VEX U – “Make It Real” Challenge

Sponsored by Autodesk

Raider Robotics – MSOE1 Presents

From Milwaukee, Wisconsin

3D Printed Traction Wheels

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Introduction:

Moving is a key part of any VEX Robotics Challenge and teams over the years have had the opportunity to optimize this part of the game. While there are many drivetrain types that a team may choose to pursue, the predominant one is the tank drive due to its unparalleled simplicity and robustness.

Teams have optimized the gearing and transmissions for these drivetrains, to try to get more acceleration and torque while maintaining a fast top speed. With the recent addition of the V5 Motor system, teams have suddenly had access to much more powerful motors, however, there has not been a significant change in these designs to take full advantage of this increased potential torque as the wheels have become the limiting factor. It has been possible to increase the top speed of drivetrains, but in a relatively small field, this speed increase is negligible due to the lacking acceleration possible by these traction-limited drivetrains.

V5 Motor (276-4840) which is more than twice as powerful as the previous 393 motor

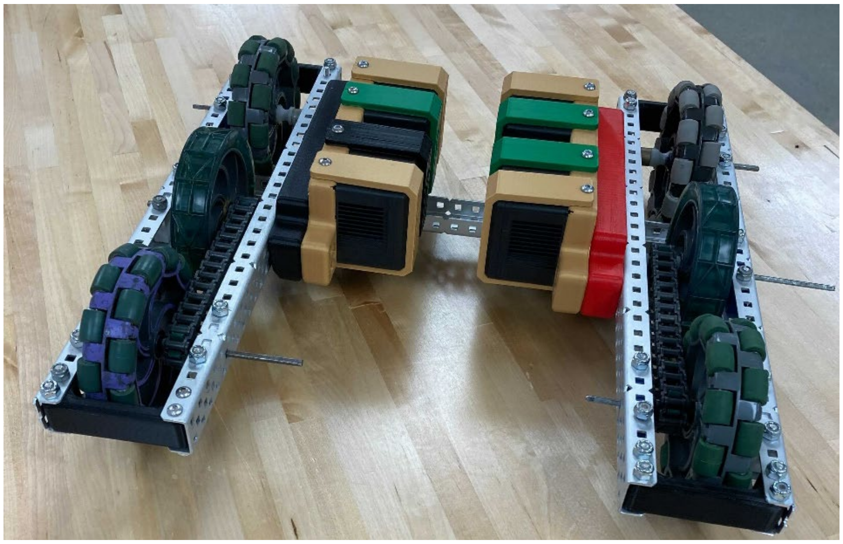
In our analysis of this untapped potential, we looked at how we could transmit this excess power into the ground. The most straightforward way to do this without modifying anything in the drivetrain is just to increase the weight of a robot. By doing so, you can increase the frictional force acting upon the wheels, making the robot better equipped to push or resist being pushed by an opposing robot. However, this has the distinct drawback in that this will not help (and may even reduce) the acceleration that is achievable by a particular drivetrain. Moreover, while this increases grip with the ground, this is not desirable when rotating the robot, as in a standard differential drive, there must be some wheel slippage as each wheel needs to move a different distance and face a different angle to follow an ideal arc. Too much grip while trying to turn can lead to “scrub”, where wheels bounce or skip to make the curve provided the drivetrain has enough torque. To counteract this, there has been a common trend of replacing some of the wheels with omni-wheels so that the robot can be stable and turn without difficulty.

Replacing all of the drive wheels with omni wheels essentially eliminates the problems with wheel scrub. The force of friction acting perpendicular to the wheels (scrub) is replaced by the negligible rolling friction of the omni wheel’s rollers. The downside to this is that the robot now has no ability to resist being pushed perpendicular to the drivetrain while under defense from an opposing robot. To combat this issue, a wheel in the drivetrain’s center of rotation can be a traction wheel instead of an omni wheel. Because this traction wheel only pivots and is not dragged along an arc like the outer wheels, it introduces resistance to being pushed perpendicular to the drivetrain without appreciable wheel scrub.

It is at this point that our design becomes relevant. There are no available traction wheels of the same diameter as the omni wheels, meaning that the ideal combination of outer omni wheels and center traction wheels cannot be utilized to its full potential.

The 4” VEX Omni Wheels (Yellow) is a larger diameter than the 4” Traction Wheel.

If a larger traction wheel is used, the drivetrain can rock between the front and back omni wheels, resulting in instability. If a smaller traction wheel is used, it will not contact the ground and will provide no benefit. Utilizing 3D printing technology, we manufactured a wheel hub and fastened a low-durometer rubber tread to it, but one that was still harder than the 40A of the foam field tiles to reduce wear. Not only does this allow us to take advantage of the ideal tank drive configuration, but it also has better grip.



Prototype tank drivetrain with outer omni wheels that prevent the center traction wheel from contacting the ground.

Make it Real Features:

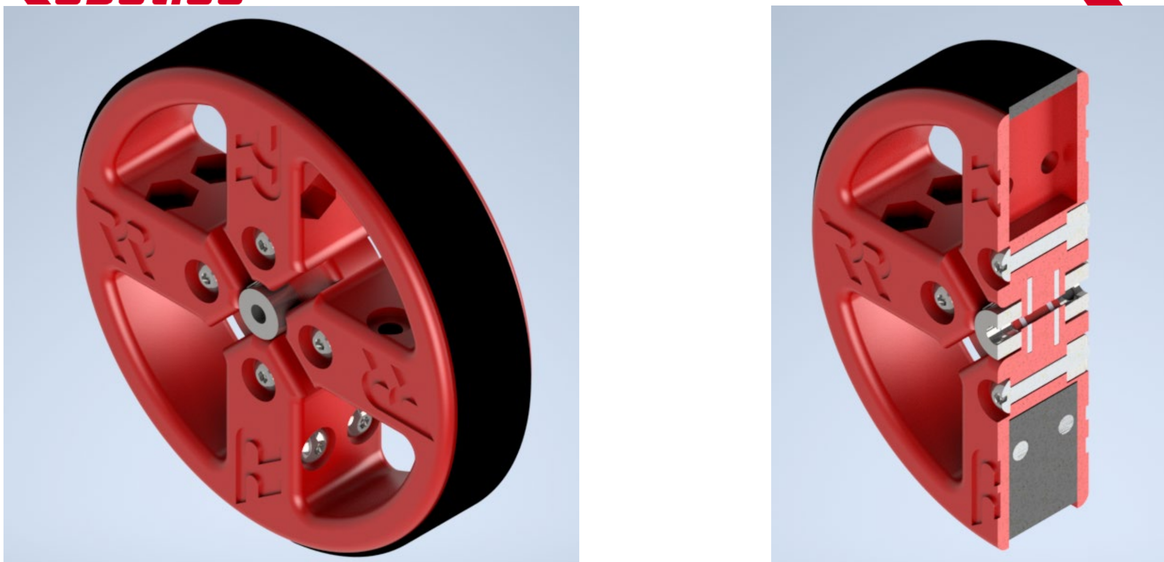
To make these wheels as effective to use as possible, we designed these wheels with several nice features from making several previous versions in year's past. In order to do this and prevent the need for support material the wheel consists of two main halves that then secure the 50A neoprene rubber to the wheel. The following is a short summary of the features available.

1. Integrated Bar Locks – Each one of the half wheels contains an integrated bar lock (275-1065
2. The tread is slotted into a pocket along the radius of the wheel for the fastener. The tread is fastened to the wheel by fasteners going through that slot into a hole in the tread. This is better than the epoxy we used in the past to fasten our tread.

Final Product Assembled

Inventor Features and Specifications:

This custom traction wheel was designed in Autodesk Inventor 2021 and this was created using the base extrude, hole, and fillet features. Feature recognition was utilized to speed up the design process and the final product was rendered.



Renders of the Custom Traction wheel showing the integrated bar locks and tread attachment mechanism.

Conclusion:

Through this project, our team further refined our ability to design 3D printed parts for high strength applications such as our drivetrain. In addition, we were able to design for ease of assembly by making the part the same in all orientations. Sourcing custom components, fastening tread in a secure manner, and easily interfacing with existing VEX hardware was also an important aspect of this project.

Bill of Materials:

PART NUMBER	DESCRIPTION	VENDOR	PRICE FOR 25 UNITS
497L39	1/8” by ¾” Wide 50A Neoprene Rubber Strip with Adhesive	Grainger	**$14.77**
	ESUN PLA Pro (color of choice)	Amazon	**$22.99**
		TOTAL:	**$37.76**
		Price/Wheel (approximate)	**$3.15**

Credits

Software Used:

- Autodesk Inventor 2021

Component Suppliers:

- Grainger
- E-Sun PLA+