APP N08-4

Engineering 1282H

Spring 2020

Team Y4

Parke   12:40 PM

Date of Submission: 3/4/20

1. Mesh Screenshot

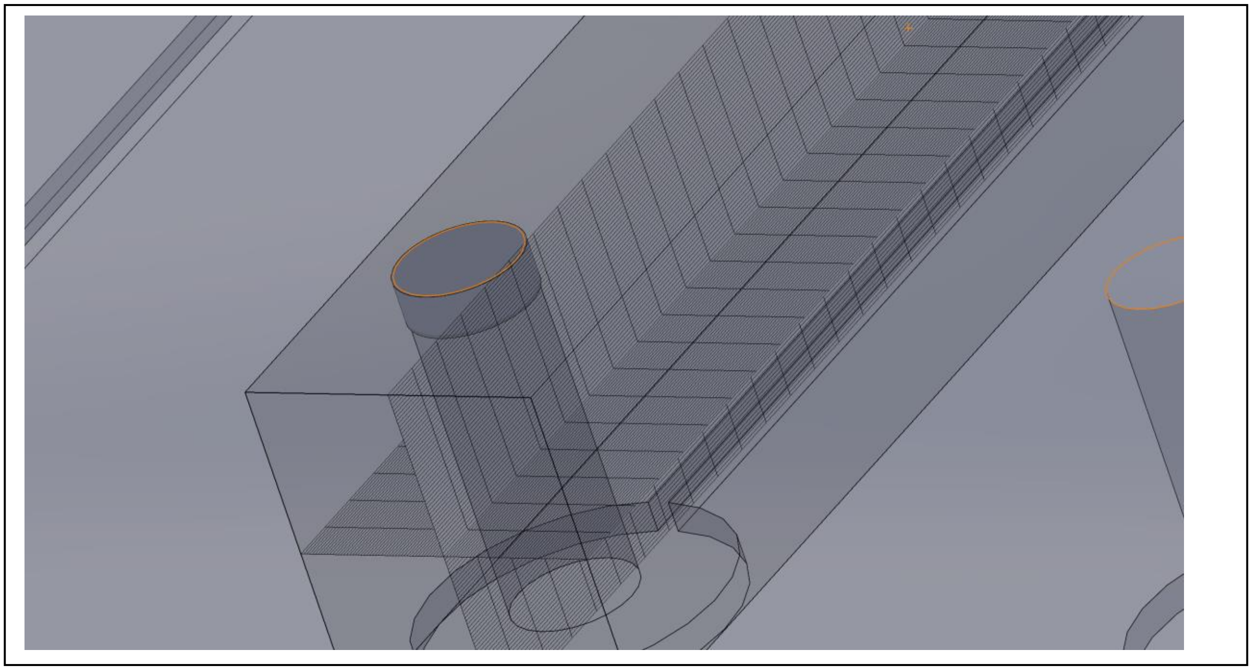

Figure 1: Mesh of the Channel

2. Goals Plot (9800 Pa pressure differential)

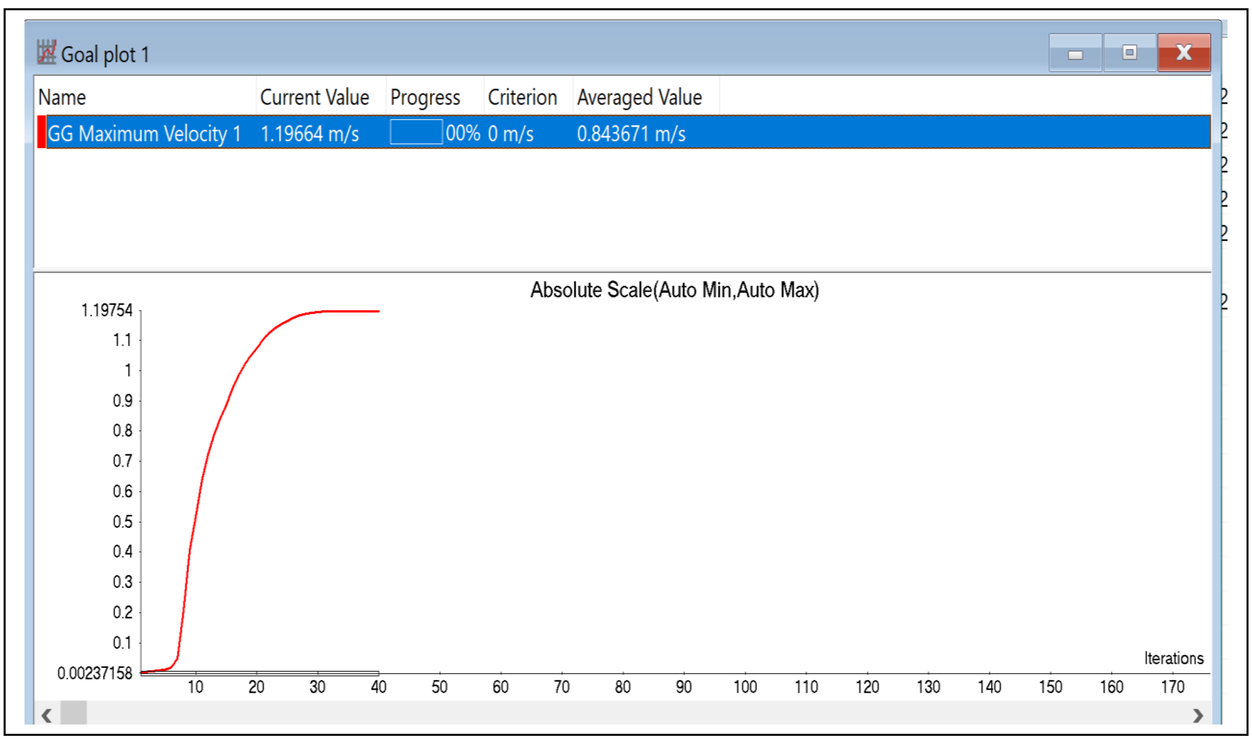

Figure 2: Goal Plot at First Pressure

3. Surface Plot (9800 Pa pressure differential)

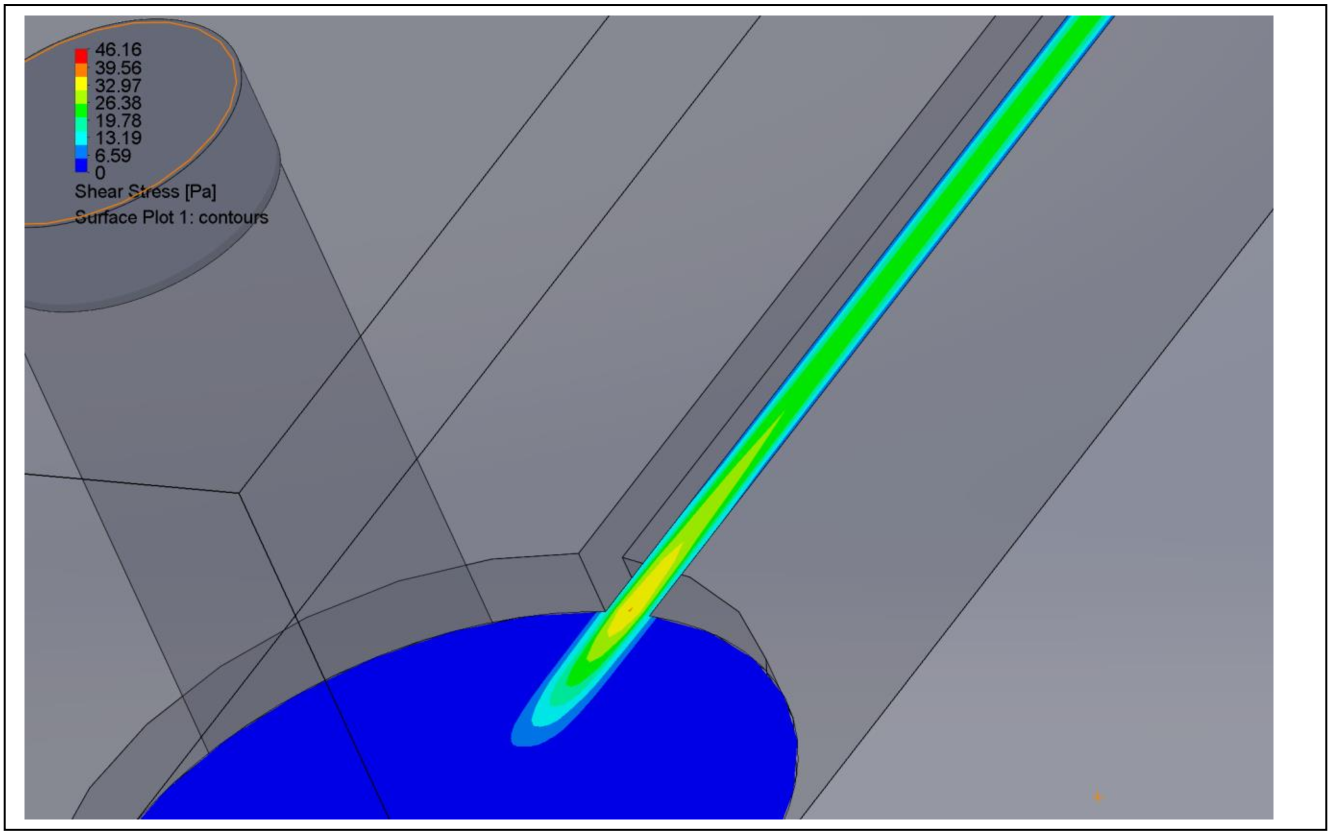

Figure *3*: Surface Plot at First Pressure

4. Cut Plot (9800 Pa pressure differential)

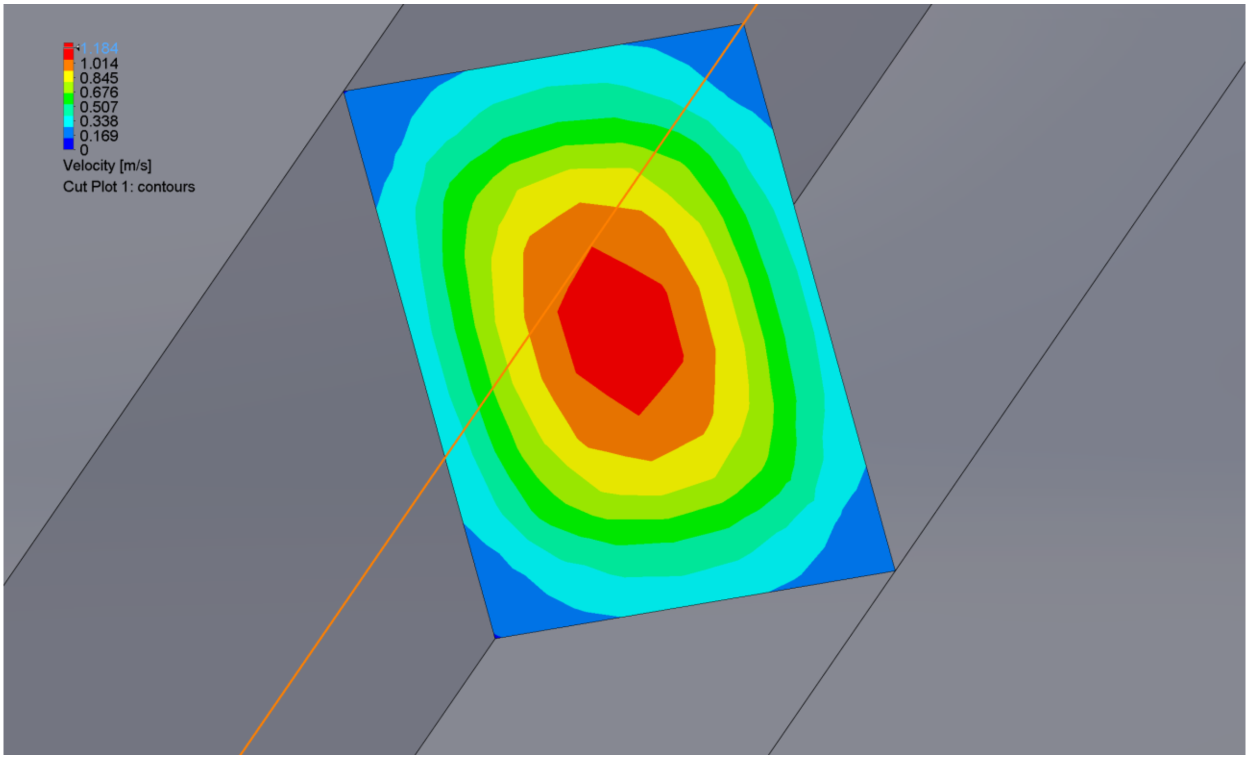

Figure 4: Cut Plot at First Pressure

5. Goals Plot (14700 Pa pressure differential)

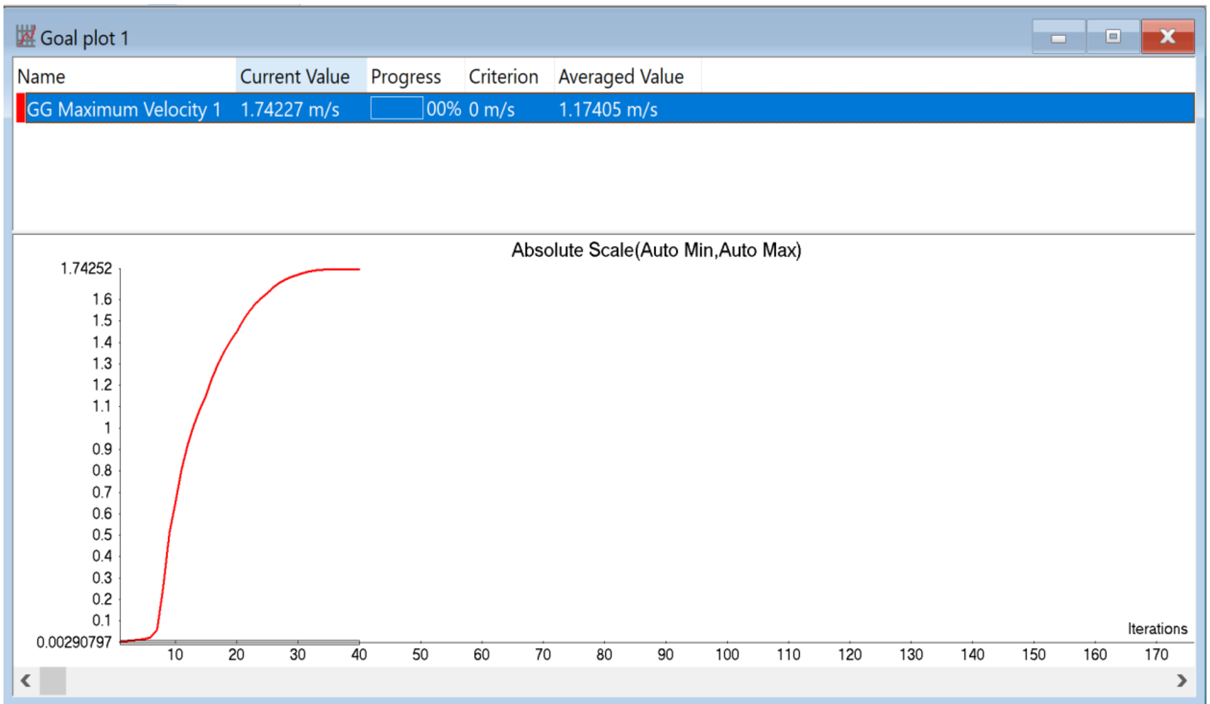

Figure 5: Goals Plot of Second Pressure

6. Cut Plot (14700 Pa pressure differential)

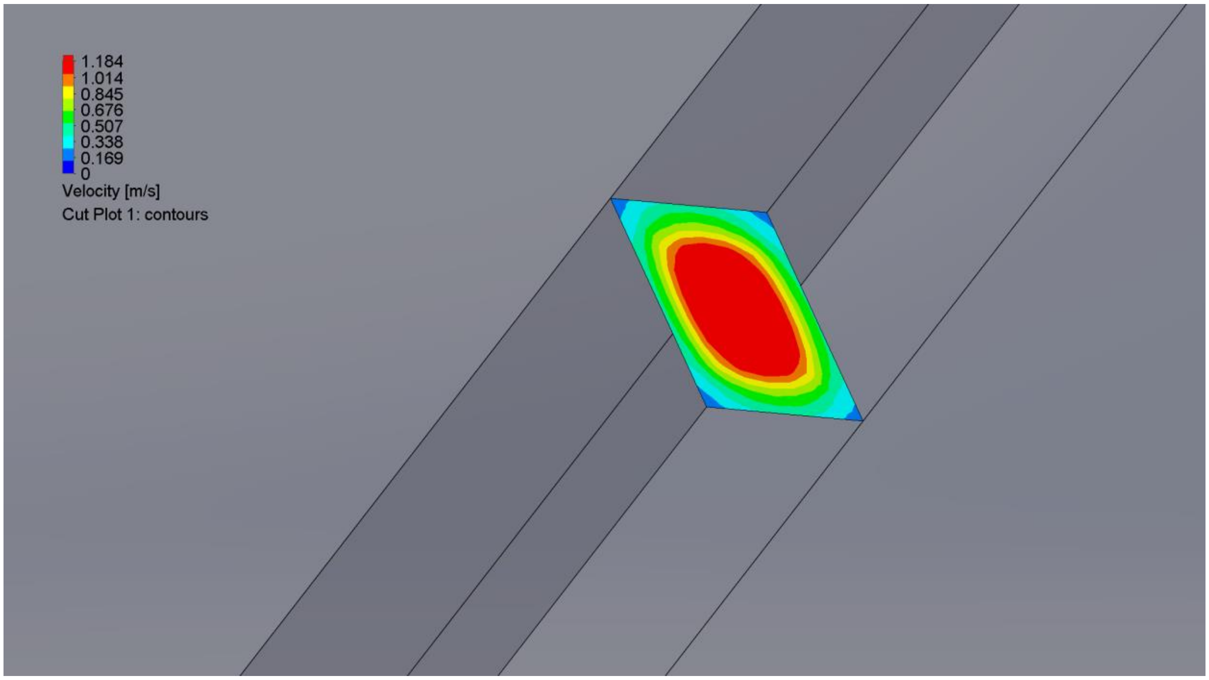

Figure 6: Cut Plot of Second Pressure

7. Surface Plot (14700 Pa pressure differential)

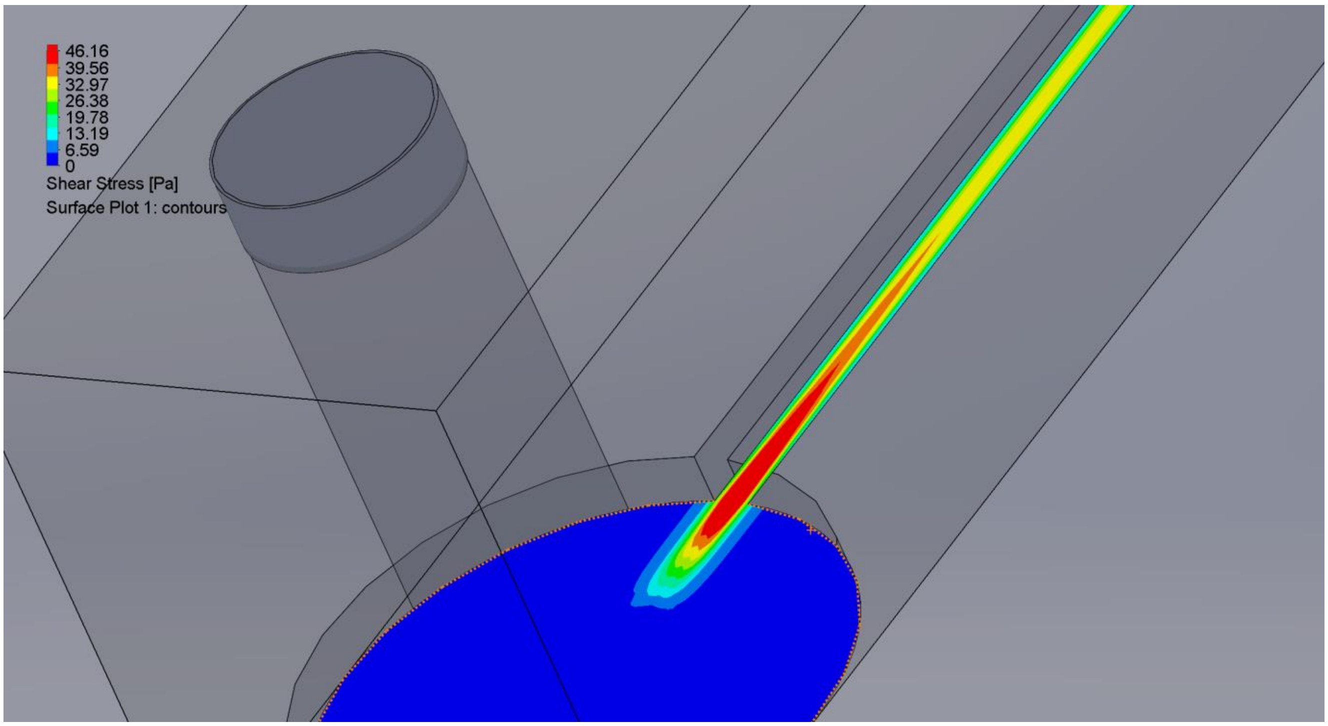

Figure 7: Surface Plot of Second Pressure

8. Goals Plot (19600 Pa pressure differential)

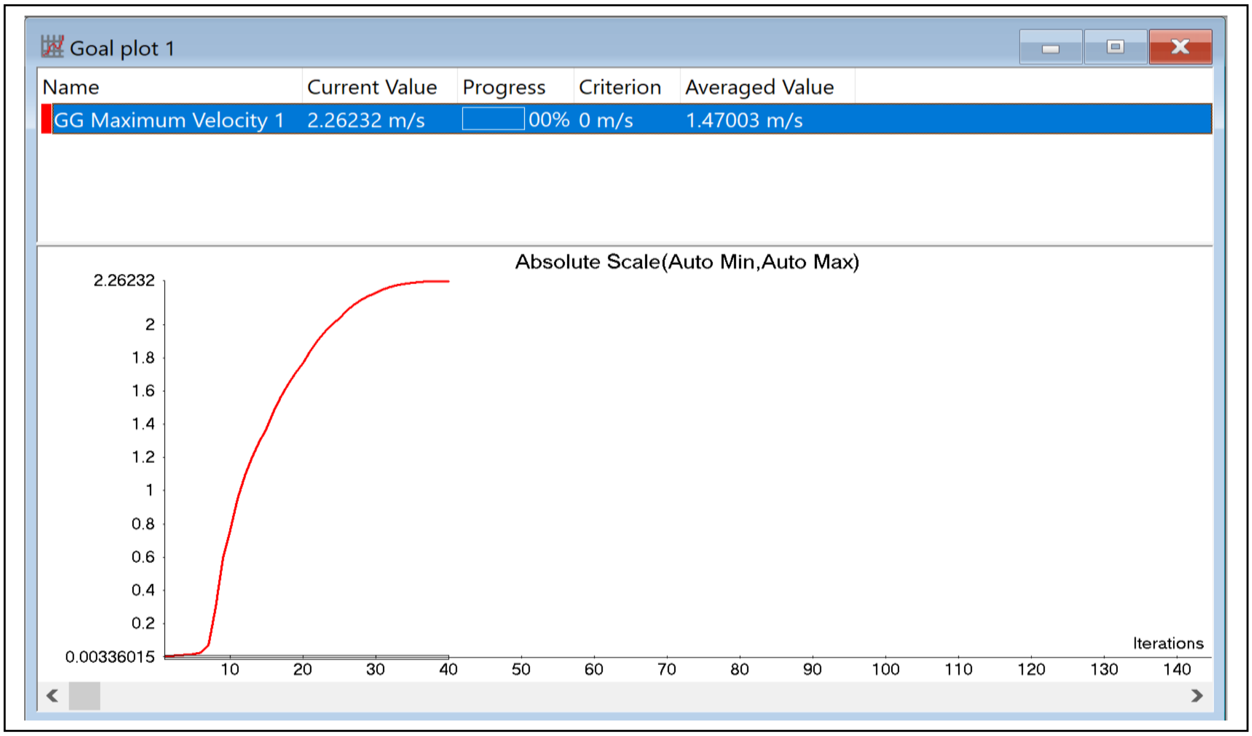

Figure 8: Goals Plot for Third Pressure

9. Cut Plot (19600 Pa pressure differential)

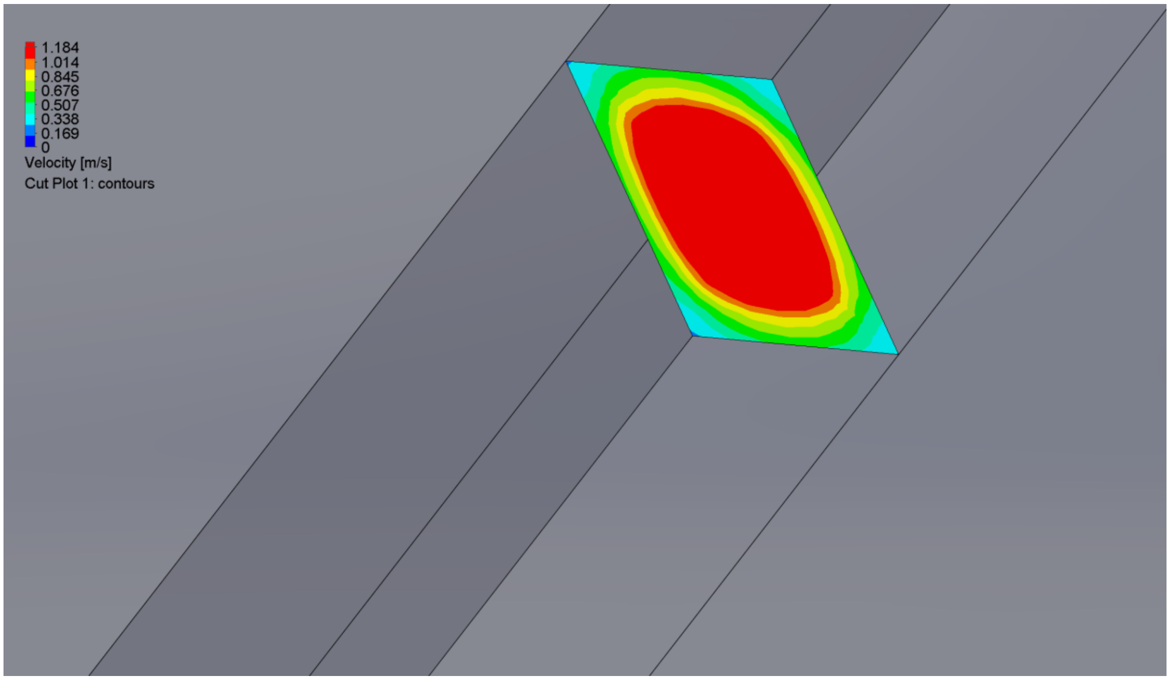

Figure 9: Cut Plot for Third Pressure

10. Surface Plot (19600 Pa pressure differential)

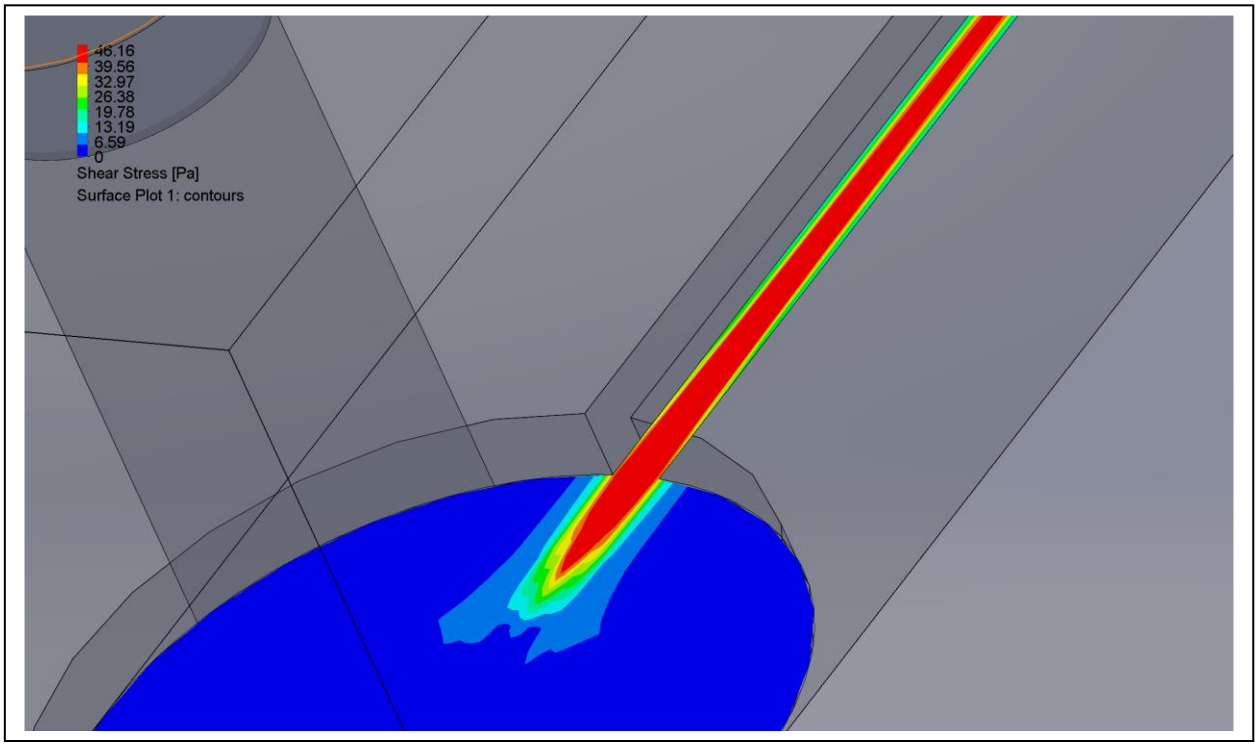

Figure 10: Surface Plot for Third Pressure

1.Do the results show what you expected? For the most part, yes. These results were not surprising compared to the in-class work, of which the velocity and shear stress contours were largely the same. This leads us to believe the design of our chip is reasonable and in-line with those used in class.

2.Try to estimate the entrance length of the flow in your channel. Does your testing region have fully-developed flow? Based on the shear stress in plot 7, this channel reaches its final pattern of flow once the shear stress has normalized. Even though it is never zero, there is a point where the red contour fades and the yellow shear stress line remains continuous. It is at this point where the flow becomes fully developed. Therefore, this testing region *does* experience fully developed flow and it is at the point where shear stress normalizes.

3.Examine the simulated cross-sectional velocity contour within your testing region at the three different inlet pressures (determined by heights) at which your team expects to run trials. Are these results expected? Explain. Does flow appear to be laminar in your channel at each of the modeled pressures? How can you tell? These were expected. The geometry of each cut plot and surface plot was relatively similar to that of our precious solidworks simulations and match those of our expectations as shear stress and velocity increased with each higher pressure differential. As the pressure differential increased, each illustration showed an expansion of the highest (red) velocity contour color, meaning that the velocity increased as a whole. Moreover, the shear stress contours showed higher contour measurements (a greater amount of red and orange), meaning that shear stress increased with pressure. This is consistent with our expectations as the simulations model different heights of the microfluidics experiment and the highest heights produced the highest velocities and shear stress measurements.

4.Examine the simulated shear stress cut plots for each of the three inlet pressures. Are these results expected? Explain. These results are relatively normal. We expected the shear stress to increase with pressure differential, and it did in each simulation. The only issue may lie with the shape of the shear stress contours, as they extend outward from the inlet in a relatively rectangular shape, yet we expected a more round one.

5.Compare the CFD derived results for one pressure head with output generated by your fluid mechanics program from APP N05-2 and your experimental data from APP N08-2: Lab 02, where such comparisons are possible. Do the results from each of the three methods make sense? Why or why not? These results do not correlate well. Since we are comparing visual results from cut and surface plots to numerical ones obtained from the fluid mechanics program, we do not have a common mode of comparison.

6.Research what Reynolds number indicates transitional or turbulent flow in a microfluidic channel. What pressure head would be required to generate transitional flow? Is turbulent flow possible in your channel? Why or why not? How high would your syringe need to be to create that turbulent flow? The transition to turbulent flow occurs at a Reynolds number of 2000. In our channel, this likely would not be possible as the height and velocity of the fluid would have to increase to such a high number. Since this could only be changed by increasing the velocity or height of the chip, an input pressure may have to be used or the height of the syringe would have to be unreasonably large. The channel will likely remain laminar unless large design changes are made to the channel so that it is "rougher" and contains a more variable surface texture.

7.Based on these results, do you need to make changes to your custom chip? Yes, we do. Our changes will not follow the logic in question 6, however. Instead of raising the Reynolds number increasing the height of the water, we will introduce new designs into the chip that will force the flow to become turbulent. With a herringbone pattern on the bottom of the chip, water molecules will react with the structures and crash into each other to create a more turbulent style of flow.