StealthBot

A FRC Team 612 Production

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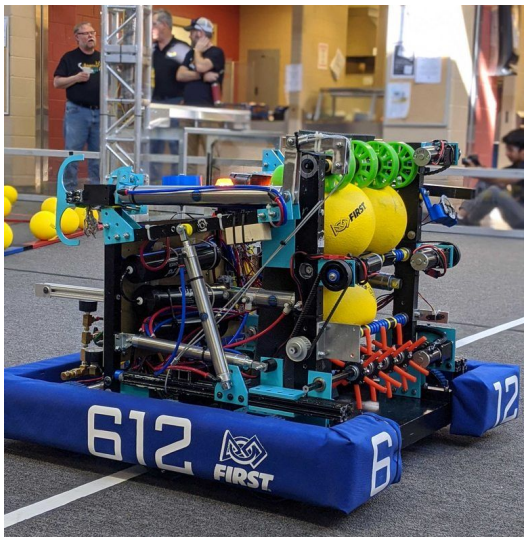
Introduction

The following tech binder serves as an intensive layout to the robot designed by Aiden Levy, Alex Hughes, and Krishigan Yuvaraj, of FRC 612, called “StealthBot”. It includes descriptions and explanations for all the major aspects that have to be taken into account when designing and building a robot, as well as competing.

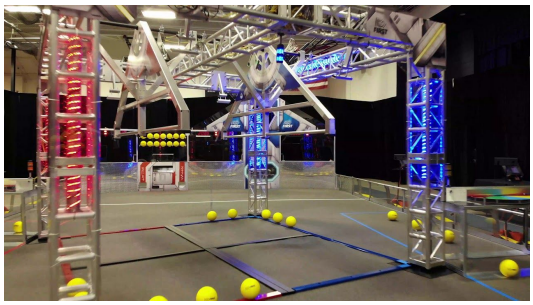
Learning From Rosie and Infinite Recharge



The 2020 season for FRC 612 was full of many excitements, as well as some challenges that we had to creatively overcome. We successfully built a practice robot, as well as a competition robot named “Rosie”. Our team was able to compete at the Haymarket Event before the season was cut short due to COVID-19. After our season abruptly ended, the team met via conference call and discussed their successes and downfalls with all aspects of their Infinite Recharge season, including robot design, build season schedule, outreach, communication, driving, and participation. Here is a list that we’ve compiled that explains everything that we thought would be important to keep in mind when creating a robot for the next FRC season, Game Changers:

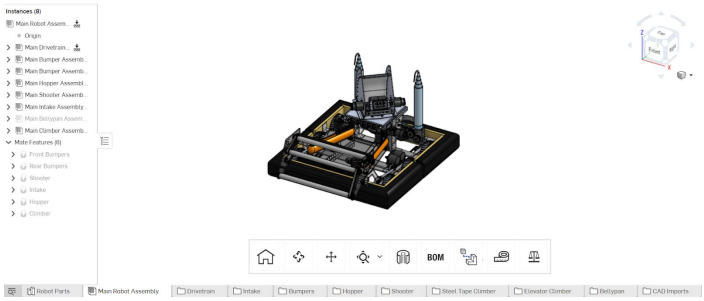
- A West Coast Drivetrain works for this type of competition, as it is stable, structurally firm, and allows for fast full-field movement.
- Blue Nitrile wheels may not be the best choice, because although they do provide maximal friction between our robot and the floor of the field, their construction required too much time and skill for them to be optimal. Additionally, they did sometimes come apart on the field or during testing, proving that they were not the most reliable.
- The Control Panel element of the game was barely touched by any robots throughout FRC, showing that it is not a necessary element for our robot, but could be beneficial if other parts of the robot are performing at a high-level.
- Inner-port and outer-port shooting are highly desirable, as they require roughly the same amount of time as low-port scoring, but provide significantly higher point values and scoring opportunities, as a robot could hypothetically score via shooting from anywhere on the field.
- Being able to climb on the Generator Switch is one of the most important feats that need to be accomplished by robots, as it needs to be done quickly and can be used to score significantly more points than other aspects of the game.

Our Interpretation of the Challenge and Prediction of Game Changers



Judging from the information that has been announced from FIRST, as well as Fairfax County Public Schools, we have made several predictions about the 2021 Game Changers season, and how both the execution of making a robot, and this year's game, will work. First, we predict that the only element of the game that will change in point value will be the color wheel. This is because robots built for the 2020 season are allowed to compete in 2021, meaning that no big changes will occur to the game. Color wheel was the most obvious assumption for change, as there were only a few handful of robots that used it to score points during the 2020 Infinite Recharge Season. Second, as FCPS schools have closed indefinitely, our robot will require a design built upon simplicity. Our goal to make the building of the robot easier is to have the robot fully modeled in CAD, so that by the time when we can start building, our design is complete, electrical knows what wires are required, and where they connect, and programming can test code in synthesis. Additionally, a robot in CAD allows people to work in the shop via drawings without too much supervision. Overall, all of 612's technical and nontechnical sub-teams can work on the robot in a virtual setting, taking into account Marketing's online meetings, and BOM discussions online, with help from the robot CAD.

What We Wanted



When our group first met, it was obvious that we needed to create a plan that listed what our priorities were so that once we moved into the designing stage, we knew what to focus on. After over 5 hours of deliberation across three separate meetings, here are the priorities that we came up with, and why they were important to us.

- Inner Port Shooting, as this has a higher point density than any of the other tele-op scoring options. And if we missed the inner port, we would still score in the outer port, which was 2x the points that Rosie scored in the lower port.
- Fast shooting, as this both allows for faster cycle times, as well as anti-defense, so we can shoot before enemy alliances can defend their ports. This means designing a jam-free indexer.
- Fast, consistent climb, as this will provide the most points to our alliance from a singular action during each match (highest point density).
- Fast and powerful drivetrain, as this allows for faster cycle times and field trekking, and enables us to play defense with a strong robot that can push other robots around.
- Shooting from our side of the field, as this allows for the most accurate shooting possible, and where our robot can be protected in the trench zone.
- Make a full CAD of the robot, as this will make building and wiring the robot in real life much easier, as well as possibly allow programming to test the robot in Autodesk Synthesis.

Design Philosophy

Before beginning the robot CAD, we had many hours of discussion and research in order to design the "perfect" robot for our team. There are multiple elements that led to the design choices we made for StealthBot, which are outlined below.

1. **"Steal from the best, invent the rest"**. We decided only to 'copy' other successful team's designs, since they proved those designs worked, and we did not have the ability to test or prototype these designs while in quarantine.
2. **"Simple is Better"**. The simpler the robot or its mechanisms, the easier and faster it would be for us to build. That's why we went with COTS solutions wherever possible, and non-COTS mechanisms could be made in an average workshop or even at home.
3. **"Give us a challenge!"**. While we agreed that building an Everybot would probably be the easiest, fastest, and best robot solution for our team, we wanted to design something that would still stretch the team's ability and be fun to design, build, and compete with. We took note of our team's current experience in design and fabrication, and we designed StealthBot to effectively address areas where our team could improve.

Short Vs. Tall: A Discussion and Debate

When discussing the overall design of our robot, the second topic of discussion was about whether we wanted a short or a tall robot. We did eventually choose to pursue a short robot, but here is a table organizing our arguments.

	Short	Both	Tall
Pro	-Robot can go under control panel -Theoretically faster cycles -Less wear and tear, as less need to go through rendezvous zone -No need for feeder elevator	-Robot can have a turreted shooter	-Less of a shooting arc -More consistent inner port scoring -More space overall, easier to design
Con	-Difficult shooting arc to perfect -More design constraints -Harder to fix issues, more compact robot	-Needs an indexing system	-Cannot go under Control Panel -Forced to deal with slower, more crowded middle lane -Theoretically slower cycles -Needs an additional mechanism to lift power cells into shooter

Doing What We Know Works

Reliability is key in the success of a robot's mechanisms. Because we have the ability to observe all of the robots that participated in the 2020 Infinite Recharge season, we have the ability to see what designs worked, and what didn't. Thus, it is easier to spark inspiration from successful and great designs that were used by many FRC teams. As our group discussed, at the end of the day, the one thing that is required by a robot's mechanisms is that they repeatedly work. It is simple to observe and gain inspiration from other teams, rather than mindlessly design additions to a robot that aren't proven successful.

Simplicity, Simply Put

Since the beginning of our designing, our group has kept in mind the things that occurred with Rosie, specifically the difficulty of working on issues with the robot and testing subsystems, as well as the challenges that will be brought from COVID-19, related to less time to test and time in the shop. This is why we designed our robot to be modular, where each subsystem can be built and tested independently. This also makes fixing issues much more seamless, as many different parts of the robot can be fixed at once. Furthermore, our group sought the best and most simple solutions to making a game-winning robot, as this then gives us more time to test our robot, as construction occurs more rapidly, and with less problems and discovery.

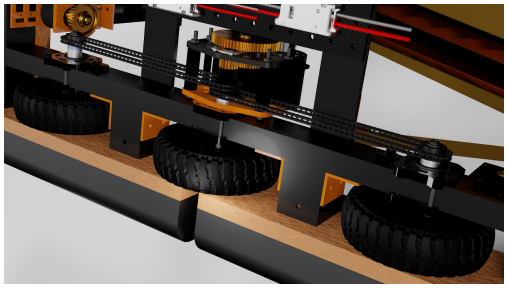
Design and Aesthetic

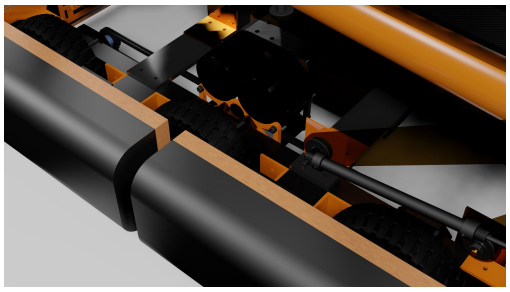
Along with designing this robot in OnShape, we wanted to experiment with making the robot more realistic than simple CAD models could show. Our group used Fusion360, Blender, and Premiere Pro to take our final CAD models and make them into real looking robot mechanisms. We hope this experience can be used by our team in the future to help make better robot reveals, or robot reveals that can be released earlier and with less requirements from the technical subteams.

Mechanisms

Drivetrain

West Coast Drive, powered by West Coast Products SS Flipped Gearboxes, using Falcon 500 motors, and 6 West Coast Products Pneumatic Wheels.





A west coast drive is a perfect mix of game-necessity and fabrication-ability for 612, as it allows for a fast, durable, and maneuverable robot that is within our team's building limits. Our thought was that worst case-scenario, we could always steal from our 2020 robot, Rosie's, frame, and then attach our new motors and gearboxes. We chose to use WCP SS Flipped Gearboxes because they were WCD-compatible, only required 2 motors, and had a low volume, so they wouldn't take up as much room as the 3-CIM ball shifters that we used on our 2020 robot. Additionally, with our choice, any adjustments and fixes are incredibly easy to make, as there is no plastic shell, like in a 3-CIM ball shifter. We included 4 Falcon 500's because we see them as a good team investment, especially because of their high torque and efficiency. On top of this, our drivetrain features pneumatic wheels, as they do not require any maintenance, can be easily replaced, and are easier to assemble than the blue nitrile wheels we used last year.

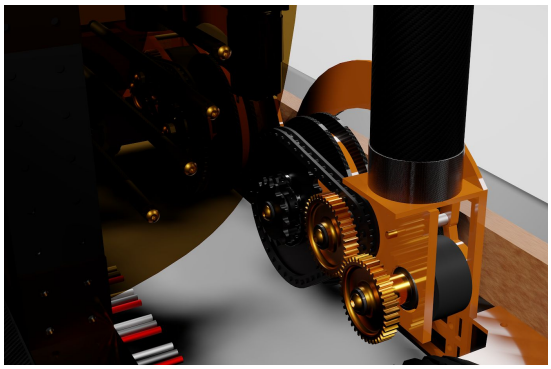
Shooter

COTS GreyT flywheel shooter powered with two Falcon 500 motors with one-position hood, COTS GreyT turret, and limelight sensor. Modular, can add FRC5990-style horizontal wheels or an actuating hood if desired later in the season.

When looking at shooters, our priorities were fast, consistent shooting from the trench zone. Options became very limited once 612's fabrication limits were accounted for, and simplicity became key. Thus, we chose to use a COTS turret and shooter, as these allowed for a good system, and we didn't have to sacrifice the time to build it. Additionally, a limelight allows us to get the accurate shots, when combined with this great shooter. What is perfect about using a turret is that during our cycles, we do not have to turn the robot to shoot, we only have to turn the turret, which we can do when we traverse the field. On top of that, we looked at some potential add-ons, such as the FRC5990-style horizontal wheels, and acuating hood, as mentioned, because they could increase our accuracy, although do increase the number of variables our programming sub-team has to work with, which is why we simply left them out of our initial design, but can be added later if desired, as they are easy to design and build, yet hard to work with.

Generator Switch/Climb

Steel tape-powered 3D-printed cascading reversible climb system, inspired by FRC 118's 2020 robot.



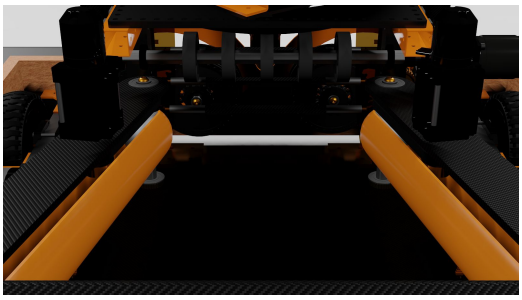
This system allows for fast and reliable climbing. A huge issue that we wanted to combat from 612's 2020 season was the issue that the climb could only be deployed once. With this system, we can actuate it up and down as we please, and not have to worry about our climb falling off of the robot in the middle of our matches. Also, with a two-arm climb, we can make the generator switch balanced, even without the help of alliance members. If alliance members do climb in the middle, though, this mechanism can reach the switch, even if it is tilted away from us, making it a simple, yet reliable system that works for our team.

We chose this design over the tube-in-tube elevator design we saw a lot of teams build in 2020 due to its light weight and intuitive design. We believed that with a little bit of prototyping, and the resources found online for 118-style climbers and other steel-tape climbers, we could build an effective climber that was lighter, faster, and easier to build than the elevator climbers.

Control Panel Mechanism

Intentionally not designed, as we did not prioritize it. Can be inspired/taken from Rosie if desired at a later time.

Indexing System



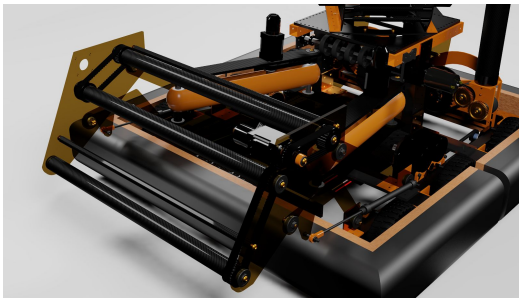
Angled indexer with an independently controlled V-belt system. Jam prevention method involves always having one belt move faster than the other, although this faster belt will switch every few seconds. Leads to a series of kicker wheels that pull the lemons into the shooter; is only powered once ready for shooting.

By observing 2020 robots, a spinning indexer (Spindexer) system seemed optimal, although our group realized that this innovation was beyond our team limits, and few teams in our skill range built Spindexers. Thus, we looked at simple options that would allow for indexing that did not discriminate how the balls are taken from the intake, from the ground or the human player station. A V-belt system was clearly the best fit, as several successful teams in our region went with this design.

Intake

Three roller intake system, piston-actuated, polycarbonate protected. Fast, prevents balls from getting run over or getting stuck under the robot, and allows for both ground intake, and human player station intake.

During our observation of the 2020 Infinite Recharge season, we noticed that most successful teams chose to use a three roller intake system. We wanted to try to implement it, as we knew it would work, but we only wanted to modify it to fit the rest of our robot's design. After little deliberation, we decided to incorporate the system by making it piston-actuated, as well as by adding several bars across the intake, in order to prevent balls from going under our robot, and to prevent balls from coming out of the top of our intake.



Match Strategy

Autonomous Period:

1. Index and shoot the three preloaded balls
2. Start to traverse the field towards the human player station

Tele-operated Period:

1. Make cycles that consist of our robot:
    a. Going to our human player station and intaking balls
    b. Indexing balls while traveling across the field and underneath the trench zone
    c. Shooting from either the trench zone or starting line at the high goal

Endgame:

1. At the last 30 seconds of the game, travel the field towards the middle, and climb in the middle of the generator switch, in order to keep it balanced

An Easy Robot To Contrive

Overall, this is a simple design for all technical subteams (Mechanical, Electrical, and Programming) to complete. Simply put, because the entire robot modeled in CAD, all that Electrical and Mechanical needs to do are apply the computer model to the physical bot, via drawing and other methods, which can be easily created from the CAD model. Additionally, the only tasks that programming needs to perform are programming the drivetrain and climb, as well as testing the shooter, with the different factors that affect shooting.

General Technical Information

Weight: ~85 pounds
Height: 26 inches
Frame Perimeter and Dimensions: 29” x 30”, 118” perimeter
Speed: 10.7 feet per second