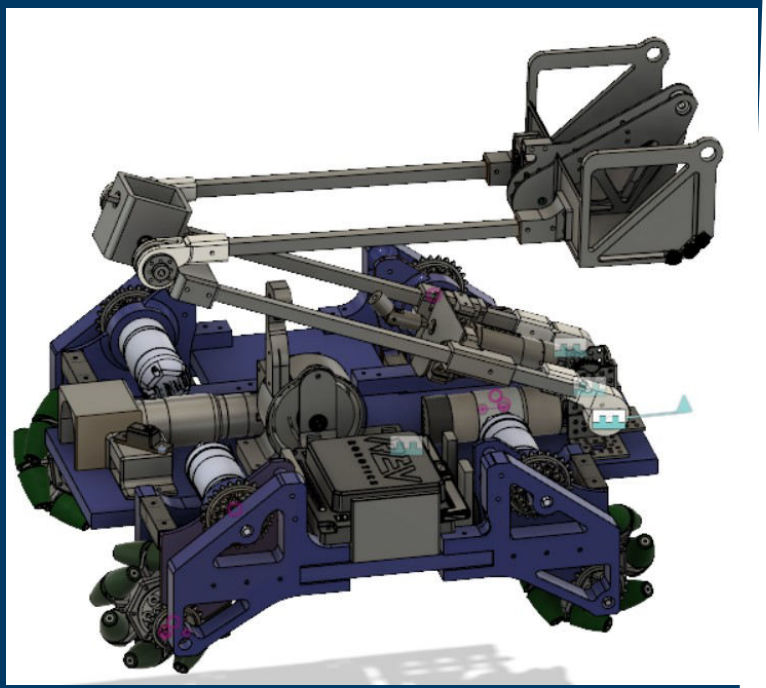
CAD

When FTC 8668 was established in August 2014, none of the team had any experience with computer aided design of any kind except maybe a little bit of Lego Digital Designer. So, Coach Belbas decided to teach a year long Introduction to Engineering class in which we learned how to create engineering drawings by hand as well as Autodesk AutoCAD and Inventor. Since we were learning these skills simultaneously with the FTC season, our notebook mostly consisted of robot assembly drawings documenting our work after the robot had been built.

In our second, third, and fourth seasons, our CAD skills improved. As a result, we began creating more custom designed parts and manufacturing more with CNC equipment such as 3D printers and routers. In our 4th season, we set a goal (and mostly kept it) to design the entire robot in CAD prior to manufacturing. With each design sprint, we might prototype to test a concept but then designed the parts in CAD before we moved on.

This season, our new team members are learning CAD so we've had a lot of inward focused learning. However, an interesting fact is that every member of our team has worked on some CAD this year, whether it be a battery box or a gear box. Later this season, we are eager to spend more time learning and experimenting with generative design which is a new feature incorporated into Autodesk Fusion.



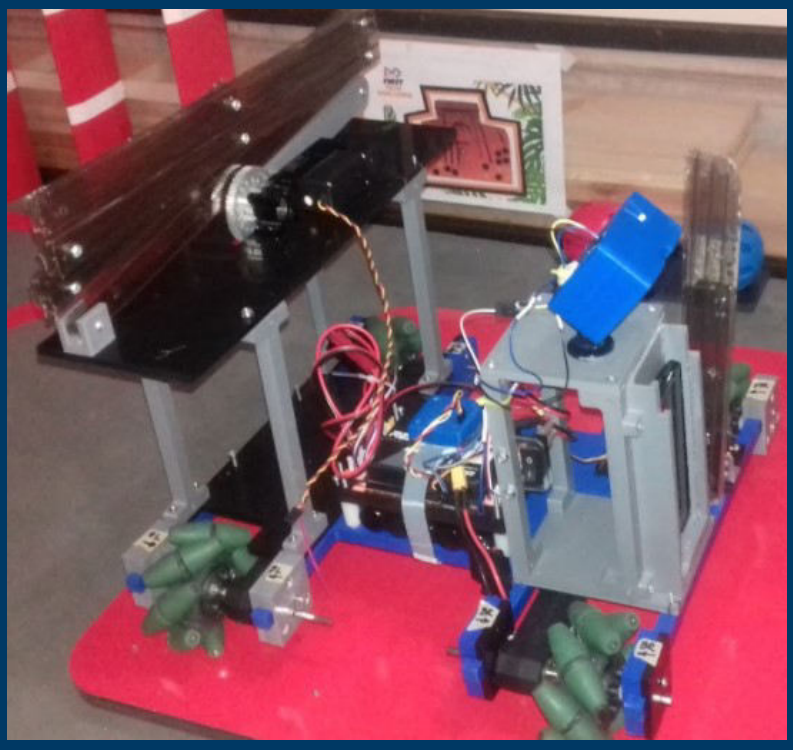
Robot—Gen 1

At the beginning of the season, we brainstormed mechanical design criteria for the robot based on experience from prior years. We decided the robot must:

- Be completely designed in CAD before any manufacturing or assembly takes place.
- Use a 4-wheel drive meccanum or holonomic system for max maneuverability and power, but preferably NOT use belts as we had a lot of problems with them last year.
- Continue to use custom designed, 3D printed parts whenever possible including use of new filaments such as Ninjaflex or carbon fiber.
- Use a lot of HDPE pieces cut on the router since we have so much HDPE left over from the previous year.
- Have a fairly centered CG to optimize balancing on the balancing stone.
- Be modular to allow for ease of replacing parts as they wear out or are upgraded.

The first generation of the robot was the version that, with minor modifications and improvements, was used in Meet 1 and Reinbot Qualifier. The primary functionalities included

- 4 wheel drive with meccanum wheels .
- Modular motor mount assemblies to allow for quick removal and replacement of drive motors.
- A jewel sword for knocking off the jewel.
- A phone box for holding the Pixy-Camera and control phone.
- A linkage arm with a gripper for grabbing and deploying the relic to zone 3 standing up. Note that the arm can reach a relic that has fallen to the floor. The original prototype arm was made from flexible polywall, but was replaced later with a 3D printed arm.



Robot—Gen 2

The robot has continually improved and changed over the course of the season.

- The original prototype arm made of polywall was too flexible which limited our ability to score two relics as we needed to deploy the arm slowly to prevent it from whipping around and dropping a relic. The prototype arm was replaced with pieces 3D printed from ABS. Later, when we noticed the ABS bending, we reprinted the pieces in carbon fiber for more rigidity. The newer arm allows us to deploy two relics generally 75% of attempts.
- After meet 1, we replaced some of the motor mounts with smaller versions that allowed for easier access to the balancing stone. The original larger versions were sometimes snagging on the edge of the stone if the robot approached the stone from an angle.
- The gripper has changed from a square gripper to a more rounded design. We experimented with ninjaflex "finger tips" for improved grip, but eventually discarded them in favor of surgical tubing. In addition the main servo at the bottom has increased in gear ratio from 3:1 to 5:1. Also, the servos at the elbow and gripper were replaced with Rev Robotics servos for more torque.
- The jewel sword hasn't changed much as the original design was simple but effective.
- The relic arm and phone box were revised to be more space efficient to allow more space for the glyph lifter.
- A glyph collector was added with custom designed ninjaflex intake wheels. The collector works great and can collect glyphs very quickly. We can successfully collect glyphs and load two rows, but we have chosen to go for two relic deploys for a higher point total.
- The glyph lifter prototype is complete but needs improvement. The glyph lifter uses a conveyor system that is lifted with a pulley drive. While the pulley drive and conveyor system both work effectively, the conveyor plate doesn't lower as much as needed. This causes glyphs to jam in the intake. Unfortunately, we ran out of time to finish the modifications and decided to remove the lifter from the robot as the additional mass and CG would require a total reworking of all the autonomous programs. Our current strategy is to attempt two relics. However, if our alliance partner also wants to score a relic, then we will collect and score two cryptobox rows.