Vex Autodesk “Make It Real” CAD Challenge

Rubber Band Intake Sprocket

Coronado High School Robotics Team 7870A

VEX EDR 2020-2021: Change Up

Introduction

Although Vex has a vast product line that teams can select from, there are still some functionalities that existing parts lack. Missing is a part designed specifically for use on Rubber Band Roller Intakes. Using Vex Sprockets (**Figure 1.1**) for intakes work but could be greatly improved on. Because of this, we designed the Rubber Band Intake Sprocket (**Figure 1.2**) for use in Rubber Band Roller Intakes.

Figure 1

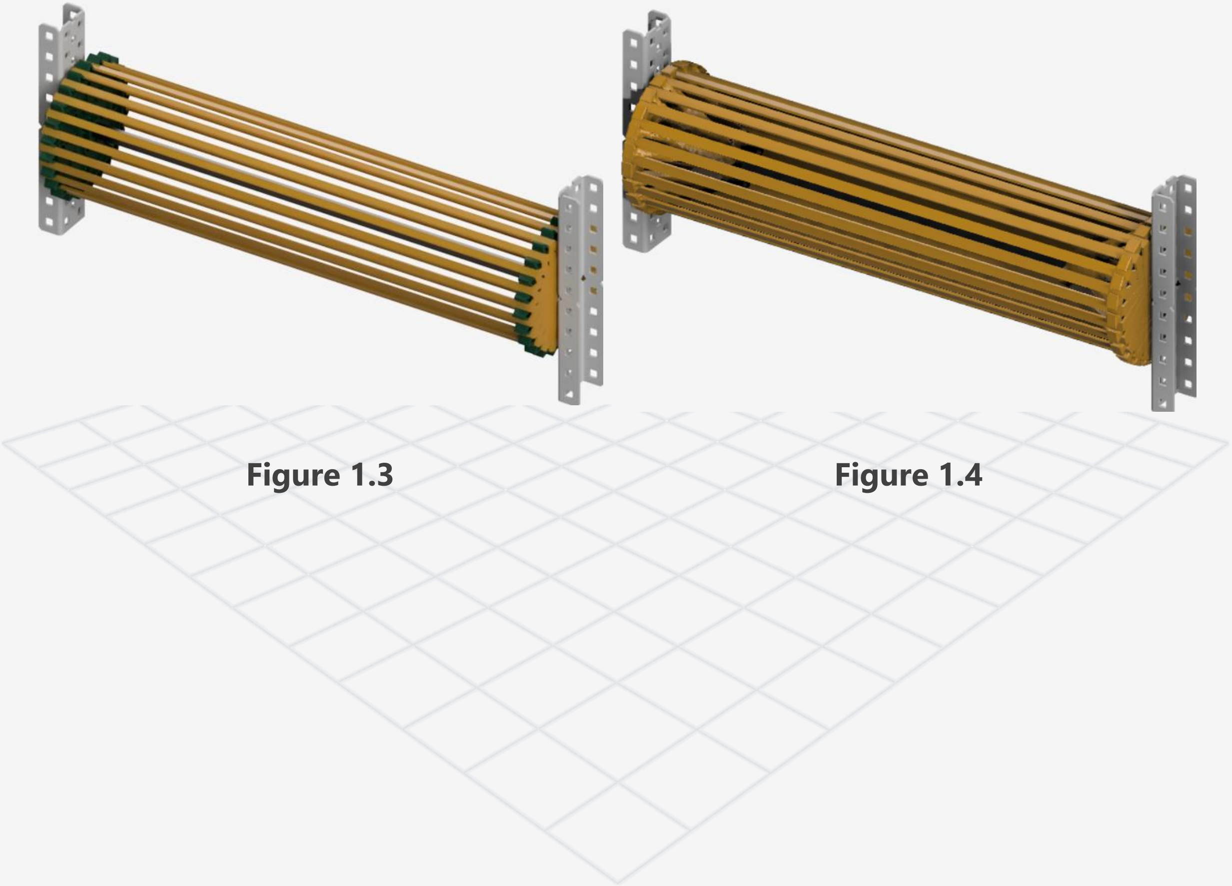
Figure 2

Rubber Band Intake Sprocket

Introduction (Continued)

Figure 1.3- Rubber Band Roller Intake using Vex Sprockets

Figure 1.4- Improved Rubber Band Roller Intake using the new Rubber Band Intake Sprockets.



Rubber Band Intake Sprocket

Introduction (Continued)

Figure 1.5- Close up of a Rubber Band Roller Intake using Vex HS Sprockets.

Figure 1.6- Close up of an Improved Rubber Band Roller Intake using the new Rubber Band Intake Sprockets.

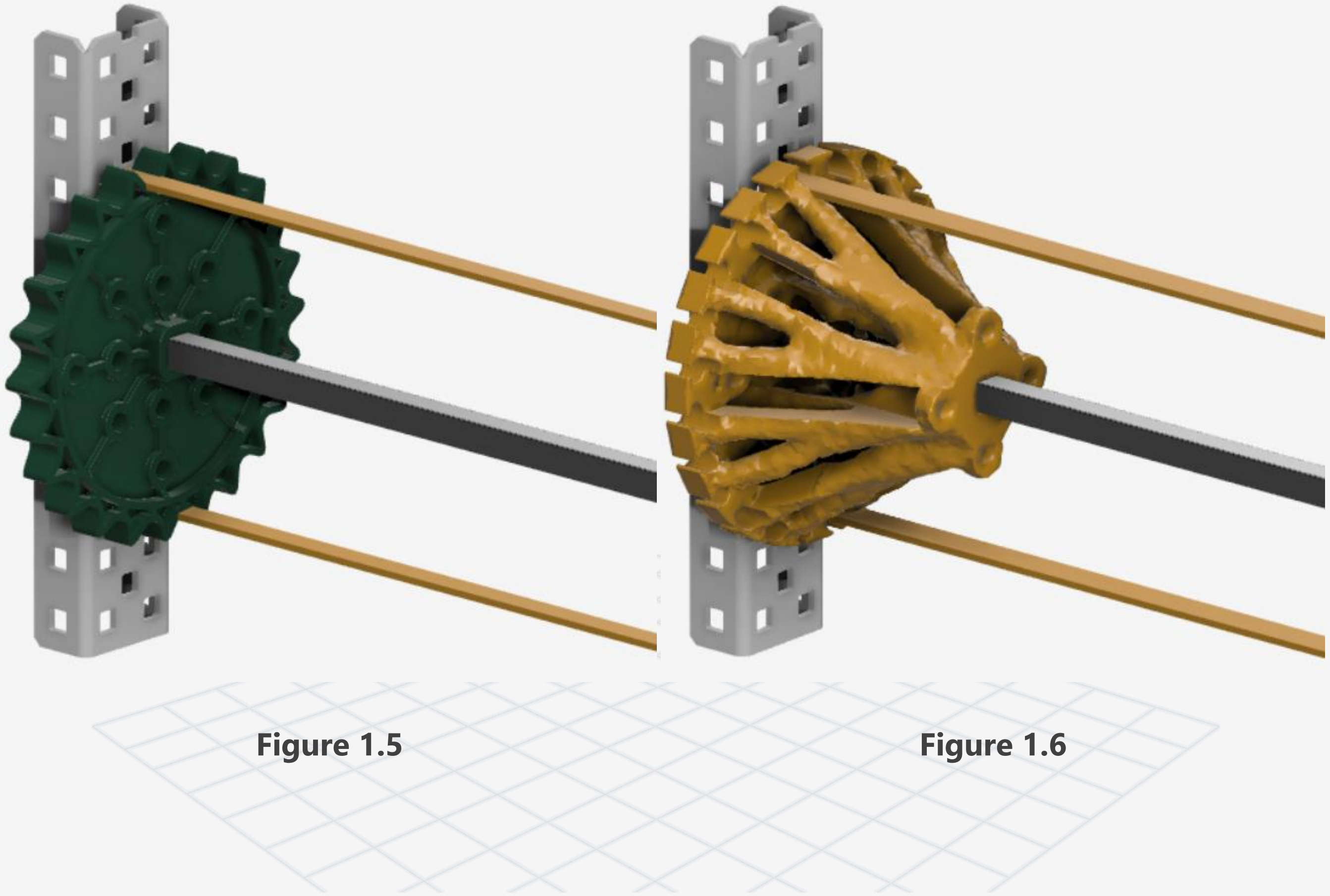


Figure 1.5 **Figure 1.6**

Application

The Rubber Band Intake Sprocket fits a very niche application in Rubber Band Roller Intakes. They are used whenever the robot must intake an object quickly. This is a core function of this year's game, Change Up. This design has also been prevalent in previous competitions, including Turning Point.

Application (Continued)

The main improvement the Rubber Band Intake Sprocket (**Figure 2.1**) has over the original Vex Sprocket is its distinctly shaped teeth can support unique rubber band patterns that can be tailored to a team's preference. It also prevents rubber bands from slipping off during a match. This allows robot intakes to better grip objects causing more dependable and efficient intaking.

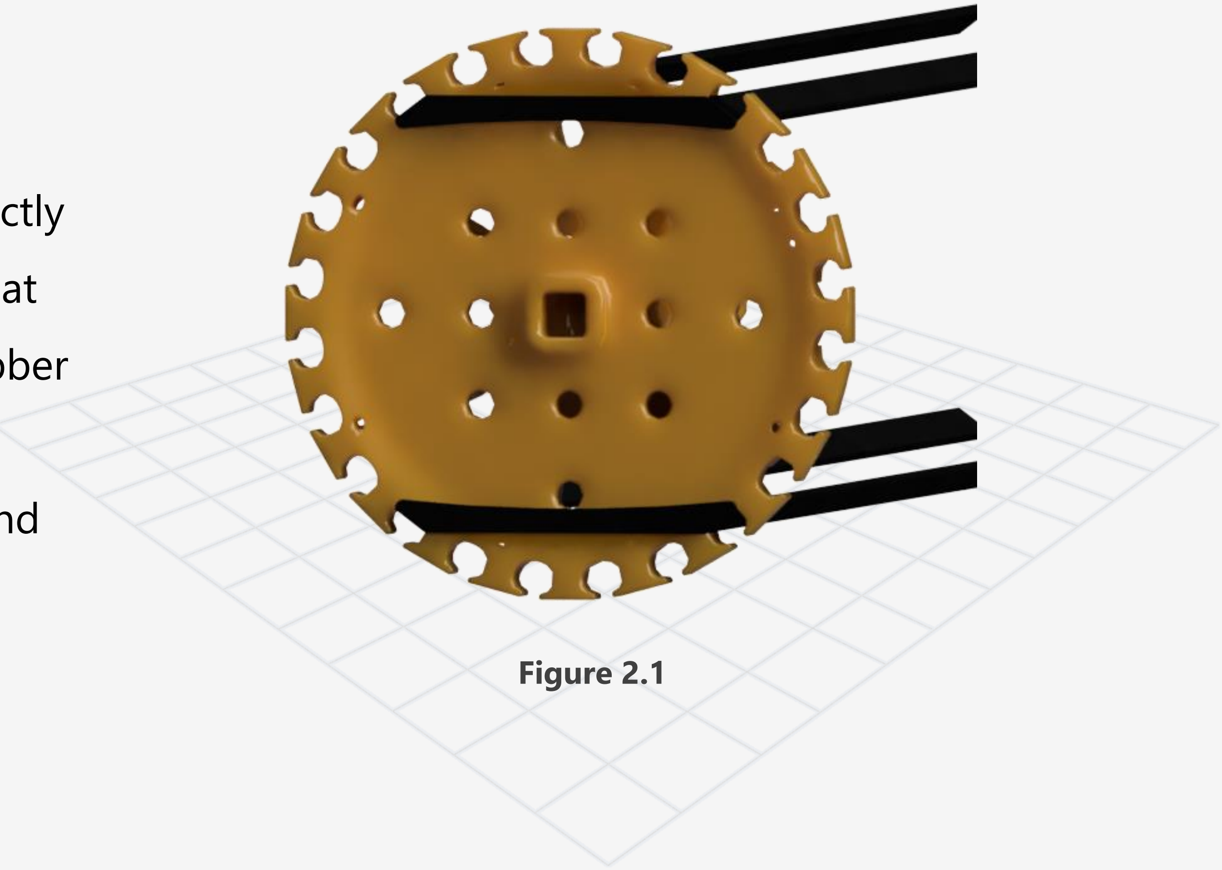


Figure 2.1

Rubber Band Intake Sprocket

Application (Continued)

The Rubber Band Intake Sprocket (**Figure 2.2**) features a square bore that fits both High Strength Axles and shaft inserts. It is the same diameter as the 24-tooth Sprocket and has 16 bolt holes for easy implementation with existing robots. It also includes hex nut retainers for ease of installation.

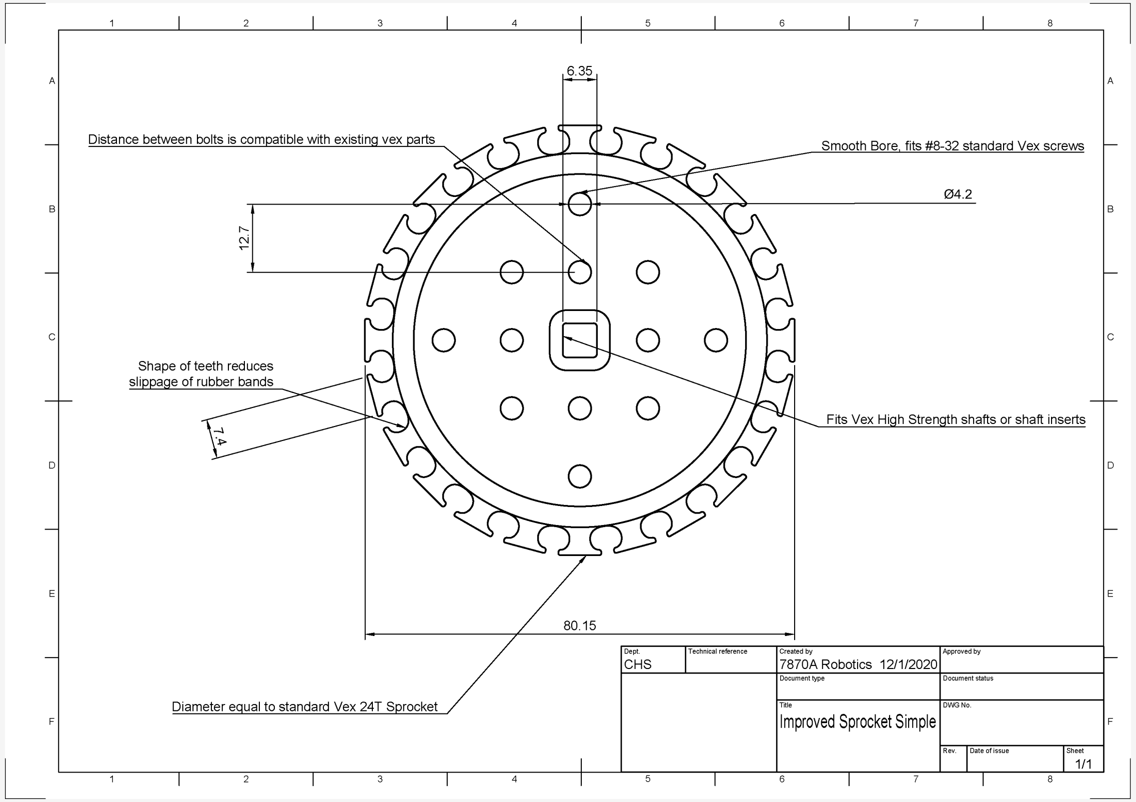


Figure 2.2

Design Process

Rubber band intakes have many design flaws that can be improved on. The rubber bands tend to slip off during a match and teams are restricted in their arrangement of rubber bands on the sprocket. That is why we created a part specifically for this application. To help with the design process, we created a list of requirements the part must fulfill. It must have teeth that can easily retain rubber bands as well as appropriate bolt and shaft bores so it can be attached to a robot. It must fulfill structural requisites such as a 3-6 minimum safety factor and manufacturability.

Design Process (Continued)

We modeled the part in *Fusion 360 v2.0.9439*. A 24T Vex Sprocket was imported into the workspace to give basic dimensions for the part. The sprocket was designed to resemble a Vex Sprocket for compatibility with existing robot designs. Each tooth of the sprocket was T-shaped so the rubber bands would not slip off under any kind of load, a massive improvement over the original sprocket **(Figure 3.1**)**.** Then, 4.2mm bolt holes with hex nut retainers were added to allow attachment points teams could use. A square bore was included along the axis of the sprocket to fit the existing vex High Strength Shaft and Shaft Adapters.

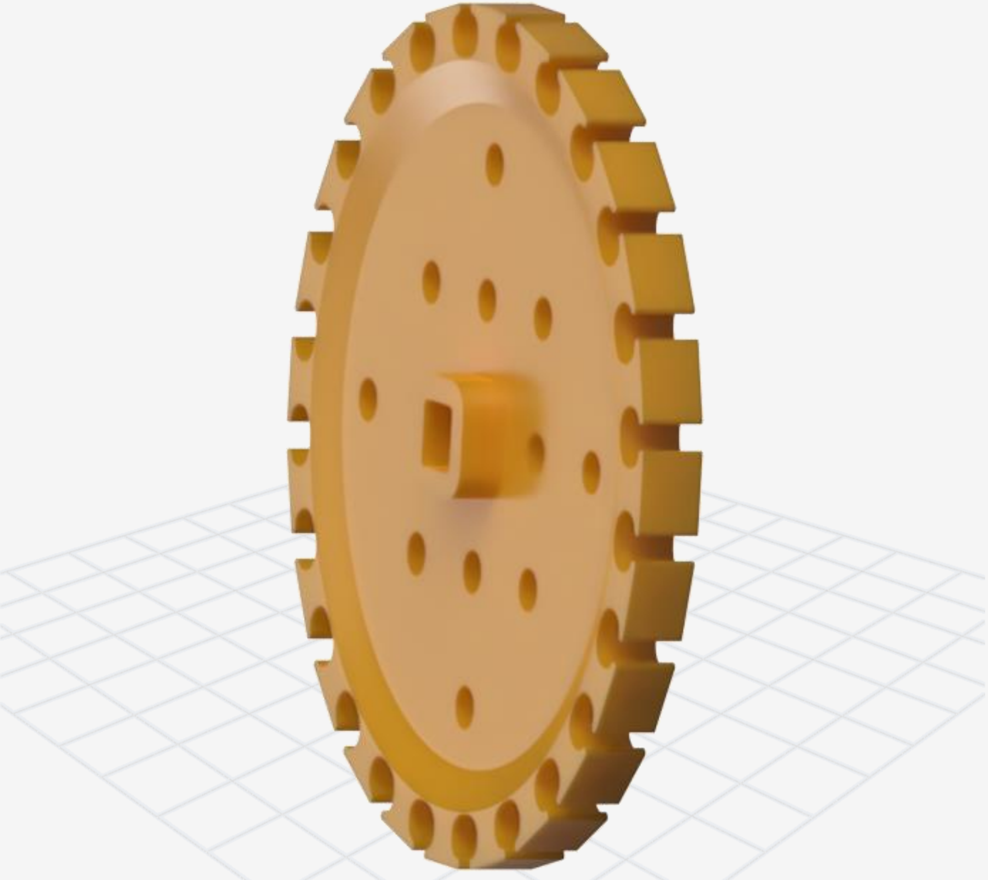


Figure 3.1

Rubber Band Intake Sprocket

Design Process (Continued)

Now it was time to use Fusion 360’s built in Topology Optimization tool (**Figure 3.3**). The tool removes unnecessary material by calculating a load path using inputted parameters and loads. The shape parameters were set to leave the functional portions of the Sprocket intact, such as the bolt holes and rubber band teeth. A load was applied on the bolt holes and teeth because those areas would be under stress during use. As a result, our part is optimized to have highest strength to weight ratio possible. This decreases cost and manufacturing time while maintaining structural integrity.

Design Process (Continued)

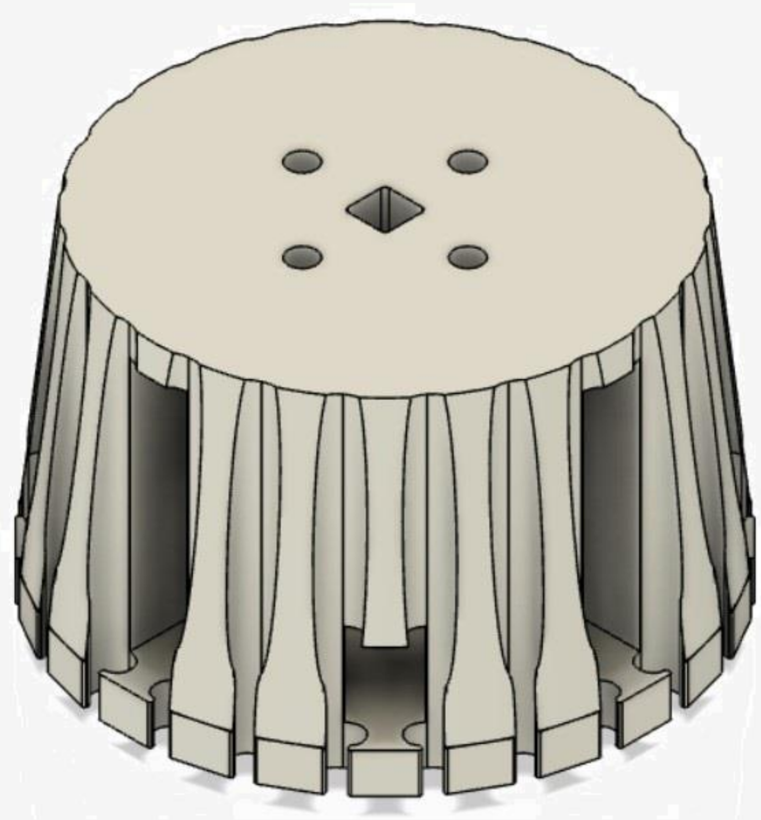


Figure 3.2- Before Shape Optimization

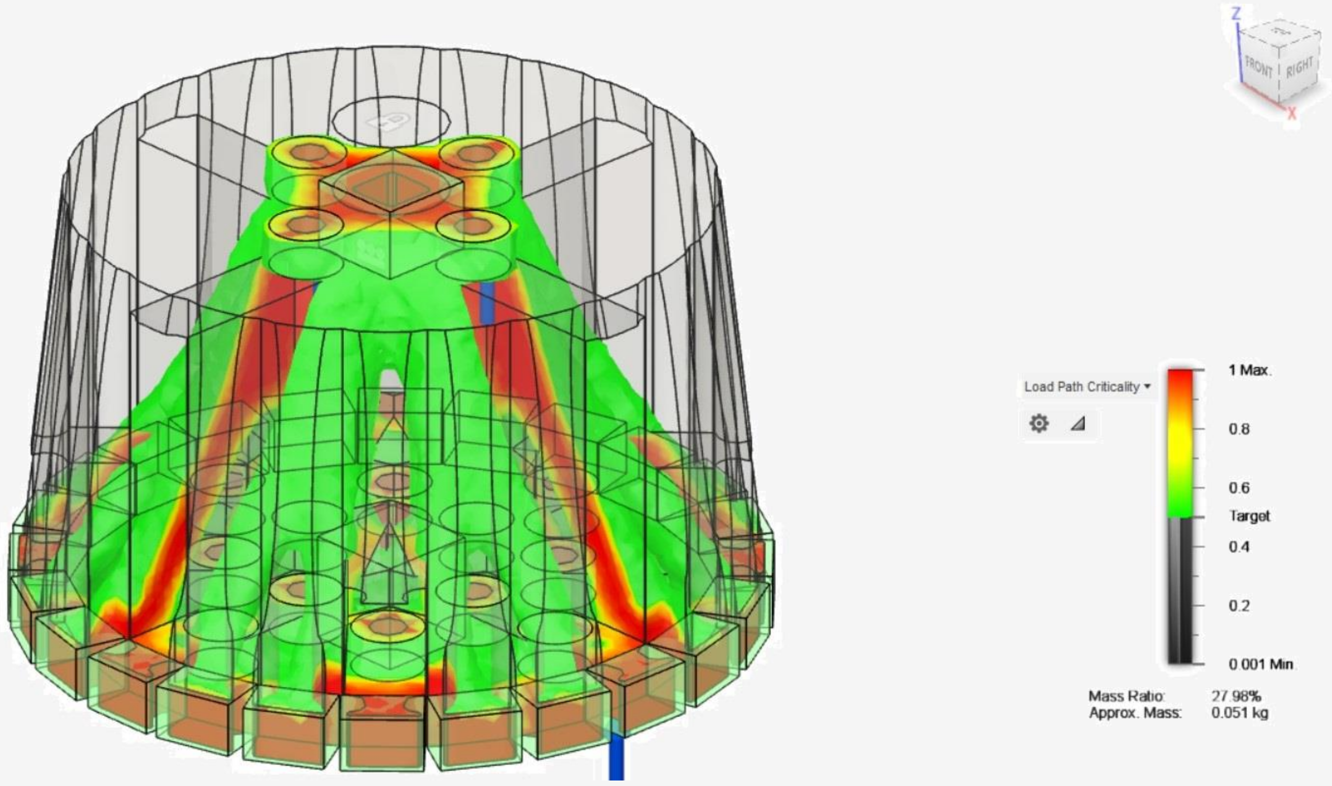


Figure 3.3- Shape Optimization Results

Design Process (Continued)

To test how strong the new shape optimized part was, we did a Structural Buckling study (**Figure 3.4**) and a Non-Linear Static Stress study (**Figure 3.5**) using Fusion 360's simulation workspace. Using a combined load of 240 N, the estimated force of 24 rubber bands, we found that the part's maximum stress was ~2 MPa and the part's first buckling mode occurred at 144 times the expected load. That gave us a very satisfactory minimum safety factor of 15, well above our target of 3-6.

Rubber Band Intake Sprocket

Design Process (Continued)

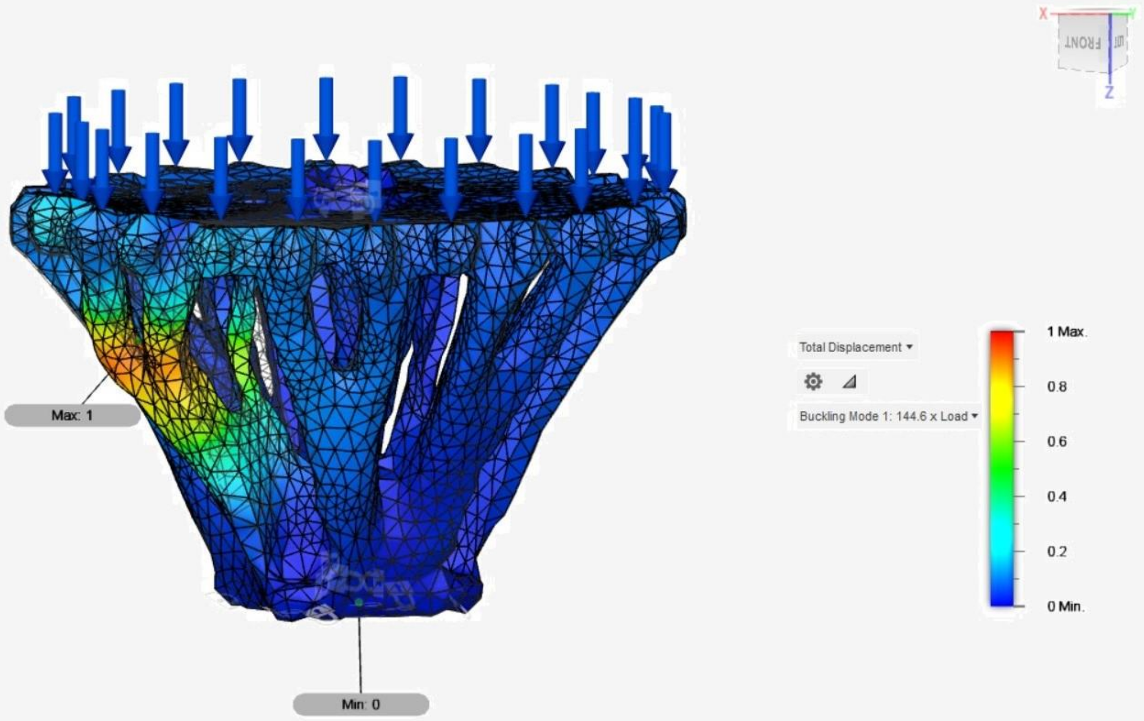


Figure 3.4- Structural Buckling Results

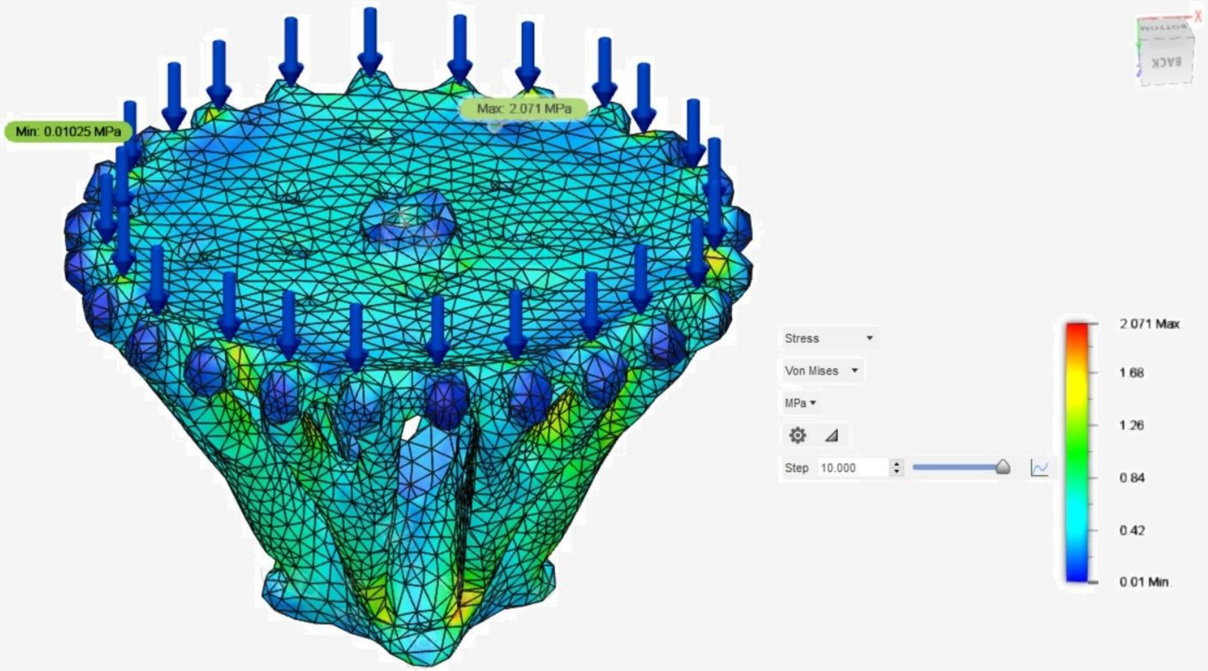


Figure 3.5- Non-Linear Static Stress Results

Rubber Band Intake Sprocket

Design Process (Continued)

To print the part, we used Fusion 360’s built-in slicing software to generate G-code our printer can understand. We used 100% infill and 0.15mm layer height for maximum strength. The material chosen was PLA because it is cheap, easy to work with, and produces high quality prints. The part (**Figure 3.6**) was printed using an Ender 3 Pro.

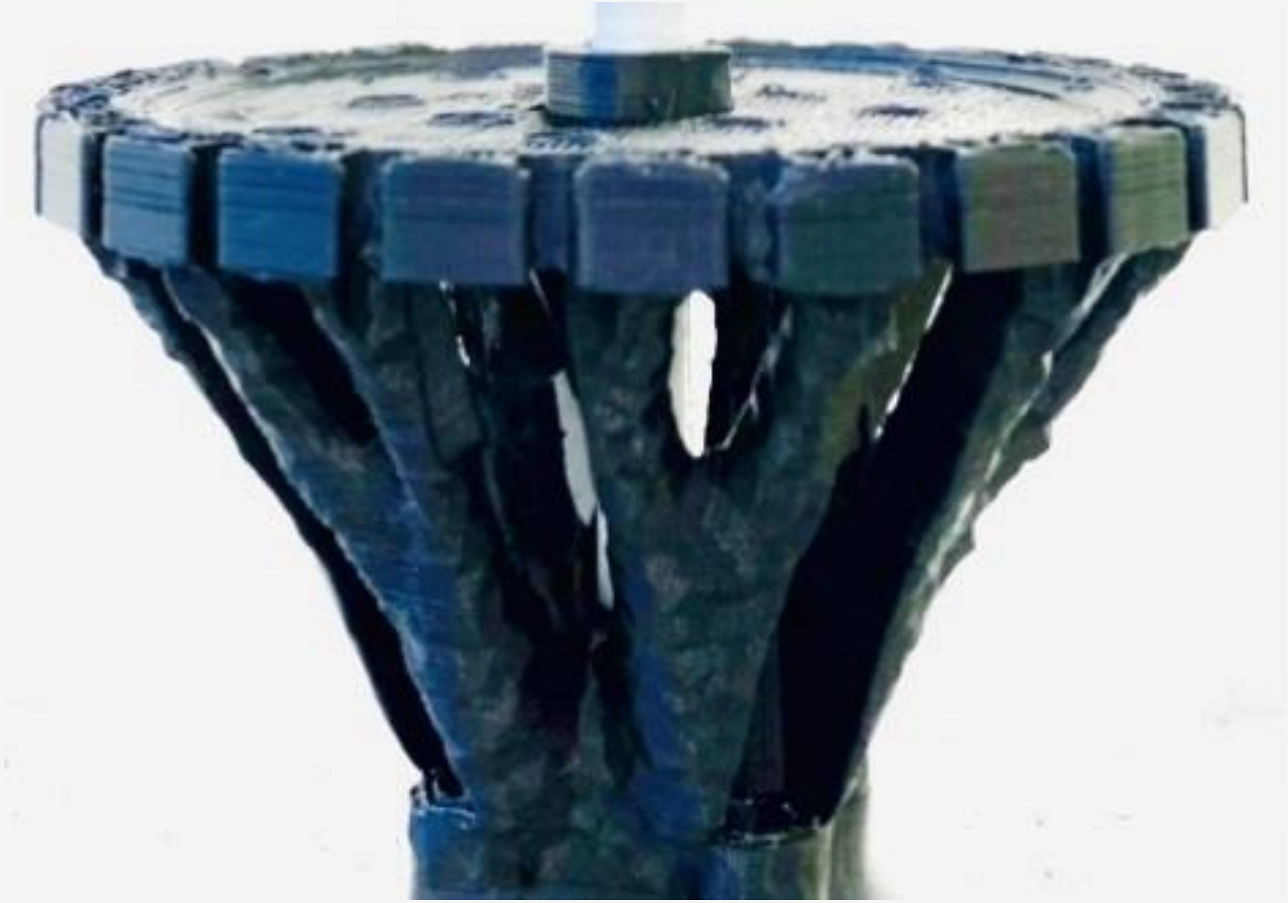


Figure 3.6

Rubber Band Intake Sprocket

Design Process (Continued)

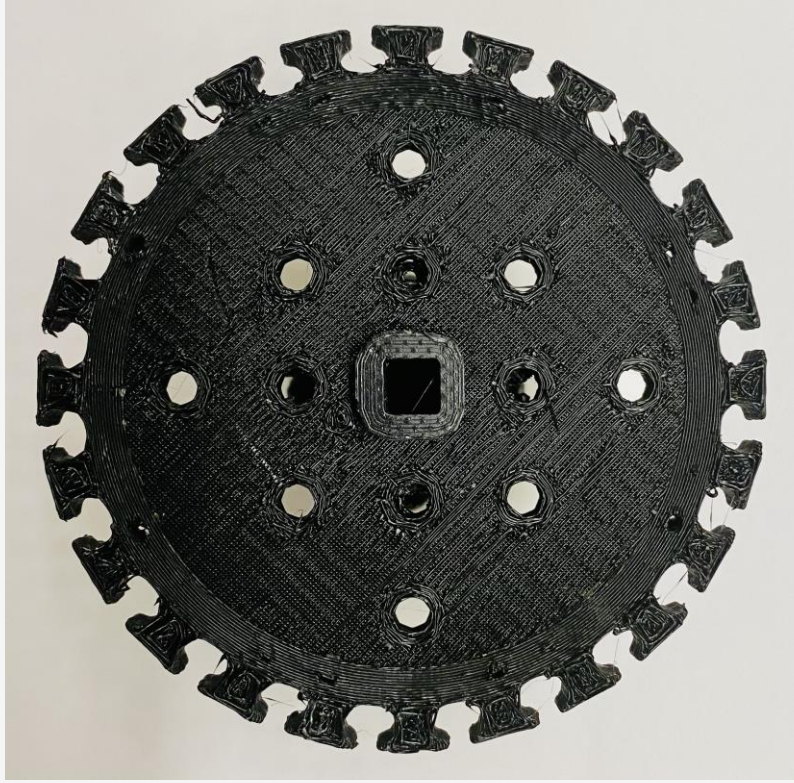


Figure 3.7- Printed Intake Sprocket Bottom View

Figure 3.8- Printed Intake Sprocket Top View

Conclusion

This project was a ton of fun to do. It was a good exercise of my 3d modeling and design skills. We learned a lot about Fusion 360's shape optimization and simulation workspace. This software is a huge help to anyone on a competitive robotics team; it allows you to design and test robot parts and sub-assemblies without wasting materials and time. This project has interested me in pursuing a career as a professional CAD designer. Even if I do not choose a career in CAD, the problem-solving skills I learned will easily transfer into whatever career path I chose. I am glad I undertook this project.