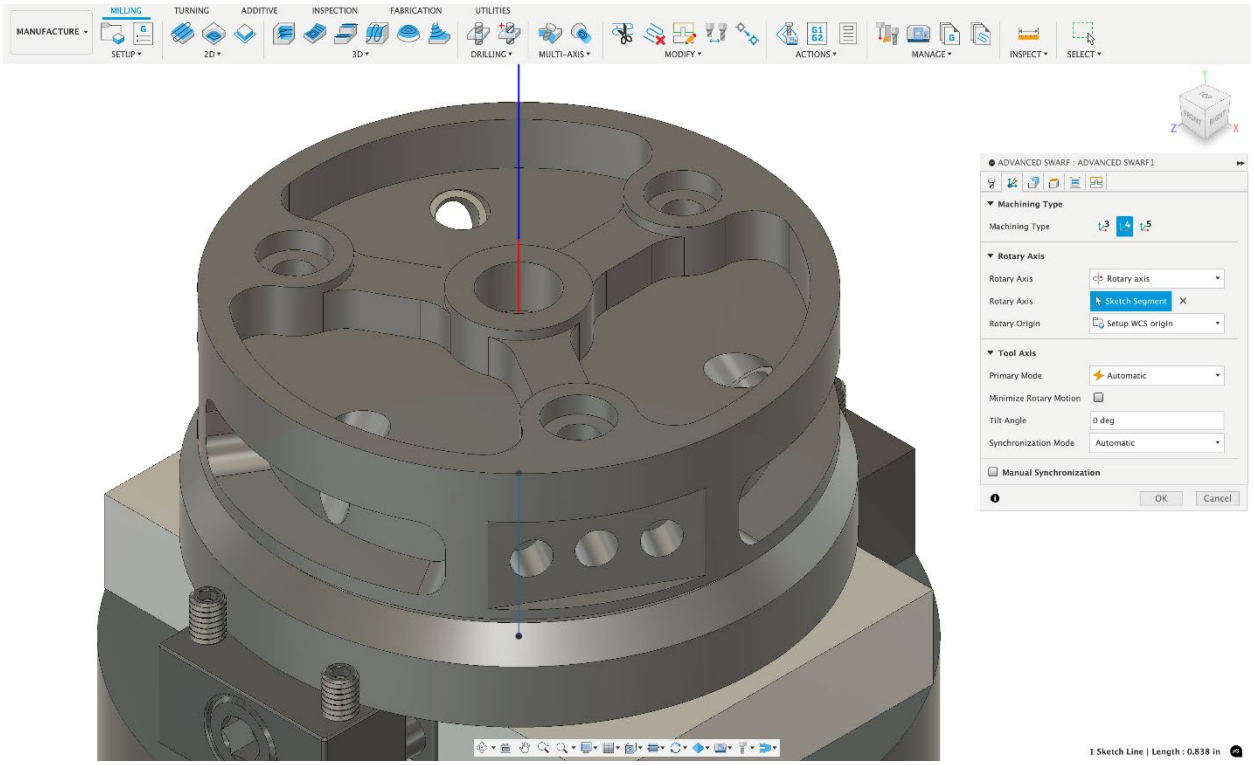



Create an “Advanced Swarf” operation. This operation type is capable of finishing the walls correctly.

## 7.2: Tool Tab

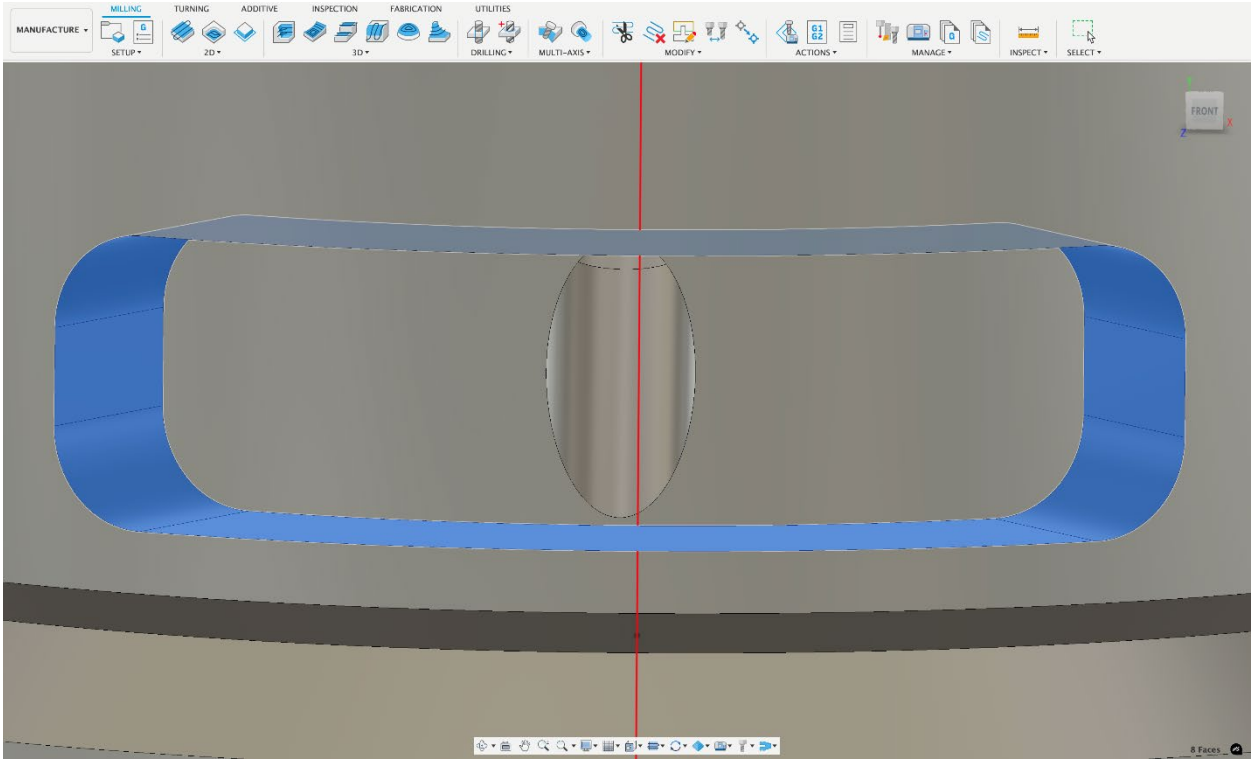
Use the settings and selections from 3.1: Tool Tab.

## 7.3: Multi-Axis Tab

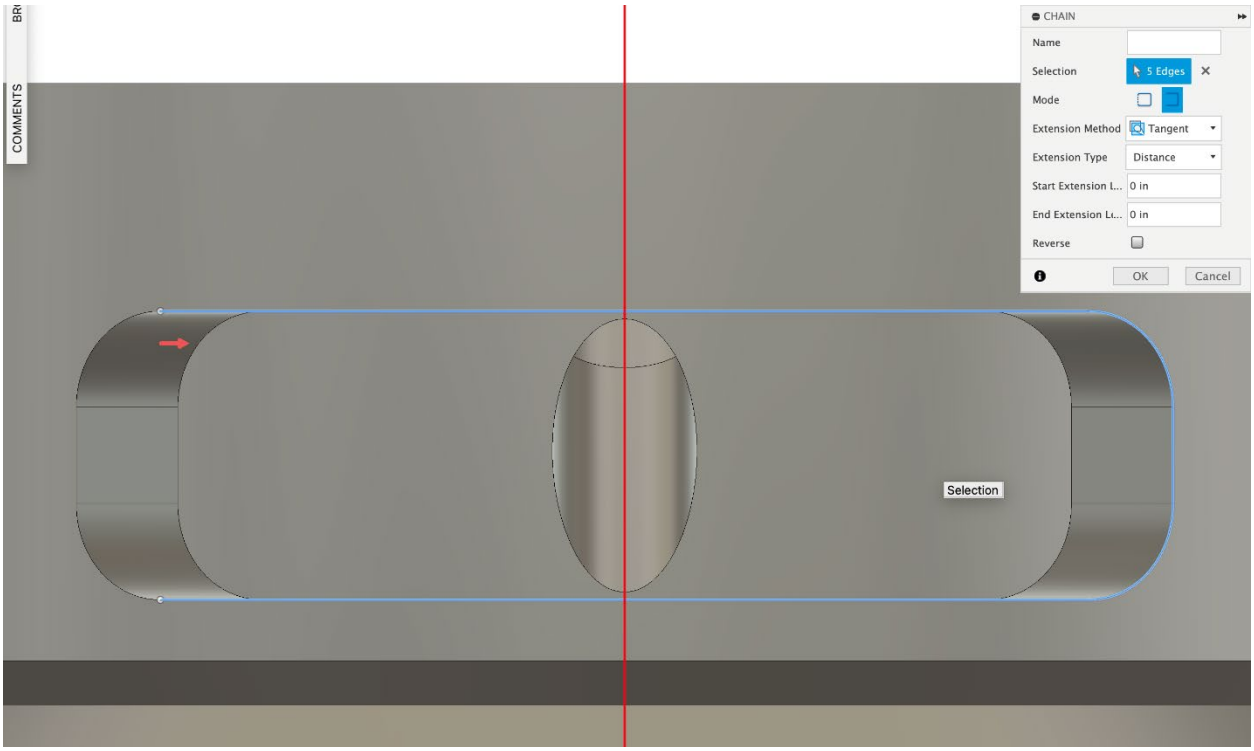



Make the changes shown in the image above. The rotary axis is selected as the B-table offset sketch.

## 7.4: Geometry Tab

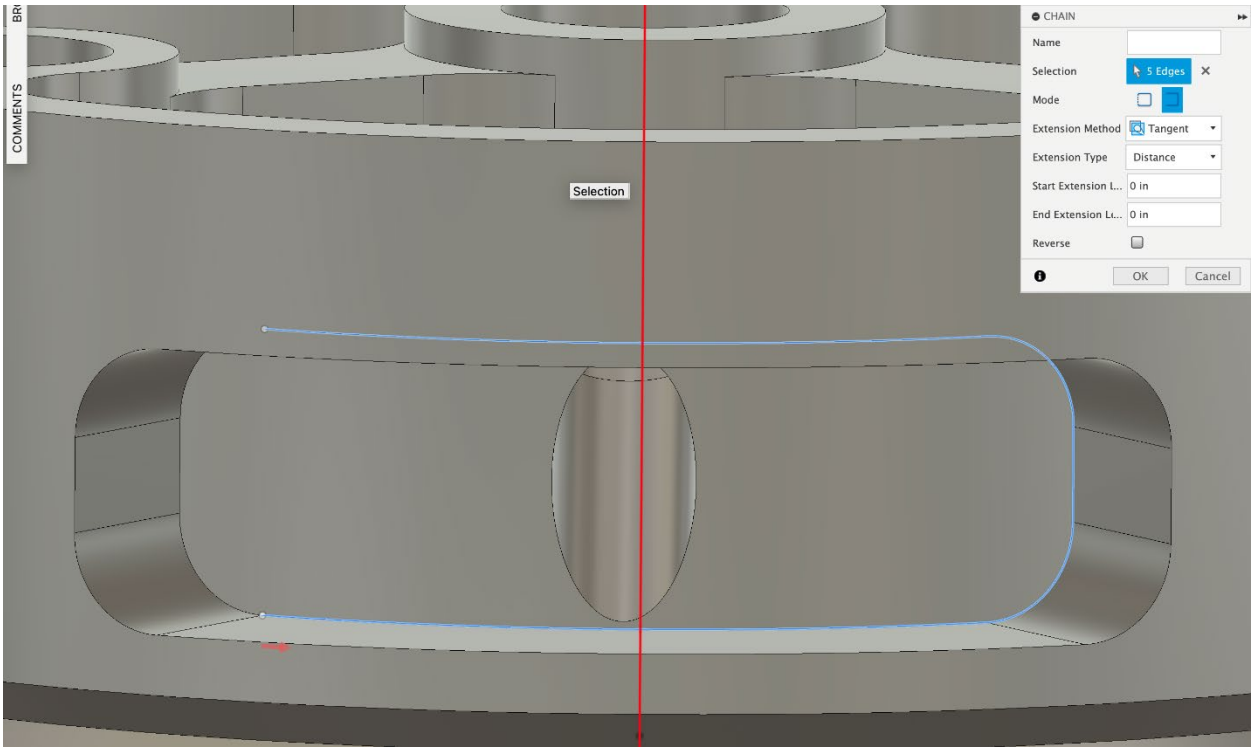



In the geometry tab, select all the wall segments of the pocket you are working on as the “Swarf Surfaces”.



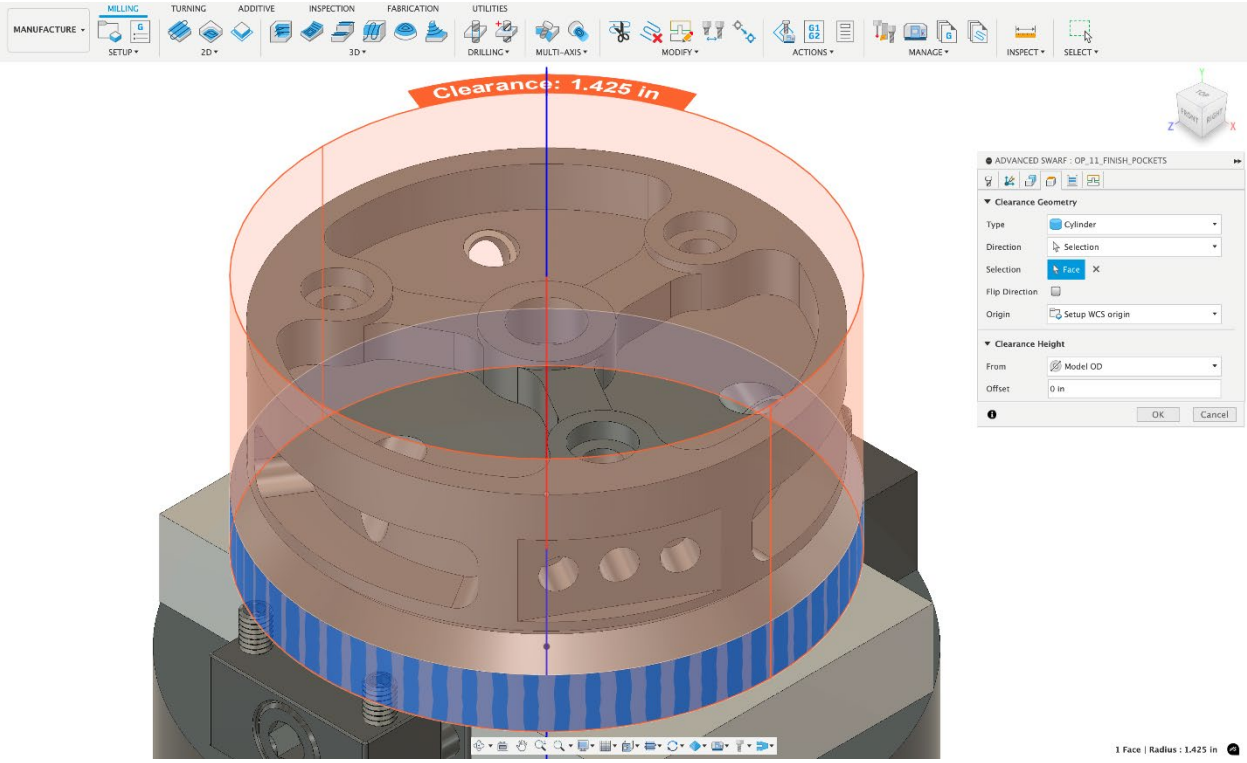

Turn on guide curves and click on the chain icon to select the upper guide curve.

Fusion will likely have difficulty determining which closed chain you want. To get around this issue, switch the mode to open chain and select one of the longest edges at the top of the pocket and work your way around the pocket until the opposite long edge has been selected as well. Once your selection looks like the image above, switch the mode back to closed chain and click OK.




The process for selecting the lower guide curve is the same as the upper. The only difference is that you are creating a chain with the edge at the bottom of the pocket.

## 7.5: Heights Tab




The default automatic clearance height is high enough that the machine's Z-axis will be commanded to a position outside of its travel limits.

Follow the steps below to lower the heights:

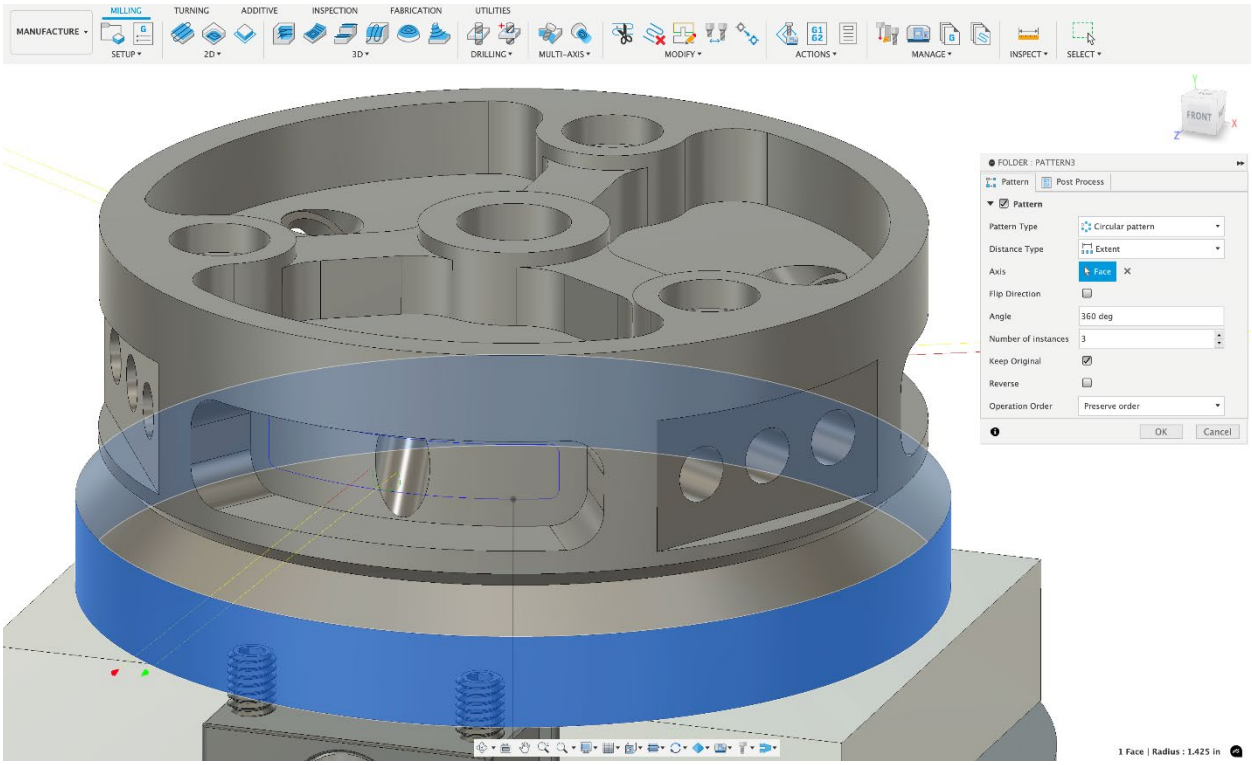
- Change the clearance geometry type from "Automatic" to "Cylinder".
- Use the blue face in the image above as the direction selection.
- Make the origin the setup WCS origin.
- Set the clearance height to "Model OD" with no offset.

## 7.6: Linking Tab

Change the retraction policy to "Minimum Retraction" in the linking tab.

Click OK to finish creating the operation.

## 7.7: Finish the Other Two Pockets




Create a circular pattern by right clicking on the advanced swarf operation, selecting “Add to New Pattern”, and following the steps below:

- Change the pattern type to “Circular Pattern”.
- Select the blue face in the image above for the axis.
- Verify that the angle is 360 degrees and change the number of instances to three.

Do not adjust the post process tab.

# Step 8: Save Work and Post Process Operations

All 4-axis operations are complete. Remember, you should be renaming each operation and running simulations to verify that there are no issues.

**Be sure that your work is saved. The 5-axis lab requires both 3 and 4-axis setups to be complete.**

Post process your 4-axis setup by right clicking on the setup and selecting “Post Process”.