## Introduction

In The Zone, with its mobile goal scoring methods, got our team thinking about how to get the robot to cross the bars into the point zones with ease. The issue was that the chassis was almost always the same distance from the ground, and this was preventing the robot from moving across the bars that lay in the way. This was because the wheels needed a shaft going through the middle, restricting the maximum height between the chassis and the ground. It was then we turned to the idea of a wheel system that could be attached at any height or location that could turn with no shaft having to run through its center.

## How It Works

With this new design, the robot will no longer need a long axle running through it to a motor, which in turn is attached to the chassis, because the motor will be *in* the wheel itself. This means that it wouldn't need to have a motor/gear system that is spread horizontally (which is traditional) but would need only the new design, which would have the whole system inside of it. By using pinions to turn a sprocket/gear hybrid, and in turn rotate sprockets that turn a chain around the wheel, this would free up a considerable amount of space in the chassis, which could be used to accommodate more parts while allowing the wheel to be attached in any direction or height and still turn without having to worry about bringing an entire motor system to its location. Also, the chassis could be attached to the upper part of the wheel in case you want to get over the zone bars (or any obstacle) with ease, or the lower part of the wheel if you are just short of that 18 inch height limit in VEX competitions. Even if the current design is somewhat rough, the concept itself will revolutionize strategies and builds.

**Making the Design with Fusion 360**

Planning took up a majority of the design building and with Fusion 360, on version 2.0.3800, we tested out different ways we could make the wheel work (and not work, in some cases). Our idea was to combine the use of old *and* new parts in order to lower the amount of printed parts needed, saving both time and resources. Thanks to the many Sketch features in the program, we were able to quickly measure out the existing parts (the pinions, sprockets, and chains) and brainstorm ideas for the new ones. We decided to create three new parts: the top and bottom casing of the wheel and the inside piece. We did this to ensure the access of inner parts in the case of wear or malfunction. Encouraged by the idea of planetary gears, we designed the inner piece, a hybrid of both a gear and a sprocket, using the pattern repeating function on Fusion, adjusting the size and number of teeth for the inside. We also used the rotation feature to create multiple copies of the outside sprocket to suit our needs.

Making the outer casing proved to be a bit more difficult, as we needed to look into the spacing between the cases as well as the placement of the original parts in the design. Encasing the inner piece was done using the Sketch feature, creating just enough space for the piece to spin while staying secure. Extruding was used for this, and was also used throughout the rest of building. The multiple features on extruding (cut, join, new body, etc.) proved very useful as the building of the design required constant revision and rethinking, as well as fine trimming and space making, especially for the motor to be inserted without interfering with any of the part's functions. It was also used to create space for the collars to be inserted, attached to the sprockets and pinions inside via short drive shafts. Choosing the locations of where the casing would come together was optimized by finding the place where the screws wouldn't interfere with the moving parts. We needed to check often if our new parts would go well with the old ones, and having the parts that VEX provided as well as the highlighting feature in Fusion, we were able to check the compatibility of the old and new parts.

**From Here on Out**

From this project, I learned how complicated building a new part is, especially since you need to take in the time, resources, and planning that goes into making just one new design. I also learned how ideas can come from almost everywhere— I realized how to attach the casings together whilst watching a video on making pancakes with molds. This was the first year I used this software, and I was surprised at how easy Fusion 360 made it to design the parts, as well as how easy it was to detail down to the thousandth of a millimeter. I will continue using this software for the rest of my high school career, for online challenges such as this as well as CADing build ideas for the VEX competitions. Our team has been using CAD to first make a general idea of how the robots will look like due to the easy maneuverability of Fusion 360, and we still plan on using this method for the future. Not just this, if you are on a competitive team, using such 3D software can be a big help when looking for adjustments that can be made to make your robot perform better, since you can cut parts and bend objects without physically doing it, and create motion joints to bring everything together, saving parts and time. Learning how to use 3D software will help me in my career path as the software provides an opportunity for me to experience the different parts of engineering and learning— the fun behind the planning, the effort behind the making, and the satisfaction behind the completion of a build.