

VEX V5 Motor Reverse Engineering



5760D

Father Patrick Mercredi Community High School

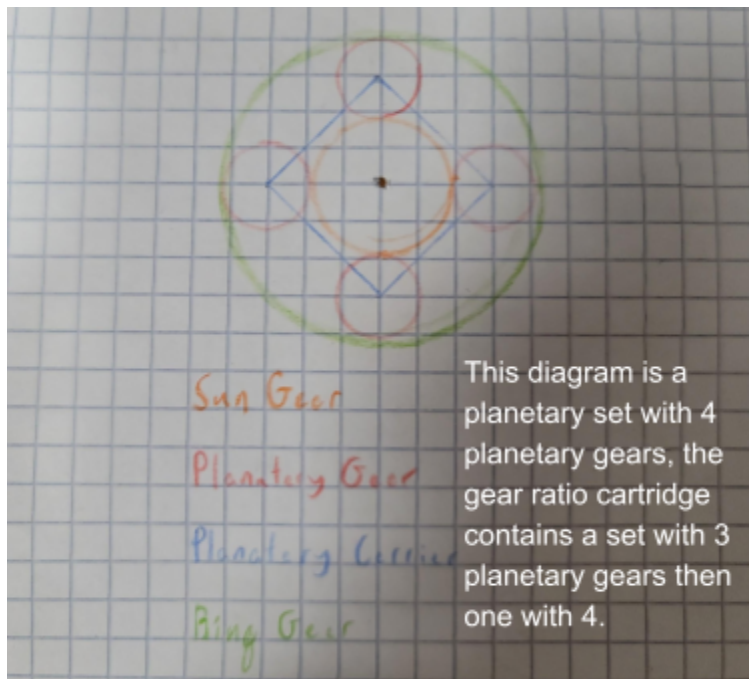
Seth Finnon AND Tristan Brady

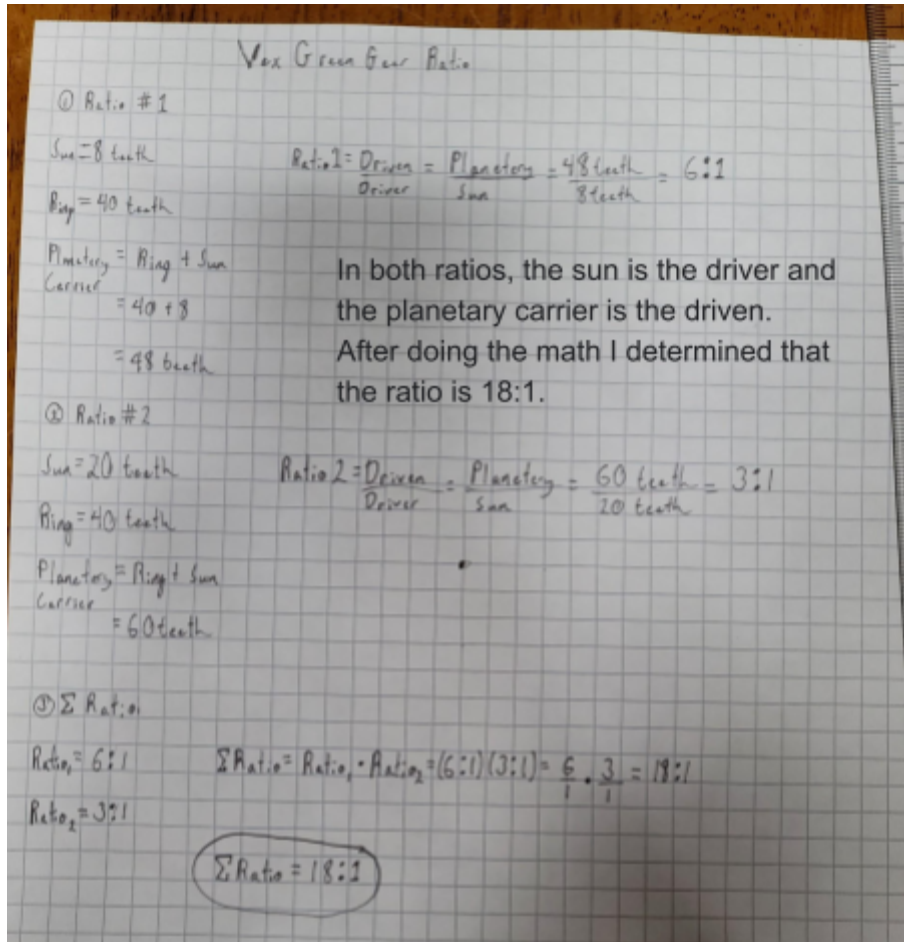
Introduction.

For the VCR High School Reverse Engineering Online Challenge, 5760D decided to deconstruct a VEX V5 motor. This was chosen due to our team's avid use of this device during VEX robotics competitions. We felt that we often rely on these motors within our robot's designs, and it would be helpful to understand how the devices worked. This is because it will allow us to repair our own motors if we need to.

December 17, 2021.

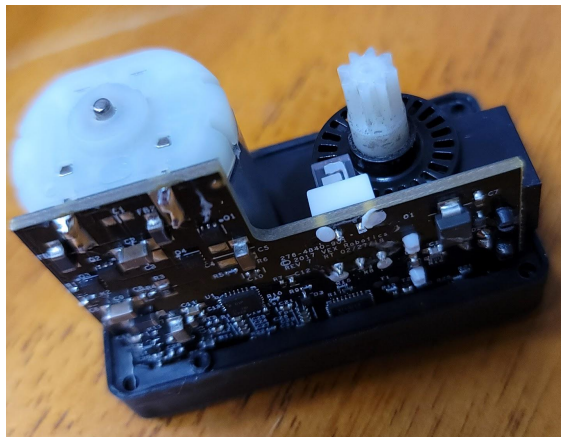
After removing the *front shell* you will find a *Gearbox*. The green gearbox we analyzed is a compound planetary gear set. A compound gear set consists of multiple sets of gears interconnected. A Planetary gear set is made up of a central gear or sun, a planetary carrier containing planetary gears surrounding that, and an inverse gear surrounding it called the ring.





December 27, 2021.

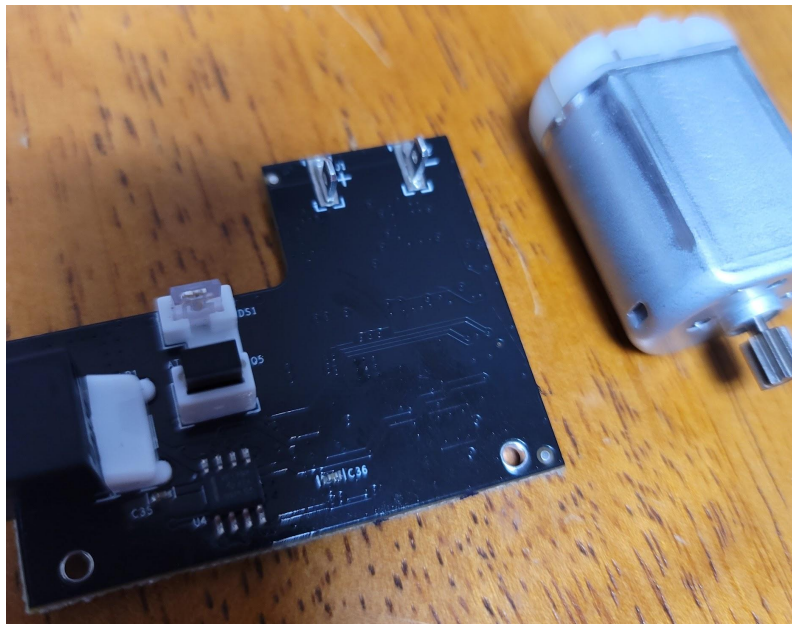
Once the gearbox is removed, the motor has a second inner shell, which gives way to the actual motor and circuit board within the V5 motor.



In order to fully remove the motor and circuit board, remove the bottom shell, revealing gears that go from the motor to the shaft. This set is composed of three gears with a 17:5 ratio.

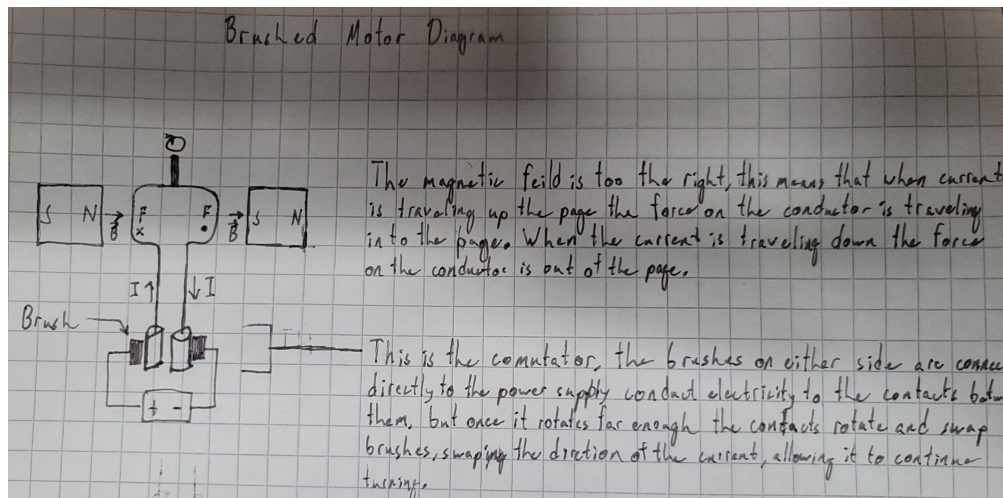


After removing the central gear you can remove the motor and circuit board from the shell. Then the motor can be unplugged.

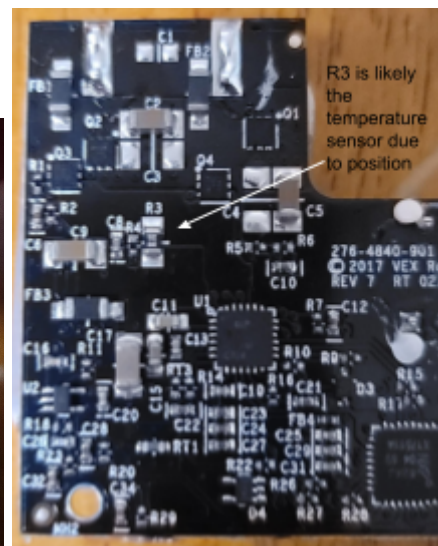
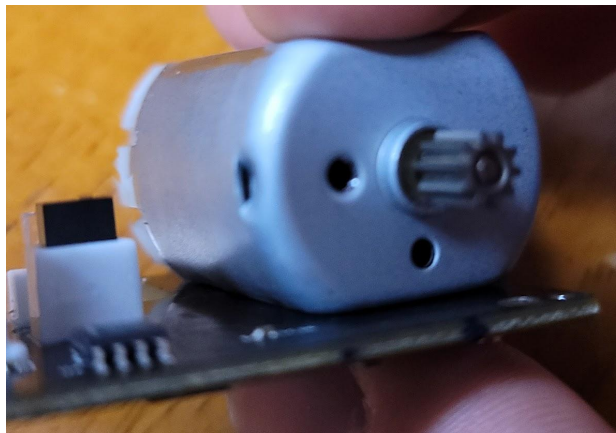


The motor itself is a brushed motor, meaning it contains two magnets each facing the center with opposite poles. Within the center is a conductor that runs up then back down,

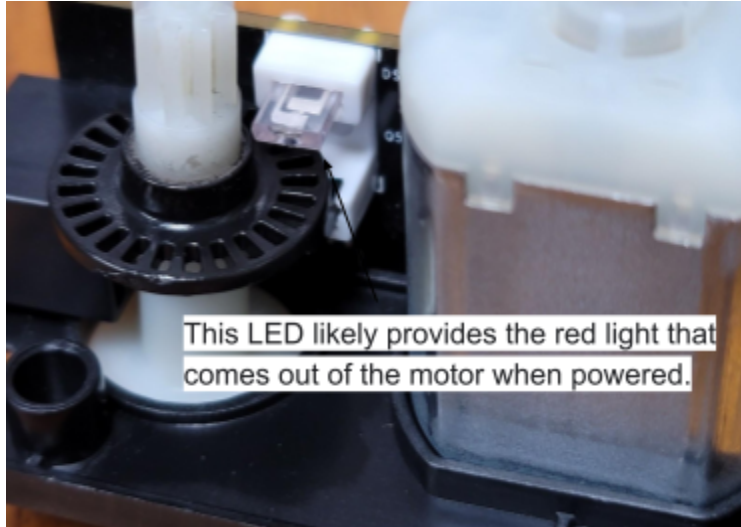
connected to the motor's shaft. Current is run to this conductor via the commutator, allowing the current to be swapped within the conductor so that the shaft is always driven in the same direction by the magnets.



The PCB itself controls the motor and records its speed, direction, position, current, and temperature. The current and direction can be determined by the PCB itself, as it is what supplies the current to the motor, which directly relates to the direction. Due to the motor's placement it is clear that a sensor built into the PCB detects temperature.



As for the speed and direction of the motor, this would most likely be done via the shaft rather than the motor itself. The shaft has a wheel attached to it, within a structure containing a black surface on one side, opposite a LED and photoresistor. Judging from the fact that the wheel and the surface are the same colour it is likely the photoresistor records the distance between itself and the reflected light from the LED. It can then detect when the slits pass so the PCB can determine the speed and location of the shaft.



Conclusion.

Through the deconstruction of the VEX V5 motor, we gained a deeper understanding of the mechanics and physics behind gear sets. It also led us to further consider the physics behind motors and electromagnetic forces that we learned in our classes.

Motor Components;

- **Shell**
 - Front Shell
 - Main Shell
 - Back Shell
 - Motor/PCB Mounting

- **Gearbox**
 - Shell Face
 - 3X 16 Toothed Planetary Gear
 - Planetary Gear Carrier (3 gears)
 - 4X 10 Toothed Planetary Gear
 - Planetary Gear Carrier (4 gears)
 - Outer Shell/ Ring Gear
 - 2.5 cm Diameter Plastic Ring

- **Drive Shaft Gear Set**
 - Drive Shaft
 - Idle Gear
 - 0.75 cm Diameter plastic Ring

- **Electrical Components**

- Motor
- PCB
- LED/Photo Sensor
- Smart Port

- **Screws**

- 4X 4 cm Screws (Hold Main and Back Shells Together)
- 4X 1.75 cm Screws (Hold Main and Front Shells Together)
- 3X 0.5 cm Screws (Hold Gearbox Together)
- 2X 0.6 cm Screws (Mount Motor)
- 2X 0.4 cm Screws (Affixed Motor Mount)

Credits;

<https://kb.vex.com/hc/en-us/articles/360035591332-V5-Motor-Overview>

<https://www.youtube.com/watch?v=bWtK5mzuddo>