Ruler

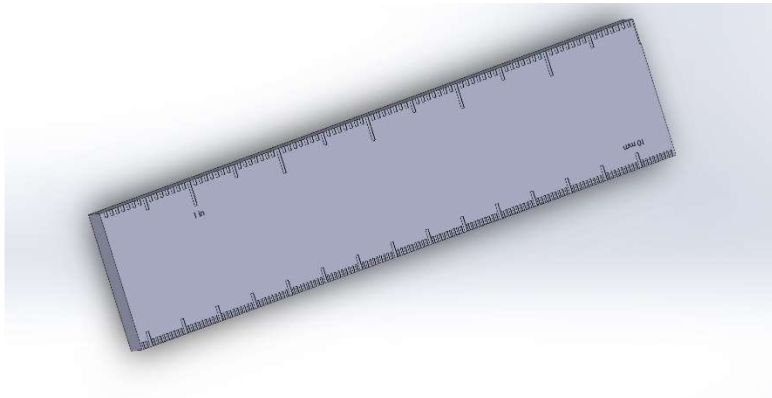


Figure 1: Solid Model of Ruler

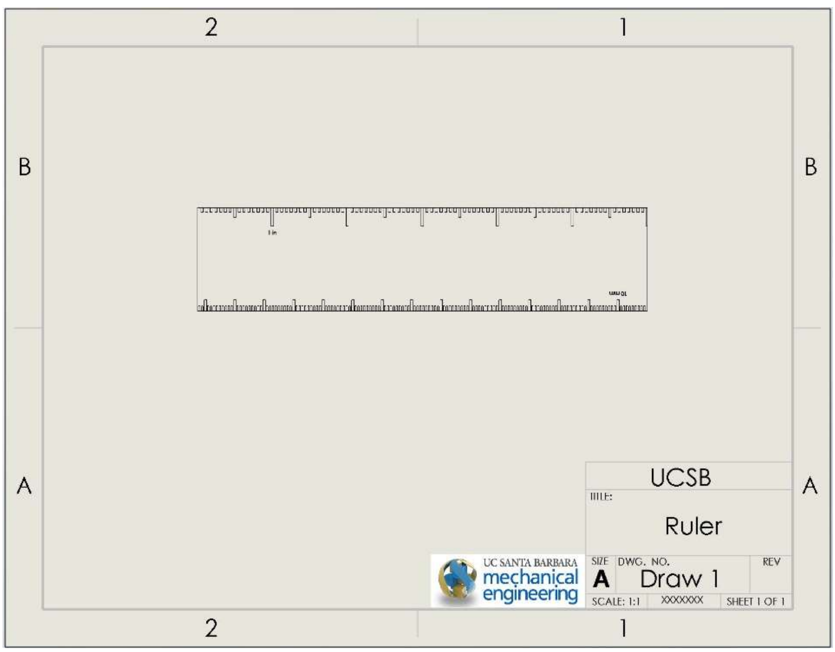


Figure 2: Drawing of Ruler Template

This project was an introduction to using linear patterns to make a simple ruler template. The ruler has a side inches and millimeters and can be printed to scale to be used immediately.

Tooling Table

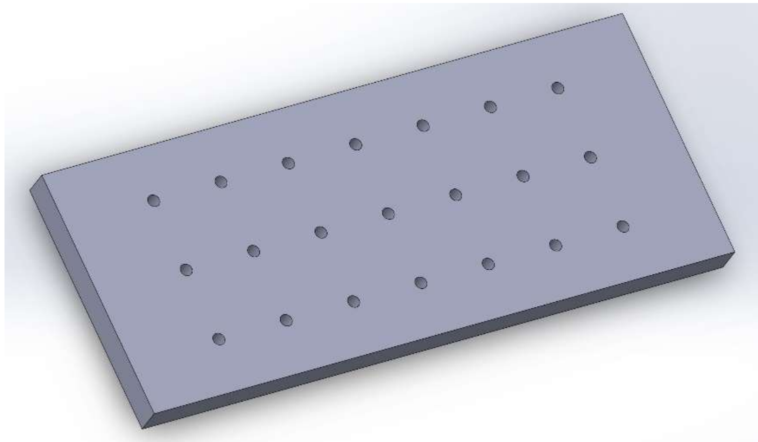


Figure 3: Solid Model of Tooling Table

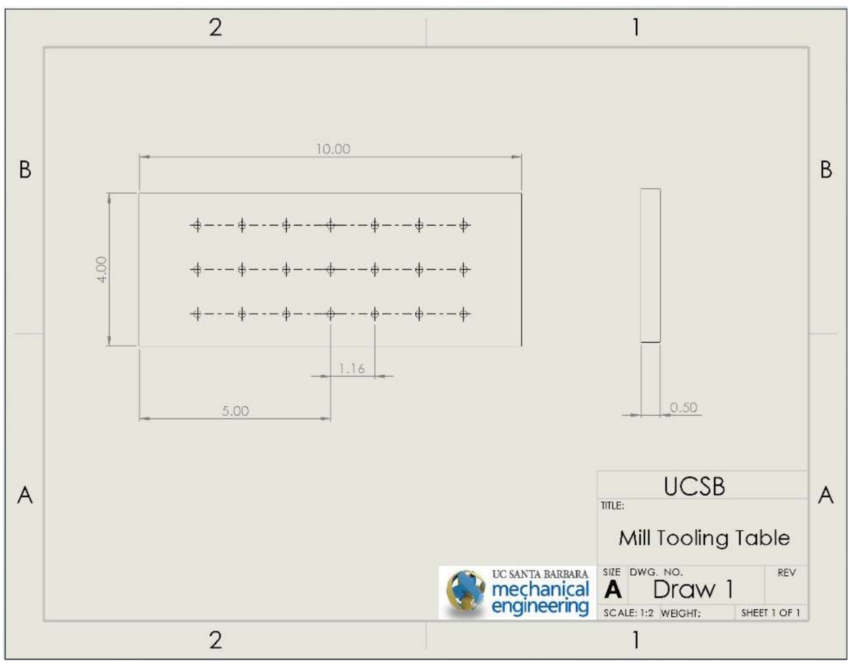


Figure 4: Drawing of Tooling Table

For this project, I designed a simple tooling plate that can be used on a Sherline Mill. This project was later used in another design project but was another great introductory to linear patterns.

Lab 3 Milling and Drilling

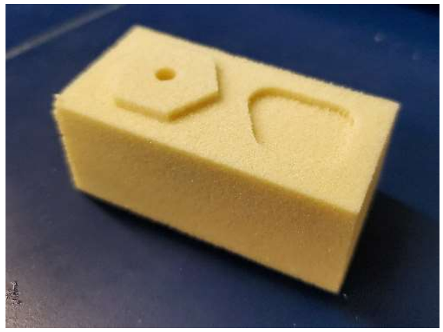
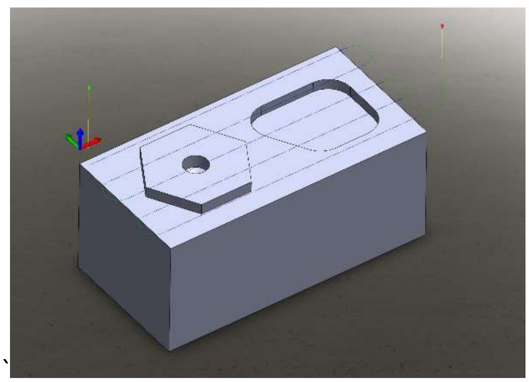
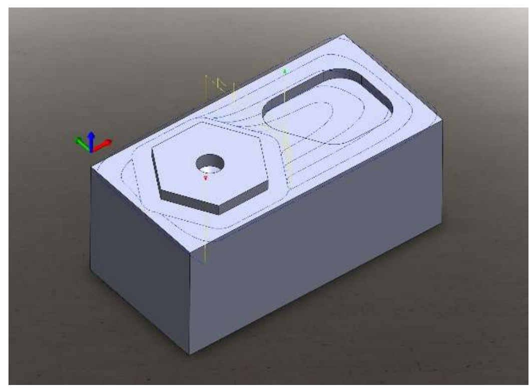


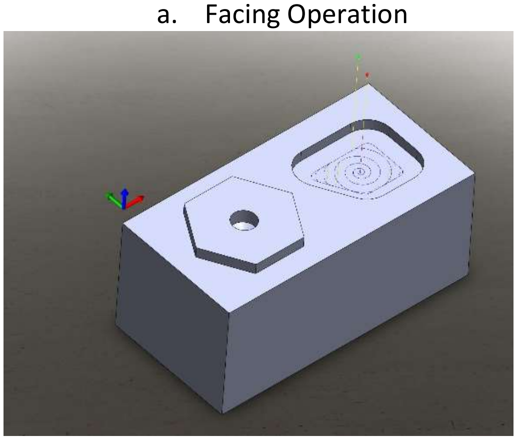
Figure 5: Lab 3 Part



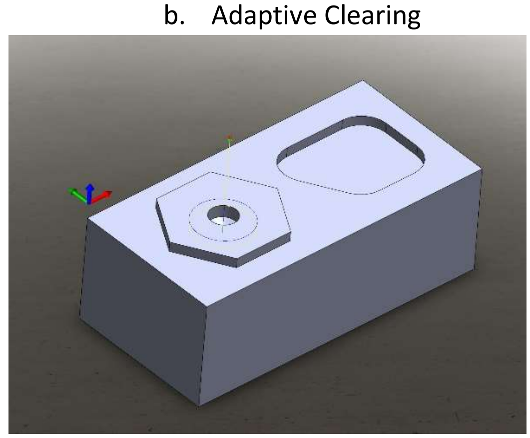
a. Facing Operation



b. Adaptive Clearing



c. Pocket Clearing



d. Hole Drilling

Figure 6: HSM Tool Path for Part

For this assignment, I learned to use the HSM add-in to simulate paths that can later be processed into GCode. In Figure 5, you see the result of the part that was created. In Figure 6, you see the operations that were done to the part. A total of 4 different milling operations were done giving great practice in all commands.

2x4 Cantilever Beam FEA

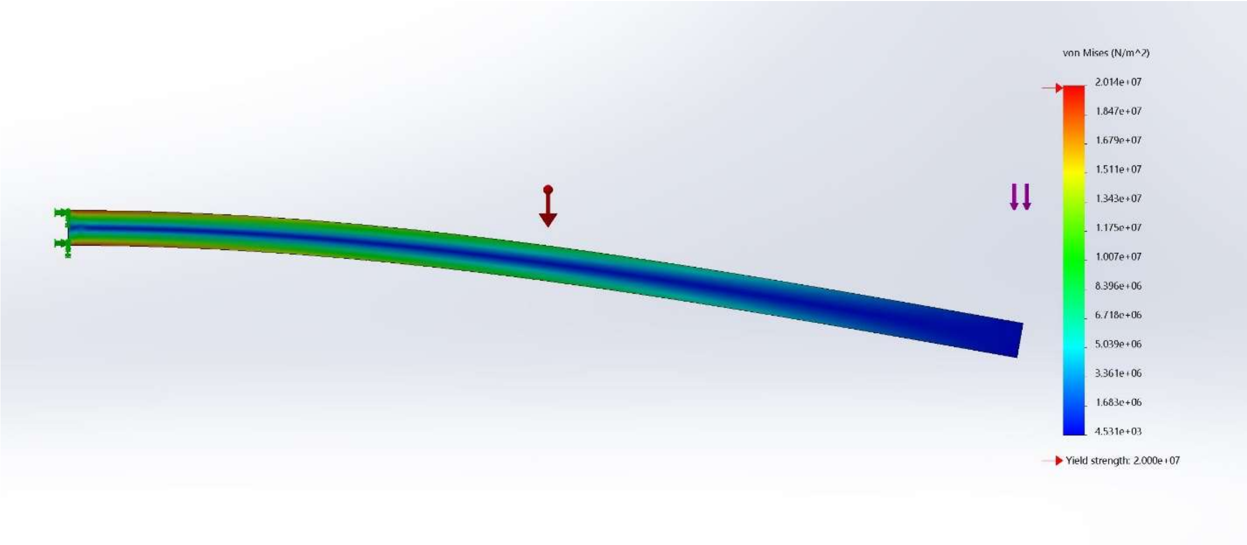


Figure 7: FEA of a 2x4 Beam

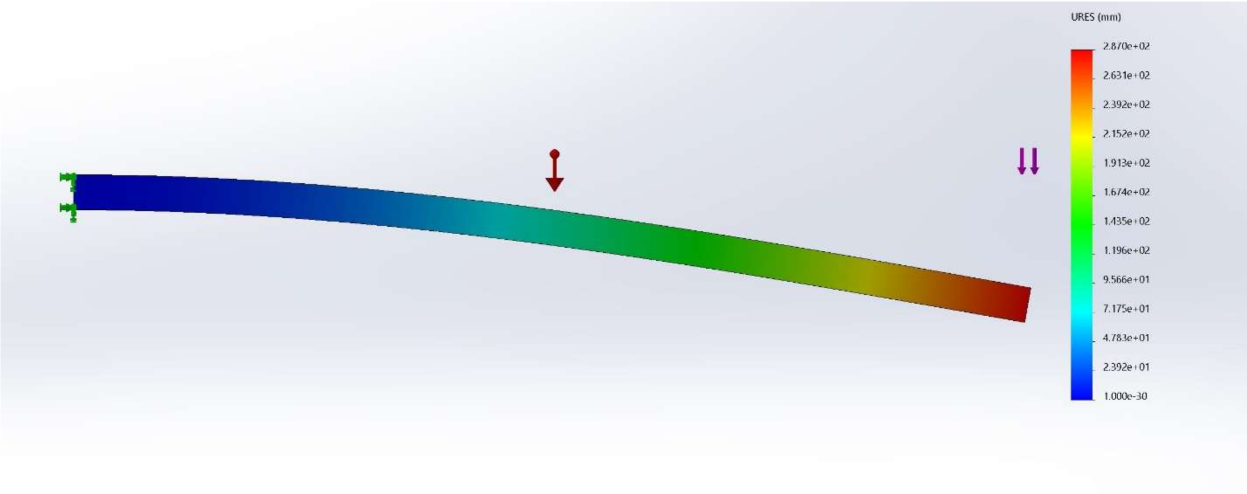


Figure 8: Displacement due to Force Applied

In this assignment, the simulation add-in was used to find the finite element analysis (FEA) of a 2x4 beam under a force load. Figure 7 displays the Von Mises stresses in the beam when the load is applied while the displacement is shown in Figure 8. This is a simple introduction to the tool to help us in other projects.

Thin Wall Dyno FEA

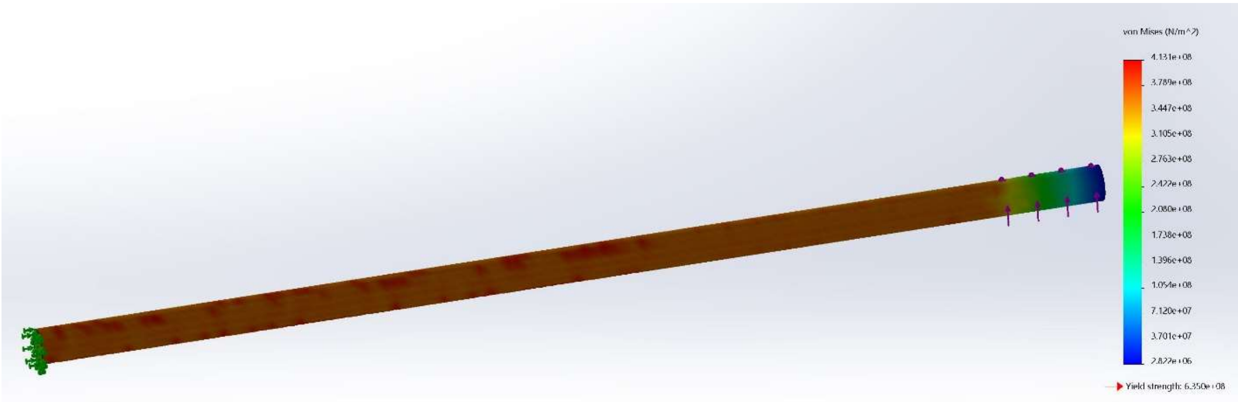
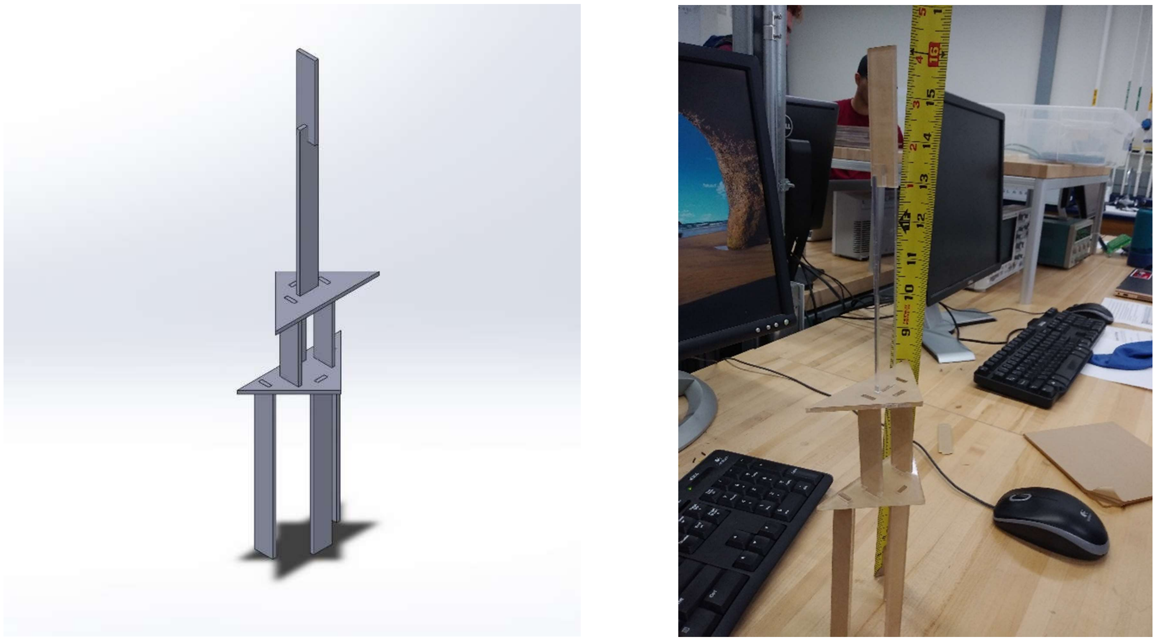


Figure 9: FEA of a Thin Wall Dyno

For this assignment, the simulation add-in was used to find more advanced force applications. In Figure 9, you see a thin walled beam undergoing a torque force at a specified section of the beam while the other end is held in place. This is to simulate the stresses that the beam would have if it were being applied to a motor.

Laser Cutting and Constructing Acrylic Tower

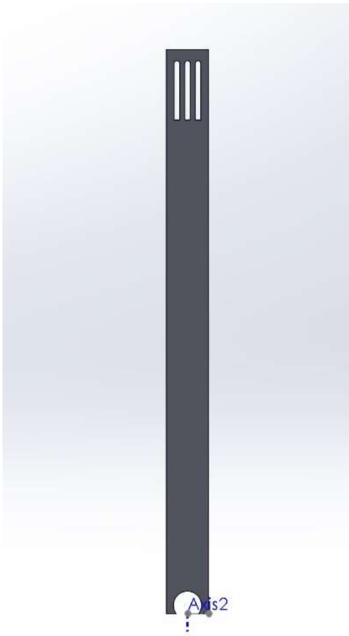


a. Solidworks Model *b. Actual Model*

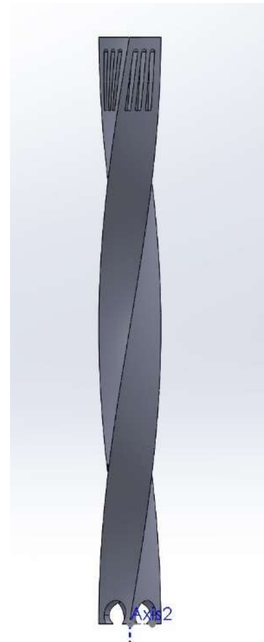
Figure 10: Acrylic Tower Design

For this assignment, I was introduced to how to use the program Retina Engrave to laser cut acrylic. This tower is made from a 5.5” x 5.5” piece of acrylic to make the tallest building possible. For this design, I was focused more on stability. However, when cut, the pieces of acrylic provided a tighter fit than expected so the design was not efficient.

Storke Tower



a. *Original Design*



b. *Original*

Figure 11: Storke Tower Design

This assignment introduced us to global variables in Solidworks. This is a useful tool to help change any part of the design without having to compensate for parts. In Figure 11 a, the original design of Storke Tower is shown while Figure b shows the result of using the Flex feature on Solidworks. This feature is also controlled by a global variable despite not being able to define it with a global variable at first.

Card Holder Fixture and Engraving via HSM

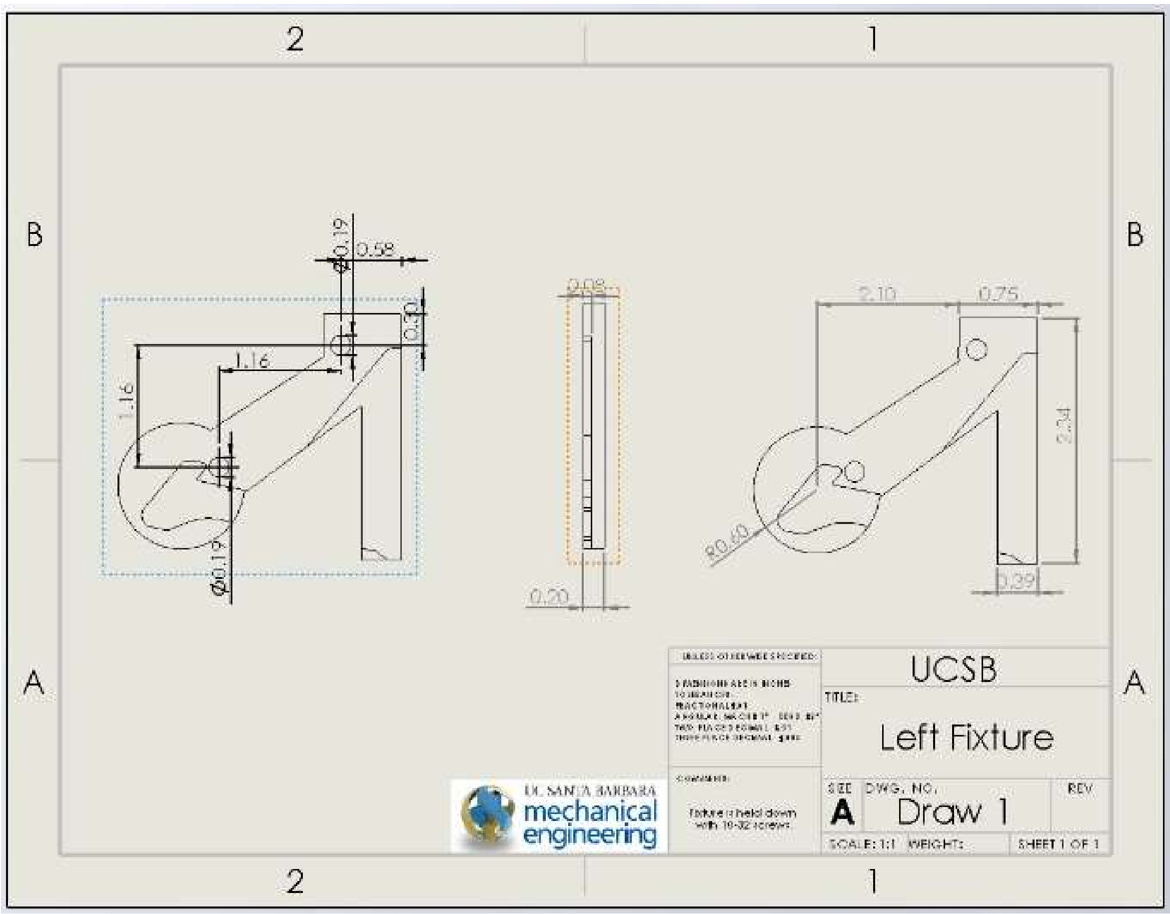


Figure 12: Left Fixture

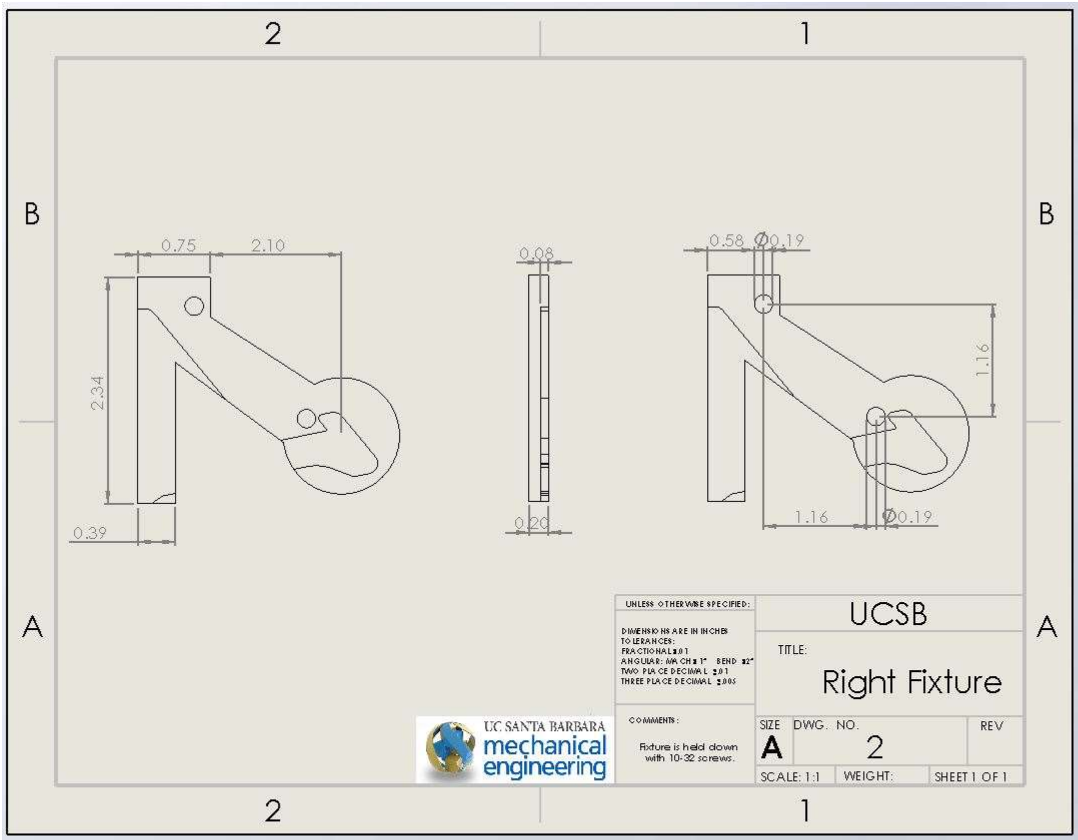


Figure 13: Right Fixture

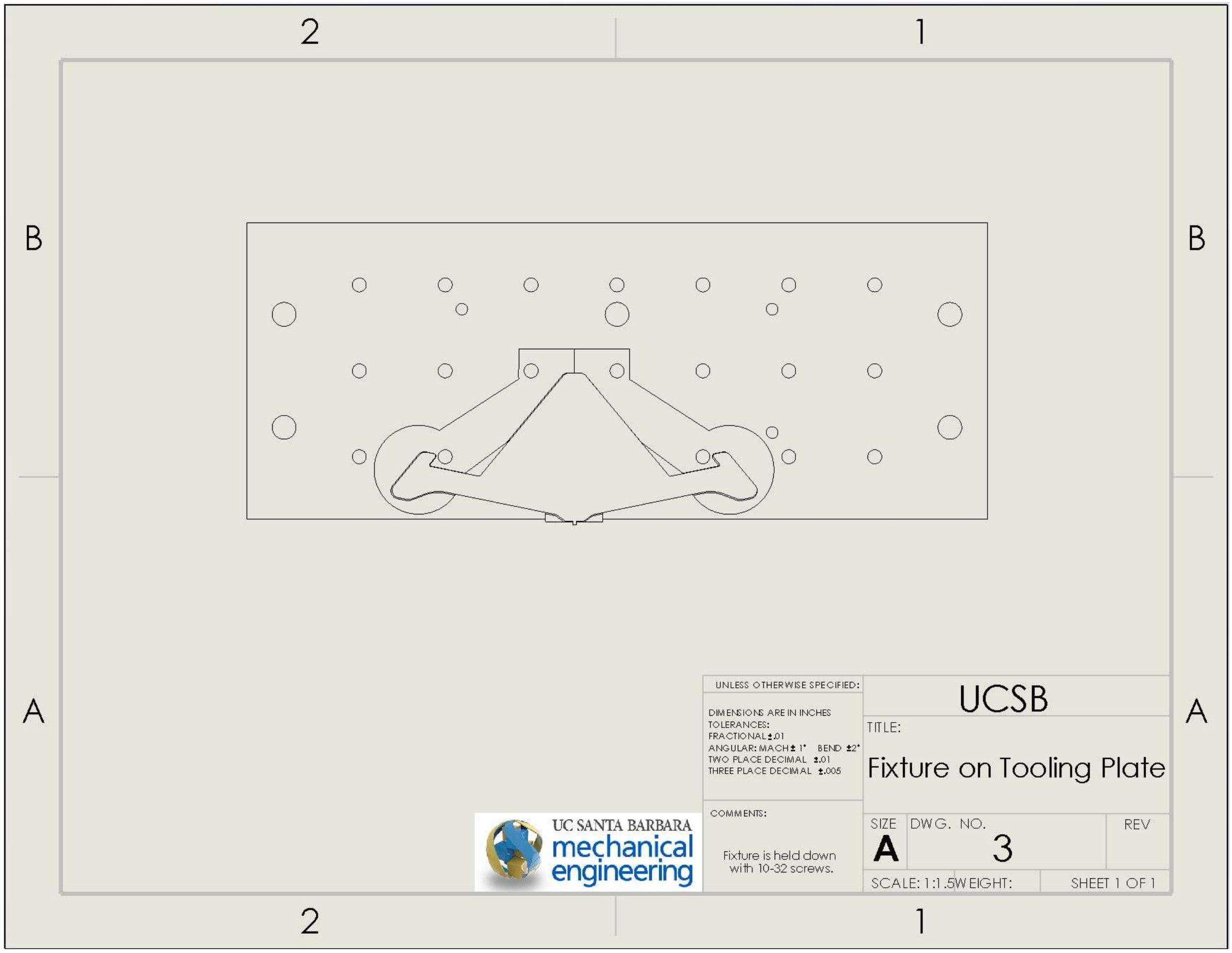


Figure 14: Complete Fixture Placement

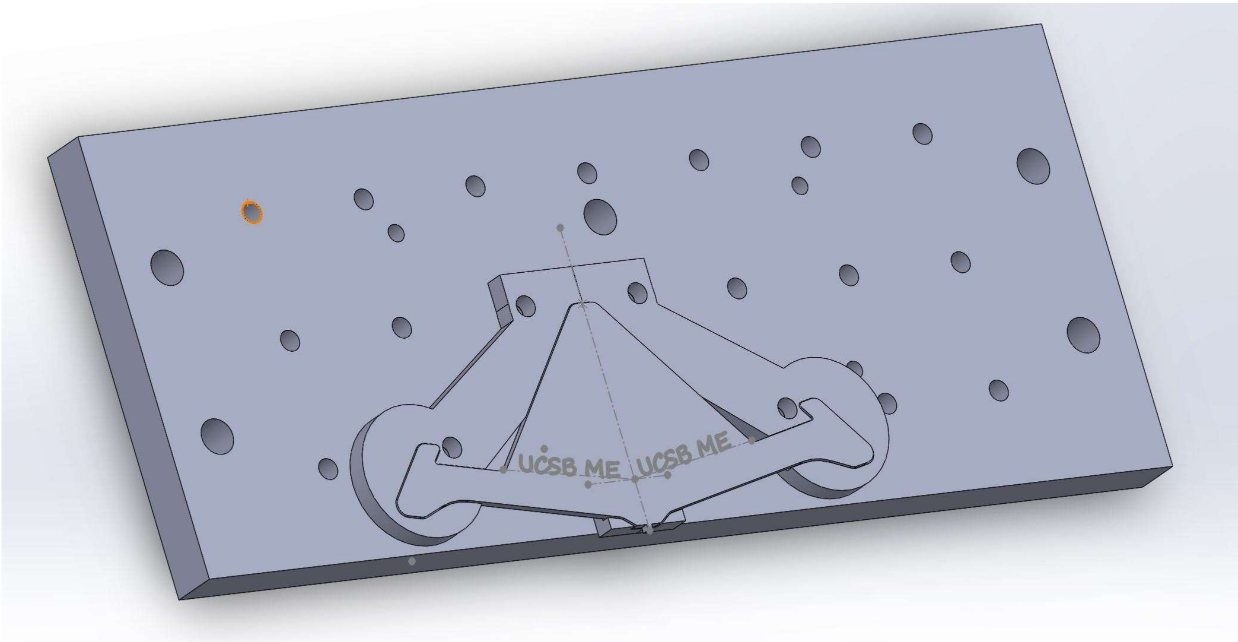


Figure 15: Model of Fixture

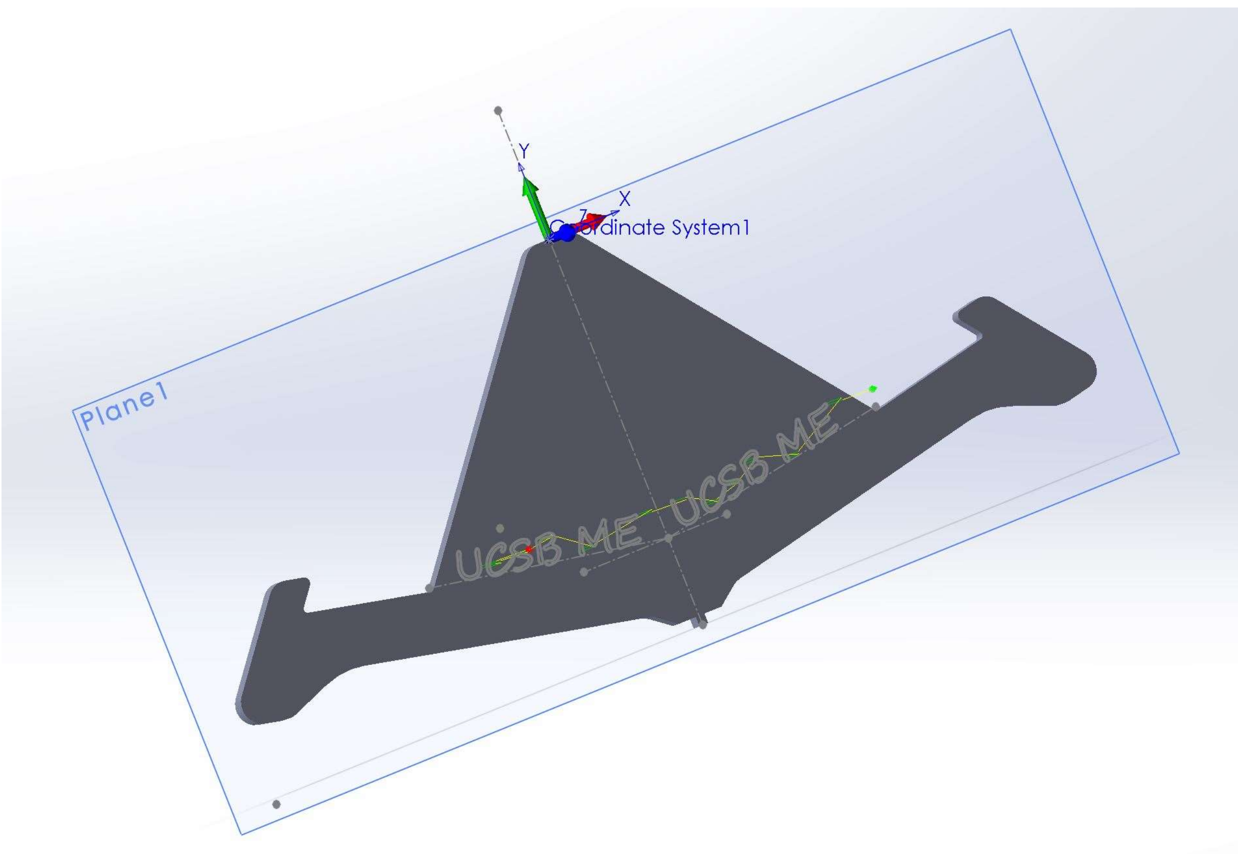


Figure 16: Engraving Tool Path

For this assignment, I designed a fixture that will hold the card holder that is depicted in Figure 16. The fixture design can be seen in both Figure 12 and 13. This fixture has a tight hold on the card holder while it is being engraved. To use this fixture, it needs to be held down on the tooling plate with 10-32 screws in the indicated holes in Figure 14. The tooling fixture does not need to placed as indicated in Figure 14 and 15 but it is ideal to keep it towards the top of the tooling table to ensure the mill can reach it.

Individual Project

Solidworks Model

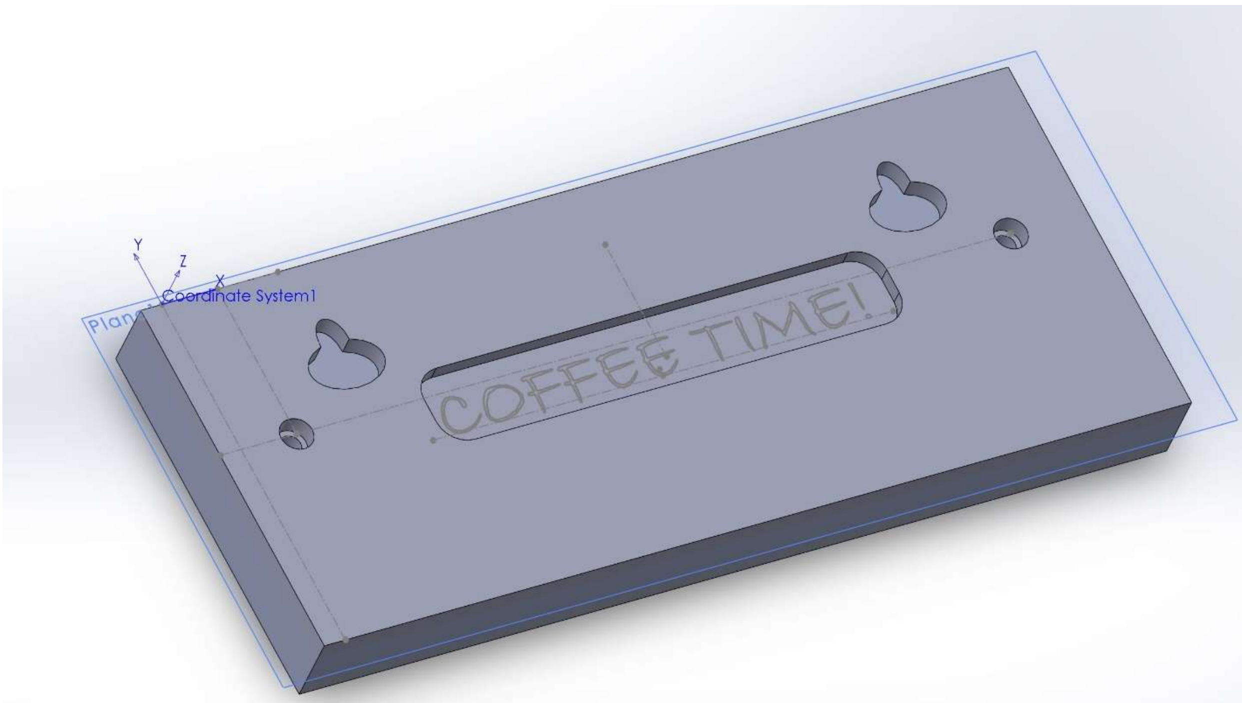


Figure 17: Final Solidworks Model

Sherline Mill Paths

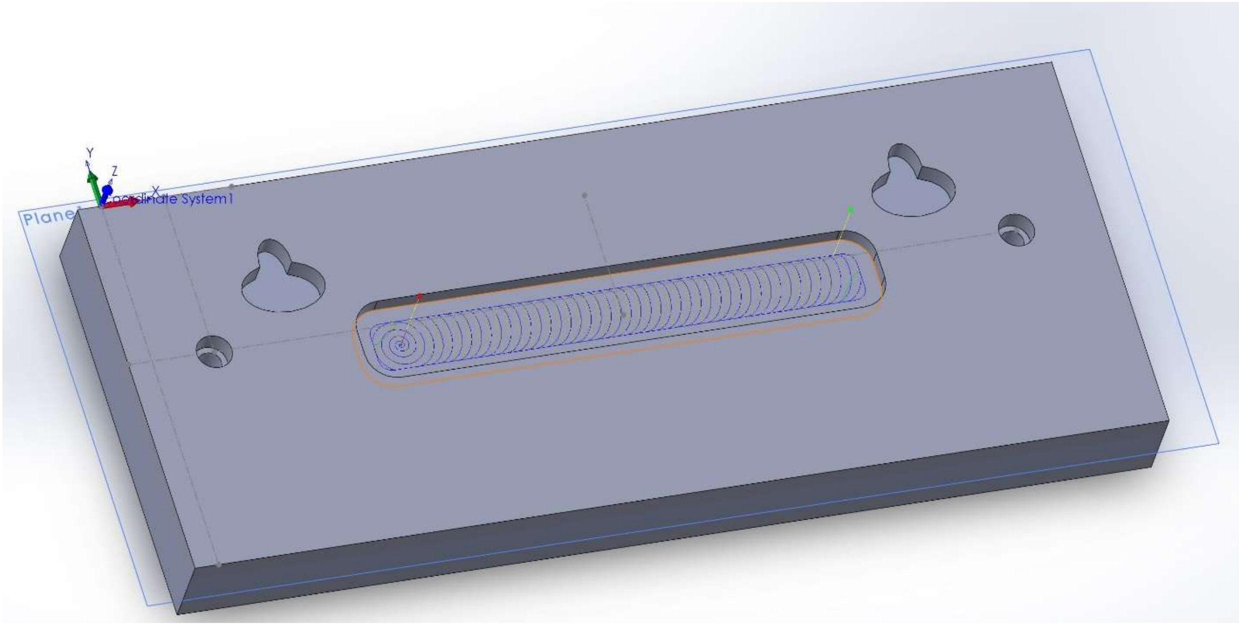


Figure 18: Tool Path for Text Pocket

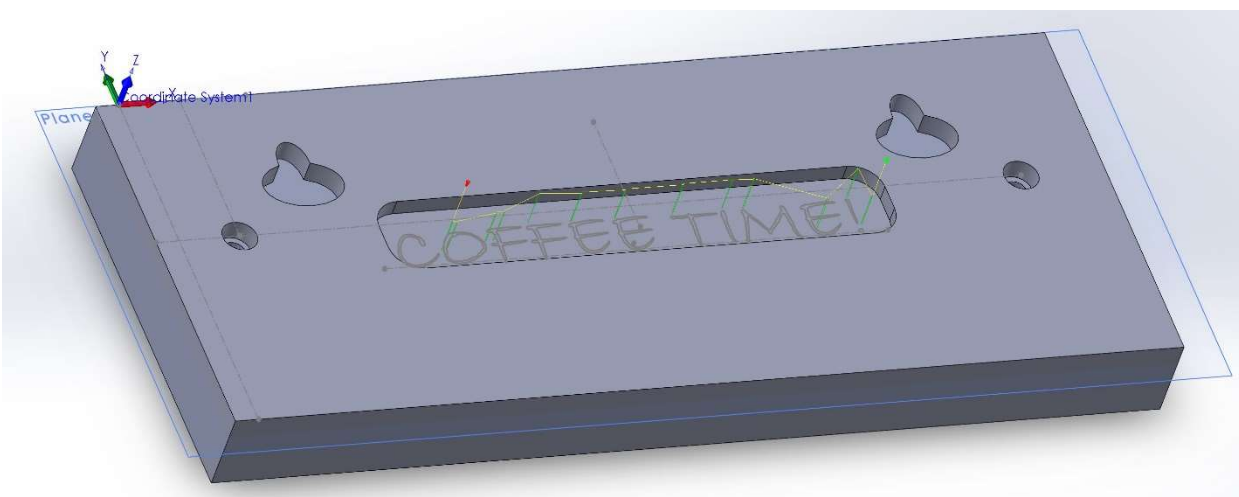


Figure 19: Tool Path for Text Engraving on Sherline Mill

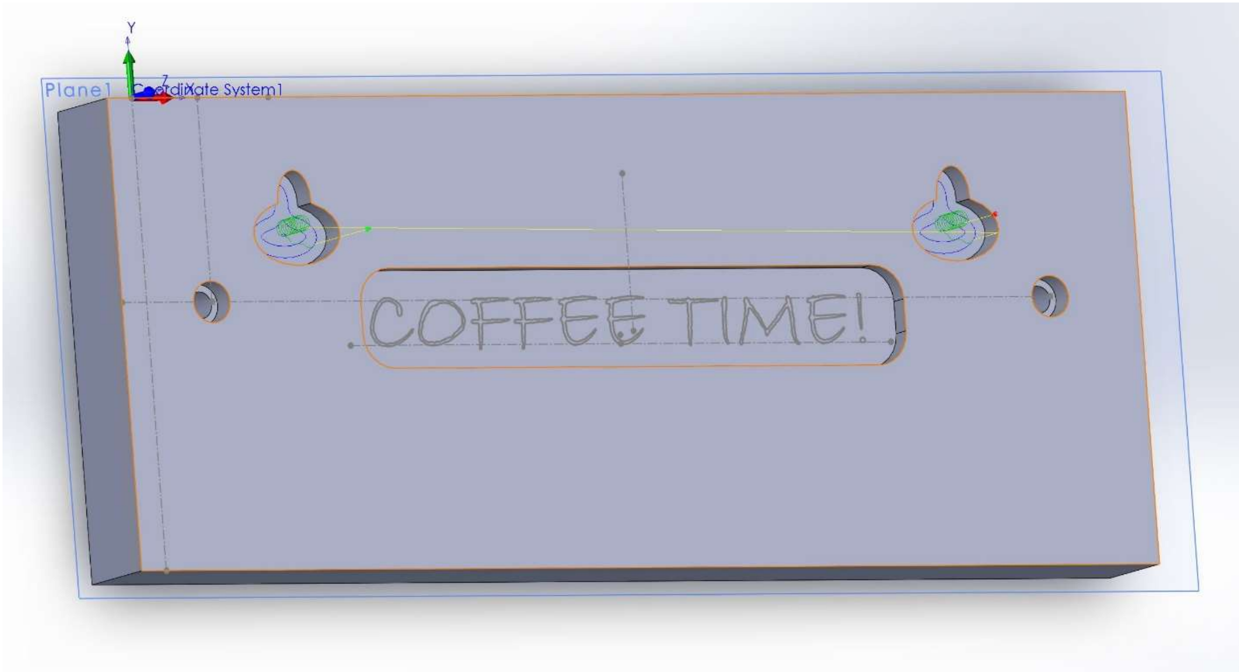


Figure 20: Tool Path for Pockets for Hanging

Drawing

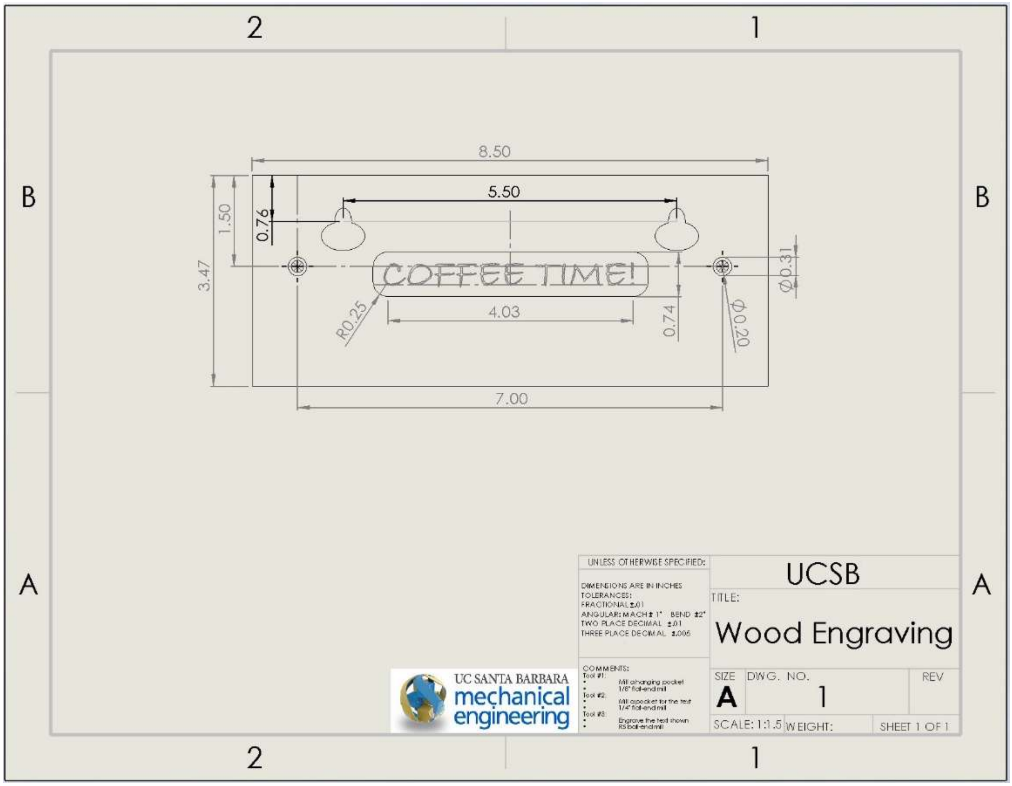


Figure 21: Drawing of Wood Engraving

Final Product

Figure 22: Front Side of Final Project

Figure 23: Back Side of Final Project

Samples of GCode

```
%
O1324 (ME 158 LAB)
(Mark Barajas Individual Project)
(This code will create pockets at the back of the stock)
(T5 D=0.125 CR=0. - ZMIN=-0.1961 - FLAT END MILL)
N10 G90 G94 G17 G49 G40 G80
N15 G20

(2D POCKET1)
N20 T5 M06
N25 S10000 M03
N35 G00 X6.7587 Y-0.9849
N40 G43 Z0.6 H05
N45 G00 Z0.2
N50 G01 Z0.1125 F10.
N55 G03 X6.7599 Y-0.9858 Z0.1065 I0.0354 J0.0477
N60 X6.7634 Y-0.988 Z0.102 I0.0342 J0.0486
N65 X6.7684 Y-0.9908 Z0.1 I0.0307 J0.0508
N70 X6.8197 Y-0.8836 Z0.0837 I0.0256 J0.0536
N75 X6.7684 Y-0.9908 Z0.0674 I-0.0256 J-0.0536
N80 X6.8197 Y-0.8836 Z0.051 I0.0256 J0.0536
N85 X6.7684 Y-0.9908 Z0.0347 I-0.0256 J-0.0536
N90 X6.8197 Y-0.8836 Z0.0184 I0.0256 J0.0536
N95 X6.7684 Y-0.9908 Z0.0021 I-0.0256 J-0.0536
N100 X6.8197 Y-0.8836 Z-0.0142 I0.0256 J0.0536
N105 X6.7684 Y-0.9908 Z-0.0306 I-0.0256 J-0.0536
N110 X6.8197 Y-0.8836 Z-0.0469 I0.0256 J0.0536
N115 X6.7684 Y-0.9908 Z-0.0632 I-0.0256 J-0.0536
N120 X6.8197 Y-0.8836 Z-0.0795 I0.0256 J0.0536
N125 X6.7684 Y-0.9908 Z-0.0958 I-0.0256 J-0.0536
N130 X6.8197 Y-0.8836 Z-0.1122 I0.0256 J0.0536
N135 X6.7684 Y-0.9908 Z-0.1285 I-0.0256 J-0.0536
N140 X6.8197 Y-0.8836 Z-0.1448 I0.0256 J0.0536
N145 X6.7684 Y-0.9908 Z-0.1611 I-0.0256 J-0.0536
N150 X6.8197 Y-0.8836 Z-0.1774 I0.0256 J0.0536
N155 X6.7684 Y-0.9908 Z-0.1937 I-0.0256 J-0.0536
N160 X6.794 Y-0.9966 Z-0.1961 I0.0256 J0.0536
N165 X6.8064 Y-0.9962 I0.0002 J0.1825 F30.
N170 X6.8087 Y-0.9865 I-0.0004 J0.0052
N175 G02 X6.7979 Y-0.9796 I0.1237 J0.2058
N180 G03 X6.7901 I-0.0039 J-0.0058
N185 G02 X6.7793 Y-0.9865 I-0.1344 J0.1989
N190 G03 X6.7816 Y-0.9961 I0.0027 J-0.0045
N195 X6.794 Y-0.9966 I0.0126 J0.1821
N200 G02 X6.8454 Y-1.0294 I-0.0001 J-0.0567
N205 G03 X6.9016 Y-1.0532 I0.0412 J0.0191
N210 X6.9325 Y-1.0402 I-0.0924 J0.2627
N215 X6.9542 Y-1.0281 I-0.109 J0.221
N220 X6.9739 Y-1.0129 I-0.0689 J0.11
N225 X6.9735 Y-0.9864 I-0.0122 J0.013
N230 X6.9266 Y-0.958 I-0.1052 J-0.1207
N235 X6.8752 Y-0.9387 I-0.7919 J-2.0261
N240 G02 X6.8343 Y-0.916 I0.0503 J0.1388
N245 X6.8013 Y-0.8829 I0.1189 J0.1515
N250 G03 X6.7867 I-0.0073 J-0.0057
N255 G02 X6.7538 Y-0.9159 I-0.1521 J0.1185
N260 X6.7131 Y-0.9386 I-0.0912 J0.116
N265 G03 X6.6616 Y-0.9579 I0.8806 J-2.4207
```

Figure 24: GCode for Hanging Pockets

```
%
O1322 (ME 158 LAB)
(Mark Barajas Individual Project)
(This code will make a pocket for the engraved text)
(T4 D=0.25 CR=0. - ZMIN=-0.13 - FLAT END MILL)
N10 G90 G94 G17 G49 G40 G80
N15 G20

(2D ADAPTIVE1)
N20 T4 M06
N25 S5000 M03
N35 G00 X2.1608 Y-1.6285
N40 G43 Z0.6 H04
N45 G00 Z0.2
N50 Z0.1218
N55 G01 Z-0.13 F10.
N60 Y-1.6298 F40.
N65 X2.1621 Y-1.6296
N70 X2.1628 Y-1.6284
N75 X2.1624 Y-1.6271
N80 X2.1613 Y-1.6263
N85 X2.16
N90 X2.1587 Y-1.6269
N95 X2.1578 Y-1.6278
N100 X2.1573 Y-1.6291
N105 X2.1574 Y-1.6304
N110 X2.1587 Y-1.6327
N115 X2.1598 Y-1.6335
N120 X2.1624 Y-1.6343
N125 X2.1651 Y-1.6339
N130 X2.1673 Y-1.6324
N135 X2.1688 Y-1.6301
N140 X2.1695 Y-1.6275
N145 X2.1692 Y-1.6248
N150 X2.1682 Y-1.6223
N155 X2.1648 Y-1.6181
```

Figure 25: GCode for Engraving Pocket

```
%
O1324 (ME 158 LAB)
(Mark Barajas Individual Project)
(This code will trace the text on the back of the project)
(T6 D=0.0625 CR=0. - ZMIN=-0.2 - BALL END MILL)
N10 G90 G94 G17 G49 G40 G80
N15 G20

(TRACE1)
N20 T6 M06
N25 S10000 M03
N35 G00 X2.3299 Y-1.6817
N40 G43 Z0.6 H06
N45 G00 Z0.2
N50 G01 Z-0.12 F5.
N55 Z-0.1937
N60 X2.3297 Y-1.6819 Z-0.1957
N65 X2.3289 Y-1.6823 Z-0.1974
N70 X2.3277 Y-1.683 Z-0.1988
N75 X2.3262 Y-1.6839 Z-0.1997
N80 X2.3245 Y-1.6849 Z-0.2
N85 X2.3127 Y-1.6919 F15.
N90 X2.3153 Y-1.7019
N95 X2.3147 Y-1.7044
N100 X2.3134 Y-1.7065
N105 X2.3114 Y-1.708
N110 X2.309 Y-1.709
N115 X2.304 Y-1.7099
N120 X2.299 Y-1.7102
N125 X2.2938 Y-1.7239
N130 X2.2721 Y-1.7383
N135 X2.2654 Y-1.7475
N140 X2.2597 Y-1.7543
N145 X2.2537 Y-1.755
N150 X2.2481 Y-1.757
N155 X2.2429 Y-1.76
N160 X2.2381 Y-1.7635
N165 X2.2334 Y-1.7672
N170 X2.2286 Y-1.7708
N175 X2.2237 Y-1.7742
N180 X2.2185 Y-1.7771
N185 X2.2136 Y-1.7792
N190 X2.2085 Y-1.7809
N195 X2.2036 Y-1.7831
N200 X2.1988 Y-1.7856
N205 X2.1941 Y-1.7881
N210 X2.1892 Y-1.7903
```

Figure 26: GCode for Tracing/Engraving Text

Project Description

The idea for this project was to make a wood engraving portrait of my family. The front side of the stock will have the laser engraving and the back side will have a phrase engraved and hanging pockets cut out on the Sherline Mill.

Sherline Mill Process

The back side of the stock has three operations on the Sherline Mill: the hanging pockets, the text pocket, and the text engraving. To secure the stock on the Sherline Mill, counterbore holes were drilled on the stock so screws can help secure the piece in place. The new tooling plate was used to help elevated the stock so that the milling tool can reach the stock. After the project is finished, the counter bore holes were covered with a wooden cork that provided a tight fit. One mistake to fix is to make sure that the counterbore holes are exactly horizontal. The hole location were estimated with a printed template that was laid over the stock and marked.

The hanging pocket will allow the project to be hanged on the wall with nails. These were made large enough to fit 1/8" nail heads with a larger hole underneath it so that the nail has enough room to slip in. The holes were made 0.2" deep to allow enough support on the nail. The holes were made to be within 8" from each other to make sure it fit within the workspace.

The text engraving was done 0.15" deep into the stock with a 1/8" flat end mill. This proved to be too wide and the design was changed to make a pocket of 0.15" that will clear the text engraving. The pocket has filleted edges to allow the mill to run smoothly with a 0.25" flat end mill.

The next process is the engraving. I used a R5 ball end mill to trace the letters on the sketch. To make sure the same mistake didn't happen, I changed the font of the sketch to make it thinner and more legible. The text was engraved 0.05" below the pocket, meaning that the text was engraved 0.2" from the stock's surface.

Laser Cut Process

For the laser cutter, I printed a self-made picture at 50 speed and 100 intensity to give a small depth of about 0.1"-0.2". The stock of wood was put in the middle of the honeycomb sheet to allow the laser to run past about one inch on either side of the image.

The image was made on Krita, the digital art program. For the portrait, I took separate images, made them into 50% transparent layers and organized them into the correct orientation. I hand traced the images to create outlines of the image and filled the outlines in black. For the text, I also used Krita with thick text and black filling. I combined these two images and made a single JPEG file.

The JPEG file was opened on a Powerpoint file and printed to the Retina Engrave program. The size of the image was adjusted according the job perimeter of the printer. One mistake is to make sure I take into account any white space that is shown on the program when centering the stock.