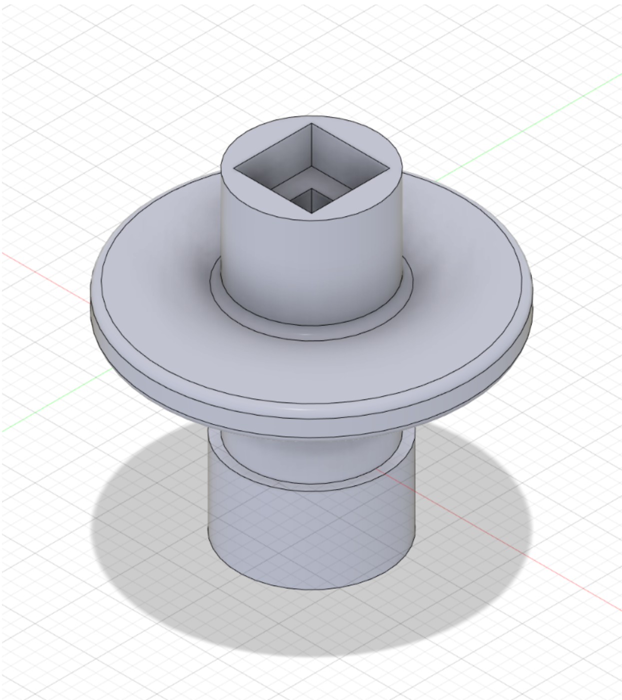
3600 RPM Direct Flywheel Motor Axle Stabilizer Final Report



C2C Robotics // Coast To Coast Robotics

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During the VEX Spin Up game, many teams have tried to reduce the amount of space that different subsystems take up and have tried optimizing them such that they run at maximum efficiency. One key subsystem that has been redesigned and experimented with extremely often is the flywheel.

Flywheel subsystems can be very large, especially those with a gearbox. To reduce the amount of space this subsystem uses, a few teams have optimized a cartridgeless motor that can output 3600 rotations per minute (RPM). implementation methods vary from team to team but this is one of the most efficient design solutions from an efficiency, complexity, space, and maintenance standpoint.

Fig 1: Gearbox of 18:1 Motor Cartridge

Each V5 motor cartridge contains a planetary gearbox that has been torqued up (via a gear system) to attain the ideal RPM output. By bypassing this cartridge, friction can be reduced inside the motor and also on the external subsystem. However, with this new method, there are some problems.

For starters, the axle is not as stable within the motor body. The current solution for developing a direct drive system is with a high strength space, rubber bands, and zip-ties originally seen in 606X, VEX HEX's YouTube videos. Due to the mechanical variance in the construction of the zip-tie spacer connection, the axle is not always centered or stable. To combat this issue, our team developed a direct motor axle stabilizer using **Autodesk Fusion 360, 13.0.0.8122**.

Fig 2: Current Solution for 3600 RPM Direct Output

The stabilizer is designed to seamlessly replace or integrate with existing motor geometries. There is a gear-shaped inlet for the driving gear on the motor. It will also eliminate the zip-tie spacer connection and instead have an external interface identical to the traditional cartridge connection piece for use with both high and low-strength driveshafts. The stabilizer can also fit inside a V5 motor cartridge which would increase the modularity and security.

The stabilizer went through many different designs and iterations. At first, the idea was to make the stabilizer replace the cartridge entirely. This idea was seen as ineffective because we determined that there would be potential vibrations due to lack of support. Therefore, the team decided to place it inside the cartridge and utilize the existing infrastructure of the motor and motor cartridge.

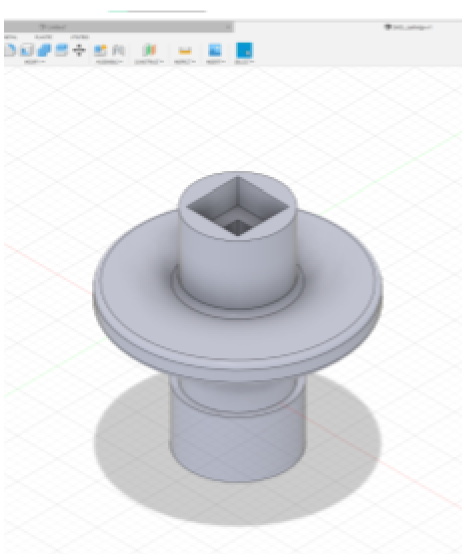

Figure 3: Isometric view of Stabilizer

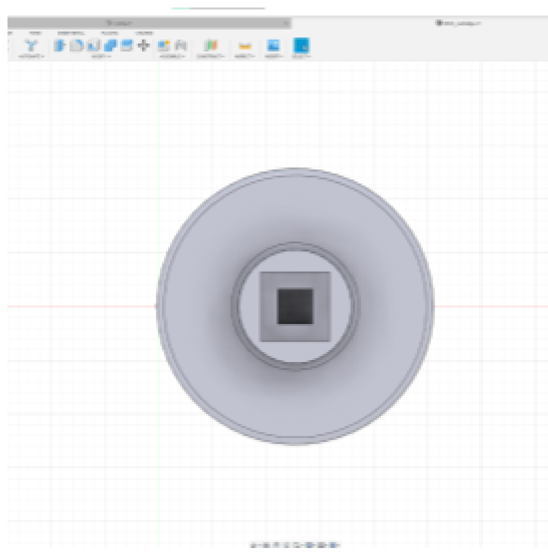

Figure 4: Top view (Driveshaft Interface)

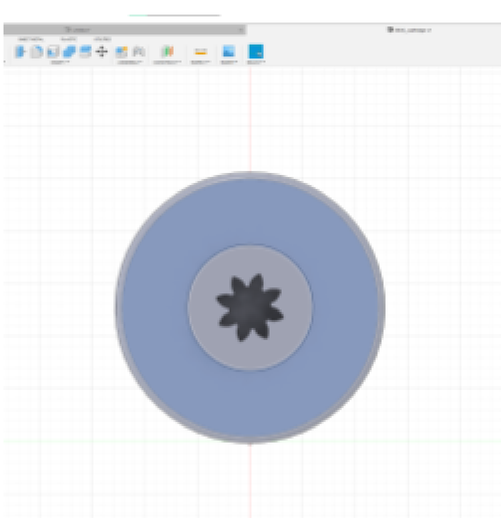

Figure 5: Bottom view, Driving Gear Interface

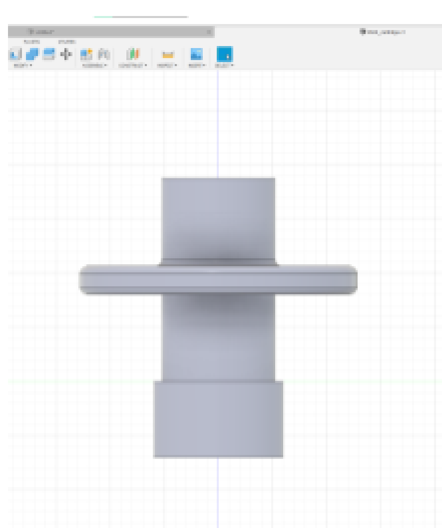

Figure 6: Side view of Stabilizer

Figures 3-6 show the stabilizer created in Autodesk Fusion. As noted in Figure 7, there is a plastic lip on the top of the part. This lip is the same diameter as the current gearbox, so it is able to stabilize the axle inside the motor cartridge. This additional stability makes implementation of the part much easier for teams who want direct 3600 RPM flywheels. Additionally, the gear driving interface was designed to fix exactly so there would be no slop or play between the stabilizer and the driving gear.

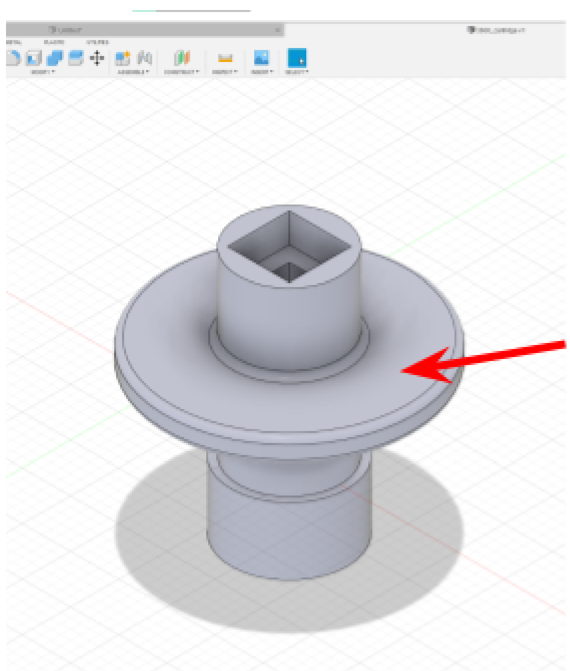

Figure 7: Lip of Stabilizer

This solution solved our issue with unwanted vibrations. However, when designing, our team encountered some problems with sizing the part to make it fit perfectly in the cartridge. Because the part would be rotating at such high speeds, it was crucial that the measurements were exact with no room left for error. We went through various iterations and at one point, the part was split up and we 3D printed only small parts of the design to make sure they fit without flaws.

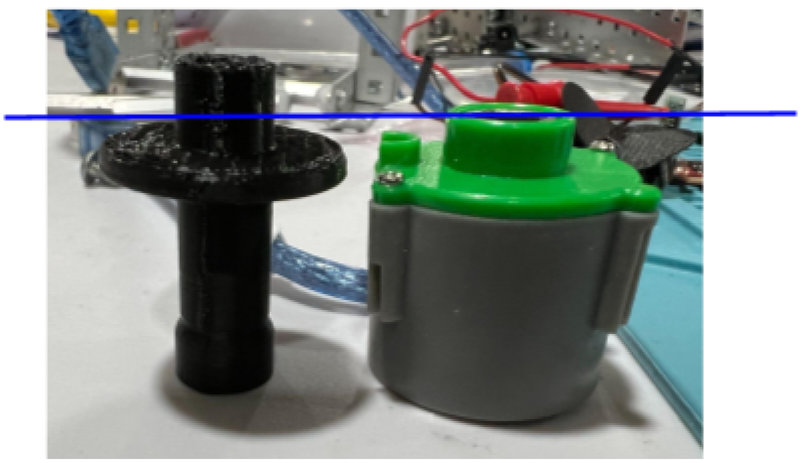

Figure 8: Stabilizer V1 print (too tall)

Figure 9: Stabilizer V1 with HS driveshaft

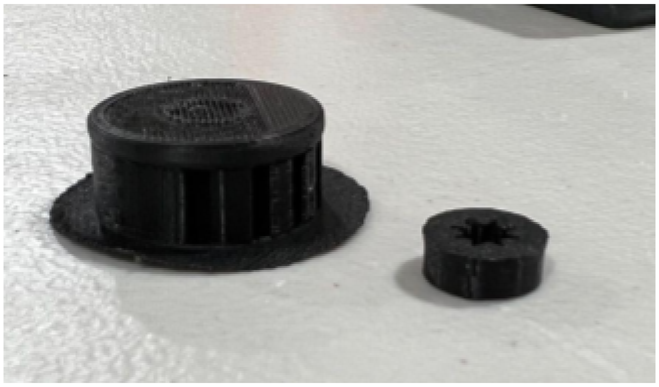

Figure 10: Failed attempt on left; driving gear interface experiment (failed).

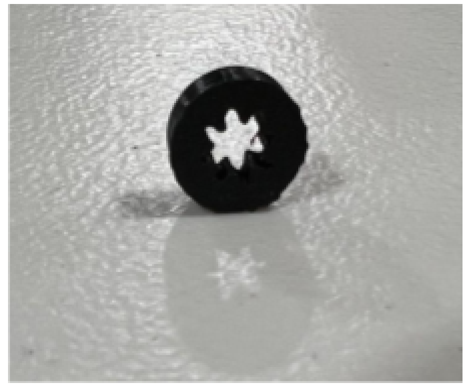

Figure 11: Driving gear interface experiment two (success)

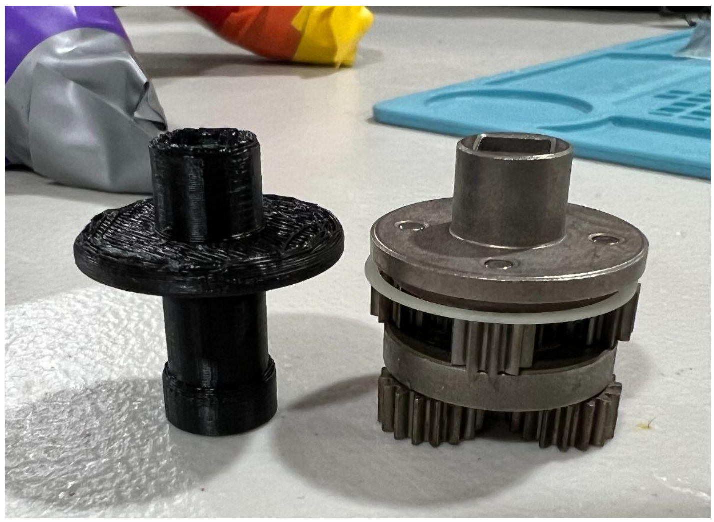

Figure 12: Final stabilizer design next to the 18:1 gearbox

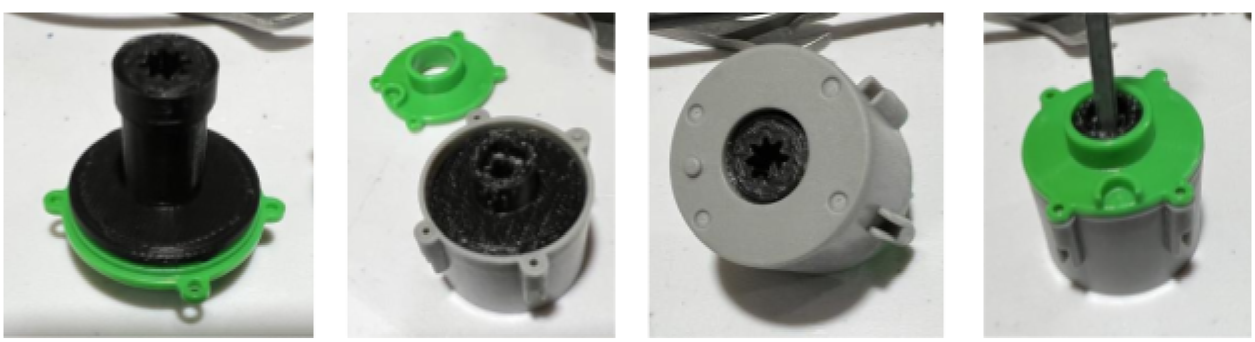

Figure 13 (left to right): Final stabilizer design in the motor cartridge cap, in the motor cartridge base, assembled view from bottom, assembled view from top with a drive shaft

Autodesk was very similar to what the team had used in the past but Fusion had some features that assisted the team make their project great. For example, the use of the spline tool really helped guide the shape of the gear casing on the bottom of the model. Filets were also used to decrease friction and the amount of material used. This way, the maximum potential of the part had been reached because of this feature. Of course, extrusions and cuts were used to create the general shape of the object. We demonstrated proficiency by completing the CAD design work in an astoundingly short amount of time of 50 minutes rather than hours, inclusive of design modifications. However, this does not factor in the brainstorming time, printing and post-processing time, and testing time.

Figure 14: Assembled stabilizer in a motor

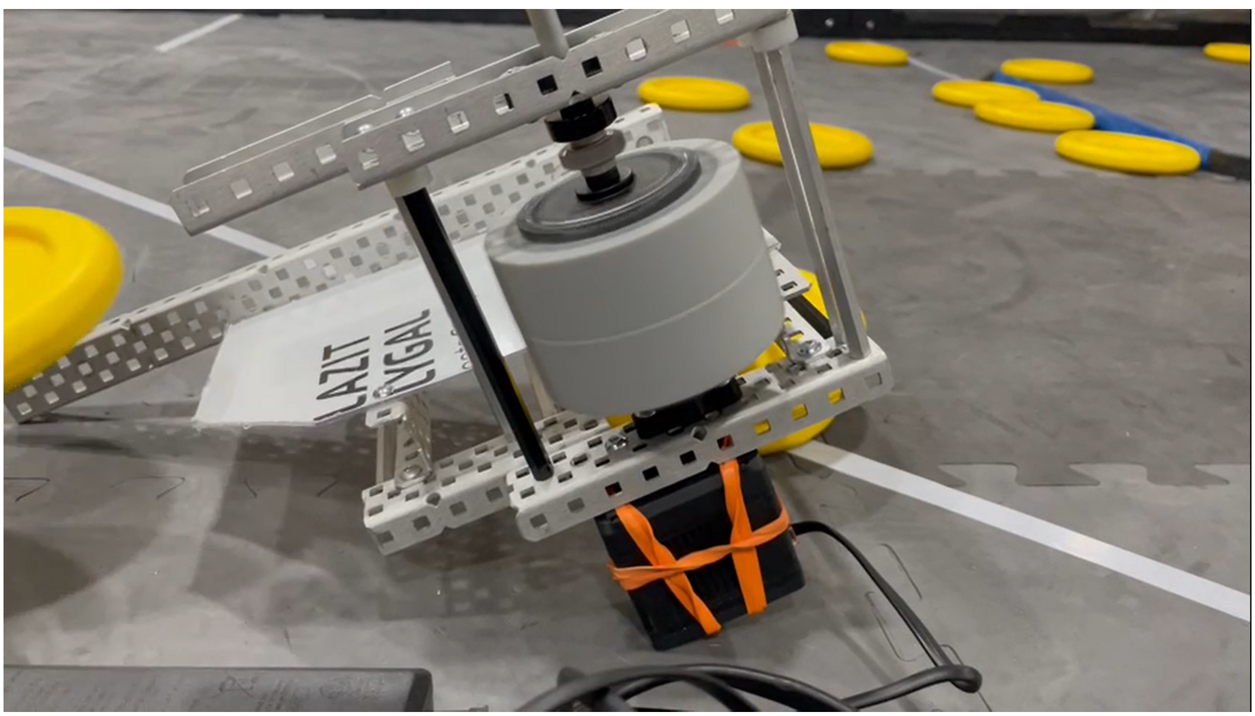

Figure 15: Flywheel subsystem using the stabilizer for a direct drive configuration

This project was one of the first 3-D designing projects for VEX-specific parts for the team. A few mistakes were made while implementing the part in CAD. Not a lot of physical dimensions were noted precisely on the motor cartridge as the CAD design was completed virtually. This caused a few setbacks while printing and creating a few unusable prototypes.

The support structure for the print involved a lot of post-processing work. The filament on the second iteration of the print also broke midway which scrapped the print entirely. We learned how to use Fusion 360 to solve a problem, and how to use its toolbox to design a simple and effective solution.

Despite the limited amount of 3-D printing that is allowed on competitive high school level VEX robots, 3D printing has been incredibly helpful in practicing more advanced levels of CAD and becoming familiar with tools and formats. It proved to be a very useful tool and we will be using it more in the future. For future VEX alumni, 3D design and 3D printing is also extremely helpful because it allows for visualization and project development, which is why it has become a staple for mechanical engineers, architects, biomedical engineers, and so many more careers. This technology has become essential for developing precise parts quickly making it a vital skill that everyone should know.