Design and Build Portfolio Overview

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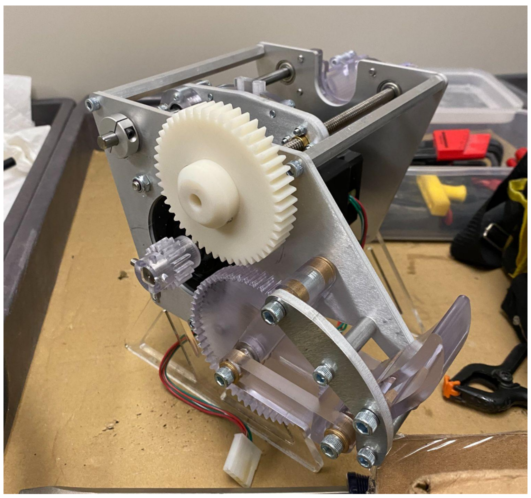
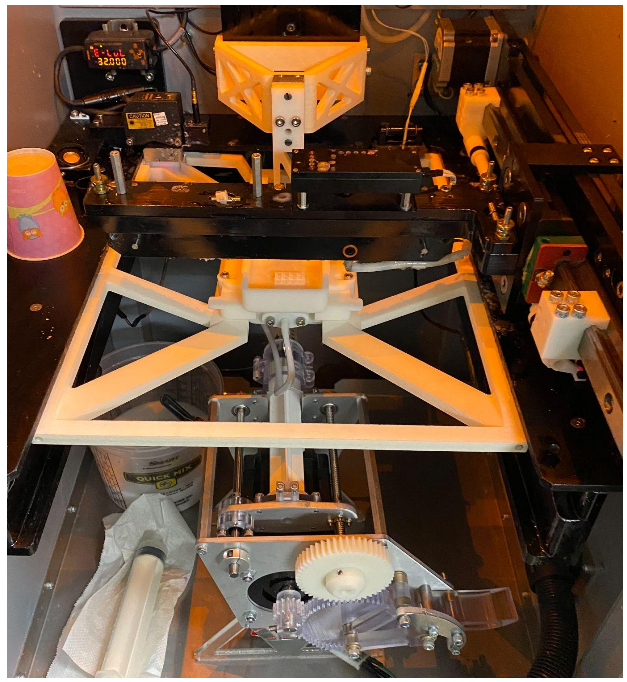
Stereolithography 3D Printer Small Batch Material Testing Apparatus

This machine facilitates rapid batch testing of stereolithography 3D printing material in an industrial 3D printer. I developed this apparatus over the summer of 2023 for Protocafe, a rapid prototyping and manufacturing company specializing in polymers, composites, and 3D printing. With the small size of the vat and build platform, the machine saves 98% of development material. When material testing is completed by the company, approximately 90% of production material cost can be saved. Some details excluded as proprietary.





Gyroscopically Stabilized Payload Quadcopter

This gyroscopically stabilized custom quadcopter is driven by an Arduino microcontroller and incorporates both custom and COTS components. Built during the summer of 2023, it is designed to hold and release a spherical payload on command. I incorporated modified open source code uploaded to hardware mounted on a custom frame that I designed for modularity, ease of manufacturing, and ease of repair. COTS electronic speed controllers and brushless motors are driven by PWM signal from the Arduino, which processes inputs from a radio receiver and stabilizes the drone with a PID loop. An external servo motor controls the payload release. The payload bay is designed to hold round projectiles of a variety of sizes similar to an egg.

Notable Features

- Custom-designed 3D printed frame designed for easy replacement of parts broken in-flight
- Gyroscopic stabilization through inputs of controller and MPU 6050 3-axis gyroscope, processed by and Arduino Uno microcontroller

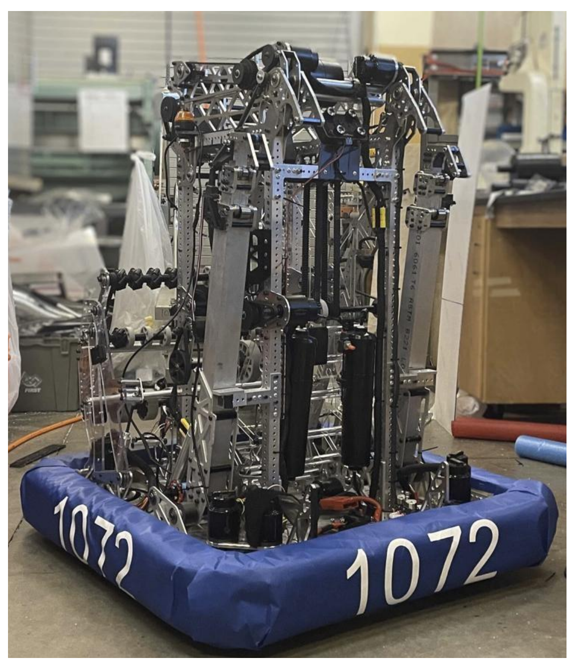
- 5-channel radio control with 4 flight controls and 1 payload drop toggle

2022 Harker Robotics FRC Team 1072 Competition Robot

As Director of Design of Harker Robotics in 2022, I led the prototyping, CAD, and assembly of FRC team 1072’s competition robot, featured on the right. As a designer, I used Onshape CAD to model ~80% of the full design, designing for tools like a CNC router, CNC mill, manual mill, bandsaws, lathes, 3D printers and hand tools. I assembled most of the systems that I designed, using both custom and off-the-shelf parts and hardware. As for fabrication, I did most of the 3D printing, communicated consistently with the student machinists, and helped with lathe jobs. The robot was designed for a competition in which balls must be collected and scored in a basket. Robots also climb sloped monkey bars to score points.

Notable Features

- Iterative rapid prototypes used to evaluate concepts (used modular materials and 3D printing)
- Rolling wheel intake mechanism that sucks balls into robot possession
- Continuous adjustable-angle flywheel ball shooter to score balls with accuracy and frequency
- Telescoping arm system that lifts robot up between horizontal bars
- Linear indexing system to store balls sequentially using belt system



- Robot climbing:
  https://photos.app.goo.gl/3ZnuhrMM7pQH3phv7
- Robot shooting:
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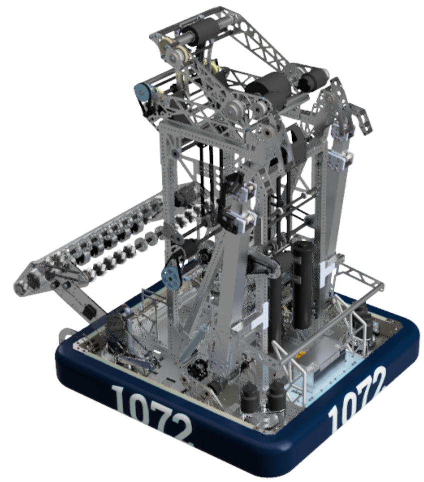
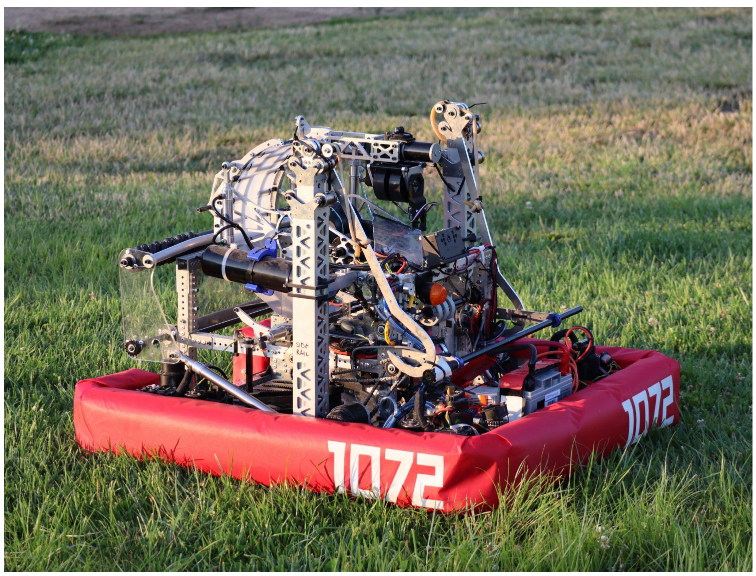


2020/2021 FRC Team 1072 Competition Robot

As a Design Lead of Harker Robotics, FIRST Robotics Competition team 1072, in 2020, I led the prototyping, design, and CAD iterations of multiple subsystems on the team's 2020 robot. The robot would collect up to five "power cells" (balls of 7" diameter), shoot all five balls into a high goal using a vision system, manipulate a horizontal spinning wheel, and climb onto bars in the middle of the field. The ball storage system was iterated upon many times, and I used easy-to-assemble aluminum tubes and plates to do so.



Shrimp Fryer - High Power Nerf Dart Blaster

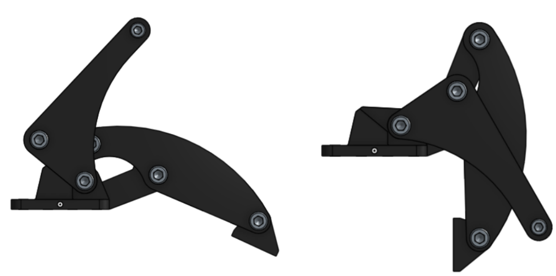
This 3D printed Nerf blaster "Shrimp Fryer" fires short foam darts with rubber heads and was designed to be high-powered and accurate in a compact form. Components include 3D printed parts and purchased springs and hardware. I spent many hours designing the 3D printed components with Onshape CAD, and each printed part took multiple iterations to operate optimally. Challenged by the limited dimensions of my printer, I segmented the blaster into modules for printing. Doing so also meant each part could be independently tested without risk of having to re-print the whole blaster. Certain parts under high load from the spring needed up to five iterations, as I learned to reinforce weaker points and revise my fastening techniques. Printed using my CR-10 and Ender 3 FDM printers.

Harker Robotics Omio X8 Router Enclosure

This enclosure is designed to house an Omio X8 router for my robotics team FRC 1072. The CNC router produces aluminum chips and coolant mist as it cuts material, creating a mess. I led the enclosure design spring 2021, helped coordinate the acquisition of materials from vendors, and led the assembly process. The design consists of a hardwood frame with four removable polycarbonate panel walls held in by custom-designed latches. Holes in the bottom panels and a garbage bag mount allow for easy chip cleanup. Foam padding seals all cracks, and an air filter on top prevents the lab from being filled with coolant mist.

Notable Features

- 3D printed over-centering linkage latch mechanism allows machinists to easily remove panels entirely. Design resists forces of panels falling out while only allowing user-controlled handle to unlock mechanism.
- Many of my builds incorporate small but unique design features like this linkage. More details available upon request.

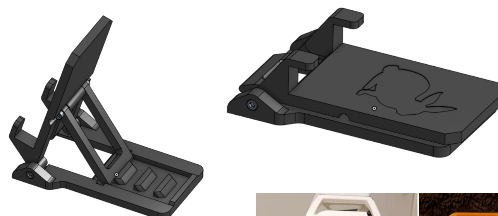


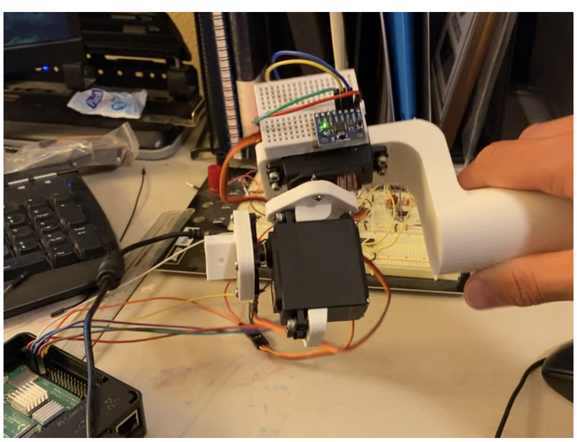
2019 FRC Team 1072 Competition Robot

Harker Robotics built this robot to compete in the 2019 FRC game. I worked as a mechanical team member to fabricate parts and assemble the robot. In the beginning of 2019, I collaborated with small groups of students to prototype mechanisms for manipulating playground balls and flat toroids (hatch panels), both used to score points in the game. Driven by hand drills and constructed with polycarbonate, shafts, and wheels, prototypes were fast and messy, used only to prove the validity of a mechanical concept. My role in a group was to execute proposals by officers, provide creative solutions to problems, and lead other freshmen with my existing mechanical knowledge. While I was less involved in the design of this robot, I was heavily involved in its construction.

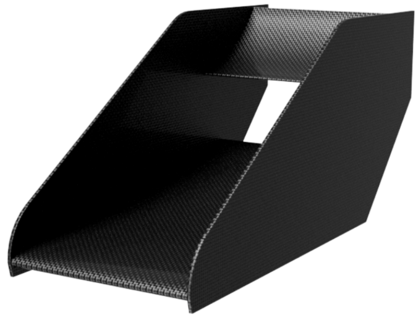
Miscellaneous 3D Printing Projects, clockwise from top left

- Collapsible and adjustable phone charging stand (2)
- Custom bike water bottle cages
- Four-bar linkage posable arm with symmetrically-actuating claw
- 2-stage 3D printed cascade elevator mechanism
- Raspberry-pi controlled 2-axis stability gimbal mechanism





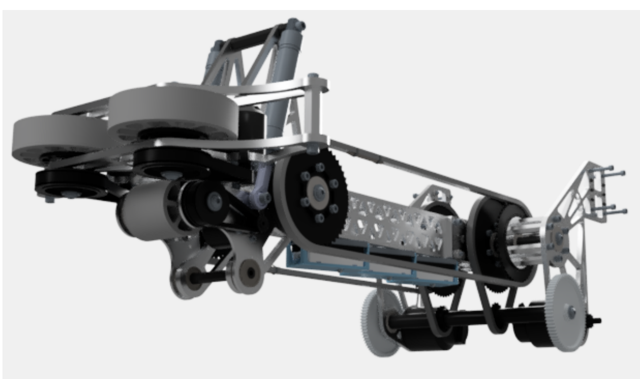
Prototype Princeton Racing Electric FSAE Car Side Pod Designs

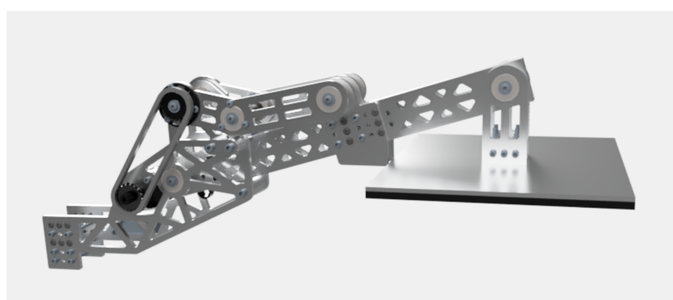


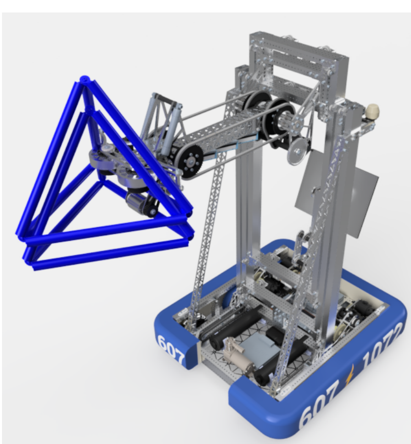
I designed these sidepod module prototypes for Princeton Racing Electric, a formula electric racing team at Princeton University. Side pods are designed to create downforce using inverted airfoils to increase car traction with the ground. I imported airfoil plots and designed sidepods that would filter air through radiators to cool the motors on the car. Designs will soon be tested in a wind tunnel.

F4 CADathon Fall 2021 Robot Design, solo

I designed this FRC-style robot as my submission to a CADathon event and won 6th place overall. This robot features a 4-stage telescoping elevator that lifts tetrahedral game pieces onto goals to score points. It utilizes a vacuum pad mounted on an over-centering linkage to theoretically lift itself onto a platform. Drives with 6 wheel drive. Notable mechanical mechanisms include gearbox, transmission, linkage, and pneumatic system design. This robot was designed for a hypothetical game and was not built physically.

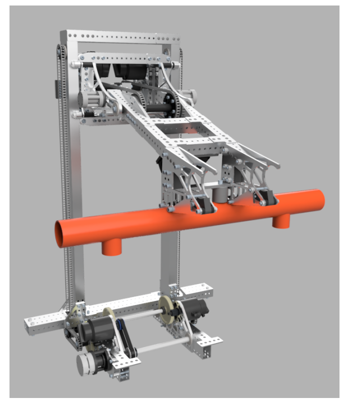




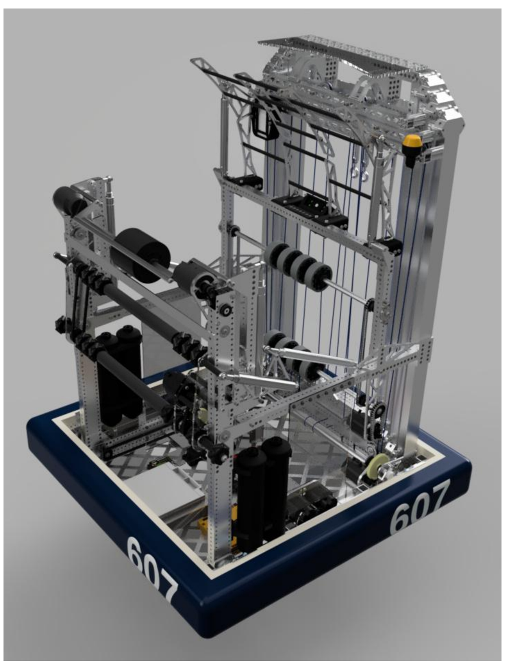


F4 CADathon Summer 2021 Robot Design, solo

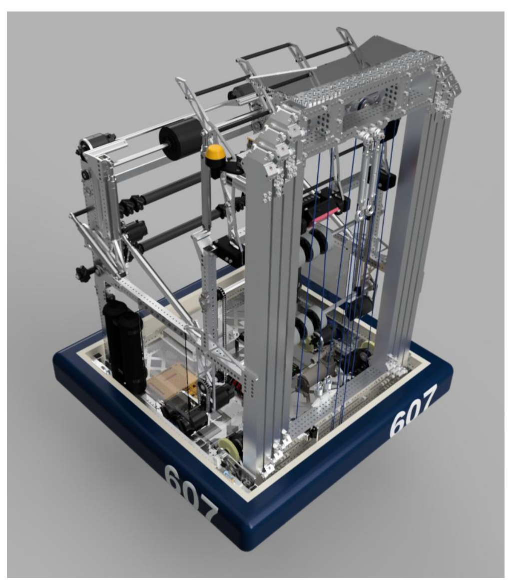
I designed this FRC-style robot for the 2021 summer F4 CADathon and won 5th place overall. It features a single-stage elevator, 6 wheel drive, soccer ball kicker, and electromagnetic pipe grasper. This robot was designed for a hypothetical game and was not built physically.



F4 CADathon Summer 2020 Robot Design, team of 3

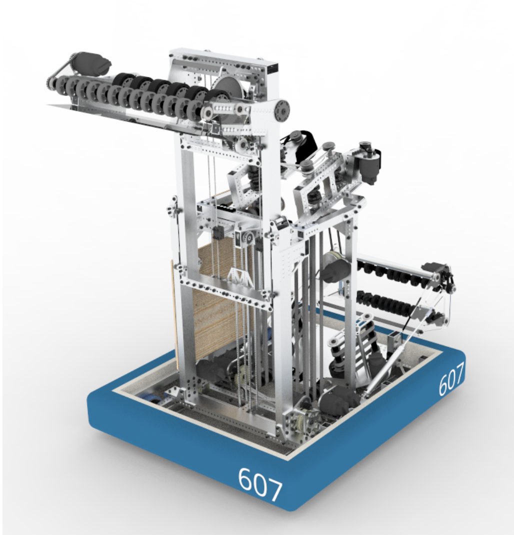


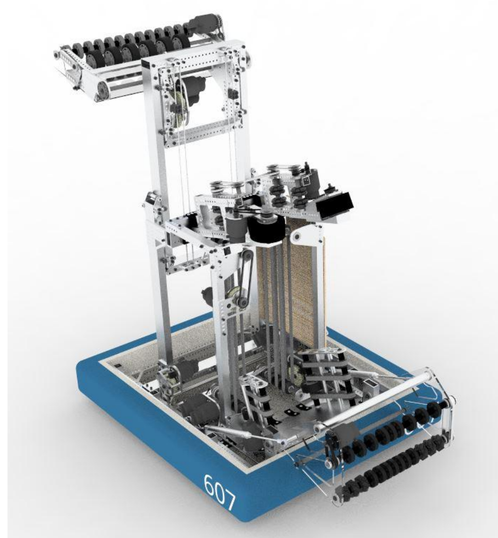
This robot was designed for the 2020 summer F4 CADathon competition. It is capable of collecting and launching large diameter (24”) balls into goals. It also features a telescoping elevator to interact with balls high up on an overhead platform. This robot was designed on a team of three and was not built physically. My team of 3 won 8th place overall.



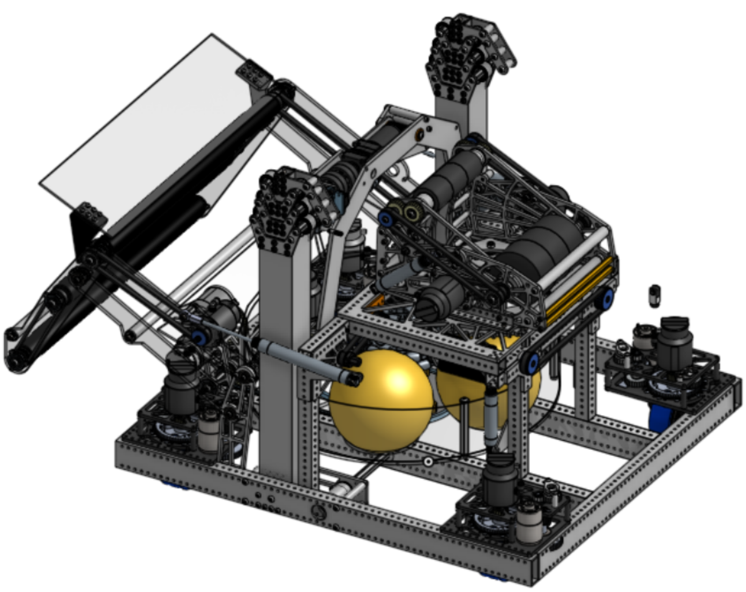
F4 CADathon Spring 2020 Robot Design, team of 3

I designed this robot with a team of 3 for the 2020 Spring F4 CADathon competition. The robot was designed to lift and place weight plates on goals and to collect and score footballs. The robot features a canted flywheel shooter to give spin to footballs, a two-stage elevator to lift plates, an intake mechanism to collect balls, and a 6 wheel drive base. This robot was designed for a hypothetical game and was not physically built.





Theoretical FRC 2020 Robot Design



I designed this robot theoretically after the 2020 FIRST robotics competition season. It was an exercise in my CAD skill and my knowledge gained from prototyping, designing, and researching other robots. I have implemented many other subsystems designed solely for the purpose of practice that are not listed in this document. This robot was not physically built.

**Additional details and media are available upon request.*
Feel free to reach out with any questions on any project.