
The VEX Two-Speed Transmission

Make It Real CAD Challenge



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2. Introduction

As time passes, the Vex Robotics Competition has gotten even more competitive. Do you need to collect scoring objects faster than your opponent? Do you need to push your opponent out of the way to score in your goal? To dominate the field, a new weapon must be used: The Two-Speed Transmission. Using the Two-Speed Transmission, the output shaft can shift to the speed and torque that suits your needs in a competition match.

3. Functionality

The heart of this design is inspired by VEX PRO products such as 2 CIM Ball Shifter (217-2428). A shaft that contains various gears spins with the 2-Wire Motor 393 (276-2177) while the follower shaft changes the gear ratio depending on which gears are connected.

In *Fig. 3-B* and *Fig. 3-C* below, we can observe an instance of gears changing ratios to increase the output rotational velocity. In *Fig. 3-B*, *gear 1* is currently connected to *gear 2*. When the external force moves the input shaft to the left, *gear 1* and *gear 2* ceases to connect and currently, *gear 3* transfer power to *gear 4* as demonstrated in *Fig. 3-C*.

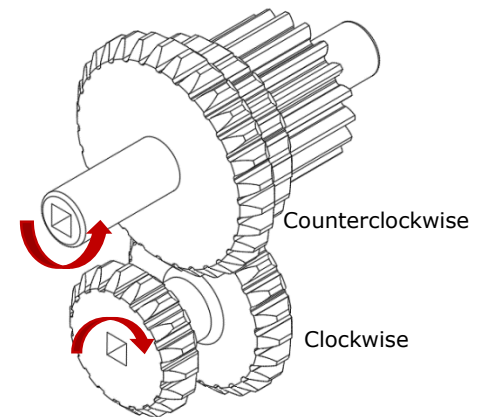


Fig. 3-A Isometric View of Internal Gearing

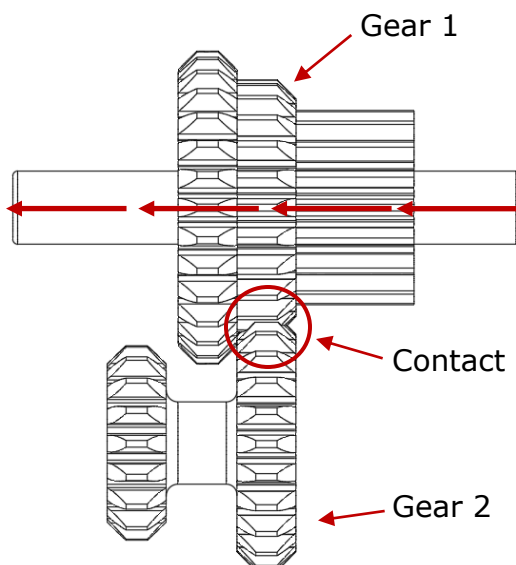


Fig. 3-B Side View of Internal Gearing demonstrating contact between *Gear 1* and *Gear 2* as first position.

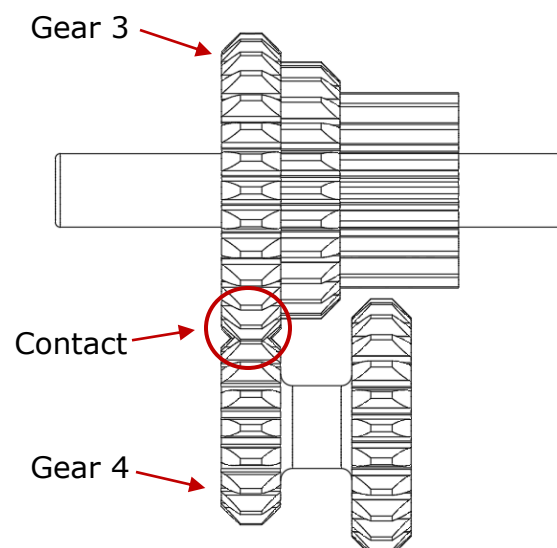
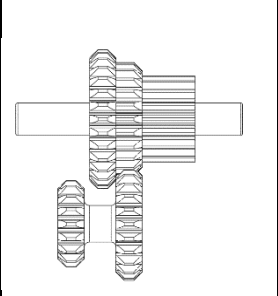
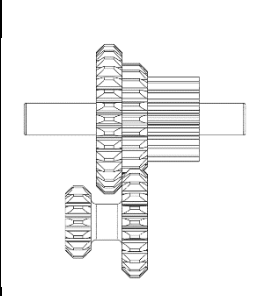
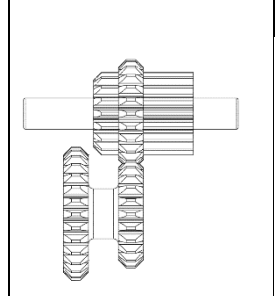
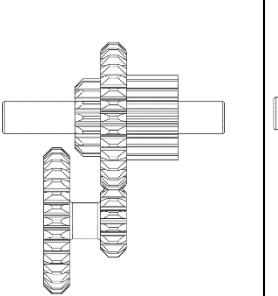
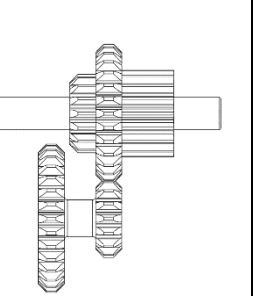


Fig. 3-C Side View of Internal Gearing demonstrating contact between *Gear 3* and *Gear 4* as second position.

The VEX Two-Speed Transmission Kit includes many preset gears with their respective ratios ideal for Vex Robotics Competition. The popular “high-speed” configuration is also included, together with a 24:24 gear ratio for “torque” configuration.

					
Ratio Change	24:24->30:18	24:24->33:15	24:24->18:30	33:15->16:32	30:18->16:32
Position A	14.76 in-lbs. 100 RPM	14.76 in-lbs. 100 RPM	14.76 in-lbs. 100 RPM	6.71 in-lbs. 220.02 RPM	8.76 in-lbs. 166.67 RPM
Position B	8.76 in-lbs. 166.67 RPM	6.71 in-lbs. 220.02 RPM	24.60 in-lbs. 60 RPM	29.52 in-lbs. 50 RPM	29.52 in-lbs. 50 RPM

The Two-Speed Transmission shift is powered by two separate one-way pistons. Both pistons are air supplied by a single VEX Solenoid (SY113-SMO-PM3-F). The small rods that are inside the pistons are jointed with shafts to the internal gearing as shown in Fig. 3-E.

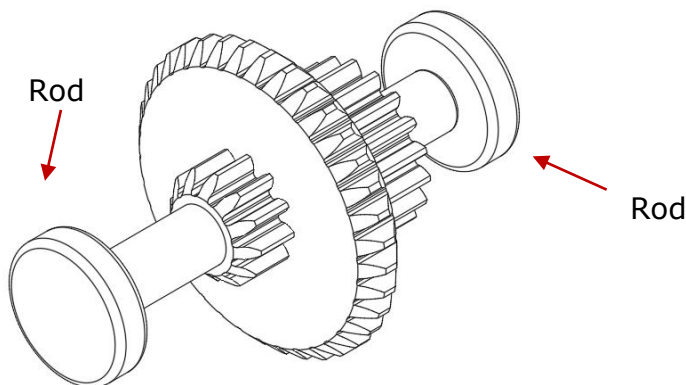


Fig. 3-E Isometric View of an Internal Gearing with Rods equipped.

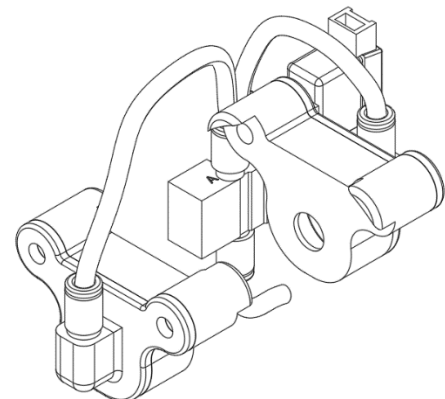


Fig. 3-D Isometric View of Pneumatic System

When a solenoid's valve is open, the air passes through a tube, until it reaches the small rod inside the piston that pushes the input shaft as demonstrated in Fig. 3-F.

The transmission also includes a sensor called Proximity Sensor shown in Fig. 3-G. The proximity sensor emits an electromagnetic beam that detects change in distance thanks to a gear-

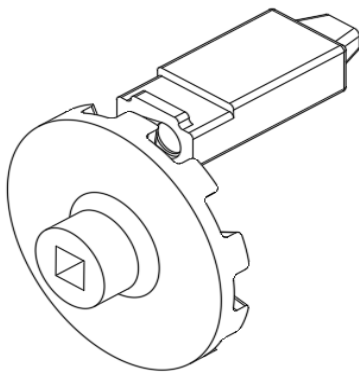


Fig. 3-G Isometric View of Proximity Sensor with gear.

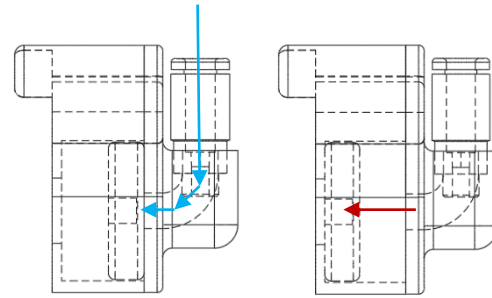


Fig. 3-F Side View of a piston with visible hidden edges, demonstrating the air flow through it.

like cylinder. Depending on how quick the change in distance happened per gear teeth determines the RPM of the output shaft.

The transmission is equipped on top of any c-channel available with a few screws thanks to the "L" structure jointed on the transmission casing. The output shaft can be connected to the wheels via sprockets and chains or gears as shown in the rendered image in Fig. 3-H.

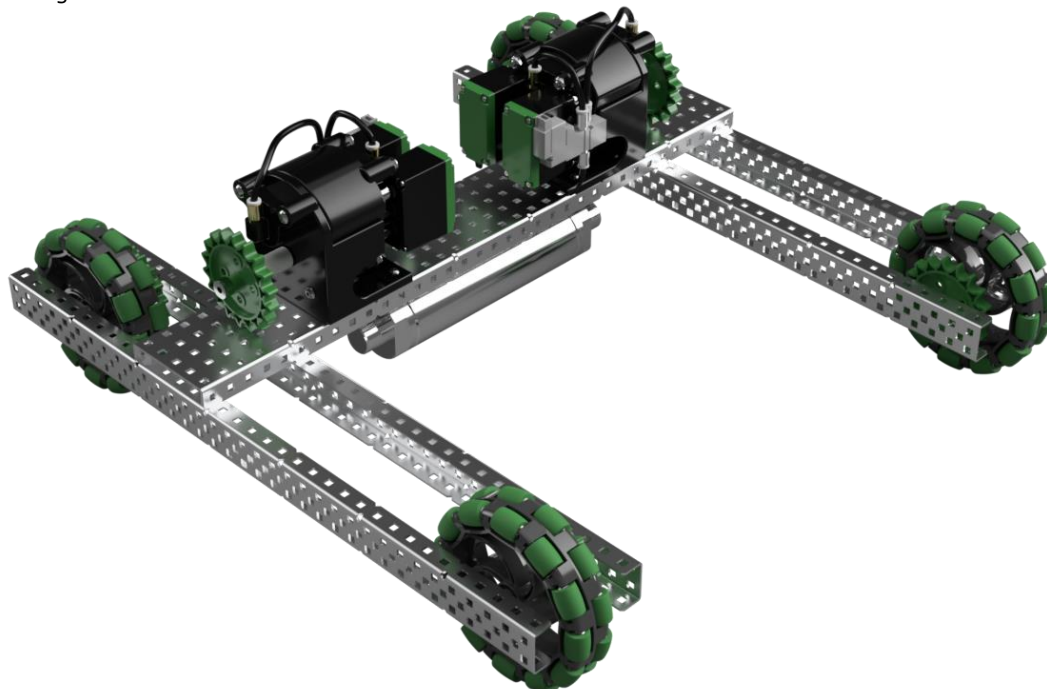


Fig. 3-H Isometric View of two VEX Two-Speed Transmission powering the wheels via sprockets.

4. Design

The idea of designing a two-speed transmission came from observing FIRST Robotics Competition teams that used variable speed transmissions to power their drive. After seeing the flexibility and power it consisted, it was known that it was needed for VRC teams to fully dominate their game. VEXpro offers many types of transmissions and products like these were used as reference to design the two-speed transmission.

Autodesk Fusion 360 (Educational License) was used to sketch, design, render, and animate the two-speed transmission. A wide variety of functions such as extrude, sweep, loft, chamfer, fillet, and many others are used to create each part of the kit. The Spur Gear Script was used to quickly create the gears based on parameters like diametral pitch, number of teeth, root fillet radius, gear thickness and pressure angle.

Inside the assembly environment, joint and align tools were used to assemble each part with precision, ensuring that the transmission would work. Cloud and local rendering were utilized to provide near-realistic images.

Each part created is converted into stl format for high quality 3D Printing which amounted around approximately 100 hours.



Fig. 4-A Isometric View of Rendered Two-Speed Transmission.

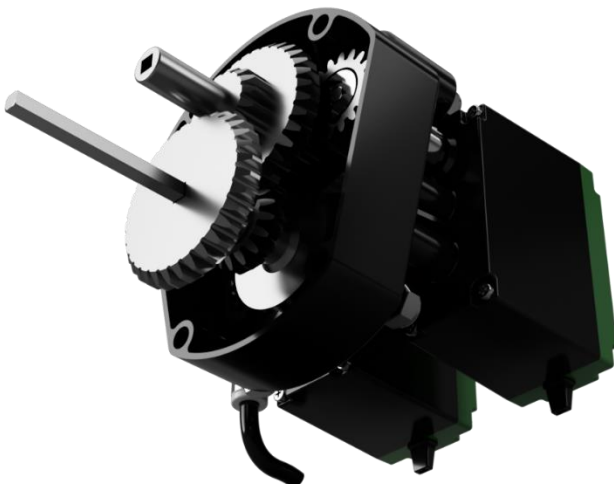


Fig. 4-B Isometric View of Rendered Two-Speed Transmission without the front casing.

5. Conclusion

The VEX Two-Speed Transmission offers a variety of modifications that can adjust the speed and torque that suits your needs to dominate your competition match. Whether you need to drive faster, load more elements, or push harder, the VEX Two-Speed Transmission is your best solution.

Fusion 360 offers simplicity, elegance and a wide range of useful features like cloud rendering, stress simulations, drawings, and scripts. It's essential for any engineering student to learn a CAD software because it demonstrates to your client better visualization and organization of the design and it's less prone to producing errors when prototyping. Thanks to Fusion 360 and 3D Printing Technology, we learned that we could design whatever limits your imagination in your home.