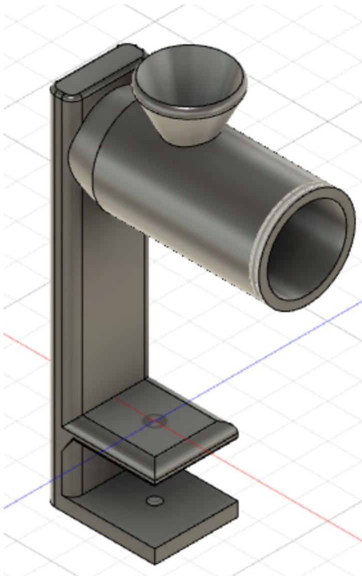
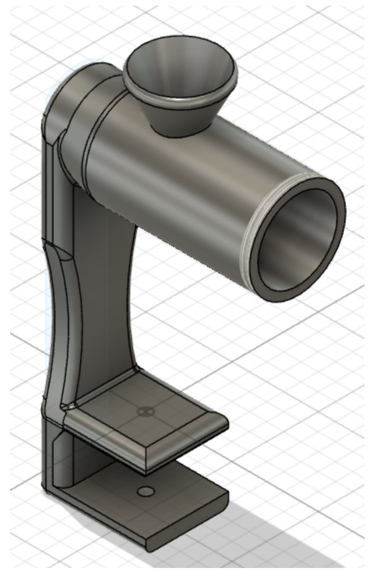
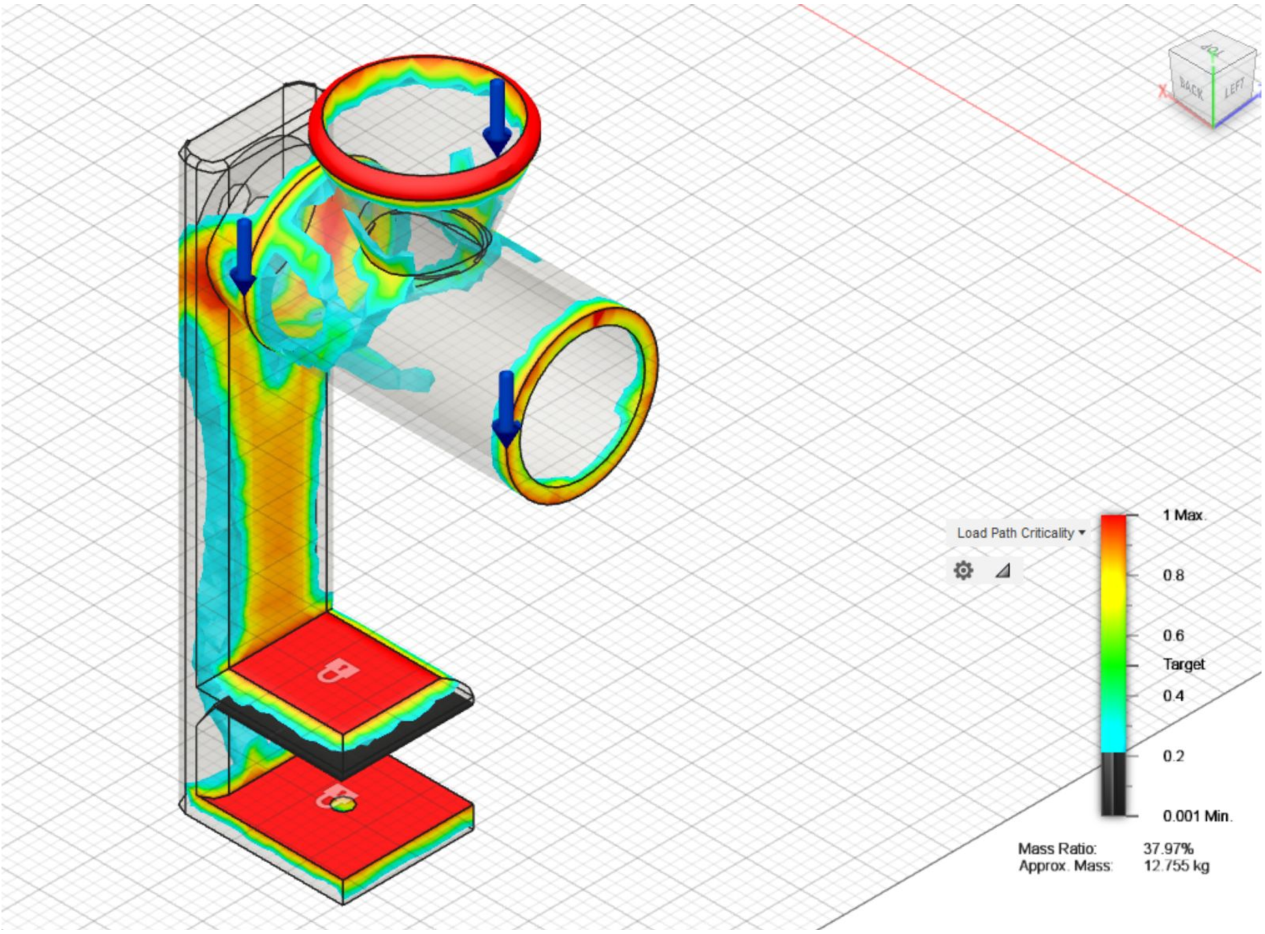
<u>Computer Aided Engineering</u>

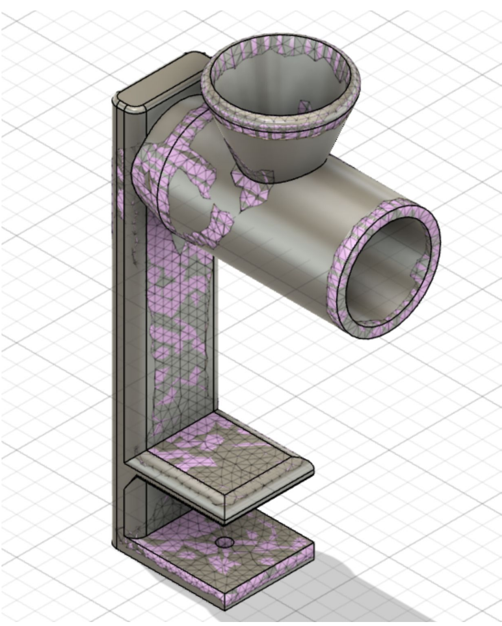
Part 1 - Body

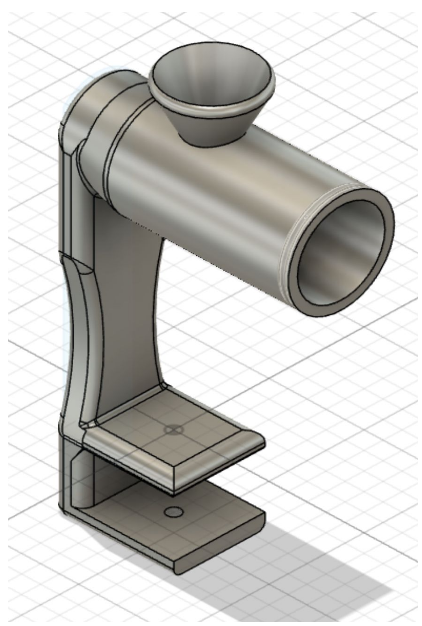
 

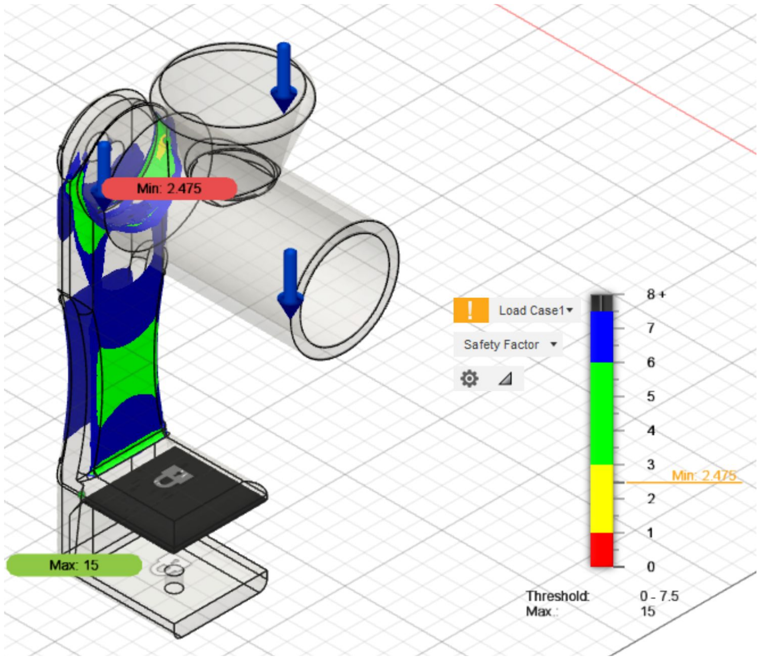
The body of the meat grinder is one of the most critical parts as it contains the entire mechanism and is exposed to the most loads due to its size. The design on the left was the initial design for the body. While material usage and optimization were taken into account during the preliminary design stage, the CAE analysis revealed that there were still areas of improvements through material reductions. The mass for the initial body part was around 34 kg, however, after shape optimization and reduction of unneeded material the mass for the modified body part was 30 kg which is a reduction of more than 12 %. The loading for the part was over exaggerated at 1500 N which is an arbitrary heavy load which the body of the meat grinder is unlikely to get exposed to. The loads were applied at three areas, the first and second are at the beginning and end of the grinding chamber and are placed to simulate a user's hand applying a force to keep the body in place while grinding. The third load is to simulate the load resulting from the ungrinded meat in the cone area of the body. In addition, fixed constraints are placed on the two bottom faces of the body as they will be secured to the table using the clamp pin.



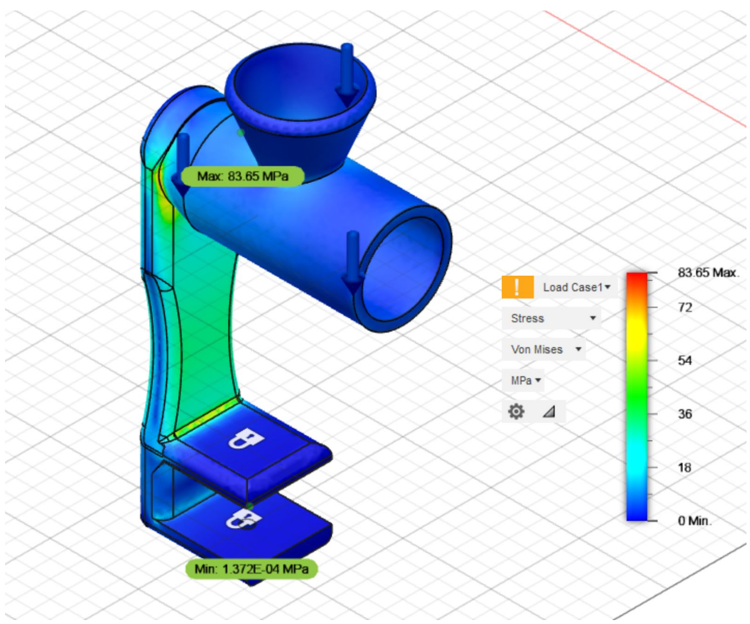
Load Path Criticality
1 Max.
0.8
0.6
Target
0.4
0.2
0.001 Min.
Mass Ratio: 37.97%
Approx. Mass: 12.755 kg







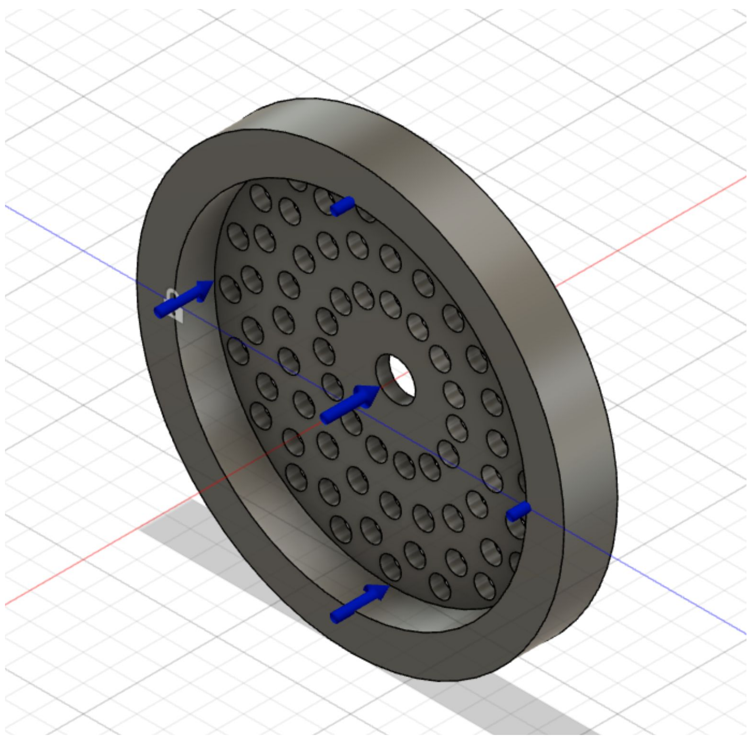
As seen from the results of the stress analysis, the material reduction did not affect the structural integrity of the body as it was able to handle the over estimated load of 1500 N with a minimum safety factor of safety of 2.475 which is suitable for a product that is not safety critical like a meat grinder. The loads are overestimated in order to test how the part would handle extreme loads after the part's optimization.



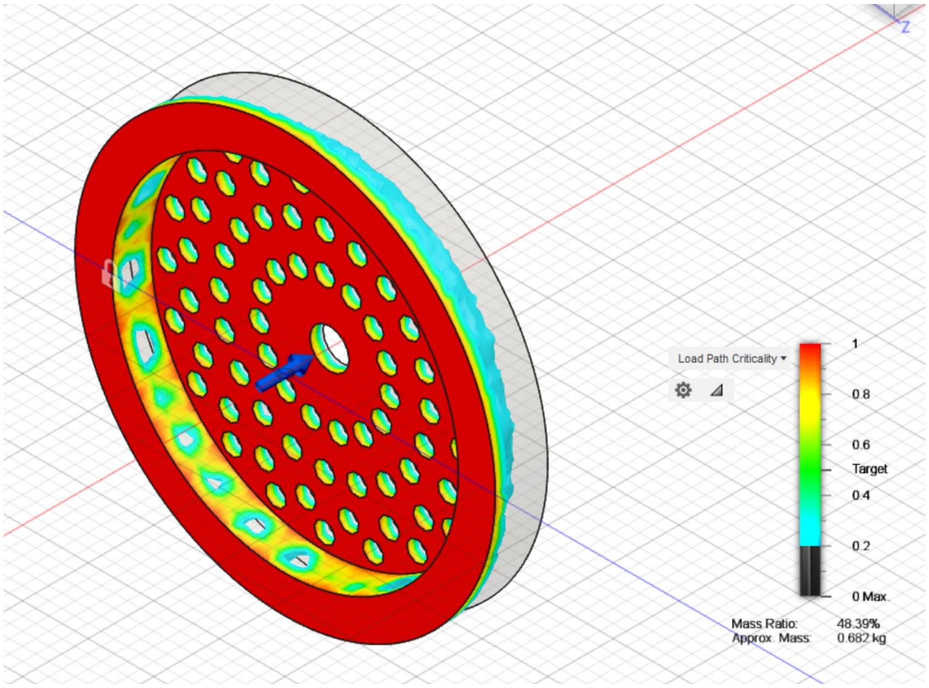
The von mises stress chart confirms the results from the safety factor chart as it shows maximum stress at the edge where the grinding chamber meets the remainder of the body. This edge is expected to have the maximum stress due to part geometry and the location the load is placed at. An improvement in the design would be changing the force at that edge to cover a larger area and thus reduce the stress concentration on that edge, however taking into account the excessive load that the test is placing on the part, the factor of safety and the maximum von mises stress seem to be within acceptable levels.

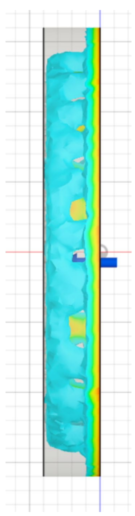
Part B - Shaper

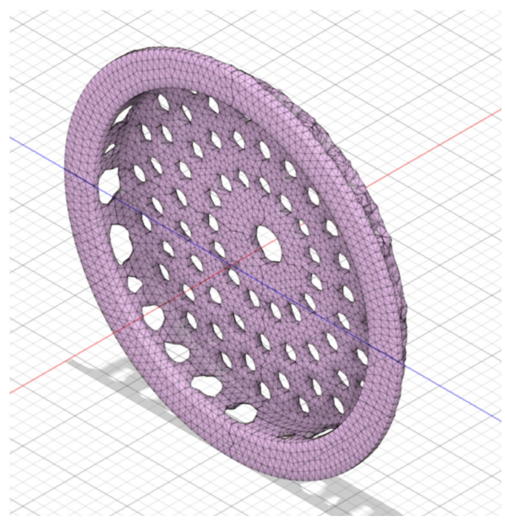
While the shape optimization analysis was useful when conducted on the body part of the assembly the shaper is an example of a part which the shape optimization simulation was not useful and did not result in a change in the part design. The load that the shaper experiences is a result of all the meat being pushed by the auger. This load was simulated by an over estimated by a constant 1500 N force over the inside face of the shaper. The fixed constraint associated with the shaper is on the inside area that is fixed to the body part and thus does not move as part of the rotating mechanism.



The results of the shape optimization simulation are the following:

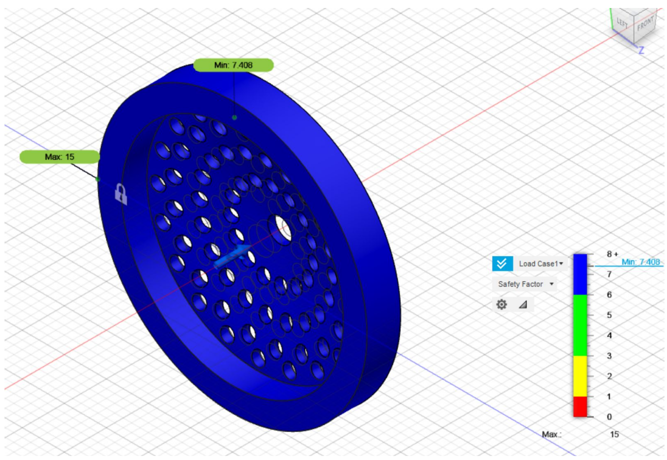


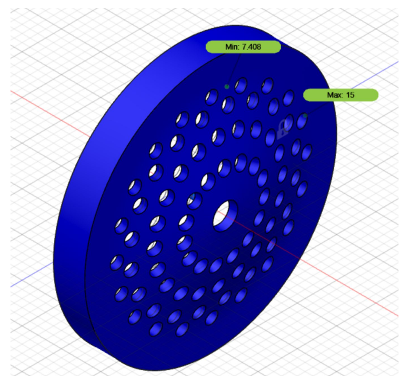




This shows that the material that is not needed according to the simulation is required in order to assemble the shaper with the body part and as any material removal form the edge might affect the neshing between the threads in the shaper and the threads on the end of the grinding chamber in the body part. Furthermore, the amount of material to be removed based on the simulation results will not be significant enough to justify removing it from an economic standpoint and as a result a decision was made to keep the part in its initial form and perform the stress analysis on the preliminary design.

The stress analysis was done using the same load and constraints used in the shape optimization analysis. The load was also over exaggerated at 1500 N in order to simulate a very excessive condition on the part. The shaper part performed very well under the experienced load as the minimum factor of safety was 7.4 which means that the part can handle much higher loads than the simulated 1500 N. The charts below show the effect of the load in adjusted view to overstate the deformation of the part under the load. This analysis shows that the part in its initial format without modification was able to handle the forces that the part will be exposed to.





The von mises analysis shows that the maximum stress occurs at the holes of the shaper which is a result of the force from the meat hitting the sharp edge of the shaper to be cut into the appropriate shape. The von mises chart shows that even that those sharp edges exist for meat cutting the maximum stress is 29.4 MPa which is within an acceptable range as it does not cause the material to yield or plastically deform since Stainless Steel has a yield strength of 250 MPa and an ultimate tensile strength of 540 MPa which are both way below the maximum stress that the part experiences.

CAE Discussion:

Throughout this project the CAE analysis, we faced some issues with the mesh sizing and solving the simulation as there were many issues that required debugging as well as trial and error. At the end of this debugging process it was realized that the optimal mesh size for solving and avoiding errors is 2%. This information would have been crucial at the beginning as many hours were wasted in order to debug why solutions were facing solving errors when running shape optimization or stress analysis.

2D Component Drawings