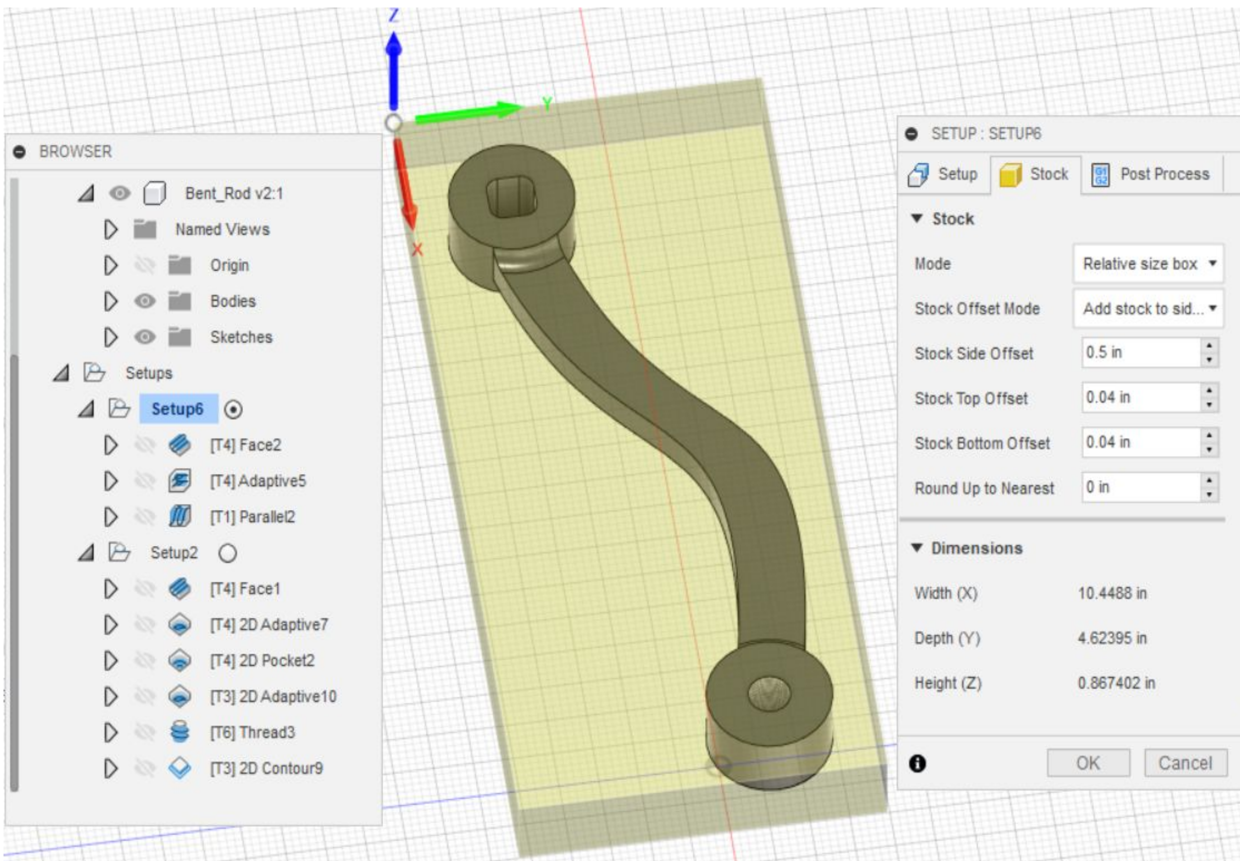
Computer Aided Manufacturing

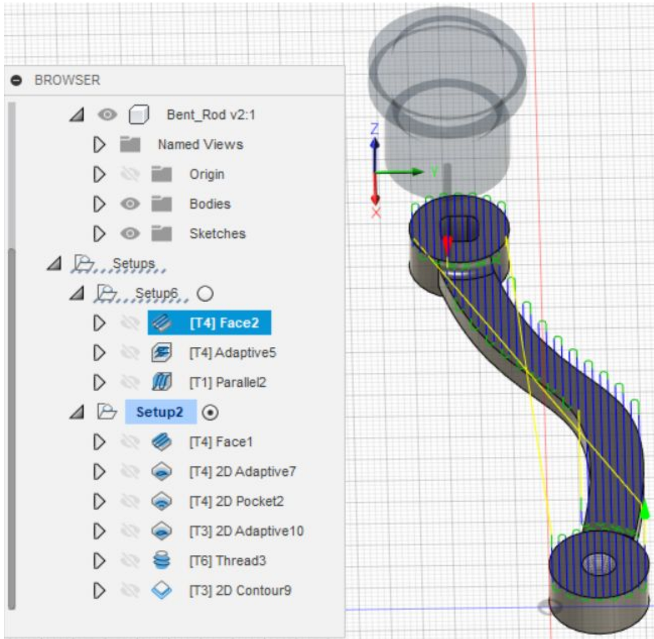
Part 1 - Handle Bar

The stock size was created to have a 0.5 inches offset on the sides, and a 0.04 inches offset on the top and bottom as shown below. This extra 0.5 inches in the stock allows the vice to firmly grip onto the stock during machining. We have two setups ready for this CAM demonstration. The operations in the first setup are performed on the top face of the stock that is shown below, and the operations in the second setup are performed on the bottom face of the stock. The strategy that will be used to machine this part is:

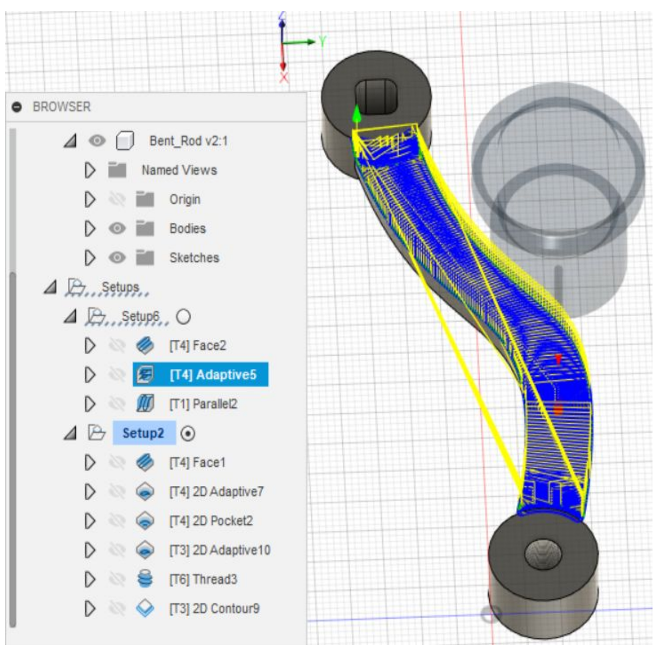
Top view operations:



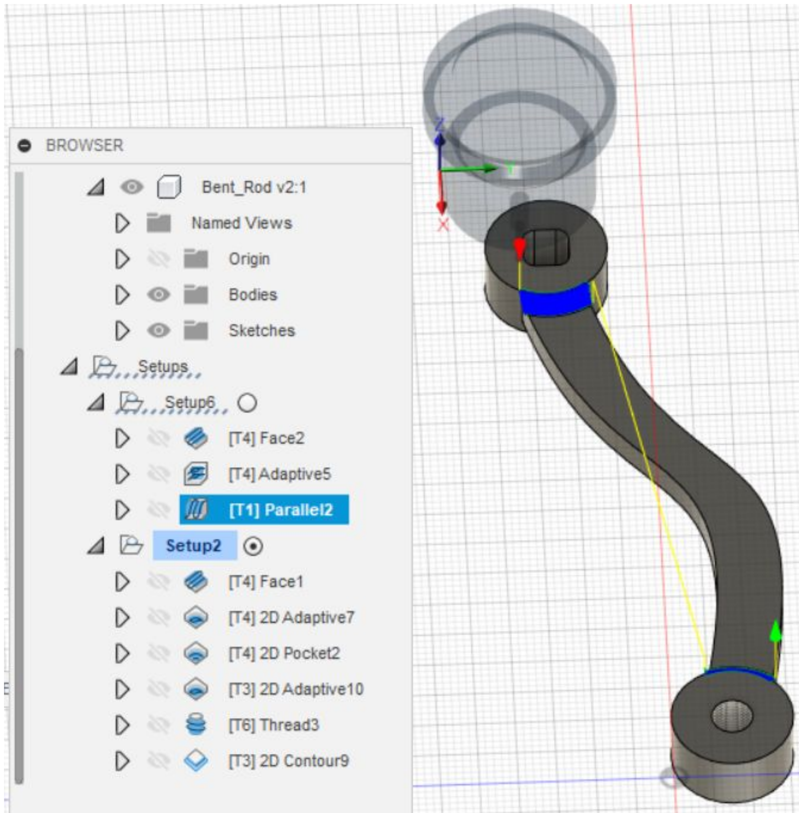
1. Firstly, a 2D face operation was performed using a ⅛” flat end mill to prepare the raw stock for machining.

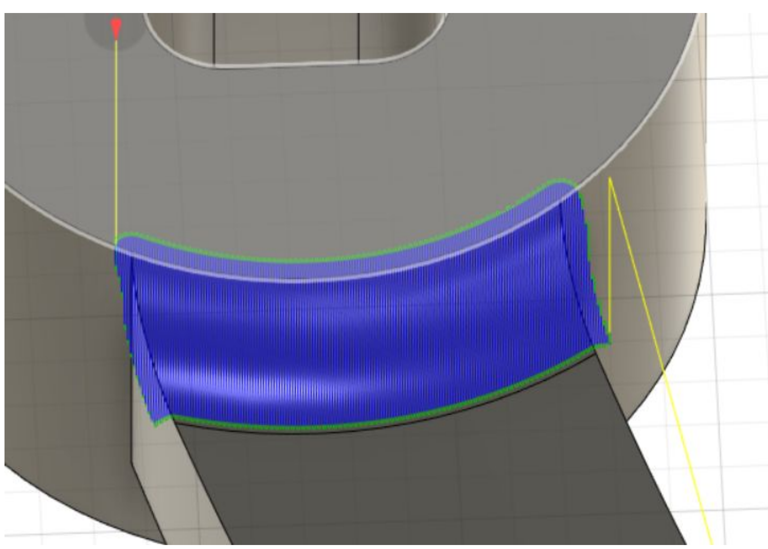


2. The next step would be to use 3D adaptive clearing to rough out large quantities of material in the middle segment of the Handle bar, with a maximum roughing stepdown of 0.05 inches. This prevents the tool from cutting the entire depth at once. This was done using a ⅛” flat end mill

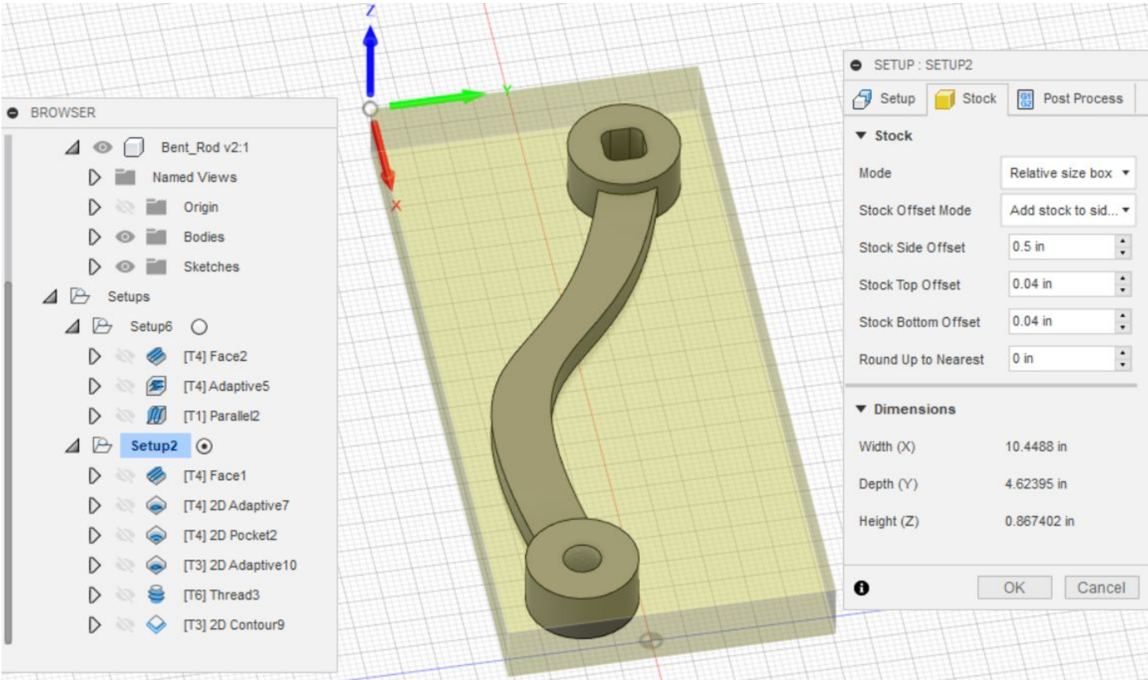


3. Finally, we used the parallel operation as a finishing operation on the ramps that are on the handle bar. This operation involved using a ⅛" ball end mill while using a really small stepover of 0.005 inches to ensure a smooth transition of the ball end mill over the surface.

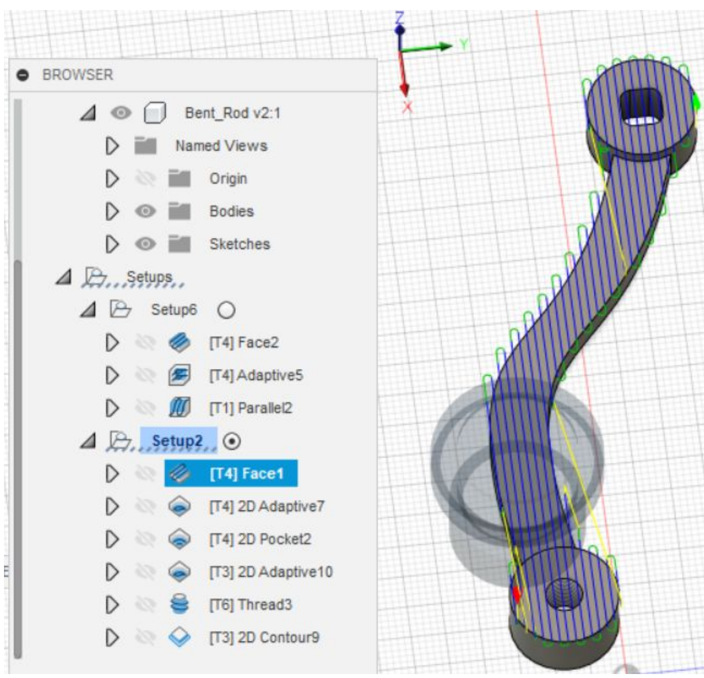




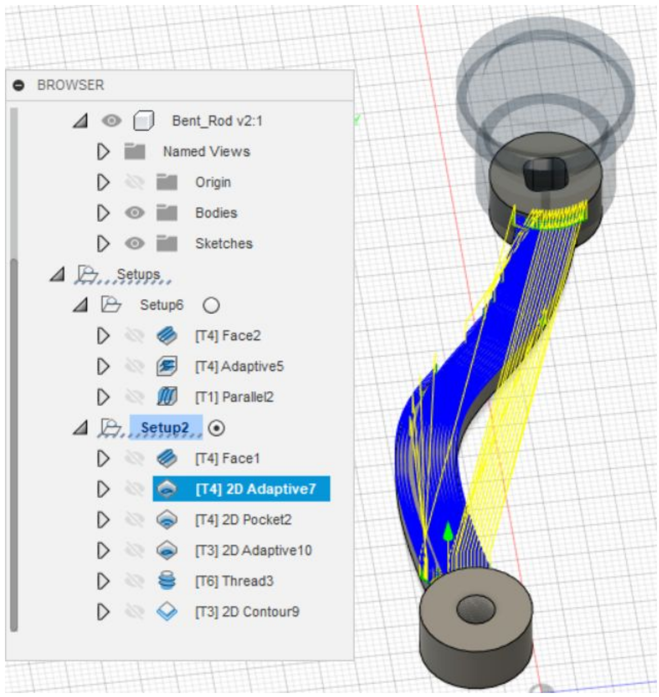
Bottom view operations:



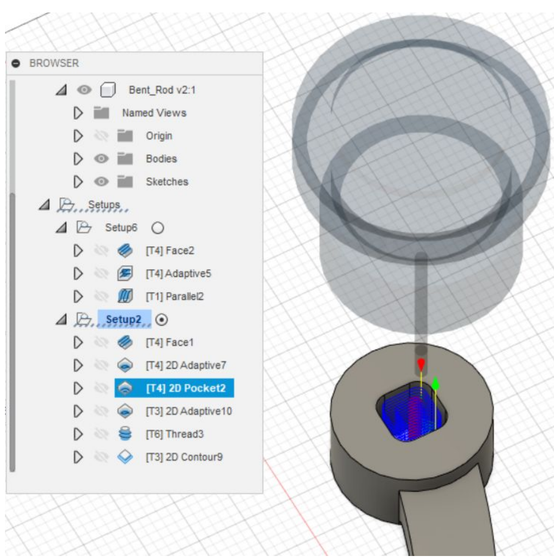
1. After flipping the stock to its bottom side, we performed a 2D face operation using a ⅛" flat end mill to prepare the bottom of the stock for machining.



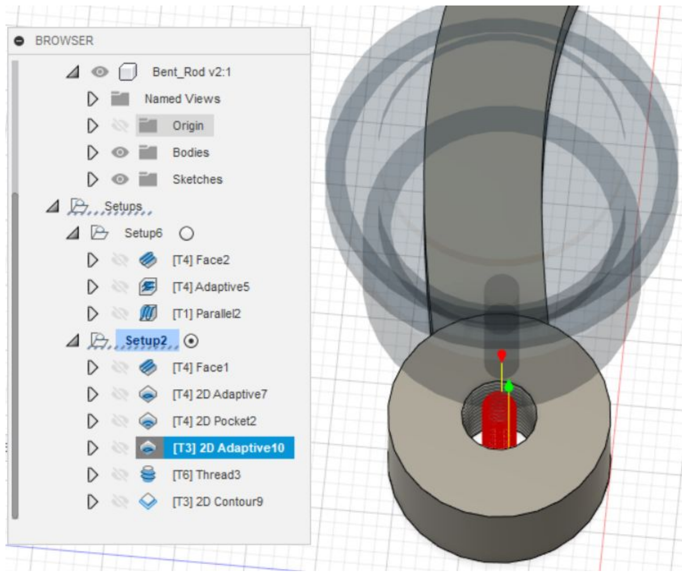
2. We Used the 2D adaptive clearing operation to rough out large quantities of material in the middle segment of the Handle bar, with a maximum roughing stepdown of 0.05 inches as well. This prevents the tool from cutting the entire depth at once. Please note that the bottom side of the handle bar does not have the ramps that were shown on the top view.This was done using a ⅛" flat end mill



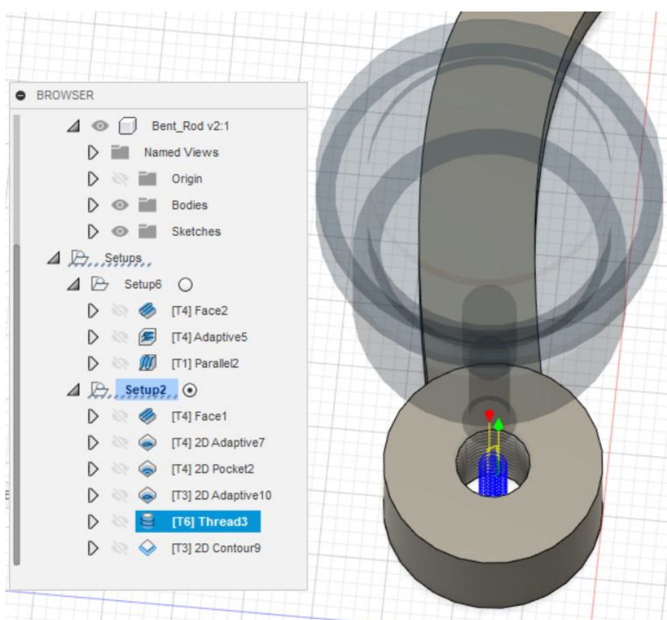
3. The next step would be a 2D pocket operation using a ⅛" flat end mill on the filleted square pocket with a maximum roughing stepdown of 0.05 inches.



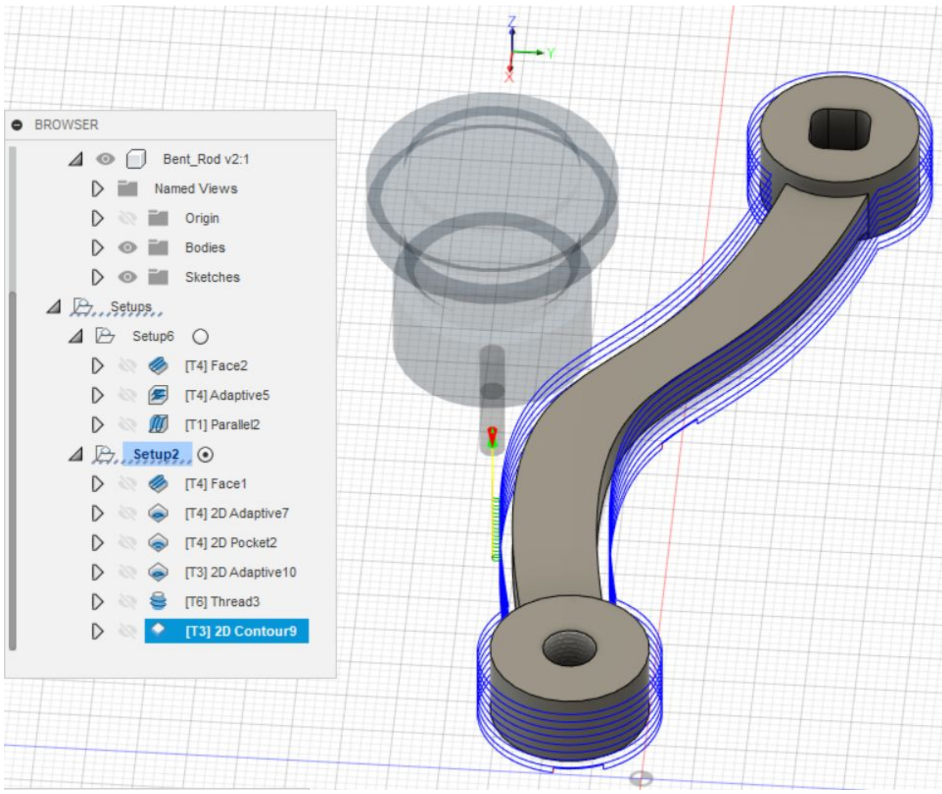
4. The following step would be a 2D adaptive operation using a ¼” flat end mill to clear out the hole before threading it. The required thread has a M15 x 1.5 designation, which means the pitch is 0.0590551 inches. Our required thread percentage is 75%. Therefore, our required minor diameter is 13.526mm (0.532519685 in) , and our required major diameter is 15mm (0.590551 in). This operation will clear out the hole to our required minor diameter of 13.526mm



5. The following step would be a threading operation on the hole that we just created in the step before. We are going to use a thread mill shown in the list of tools below. The thread pitch would be 0.0590551 inches and the pitch diameter offset which is the difference between the major diameter and minor diameter is 0.058032 inches.



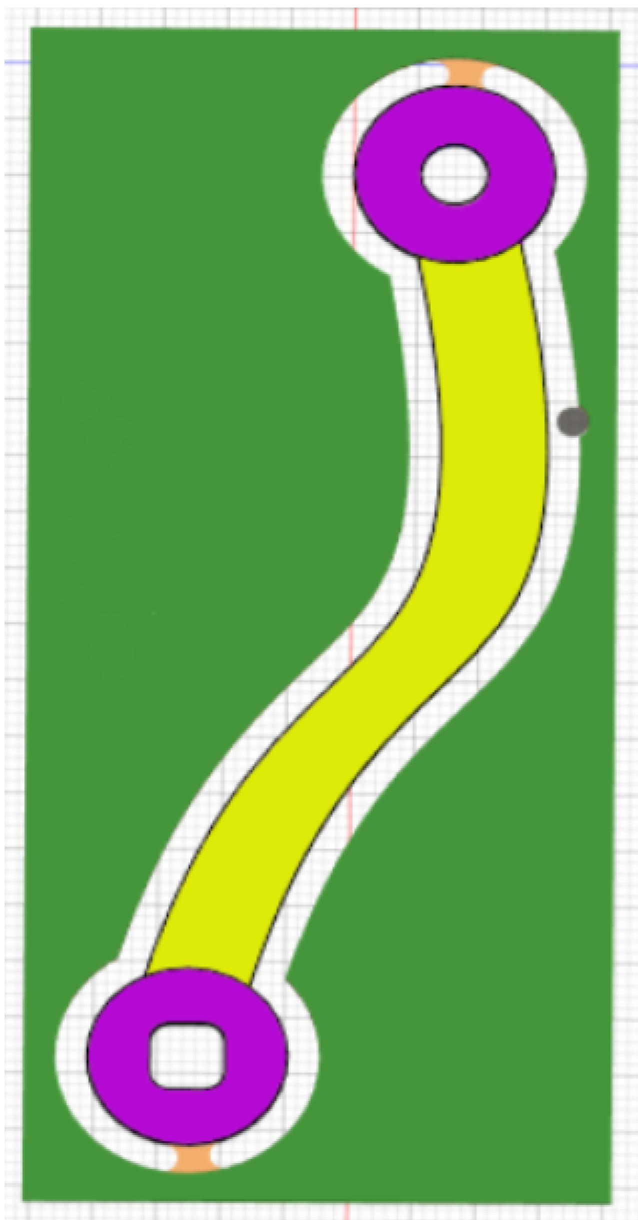
6. The final operation would be a 2D contour to separate the manufactured handle bar from the excess stock while leaving Two tabs behind to prevent the part from breaking free during the machining process. The maximum roughing stepdown was set to 0.1 inches to prevent the tool from cutting through the entire depth at once. The tool used a ¼” flat end mill.



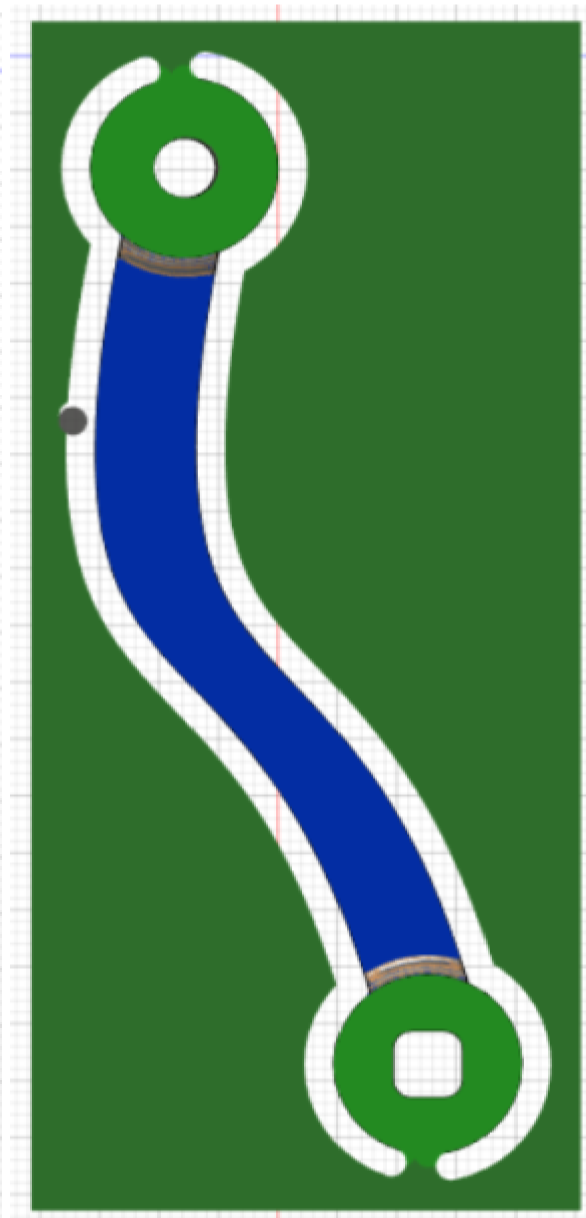
The following tools were used to machine the handle bar:

Name	Cutting diameter	Corner radius	Overall length	Flute length	Surface speed
Bent_Rod v2					
1 - Ø1/8" - ball	0.12500 "	0.062500 "	1.2500 "	0.50000 "	492.50 ft/min
1 - Ø1/4" - ball	0.25000 "	0.12500 "	1.2500 "	0.50000 "	985.00 ft/min
3 - Ø1/4" - flat	0.25000 "	0 "	1.2500 "	0.50000 "	985.00 ft/min
4 - Ø1/8" - flat	0.12500 "	0 "	2.0000 "	0.25000 "	985.00 ft/min
6 - Ø0.393701" - thread mill ...	0.39370 "	0 "	1.9685 "	0.78740 "	515.35 ft/min

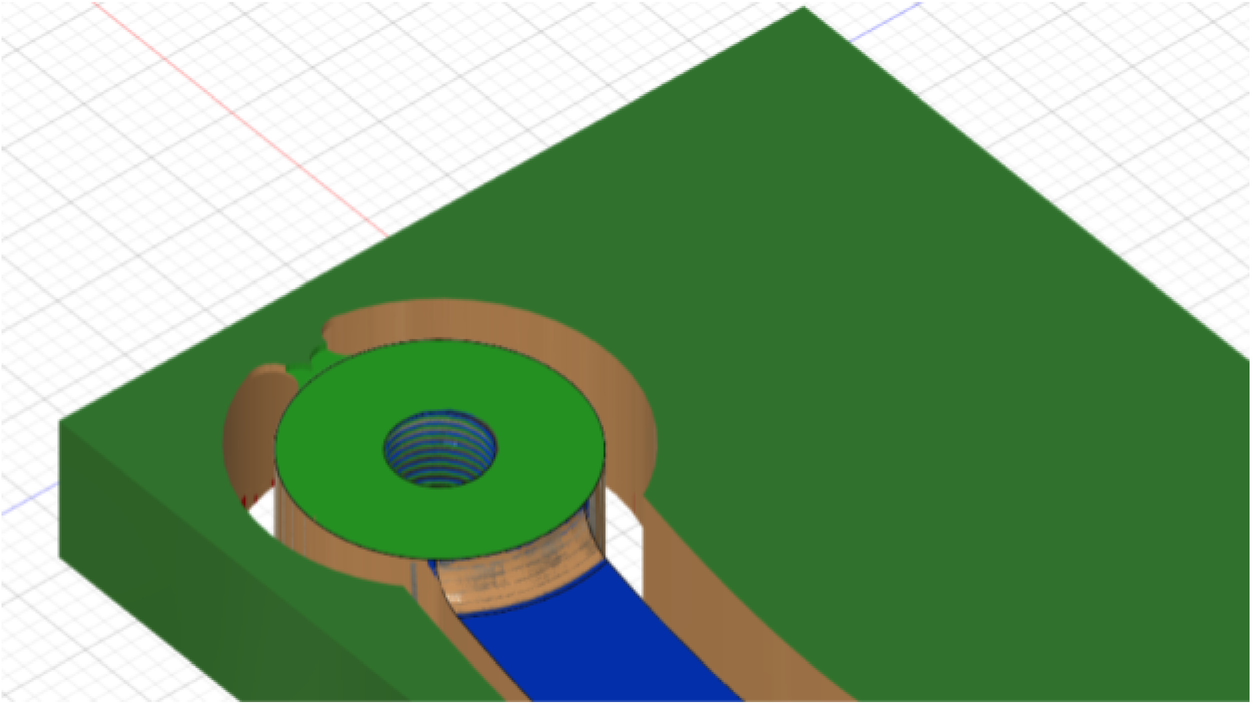
The results of the simulation can be seen below:



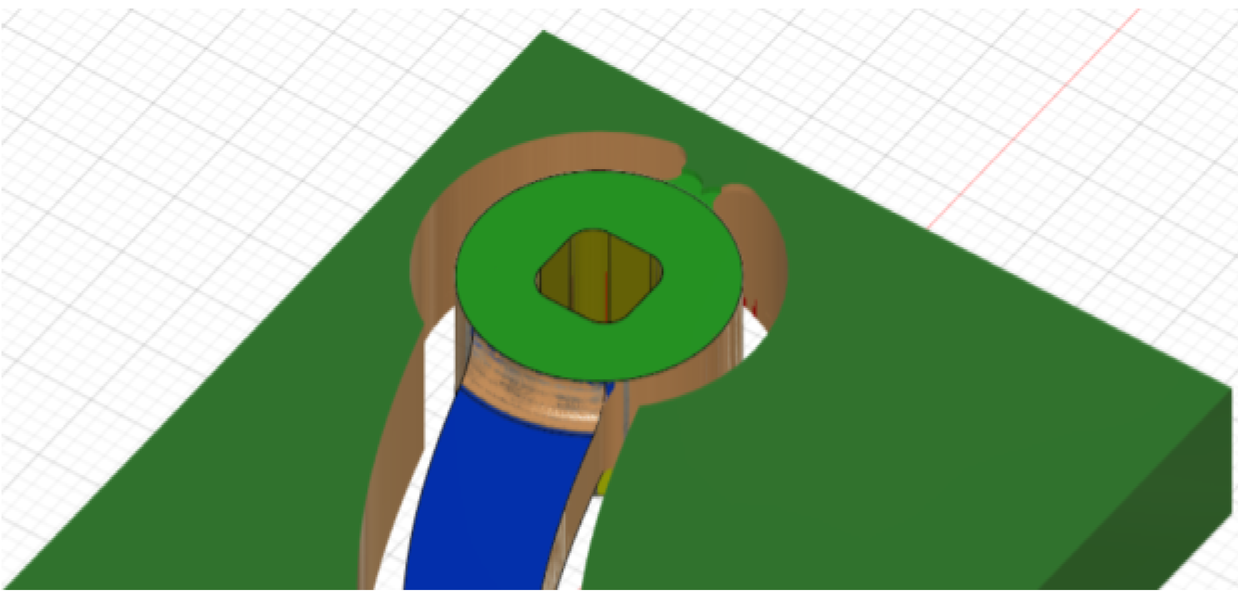
Handle Bar - Top view



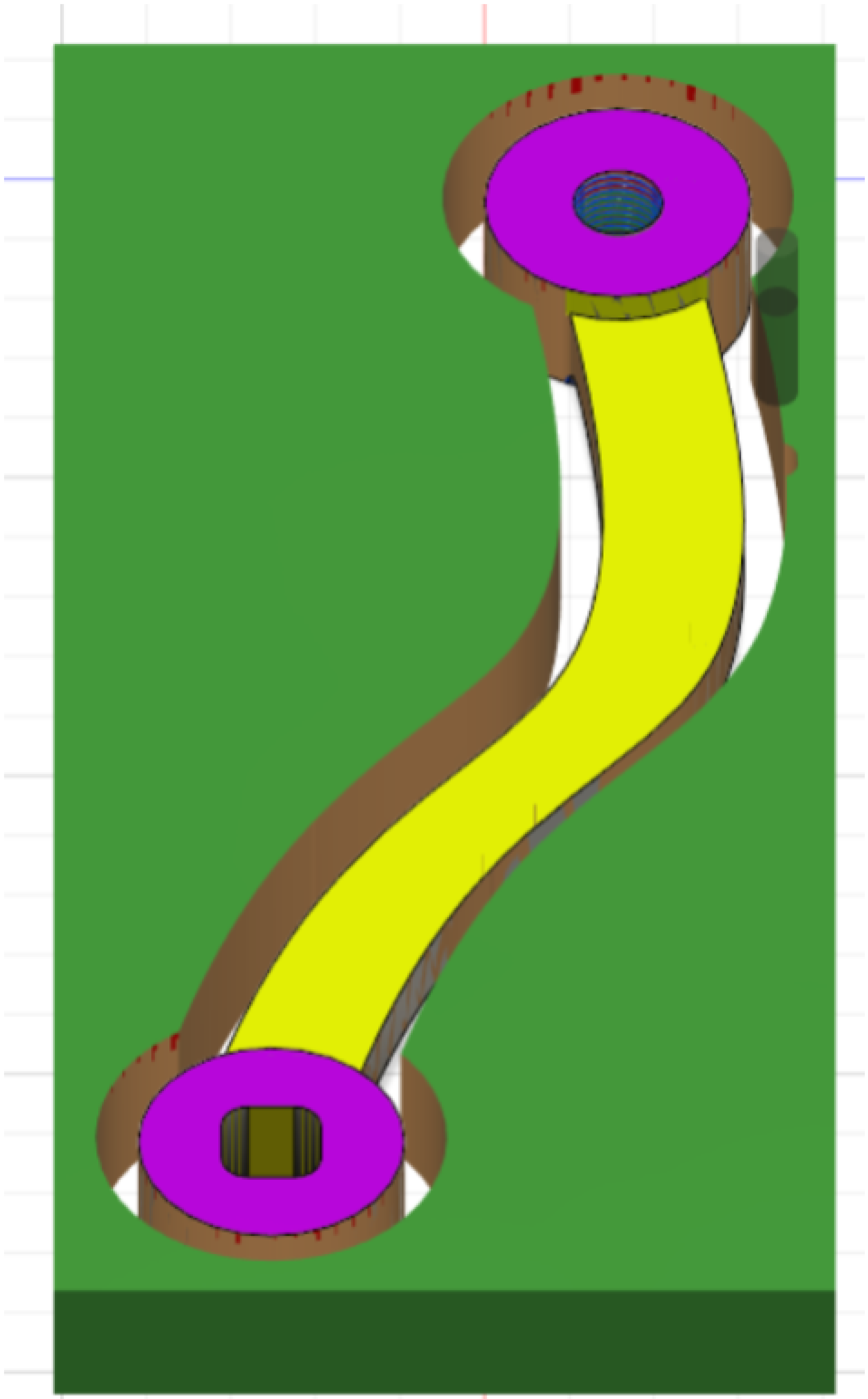
Handle Bar - Bottom view



Corner view - Threaded hole and Ramp



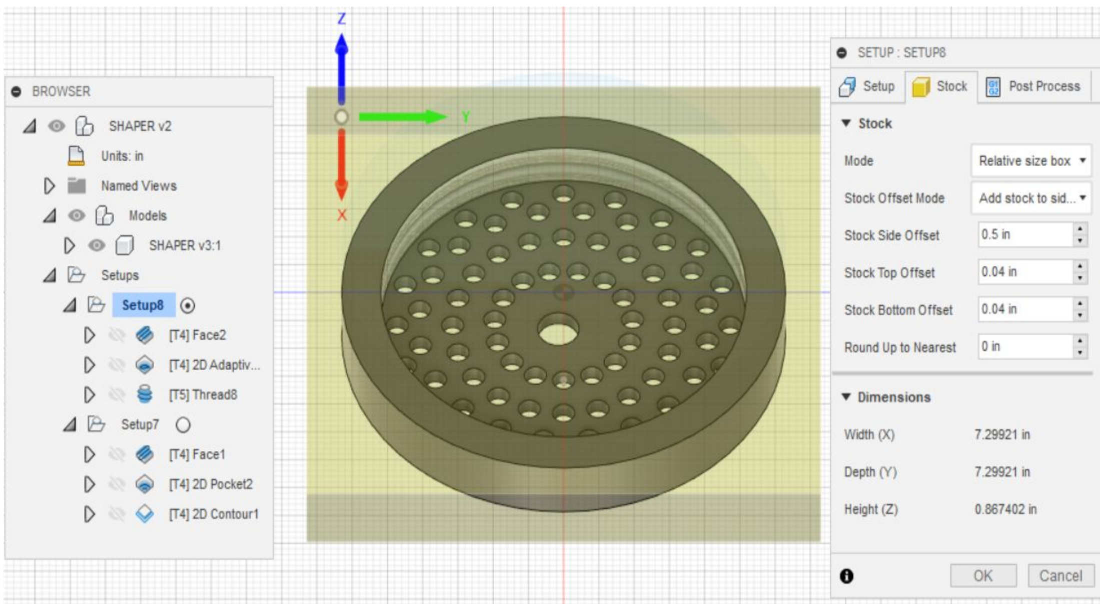
Corner View - Square hole and Ramp



Top face cornered view

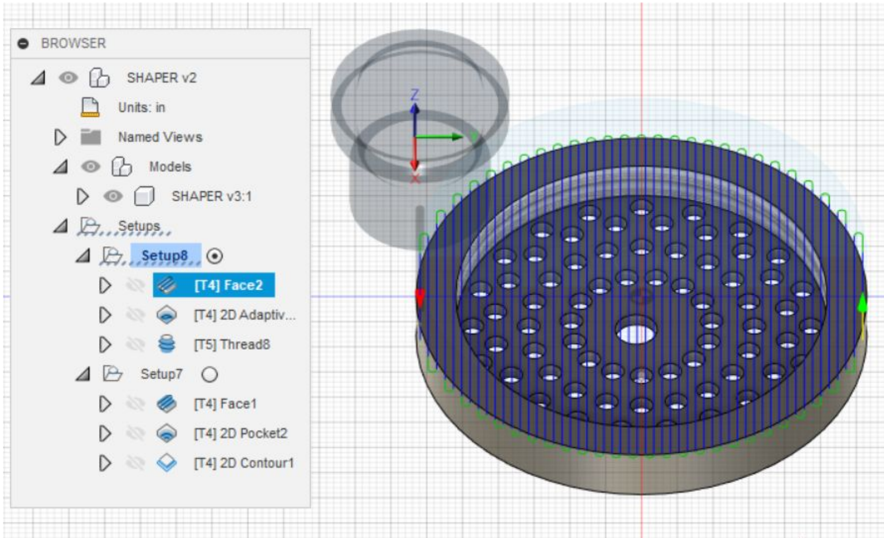
Part 2 - Shaper

The stock setup for the shaper part was created to have a 0.5 inches offset on the sides, and a 0.04 inches offset on the top and bottom as shown below. This extra 0.5 inches in the stock allows the vice to firmly grip onto the stock during machining. We have two setups ready for this CAM demonstration. The operations in the first setup are performed on the bottom face of the stock that is shown below, and the operations in the second setup are performed on the top face of the stock.

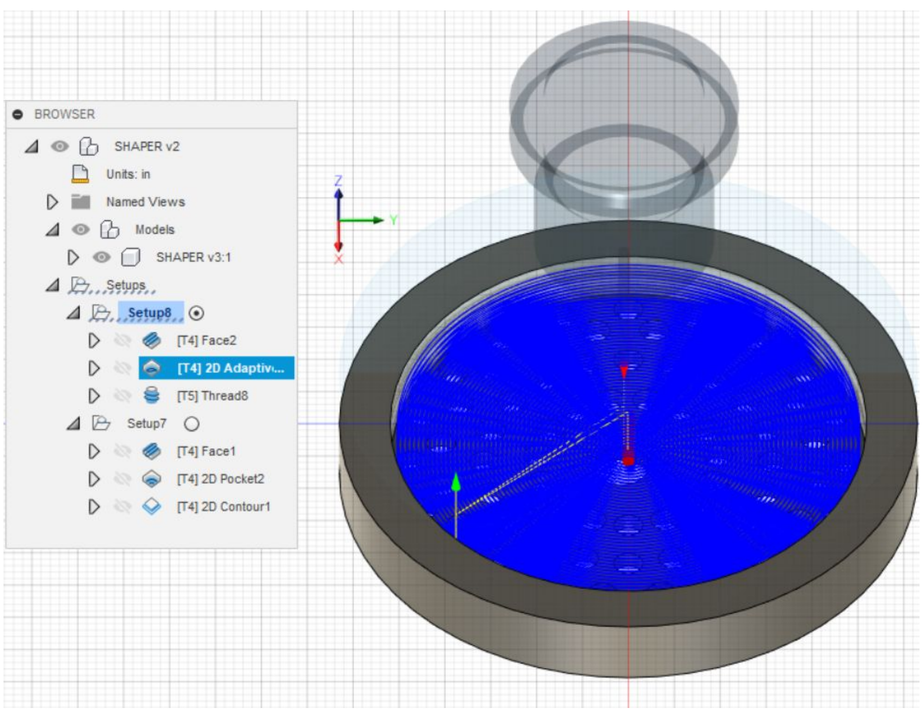


Bottom view operations:

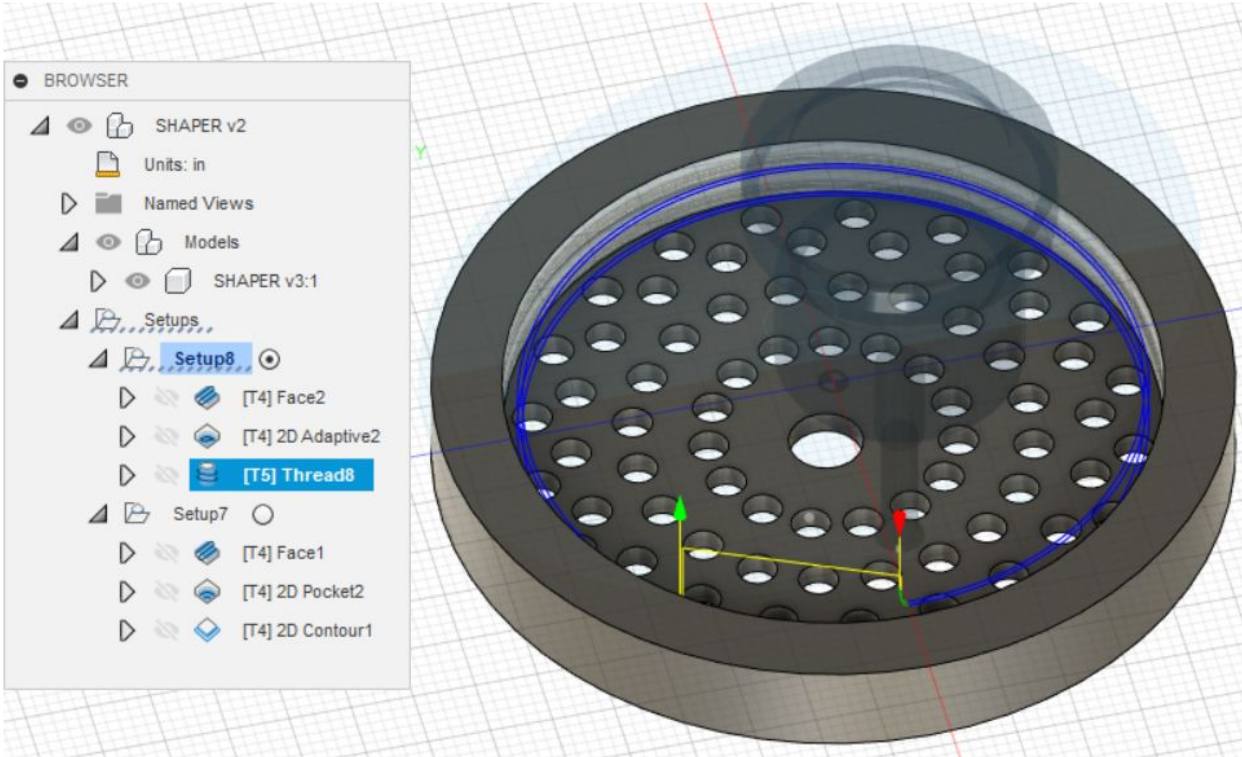
1. Firstly, a 2D face operation was performed using a ⅛” flat end mill to prepare the raw stock for machining.



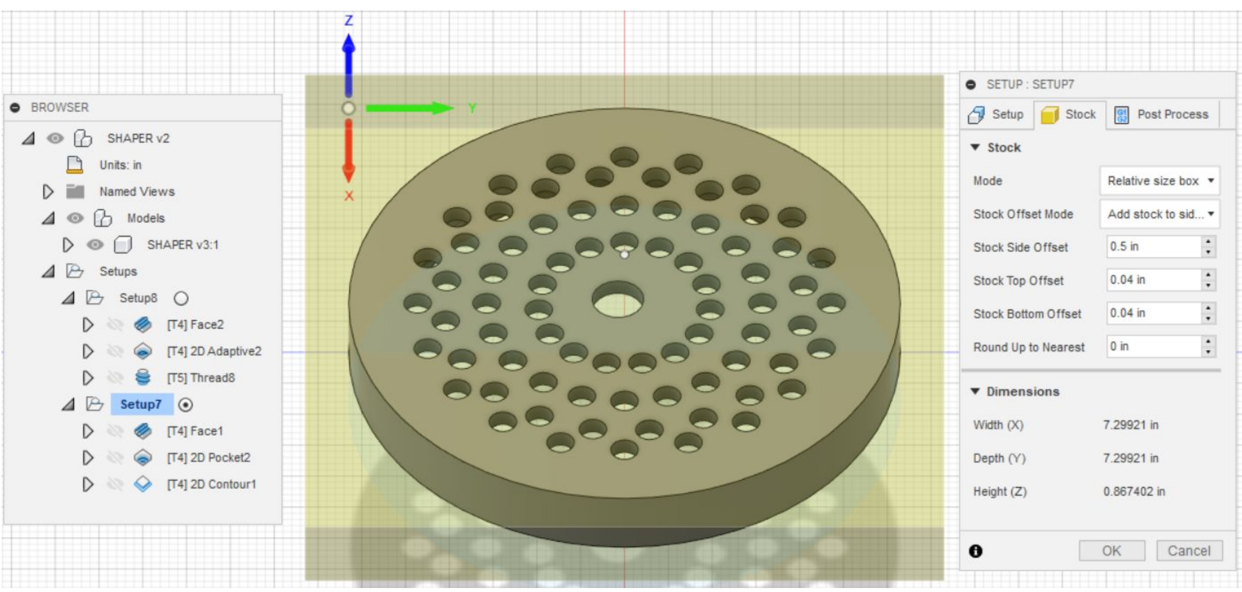
2. The following step would be a 2D adaptive operation using a ¼” flat end mill to clear out the hole before threading it. A maximum roughing stepdown of 0.1 inches was used to prevent the tool from cutting the entire depth at once. The required thread has a M140 x 8 designation, which means the pitch is 0.315 inches. Our required thread percentage is 75%. Therefore, our required minor diameter is 5.191 inches , and our required major diameter is 140mm (5.51181 in). This operation will clear out the hole to our required minor diameter of 5.191 inches.



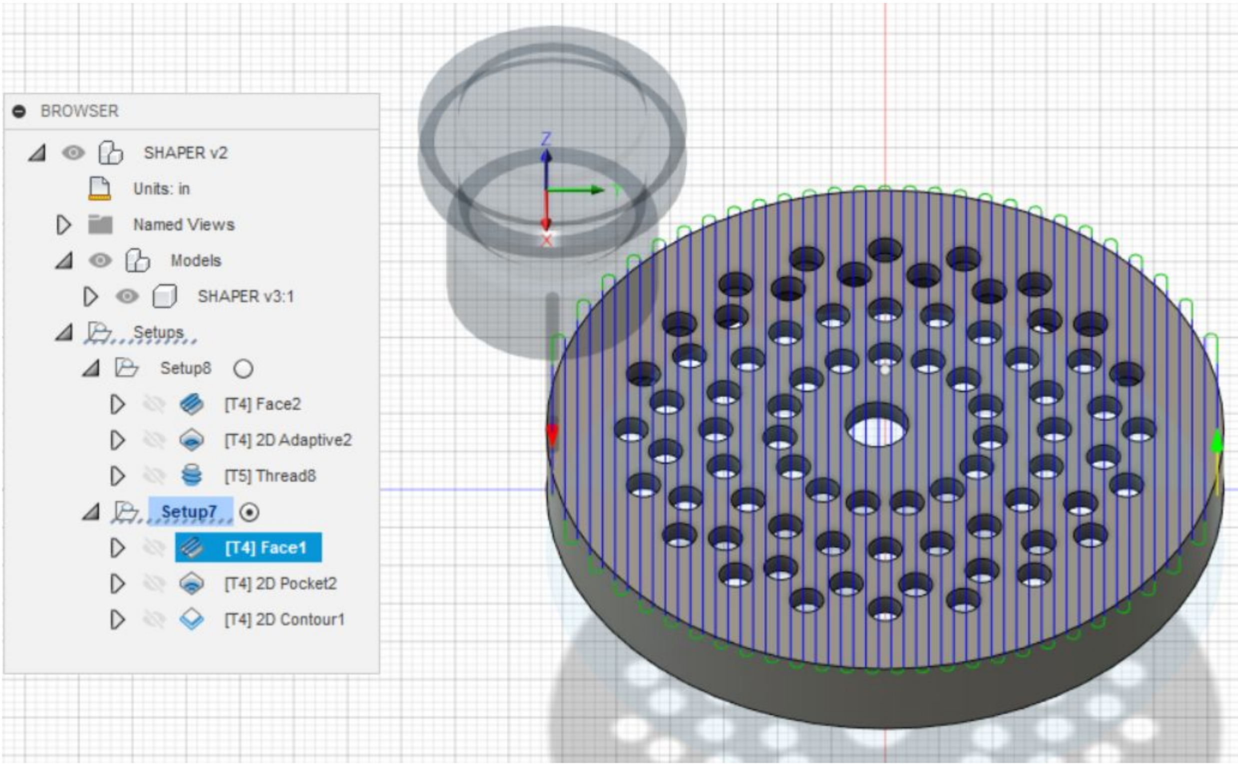
3. The following step would be a threading operation on the hole that we just created in the step before.We are going to use a thread mill shown in the list of tools below. The thread pitch would be 0.315 inches and the pitch diameter offset which is the difference between the major diameter and minor diameter is 0.32 inches.



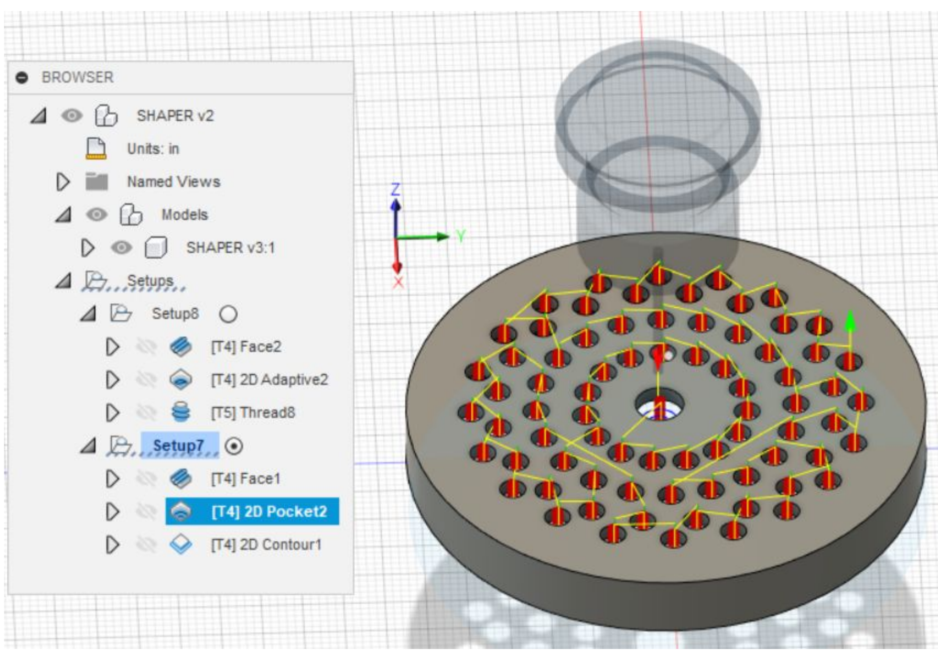
Top view operations:



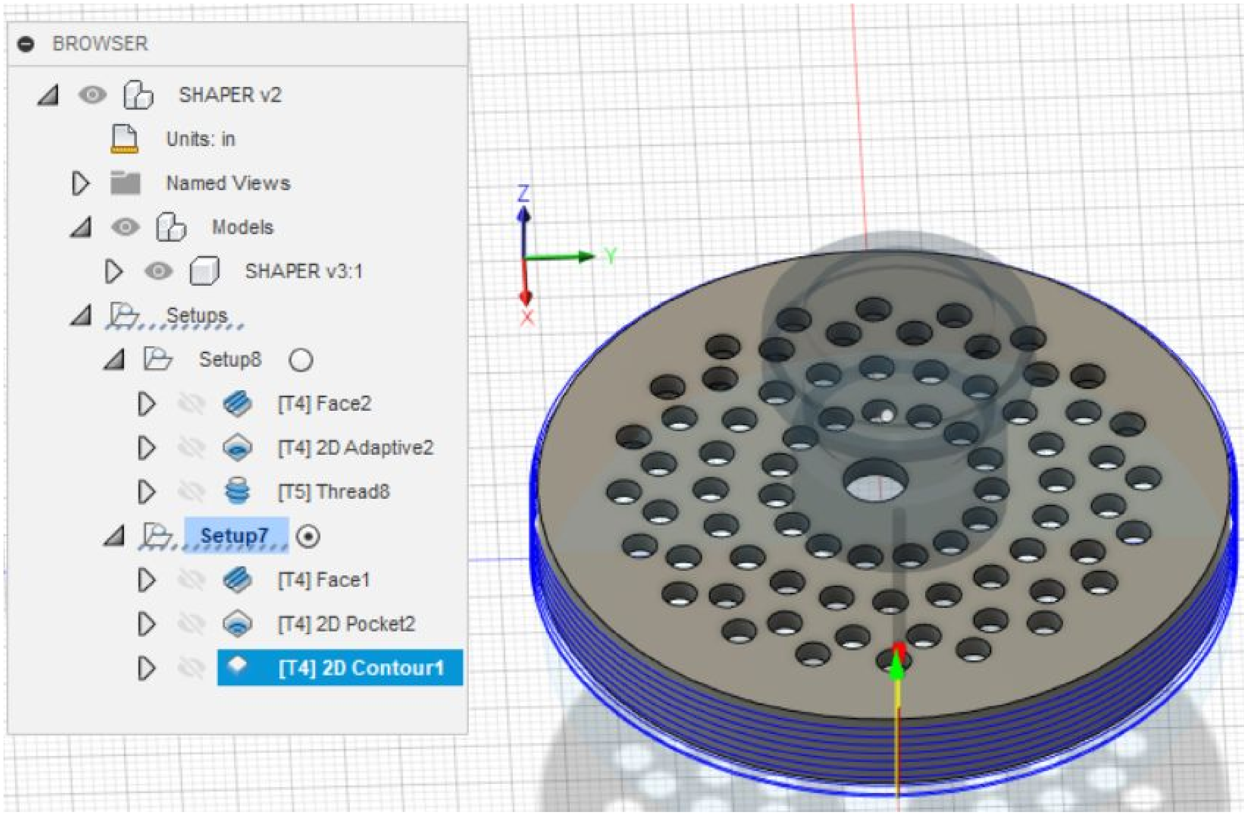
1. After flipping the stock to its top side, we performed a 2D face operation using a ⅛” flat end mill to prepare the top of the stock for machining.



2. The next step would be a 2D pocket operation using a ⅛” flat end mill on the 76 holes that are on the top of the shaper.



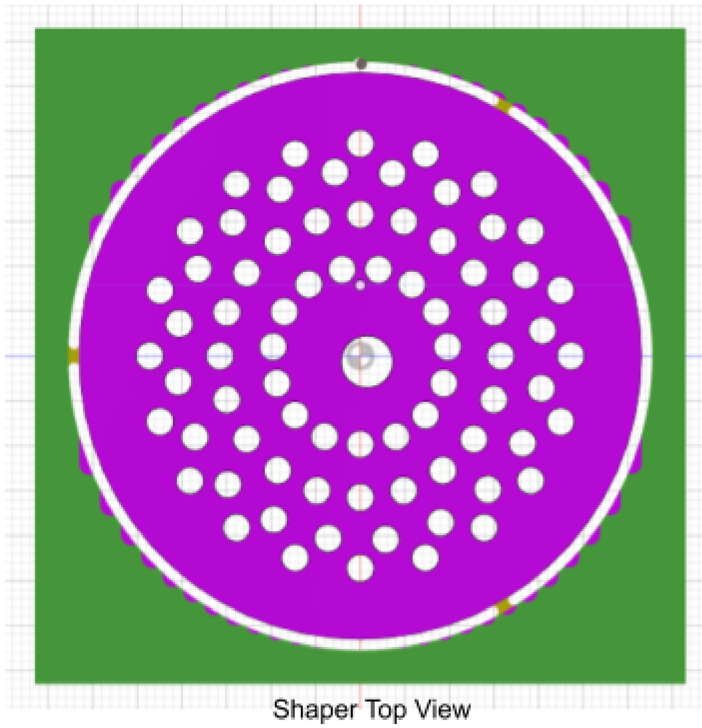
3. The final operation would be a 2D contour to separate the manufactured handle bar from the excess stock while leaving Three tabs behind to prevent the part from breaking free during the machining process. The maximum roughing stepdown was set to 0.1 inches to prevent the tool from cutting through the entire depth at once. The tool used a ¼” flat end mill.

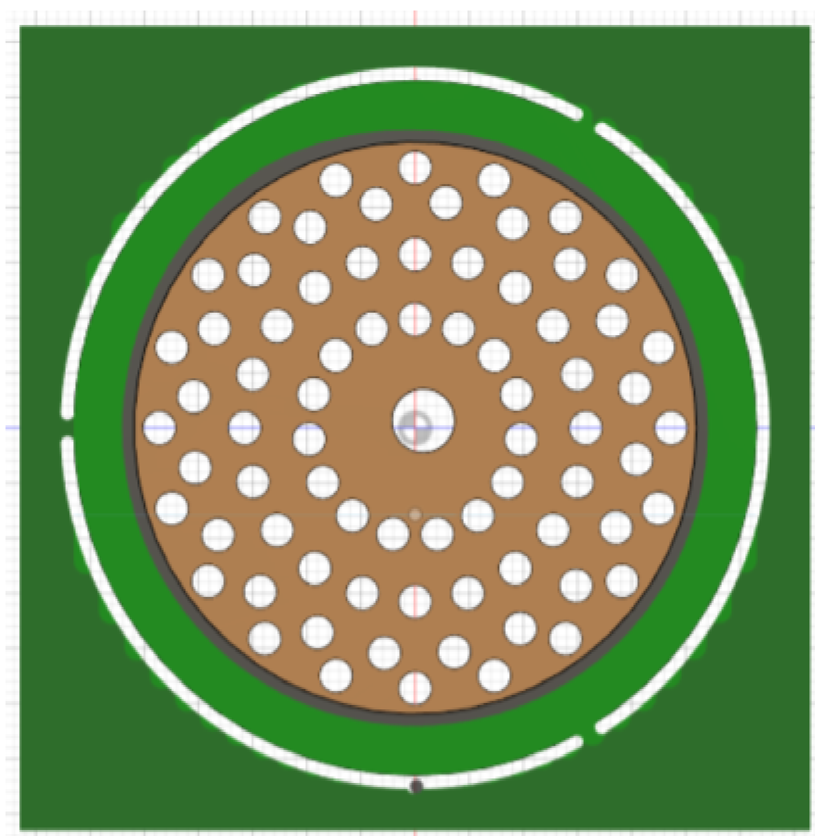


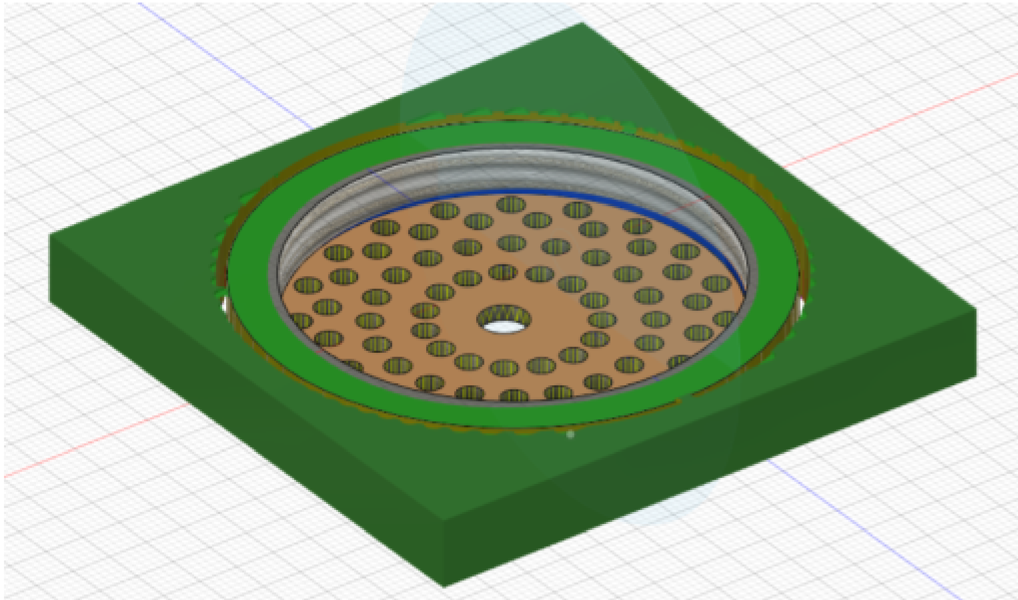
The following tools were used to machine the handle bar:

Name	Cutting diameter	Corner radius	Overall length	Flute length	Surface speed
SHAPER v3					
4 - Ø1/8" - flat	0.12500 "	0 "	2.0000 "	0.25000 "	985.00 ft/min
5 - Ø0.393701" - thread mill	0.39370 "	0 "	1.9685 "	0.59100 "	515.35 ft/min

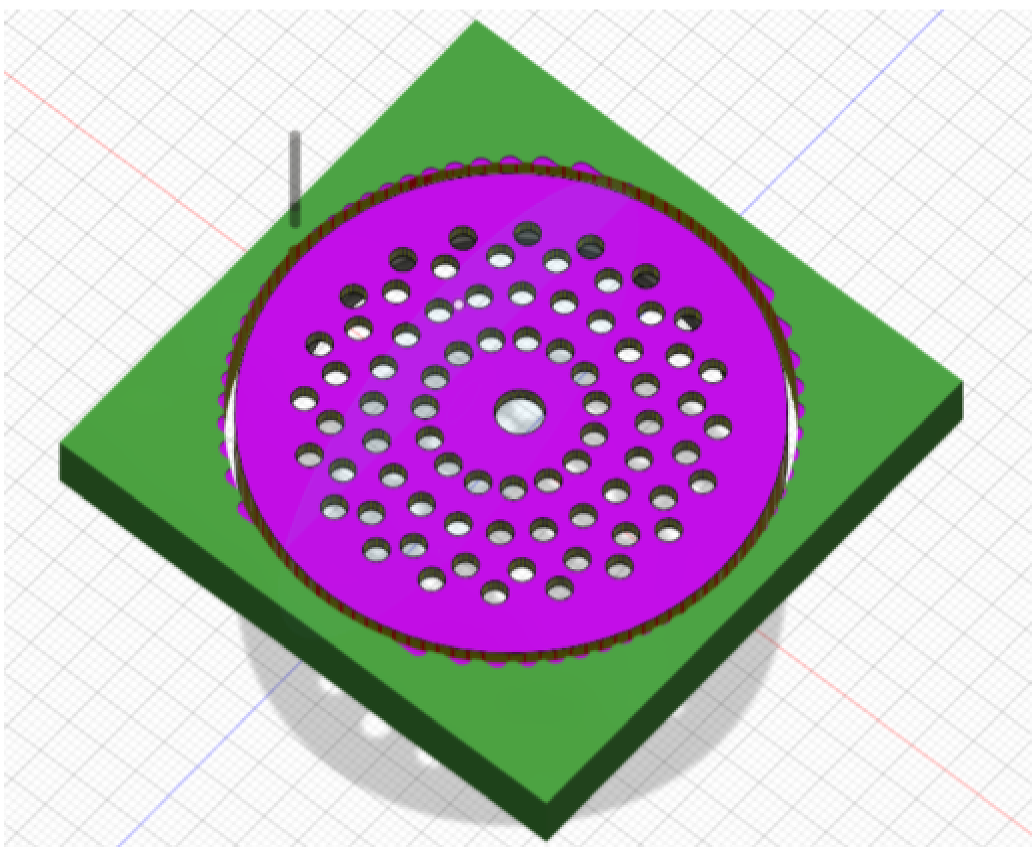
The results of the simulation can be seen below:


Shaper Top View


Shaper Bottom View



Shaper Bottom Corner View - Visible threads



Shaper top corner view

One of the main difficulties encountered in this CAM demonstration was machining the ramped area on the handle bar. The ball end mill that we used for surface finishing kept milling into the middle segment that was not part of the ramp, making it really hard to machine a very accurate ramp. To try and address that, we tried using the “avoid/touch surfaces” feature under the parallel operation to try and constrict the toolpath of the ball end mill to be strictly within the ramp. One other problem that we encountered with the ramp was that the ball end mill was missing the sides of the ramp. This left a lot of rough edges at the sides of the ramp. To try and fix that, we decided to add an offset to the tool containment to try and cover the sides of the ramp that the tool was not able to reach. Another issue was the threading inside the shaper part. The diameter of that threaded hole was really big, making it really hard to work with using a threaded mill with a small diameter. Something we learned from the CAM development was that some tabs need to be left in place to attach the part to the extra stock to make sure that the part doesn't break free during machining. To reduce machining time we would probably get rid of the ramp on the bar handle as it does not serve a very important mechanical role, as it is costing a lot of machining time with its rough and finishing operations. Another thing we can do to reduce the machining time is manually threading the hole in the handle bar, as we save some machine power and machining time doing so.