Assignment 3			
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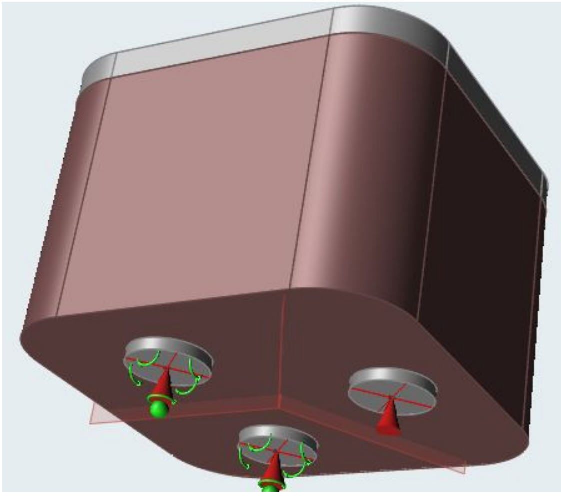
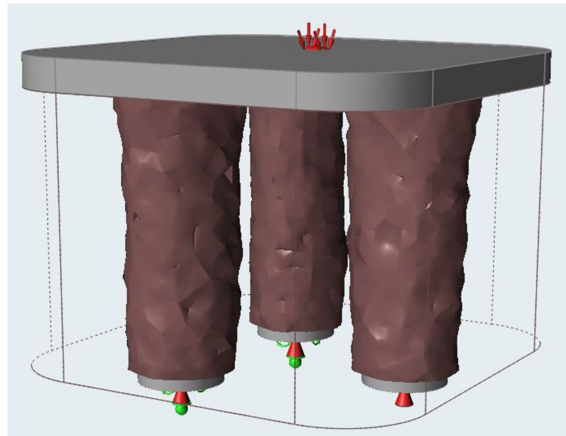
LAB DATE	THUR		

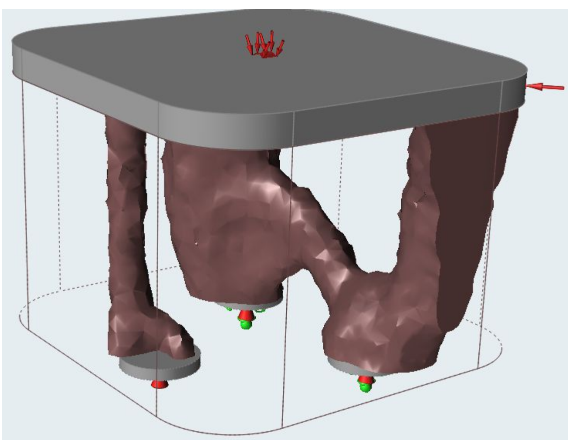
Short Description of Design
The team chose to create a simple stand for a small, portable video projector. This part has well defined loads, contact surfaces, and a significant volume in which the part does not need material, which can be used as a design space for the TO. The only material which must be preserved, is the surface the projector rests on, and any surfaces which must contact the ground. From going undergoing a topological optimization, Inspire was able to create a tripod design, with three pads touching the ground surface.

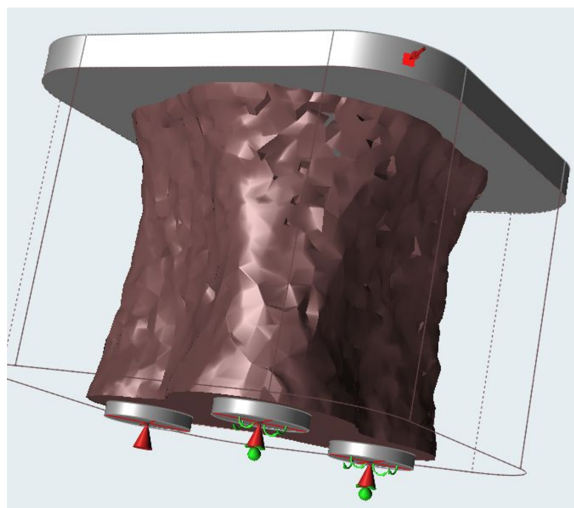
Topological Optimization approach
The team chose to use Altair Inspire for the topological optimization. While there were other options such as trial versions of Solidworks Live Parts, and nTopology, Inspire was the most stable option and provided the ability to jump in and begin learning the software. Inspire's methodology of a topological optimization is to apply loads and moments to a part, where the program will remove material that is unnecessary. After many variations of loads applied to the part, different TO were created, but the most valuable one was the one that was printed. Having TO functionality integrated into CAD software like SolidWorks would be convenient, particularly as the native tools in Inspire for editing part geometry can be a hindrance when trying to modify the part or design space on the fly.

Pictures of first iteration of design and analysis









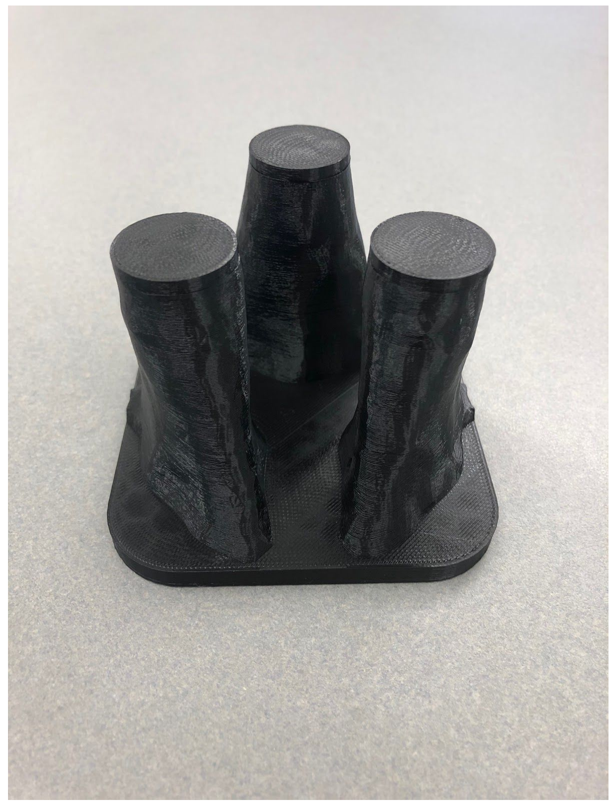
The initial iterations of our part were never printed, but CAD images are shown above. With these iterations, there was a difficult time producing an aesthetically pleasing structure. Because there were only point forces, rather than pressures distributed across the entire surface of the part, very limited geometries were possible.
While attempting to improve these designs, the focus on adding point forces and moments in various locations on the top surface of the part. This was ineffective in achieving the symmetry and curvature desired.
There was also experimentation with the design space, ultimately deciding to allow the entire area below the rectangular top plate to be designed in.

What feedback did you get from your peers?

- Add horizontal loads
- Pin one “leg” of the part while constraining the other two legs only in the Z

direction
- Use cyclic symmetric shape control on base of part
- Use a pressure rather than a load or mass on top surface

Pictures of the second iteration of design and analysis



This print turned out to have a very nice surface finish and no flaws, but the design could be further improved. Even though the FDM printer was used, the resolution of the print was very high, to be able to actually visualize dimples and other topological optimization on the legs of the part.
One problem which was encountered during printing was poor adhesion during raft construction. The part is printed upside down, with the “feet” pointing upward. This meant a very large raft was needed to print the part, allowing many opportunities for adhesion failure to the base.
A portion of the material could be removed on the top plate where there is no support underneath, leaving a hole in the center of the part without compromising its structural integrity. The top plate could also be thinner while still being able to support the required weight. The plate could also be shaped differently to more closely fit the projector it is designed to support.
In the next iteration, the team would likely redesign the top plate to both reduce material and improve functionality.

What build direction did you pick and why?
The part was placed upside down on the build plate with the legs of the stand pointing up. This is the natural build direction for a part like this, and it required no support to print, as the legs are tapered and have no overhangs. Printing the large raft required by the large surface of the stand was challenging, possibly due to

leveling issues with the FDM printers. Multiple prints failed on the raft, prior to the successful print.

How did you optimize the part for supports?
Because it was positioned upside down with no overhangs, this part did not need supports.

How did you reduce the weight as much as possible?
The main goal of topological optimization is weight reduction of parts, so this was the principal strategy to reduce weight and material. Of course, the material chosen in Inspire was ABS, and the part is assumed to be a solid body, so the printed part is not fully representative of what was created using topological optimization. The topological optimization setting was “maximize stiffness”, as this tended to produce better results while reducing weight.

Team: Process settings and materials
The default settings were used, but infill percentage was reduced to 10%, as the default 15% infill is not really required for large solid parts like this. The amount of material used for the print was 29.45 m and took 5 hrs and 34 minutes.

Team: what did you learn
The process of doing the topological optimization was difficult for the team to learn on Inspire, but eventually, but became easier to understand with practice. Things that could've been done differently in the next iterations include adding combinations of different forces and moments to see if a more intricate design can be made as well as changing the dimensions of the actual part to be more adequate for a projector. Further changes to the design space could be made to influence the final geometry. All in all, the team was able to learn and properly use Inspire for a topological optimization of a 3D part, and successfully use an FDM printer to show the optimization.