Reverse Engineering Challenge

2023-2024 Season

Vex Robotics Competition Team 15442A Canyon Cooks

Anaheim, California, United States of America

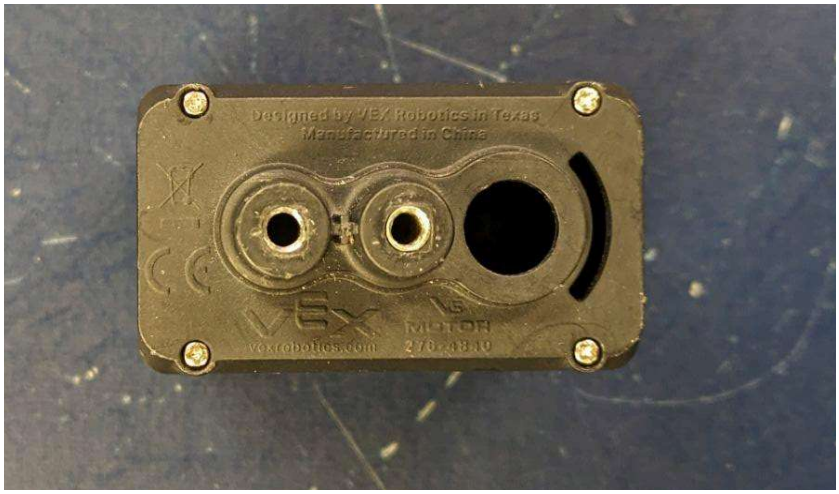
Team Members Who Participated: Wesley, Omer, Lukas, Samuel, Dylan, Rohan, Ryan, and Timothy

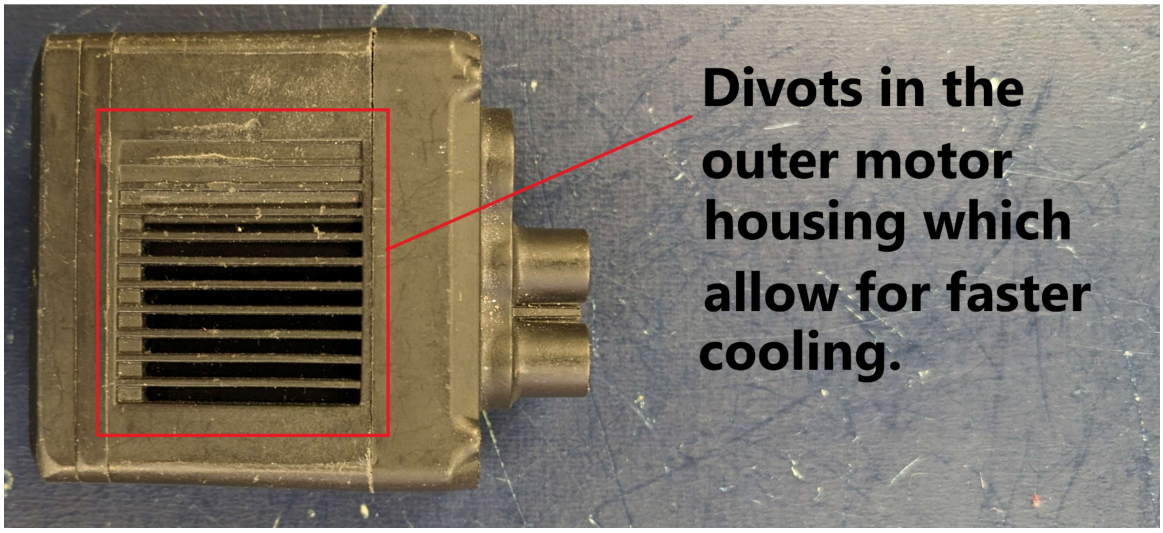
For the 2023-2024 season Reverse Engineering Challenge we chose a VEX V5 Smart Motor, a fundamental device which powers almost all mobile components in the VEX Robotics Competition. In general, motors are important components which power everything from children's toys, to the Ferrari SF90 Stradales, and even medical pumps used for IV and blood transfusions. While motors may seem simple, it is this simplicity that has made them so versatile and fundamental to society. It is for these reasons we have chosen to reverse engineer the V5 Smart Motor.

The V5 Smart Motor contains 22 separate components: 12 screws, 1 washer, 2 gears, 1 interior/base motor, 1 circuit board, and 5 plastic pieces that compose the motor housing. The function of the 12 screws is to hold the pieces of the motor housing together. The washer helps reduce friction on the motor's gear train. The 2 gears make up a gear train that together increase the torque, the rotational force, of the motor. A gear train is a row of gears of different sizes used to increase the speed and/or torque of a motor. The ratio of the gear train is a 1:4 torque ratio followed by a 4:3 speed ratio to create an overall torque ratio of 1:3. It is important that the torque ratio is first, because if the speed ratio comes first it puts too much pressure on the teeth of the gears, causing them to break. The interior motor turns initially the 10 tooth gear at 1,200 rotations per minute (RPM) which spins the gear train creating an output of 3,600 RPM on the final 30 tooth gear. The circuit board, also known as a motherboard, contains all of the components which control the interior motor. Attached to the circuit board is an extension which allows for a wire to be plugged in through the motor's case. The wire brings power to the motor and sends electrical signals, which controls the rotation of the motor based on wattage. The final components of the motor are the five plastic pieces which are used to construct the motor housing. The motor housing protects the internal components. The main piece of the motor housing has divots in it. These divots increase the surface area of the motor, which allows for greater contact between air and the motor. This allows the motor to cool faster, preventing overheating and motor burnout.

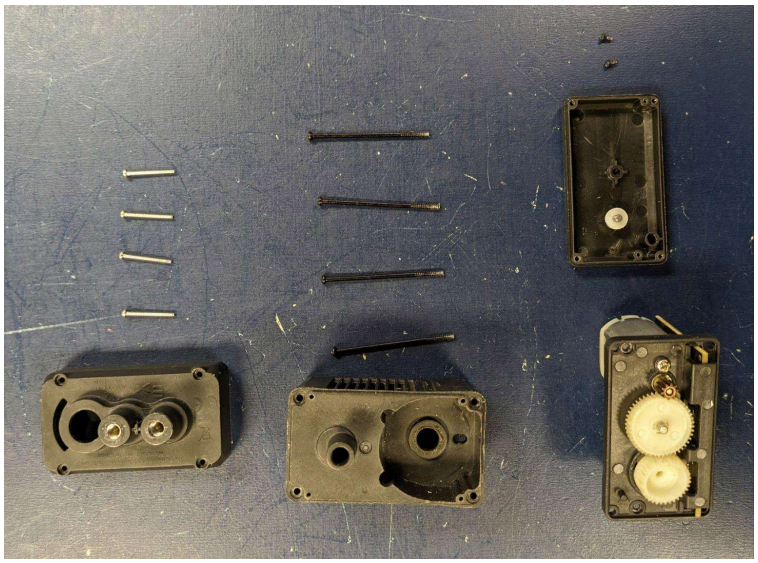
Our key takeaway from this project is that as simple as V5 Smart Motors seem, there are many intricate details like divots for faster cooling and gear trains enabling greater speed and torque, which allow the motors to run at optimal performance. We also learned that the simplicity of motors makes them easy to adapt the same ingenious design to fit a multitude of tasks. From powering a train set to saving lives through blood transfusions, motors are a powerful tool that turns gears, as well as society into what we know today.

V5 Smart Motor before reverse engineering:

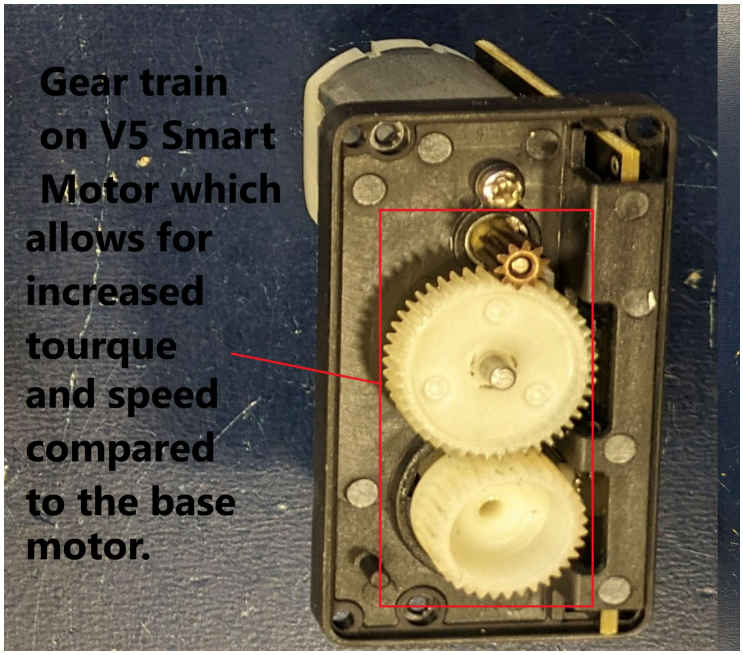




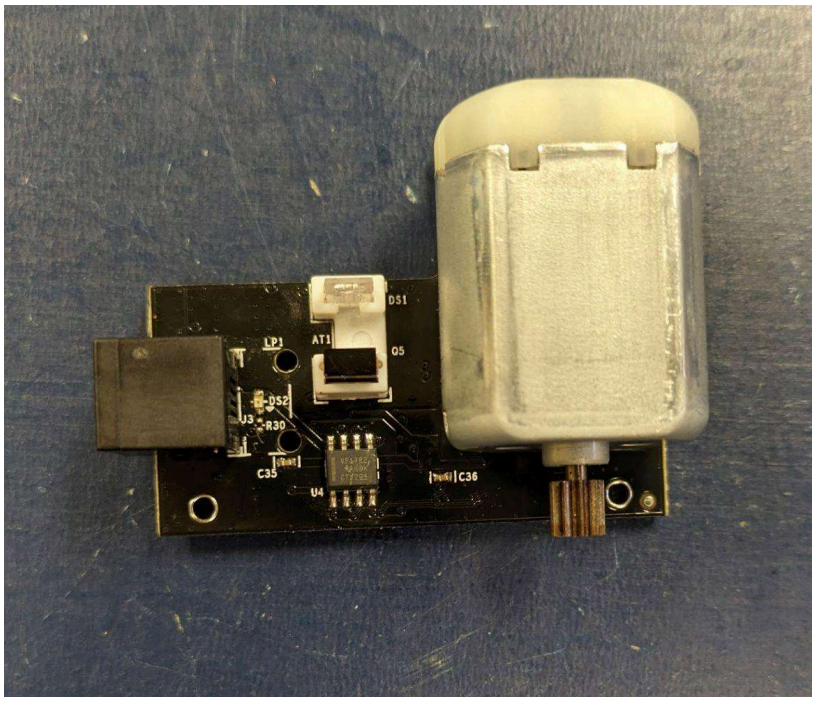
V5 Smart Motor with plastic housing removed:



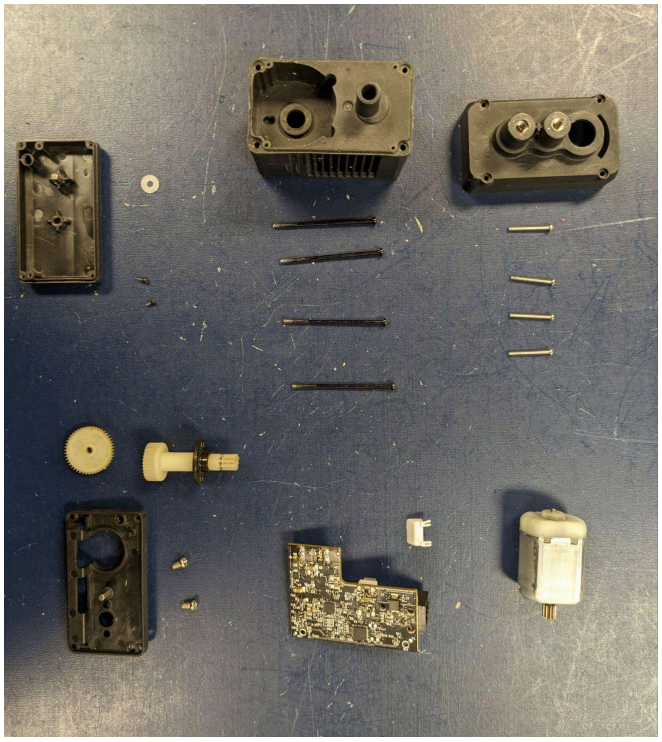
V5 Smart Motor gear train:

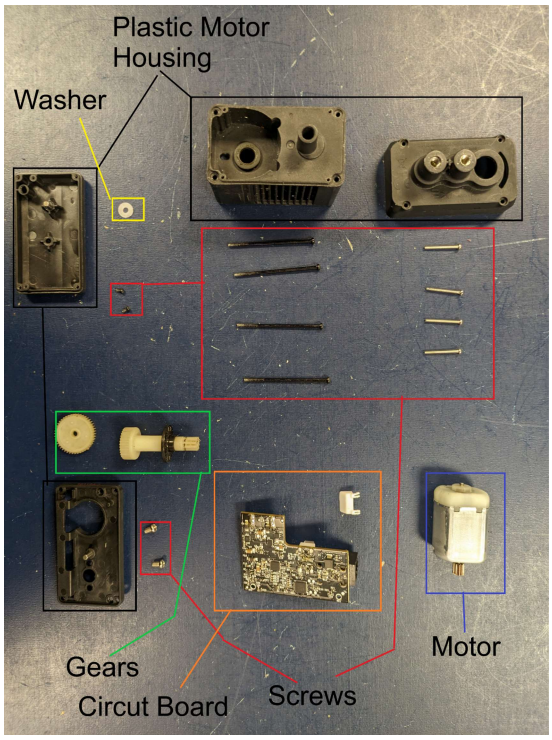


V5 Smart Motor with motor attached to circuit board:

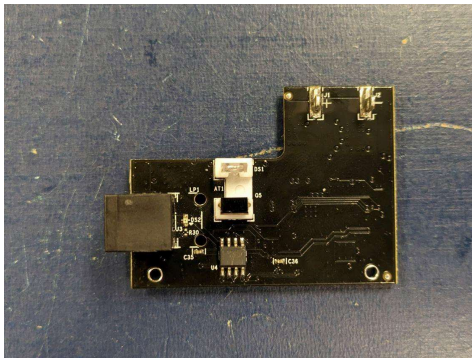


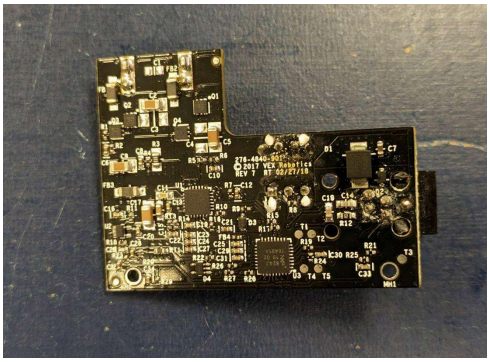
V5 Smart Motor after reverse engineering:





V5 Smart Motor circuit board:





V5 Smart Motor motor: