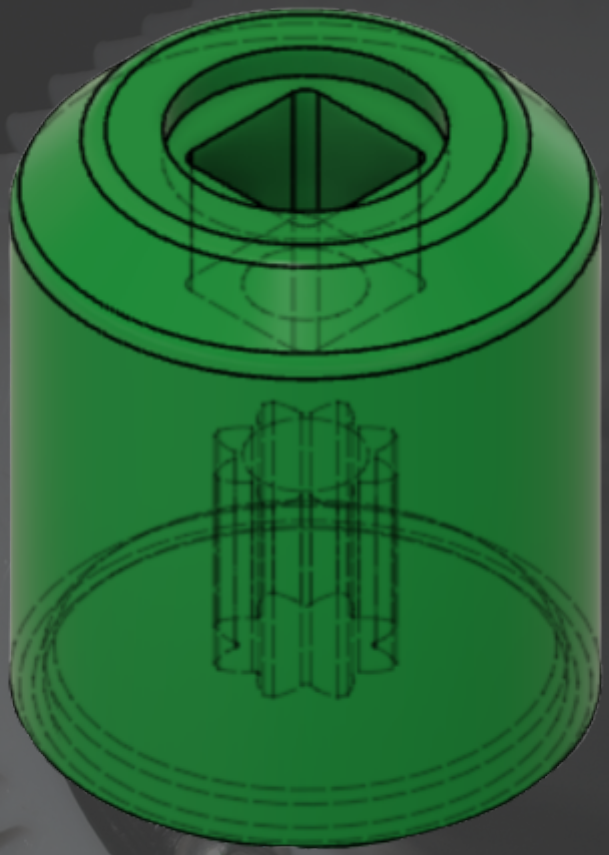
Direct Drive Gearing Cartridge

2023 "Make It Real" CAD Engineering Challenge
Sponsored by Autodesk



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ANTI-BACKLASH GEAR
FINAL REPORT

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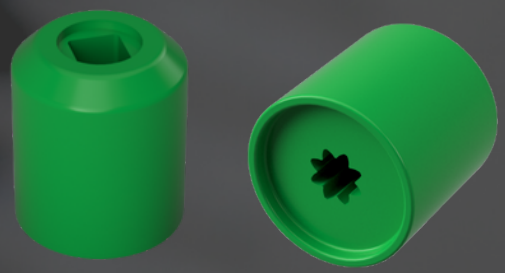
Introduction

Insights into our development scope

Within the VEX Robotics V5 ecosystem, only 3 internal Smart Motor gearboxes are available for purchase and use during competitions. This leaves systems that require gearing tailored for a higher speed output (such as a flywheel) needing to be done externally. External gearing can be heavy, and space-consuming, due to the added assembly of additional axles, bearings, gears, and structural parts. For our flywheel assembly this season, we opted to tackle this problem by designing a part that would replace VEX's Smart Motor gearbox cartridges with a coupler that would connect the drive shaft of the motor directly to a VEX Robotics Square Axle.



AON Robotics Direct Drive Cartridge (3600RPM)

Replaces

Smart Motor 6:1 Cartridge (600 RPM)

Smart Motor 18:1 Cartridge (200 RPM)

Smart Motor 36:1 Cartridge (100 RPM)

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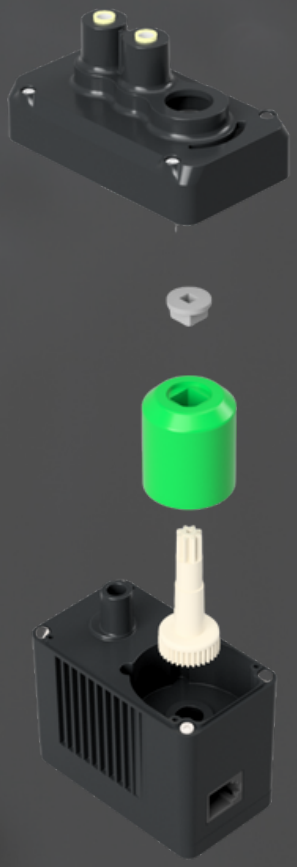
Specifications & Platform Integration

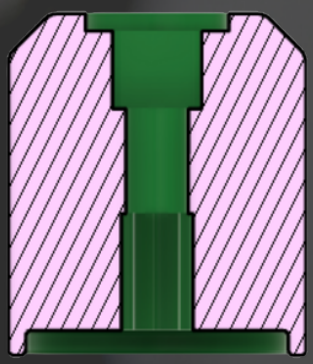
Technical description & use-cases

This part was designed to be a drop-in replacement for a standard VEX Smart Motor Gear Cartridge. The assembly consists of single 3D printed part, making use of press-fit VEX High Strength Shaft Inserts to have a tight fit on the output shaft. This part is then placed within the motor housing, coupling to white pinion gear.

The cartridge is 3D printed in ABS using the fused filament fabrication (FFF) method. This material was chosen due to its higher toughness and ductility than other common FFF materials.



Section Analysis



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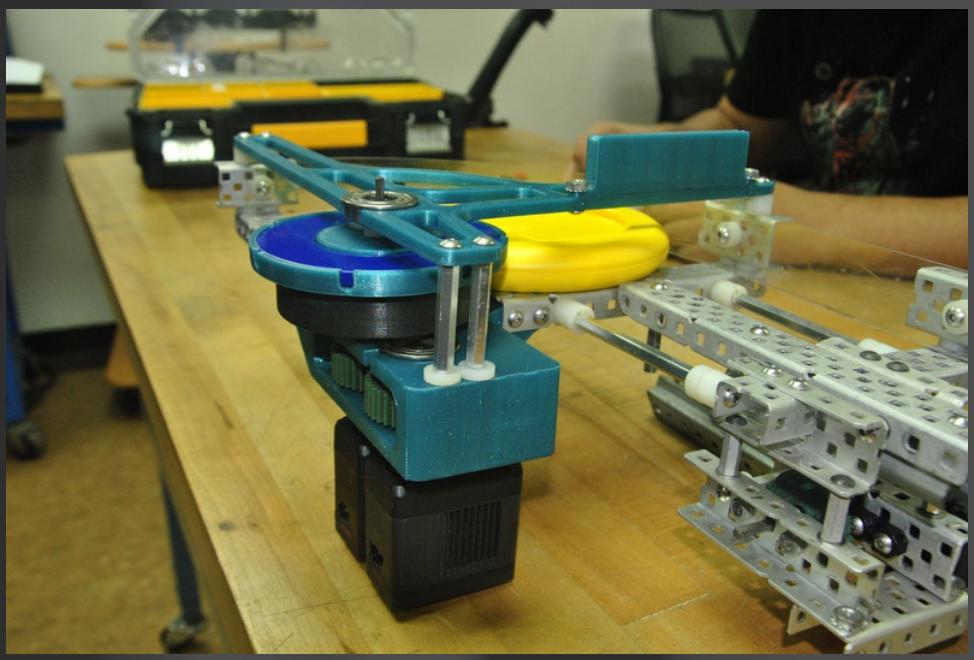
Specifications & Platform Integration

Technical description & use-cases

By constraining our design to hold a similar footprint as a VEX Smart Motor Gear Cartridge, any motor-powered high-rotation-speed application in a vex competition robot such as a flywheel or intake may benefit from using this part. This is due to the need for external gearing would require increased complexity in high-speed rotating assemblies, which require high manufacturing precision to minimize vibrations and friction. Using this coupler is a highly economical way to vastly improve robot performance whilst also enabling development lead-time savings, particularly.



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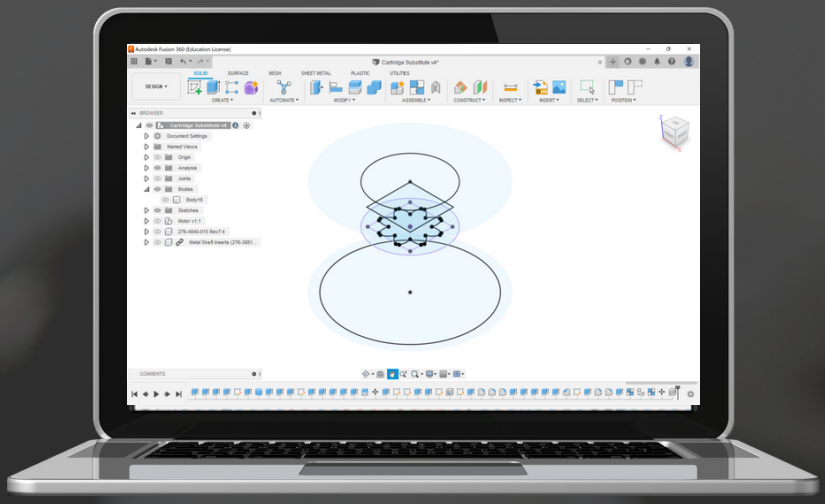
Design Process & Tools

Applied PMTs (Process-Method-Tools)

Autodesk Fusion 360

As a platform, we opted to employ Autodesk Fusion 360 for Students for the development of this component in order to maximize in-team collaboration and inputs. We began by importing the official model for the VEX V5 Smart Motor Assembly and High Strength Shaft Insert to project upon an initial sketch to guarantee that our new model preserves the exact same dimensions. Using the offset tool we created offsets of those projections in order to compensate for the tolerances of our available 3D printers to secure a press fit without creating excessive stresses that would damage the printed parts. Making use of the multiple options Fusion 360 provides to define a start plane for an extrusion, individual sketches were used for multiple extrusions.

The taper at the top of the part is at a 45 degree angle since it will allow us to print the part comfortably without support material. Using support material would be detrimental to this parts performance, as dimensional accuracy is a must for an enclosed part rotating at up to 3600RPM, since any asymmetry or manufacturing defect will induce vibrations in the assembly.



Sketches used to create the cartridge

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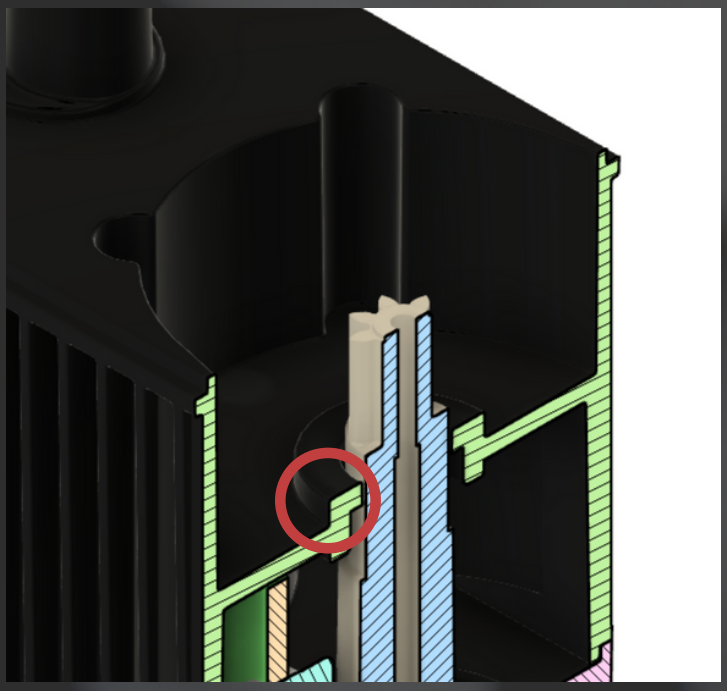
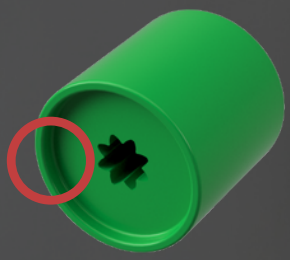
Design Process & Tools

Applied PMTs (Process-Method-Tools)

Autodesk Fusion 360

An additional feature was added to compensate for a gap between the floor of the bottom motor housing and a slightly elevated bump used typically to fix the Smart Motor Cartridges in place. This feature was a thin ring which allows the part to rest on the bottom while rotating, while reducing friction. Aided with lubricating grease, the part should not damage the lower housing when in use. The need for this ring feature arises from the reluctance to make the spline a press fit with the plastic pinion, considering this could lead to permanent damage, which is undesirable due to this being a part that is meant to be swapped out if the motor will be used as normal with the VEX gear cartridges.





Conclusion

Process-driven gains: their impact and their value

Through the challenge of developing our direct drive motor coupler, we learned the design freedom and opportunities CAD in Fusion 360 provides for rapid prototyping and robotics. In like manner and as we progressed with Fusion 360, we got acquainted with better parametric design practices, especially when creating sketches. CAD is at the core of modern engineering, and for this reason we will continue to use it in our robotics team to prepare our team members to excel in their future engineering careers. We have made CAD an integral part of our design process when creating our competition robots, since we assemble each robot within Fusion 360 to verify everything fits correctly before building our designs in real life, saving us both time and materials thereby ensuring that our project remains on-scope, on-budget and on-schedule.

Acknowledgements

Sponsors critical to our team's success

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gm

INME

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