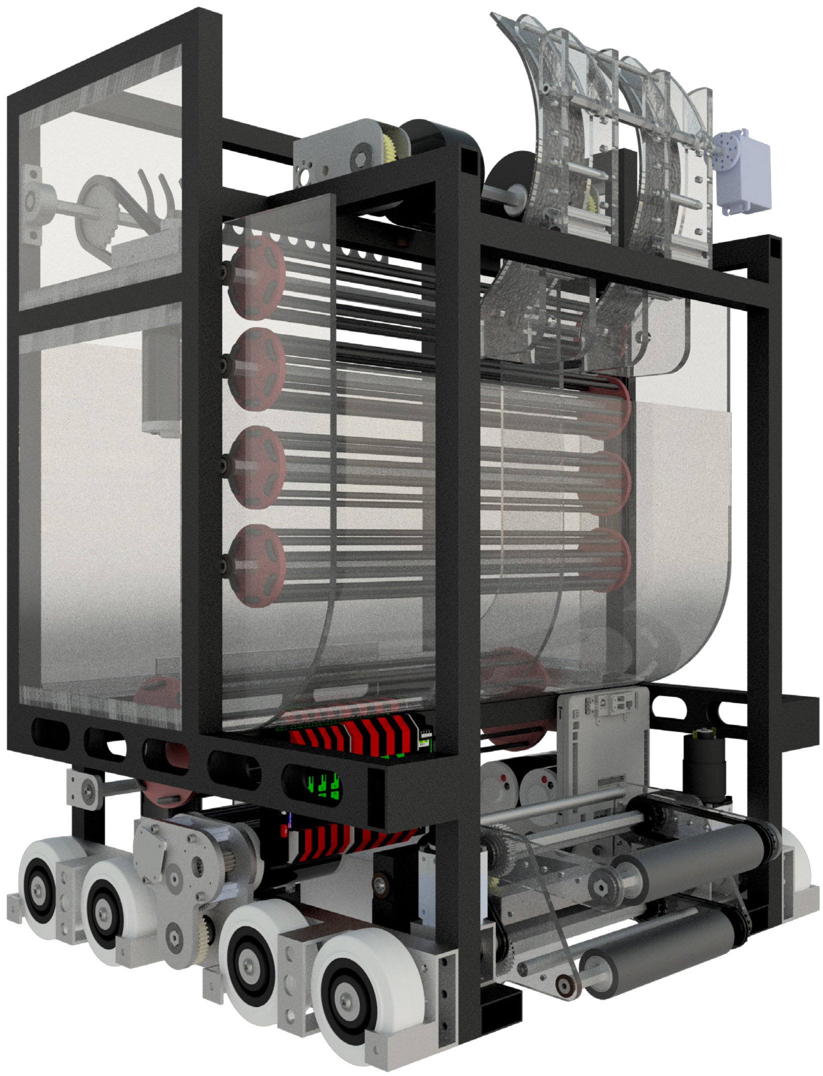
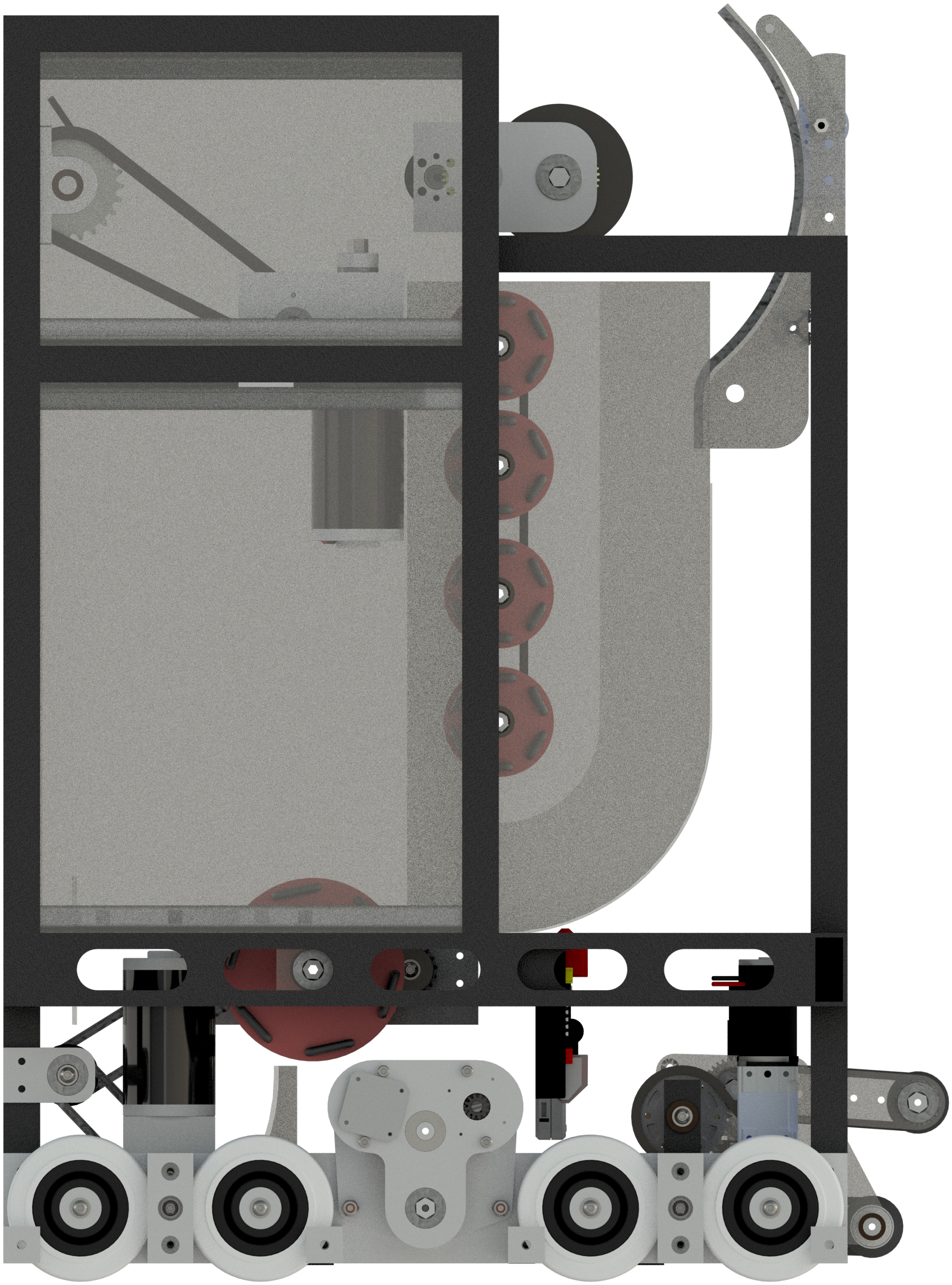
Robot Design: Knight Rider



TEAM 708 HATTERS ROBOTICS



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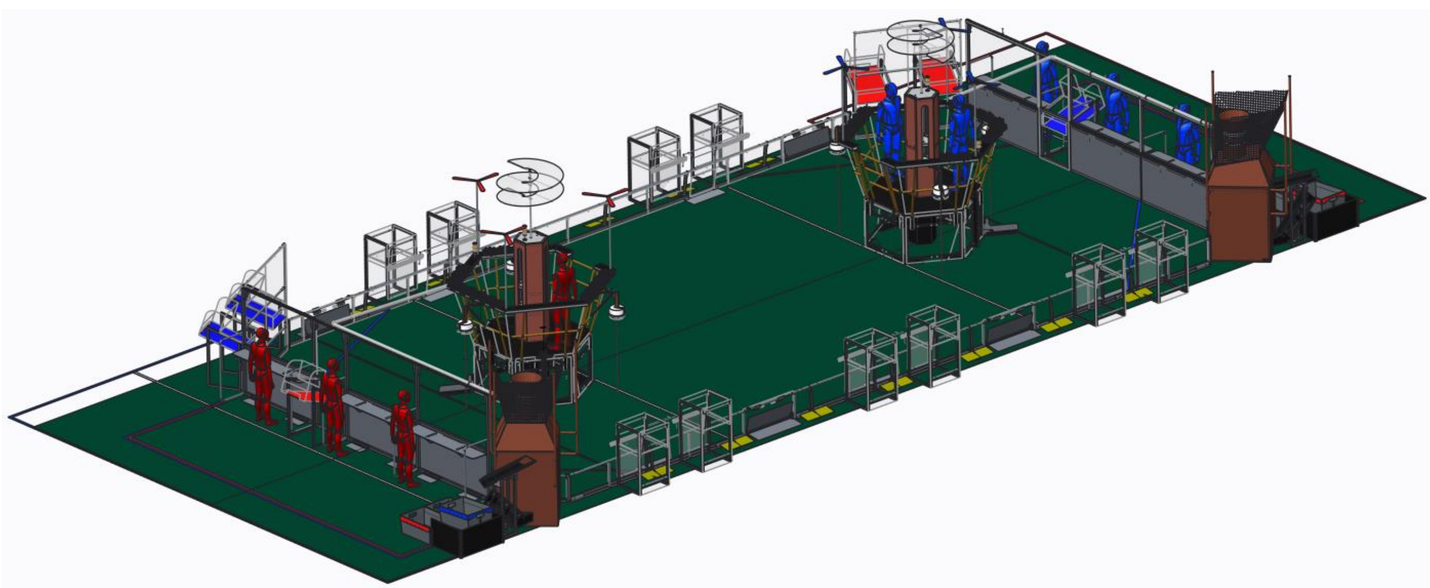
Introduction

Every phase of Team 708's build season, from conceptualization and fabrication of the robot to programming and videos, was all done collaboratively. As a group, the team read the entire manual after kick-off, keeping track of crucial information that could be useful later in the design process. The main information we took note of included the details of scoring and ranking points, as well as the geometry of the field and game pieces. These factors helped during strategy discussions, where we decided what components we wanted our robot to focus on so we could score the maximum number of points with our alliance partners.



The 2017 FIRST Steamworks game has many moving parts. Robots must be able to able to shoot fuel into the low/high goal located at the boiler, pick gears up and transport them to a lift device on the Airship, and be able to climb a rope during the endgame. The gears are placed on a peg that human player pulls up and places on a gear train. When the appropriate number of gears are placed, the human player then starts a rotor and earns points.

Action	Value
Cross the baseline	5 match points
1 fuel in high efficiency goal	1 match point, 1 kPa
3 fuel in low efficiency goal	1 match point, 1 kPa
Rotor turning	60 match points

Action	Value
3 fuel in high efficiency goal	1 match point, 1 kPa
9 fuel in low efficiency goal	1 match point, 1 kPa
Rotor turning	40 match points
Ready for takeoff	50 match points

Another aspect of this years game is the autonomous mode. The autonomous period is 15 seconds of the 2 minute 30 second match, where robots move by themselves using pre-programmed software without human controls. In autonomous mode this year, points can be earned by reaching the baseline (5 pts), delivering gears to the Airship (60 pts for each rotor started), and scoring fuel into the boilers (1 pt/1 ball in top goal, 1pt/3 balls in bottom goal). After the autonomous mode is over, there is a teleoperated period where human players operate the robots. In teleoperated mode, points are also earned by scoring fuel in the boilers, and adding gears to the Airship to start rotors. In addition, ranking points can be scored by having all 4 rotors turning by the end of the match, accumulating 40 kPa of pressure in the boiler and by winning or tieing in matches.

Robot Overview

Drivetrain

- 8 wheel drive with 4 inch Colson wheels
- 4 CIM motors power the tank drivetrain
- Customized gearbox with swappable gearing provides customizable speeds of 12.5, 14, 16.2, or 18 feet per second

Shooter

- 2 VEX 775Pro motors
- Encoder detecting the motor's RPM
- 35 durometer Abrasion Resistant Rollers that propel fuel
- 2200-2500 RPM at the wheels
- Adjustable shooting angle powered by an HS-805mg high torque servo motor

Gear Claw

- BAG motor
- VEX 775Pro motor
- Pivoting arm
- 3 Custom surgical tube rollers

Fuel Intake

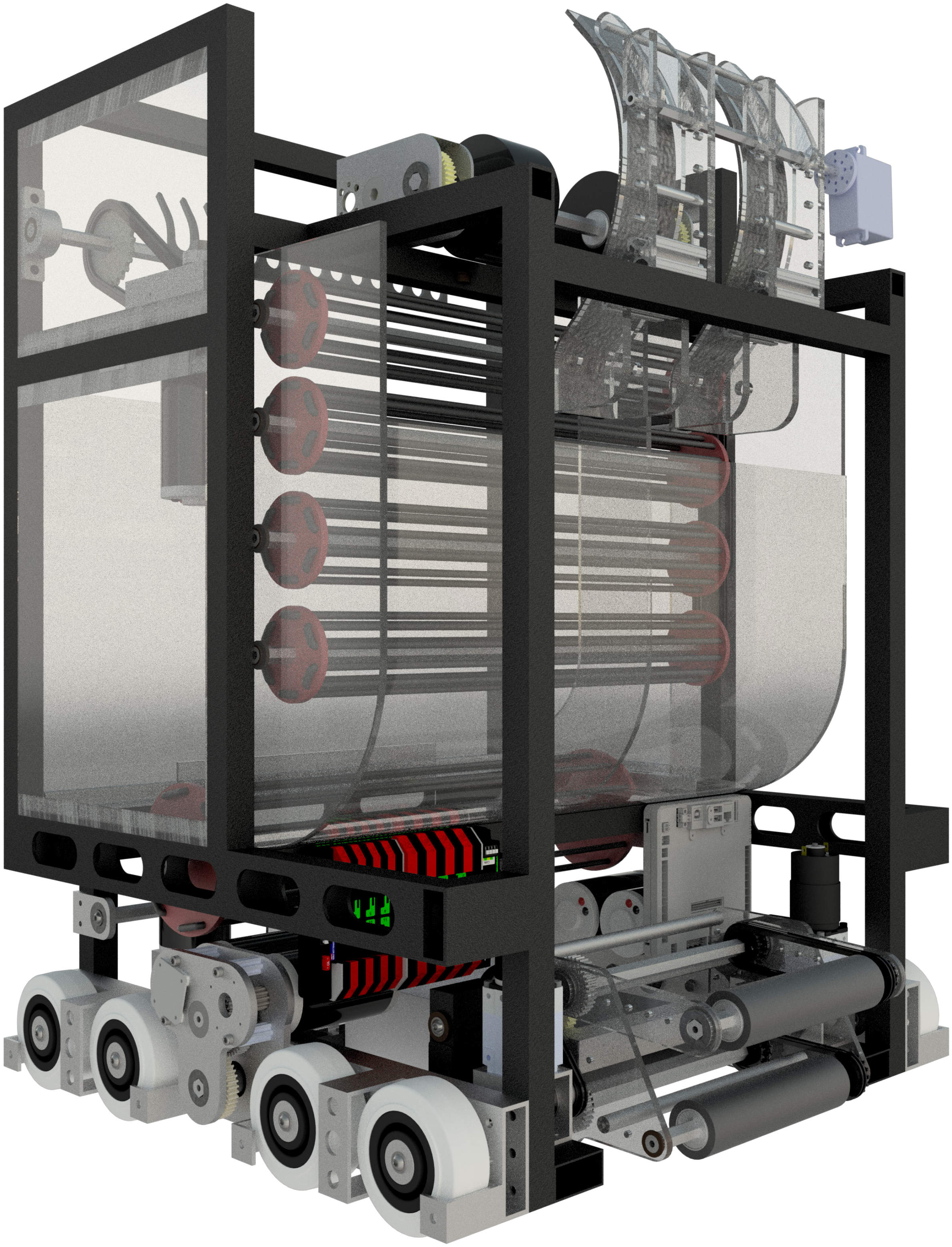
- CIM powered
- Custom surgical tube roller
- Ramp backing

Hopper

- Holds 40-50 balls
- 5 custom surgical tubing rollers
- Clear j-shaped backing called the banjo

Climber

- CIM powered
- Non backdrivable worm gearbox

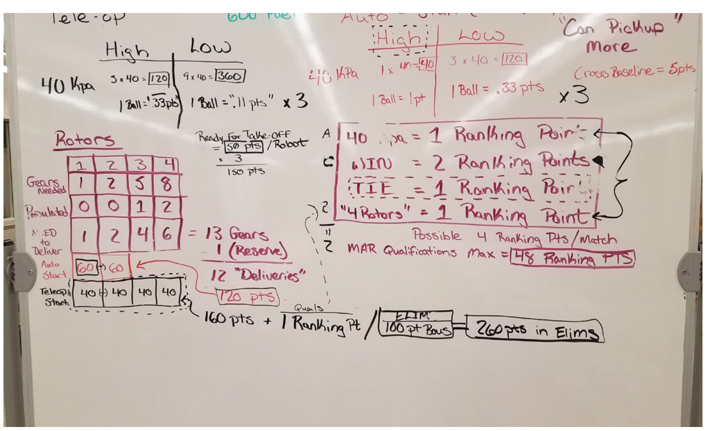


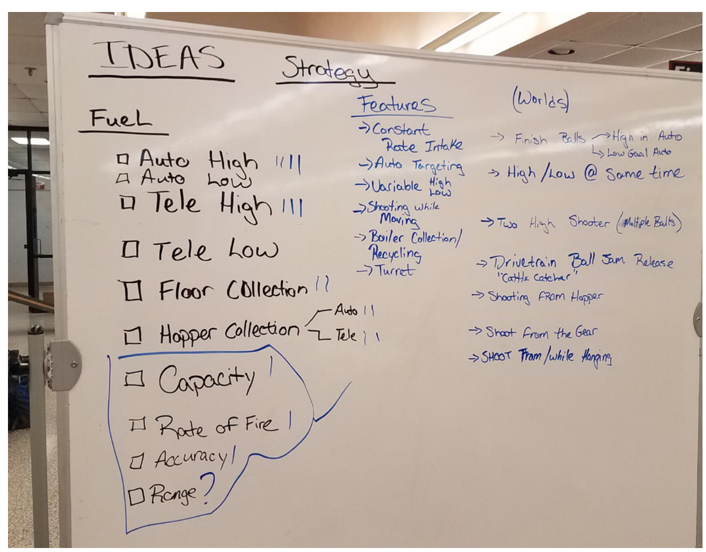
Strategy

At the beginning of this season, our team collectively discussed what we wanted our robot to accomplish during this year's game. After reading the rules, we weighed out the pros and cons of each aspect of the game. Our whole team came together and decided it would be beneficial to attempt almost all aspects of the game other than scoring in the low goal located at the boiler. As we continue through the season, our robot is able to accomplish all of the goals we set forth. However, we continue to improve upon our shooter to increase the number of balls scored with each blast of shots, and also improve on the climber to increase the speed of the climb

After we talked about the design of the robot, we discussed what autonomous modes we wanted to complete. Since the beginning of the season, we have gone through many different ways of getting points in autonomous. Originally, we had thirty modes that included similar tasks just in different orders and for the blue/red alliances. This totaled 15 modes per alliance. We now have only four different autonomous modes, each of which drives over the line. In addition, these modes work for both the blue and red alliance side of the field.

- Places a gear on the center peg and shoots 10 balls into the high goal of the boiler
- Places a gear on the left peg and shoots 10 balls into the high goal of the boiler
- Places a gear on the right peg and shoots 10 balls into the high goal of the boiler
- Empties balls from the hopper into the robots hopper, shoots the 60 balls, and places 1 gear on the right peg



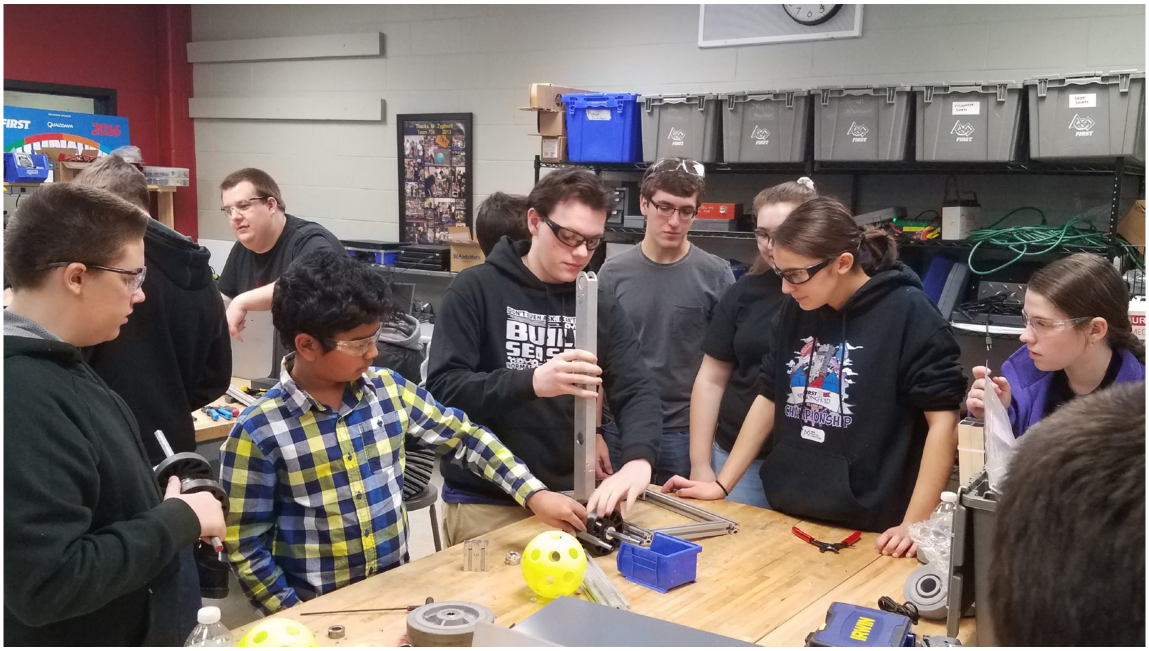


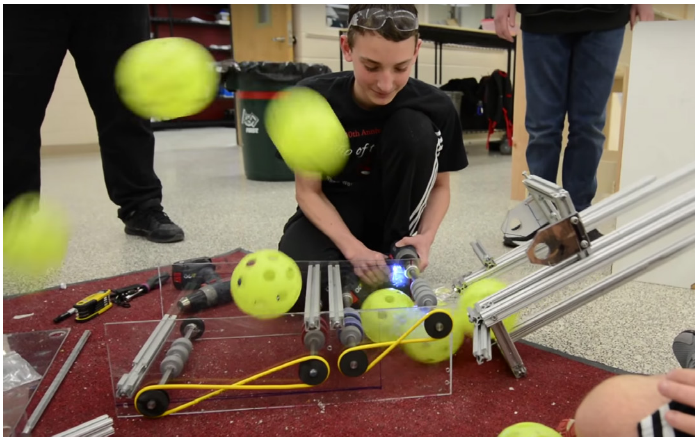
Another part of strategy is scouting. Our team does both pit scouting and match scouting to ensure we get the most accurate information on all teams. During pit scouting we find out what teams say their robot can do. This information includes what autonomous modes they can do, whether they can shoot in the high/low goal, how many balls they can hold, the type of drivetrain, and whether they can climb. In match scouting, we have a set of 6 students who complete a match sheet for each robot on the field which identifies the performance of the robot for the match. Information collected includes the number of gears placed on the peg, whether the team can score fuel in the high goal or low goal, climbing, penalties, and human player scouting. With this information, our scouting team creates a pre-match sheet which the drive team uses to determine a strategy based on what autonomous modes our alliance partners can do so that we can score as many points as possible in the 15 seconds. In addition, this information also provides the drive team on how the other alliance does in teleop so they can adjust their play accordingly. Finally, the scouting team uses this information to help create an alliance selection pick list so the scouting lead has all of the information needed to select a successful alliance for elimination matches.

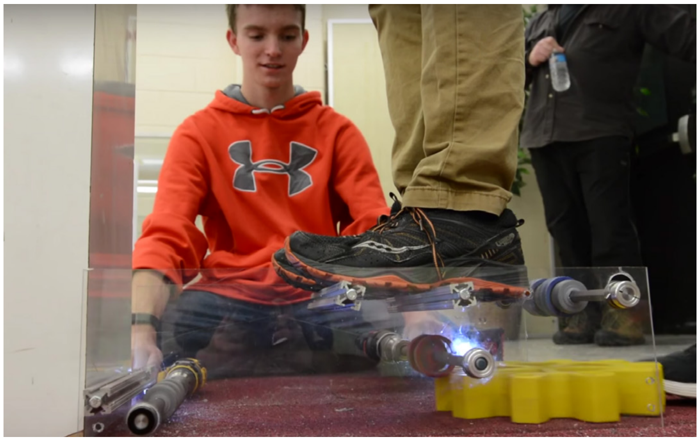
Prototyping

The next step after determining the game strategy for our robot, the whole team worked on prototyping different concepts and designs in order to find the best way to complete the tasks needed for this year's game. A prototype is a practice design used to prove a concept. We began this stage by brainstorming different designs and discussing how each idea would work. Based on the different prototype ideas, we broke into groups and developed these prototypes first on paper and then with cardboard. Each team continued to develop their prototypes through many iterations and finally with wood and scrap pieces of metal and plastic from years past along with many other materials.

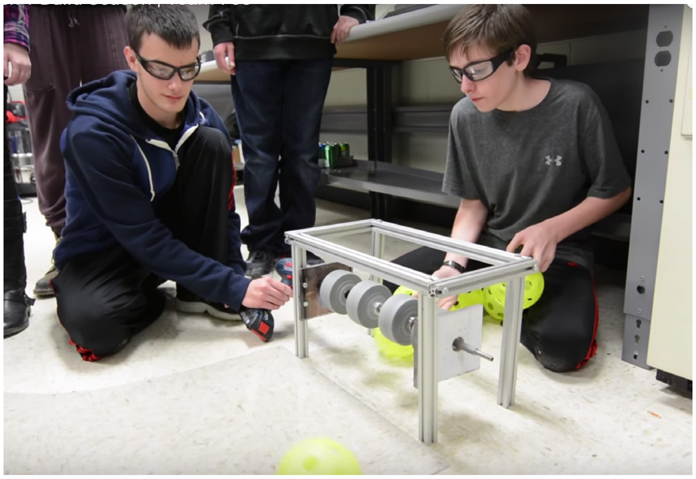
After spending a week to develop working prototypes, the team reconvened to discuss the pros and cons of each design and how the prototype helped define our strategy. Many of our first prototypes had several similarities. For example, our two shooter prototypes performed the same functions but were laid out differently.

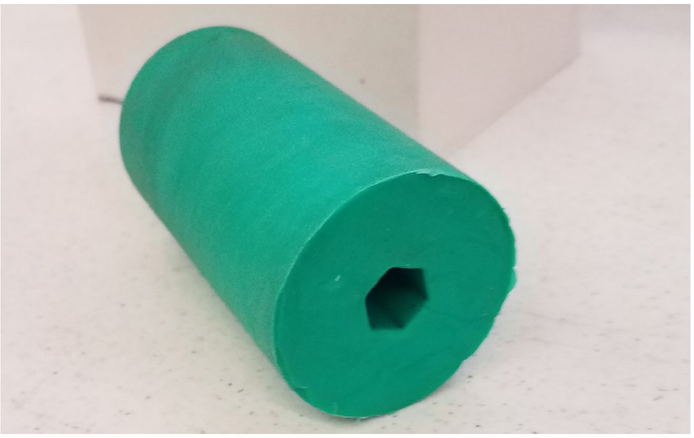


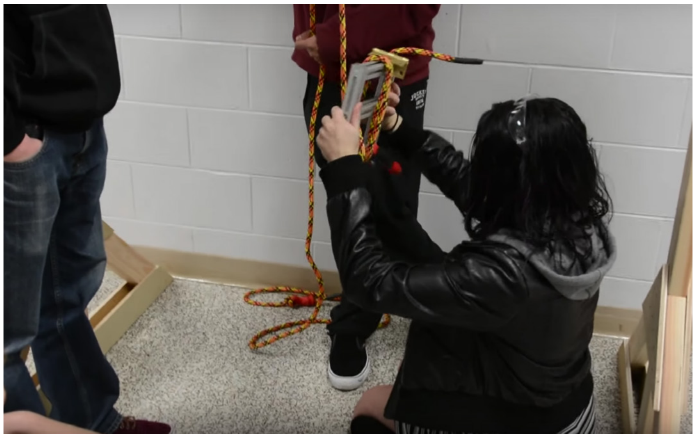





CHAIRMAN'S
AWARD
AWARD



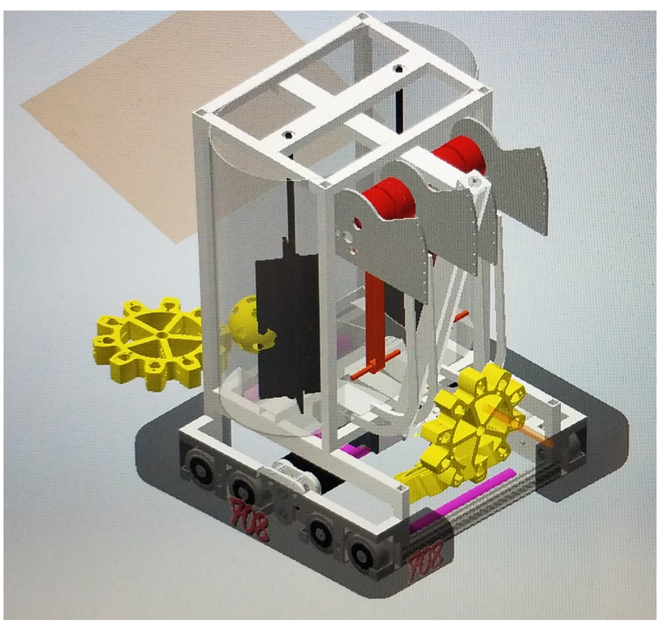




Design Process

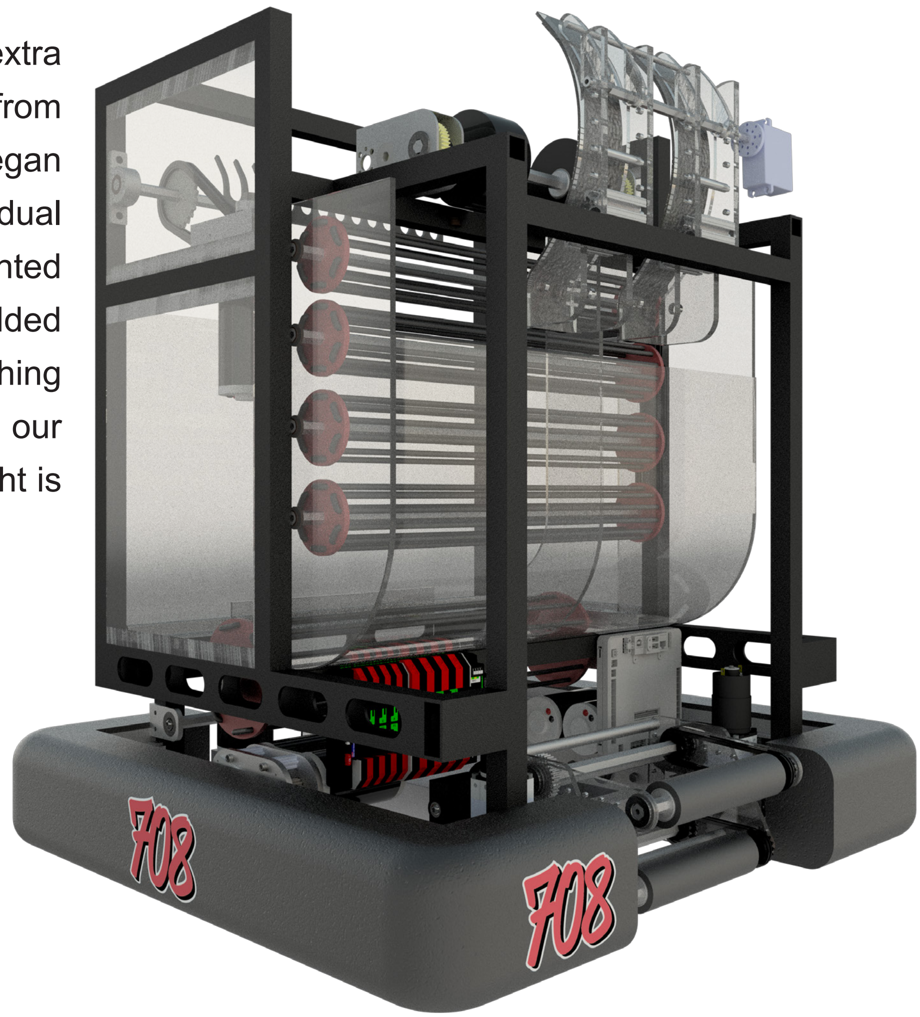
At the end of week one, the team reconvened to discuss the pros and cons of each design and how the prototype helped define our strategy. Many of our first prototypes had several similarities. For example, the two shooter prototypes performed the same functions but were laid out differently. Though we only went forward to continue building one prototype from each task category, we had merged the best parts of similar prototypes and continued design. Throughout the season, each system changed drastically. None of our original models look like what they do now. While creating each of these more complete designs, the subteams worked with a mentor to guide them and each subteam had to communicate with others to ensure the final product would all fit together within the specific size and weight limits of the robot.

This year was the first year that there were specific options for the frame size. Considering all of the tasks we wanted our robot to complete this year, we thought it would be best to go with the taller of the two options (30 in. by 32 in. by 36 in. tall). Something special we did with our robot frame this year was getting a matte black powder coat on it after welding the frame together.



As we began to finish our final designs, we added them to a mock robot frame made of pieces of 80/20. This allowed us to identify where each subsystem of the robot was going and to make any size adjustments before mounting it onto the frame. However, as we began mounting on the mock robot, we soon realized the robot was going to weigh about 135 lbs after it was built; which exceeds the weight limit. Our team instantly started searching for ways to remove weight while keeping the same functionality of each component. We combined our intake system and hopper system to create the "sawmill" which helped reduce about 15 lbs. Gearboxes were also remade to weigh less. Extra agitators in the hopper were removed. We also rebuilt the intake to make it lighter and less complex which eliminated 10 lbs.

Once we eliminated the extra weight and had the frame back from getting the powder coat, we began final fabrication of the individual modular components. We mounted everything onto the frame, added electronics, made sure everything was working and bagged it for our first competition. The robot weight is 119.5 lbs.



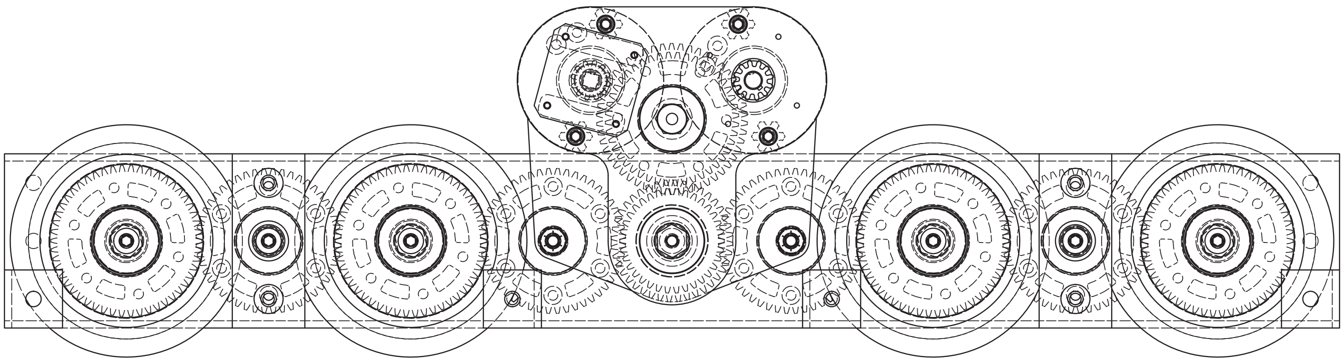
Drivetrain

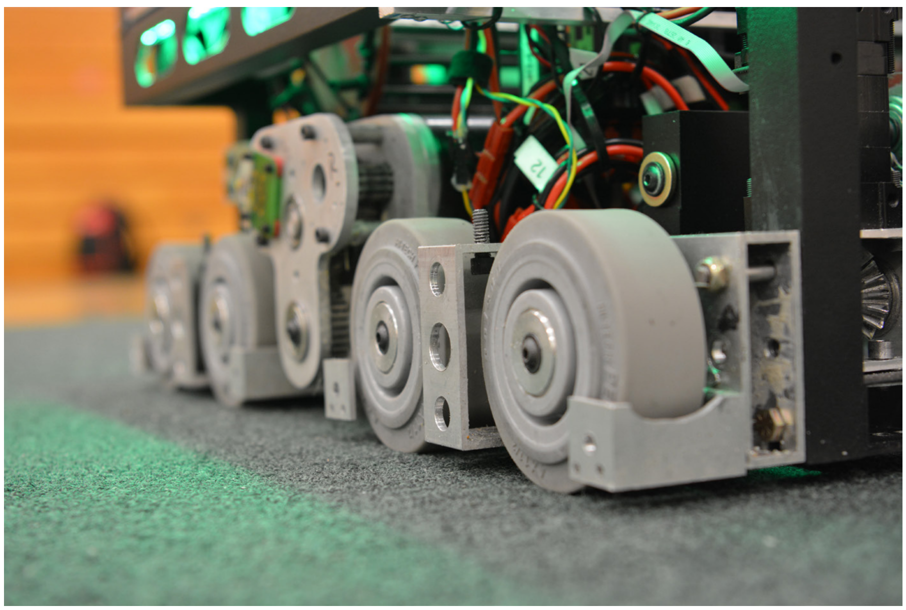
One of the most important design decisions while building the competition robot was what the drivetrain will be used for and how it will be made. We started discussing drivetrains by gauging what we thought was most important aspects were.

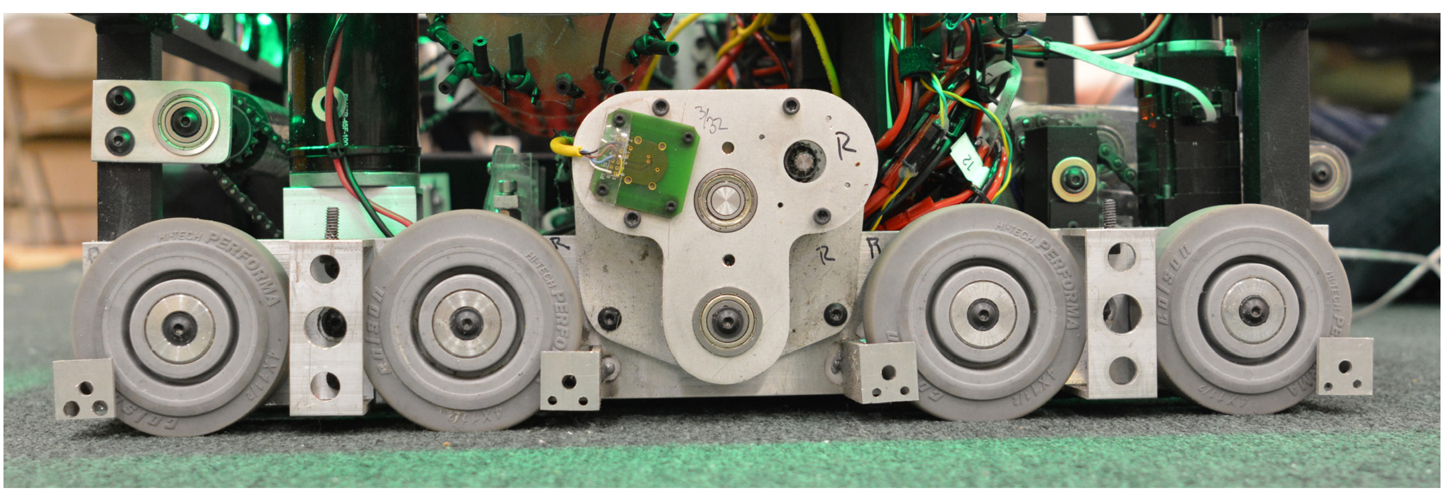
Our team had decided that modularity and ease of service were at the top of our priorities for this year's drivetrain. We went over several different types of drivetrains including tank, swerve, butterfly, lobster, and Omni drive. Our team narrowed down the options by stating the pros and cons for each type of drivetrain to see which would serve as most beneficial. To counteract bias, we made these decisions using a weighted decision matrix.

After we were done weighing the options, our team as a whole voted on whether or not we all agreed on the type of drivetrain. By the end of this whole process, we decided to use tank drive this season.

This year, the drive train gearbox has swappable gearing which helps our robot customize speed for each competition or match. The gearing starts at 14ft/s and allows for 12.5, 16.2, or 18ft/s with minor variations in between. The gearbox and drivetrain rail are both modular this year which allows for easy and quick removal. We have also modified the gearbox to put in an encoder to give accurate velocity readouts. This year we have a solid gear train so that we have the closest accuracy to motor velocity due to the least amount of backlash and maximum possible translation of torque. The drivetrain is powered by 4 CIM motors to power all of the wheels. Each side has 4 inch Colson wheels, 4 on each side, 8 total. We chose Colson wheels for their relatively high coefficient of friction so we would not lose traction while driving or pushing.






PERFORMA

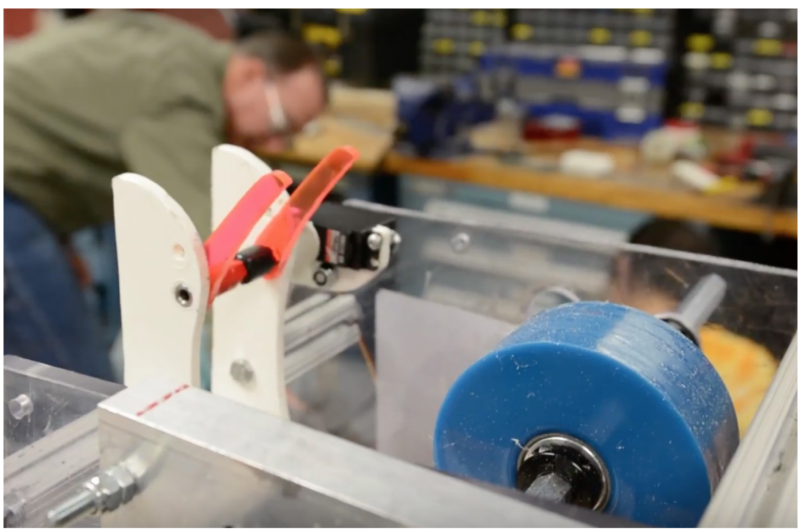
Shooter

On Team 708, we make it a priority to be constantly improving ourselves and our robots throughout our time on the team. We saw the improvements that our shooter needed last year and tried to start the season with those ideas in mind. For the shooter this year, we thought about centering methods throughout the whole prototyping period and made consistency one of our number one goals. After approximately 6 prototypes and 2 iterations of the shooter, we have landed on a solid design.

We started our design process with a simple u-shaped arc that allowed us to play with compression due to us placing shims under the bent back plate and wheel size/shape. During this phase, we also determined our minimum angle that was required to shoot the fuel consistently.

After we fine-tuned these variables, we moved to a rail design with the hope of it allowing the balls to be consistently centered. Continuing with later designs, we thought the fuel would need to be better controlled in terms of how fast the fuel would go in. We implemented a “ninja star” method that scooped and centered the fuel and allowed the fly-wheel time to speed back up.

Due to the nature of Steamworks and the amount of fuel in the goal really needed to make a significant impact in points, we decided very early on to have two shooters. The “ninja stars’ would allow us to space out each fuel between our two shooters to avoid mid-air contact. Even in one of our final designs, we still had rails with the “ninja stars,” but we began to realize that

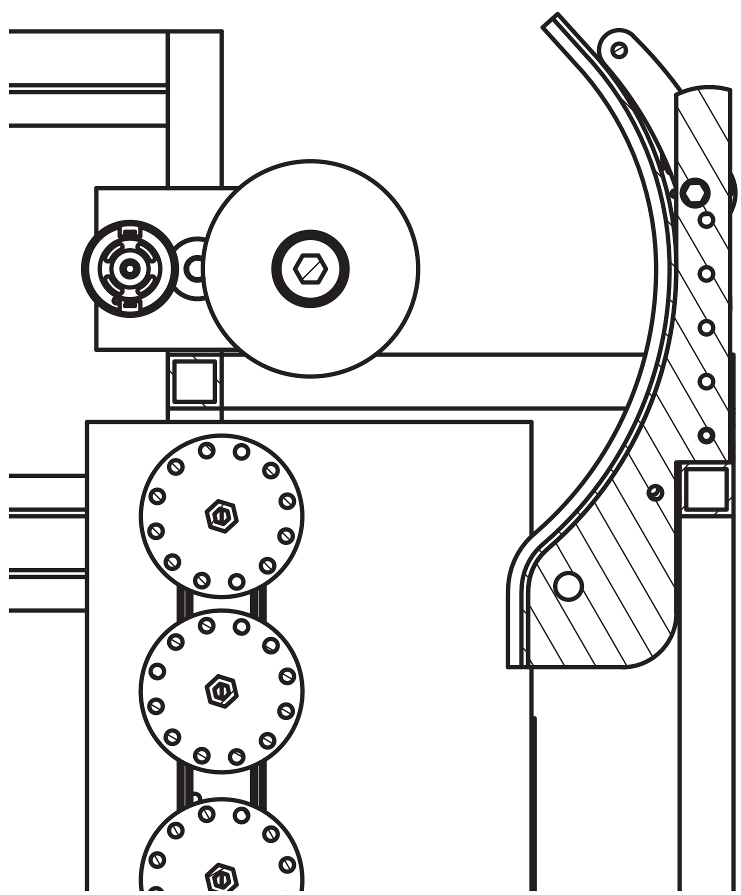


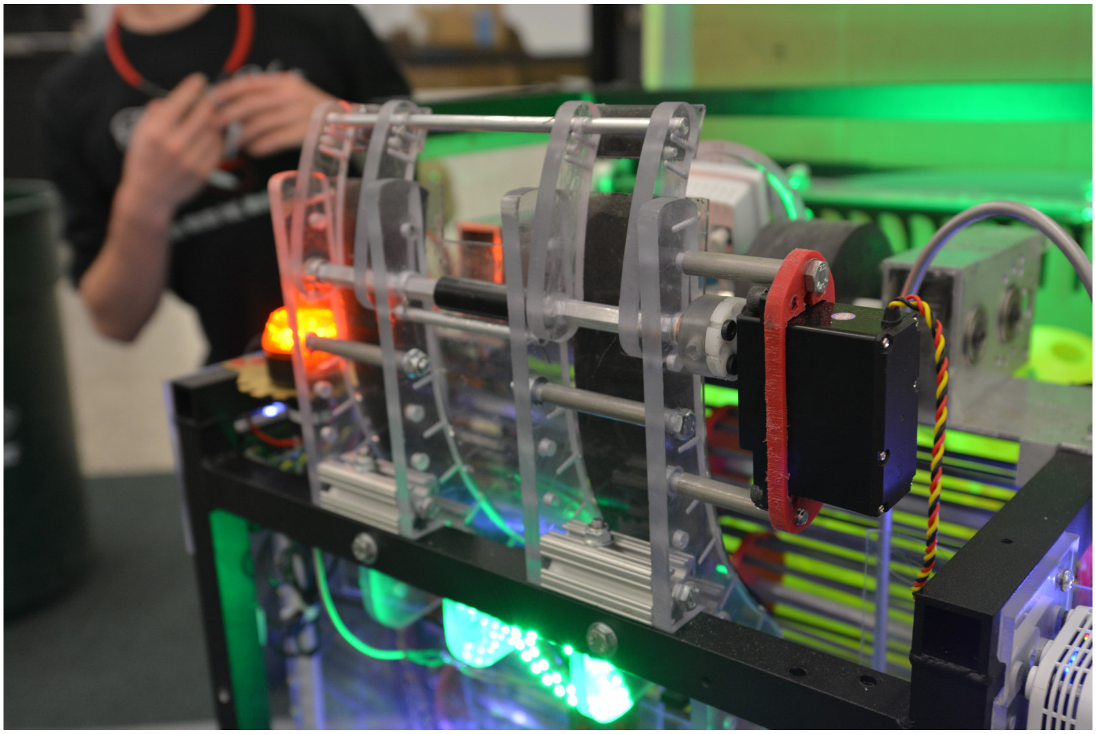
they only provided us inconsistencies. As we neared the end of build season we realized that one of our underlying variables that we had not realized were the holes in the fuel. At this point, we decided to move back to our original back plate with some iterations.

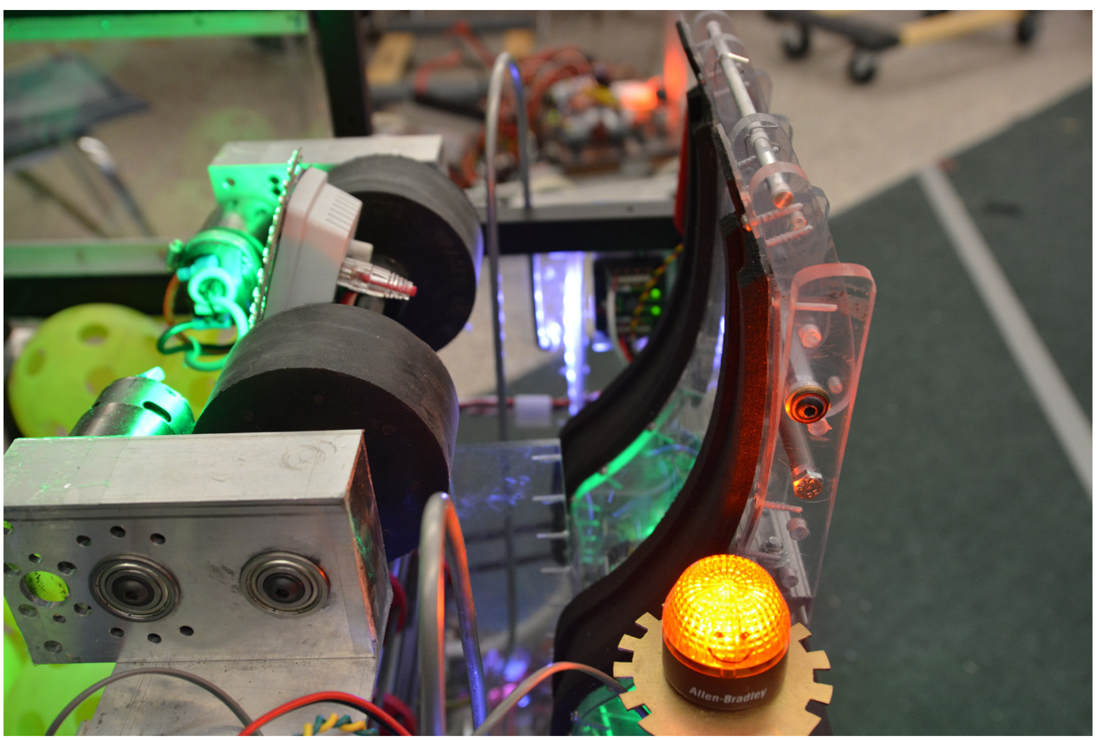
In the current design, we have two 35 durometer Abrasion Resistant wheels spinning on a single stainless steel hex shaft, with in-shop fabricated gear boxes each powered by a VEX 775Pro on either side. Attached to the frame is a single piece of flexible polycarbonate sheet creating an adjustable backing plate for the balls which is referred to as the hood. This back plate has the ability to flex to form the different arcs as the hood adjusts. We also use a thin piece of foam covering the plastic backing plates to help with fuel compression and grip. To center the fuel on the backing plates, we use two thick strips of foam on the outer edges of our backing plates. This helps to increase the shooters accuracy. This design also allows for the holes in the fuel to not affect the level of compression.

Another aspect we wanted the shooter to be able to do was to have an adjustable hood. With the possibility of our teammates all trying to shoot at one boiler, we wanted to give the robot the ability to be able to shoot from different distances. We built “ears”, two pieces of ⅜” thick polycarbonate attached by a thin plate of plastic, that help alter the angle between the bumper shot and the twelve-foot shot. The “ears” rotate on a ⅜” hex shaft that is powered by an HS-805mg high torque servo motor. We identified an issue with the servo motor in that it slipped the hood back to its original position as the robot shot. We found a simple fix to help keep the twelve-foot hood angle in place by using surgical tubing along the top. This helps keep consistent compression and helps adjust for the backlash of the shot in coordination with the servo as a fuel piece is passing through.

We have the shooter running between 2200 RPM and 2500 RPM and we track the data through the encoder that is directly mounted onto one of the VEX 775Pros. The axis camera, placed between the two wheels, provides a more accurate method of sight for the drivers and through the vision software. This allows us to perfectly line up the shooter at whatever distance the drive team prefers.



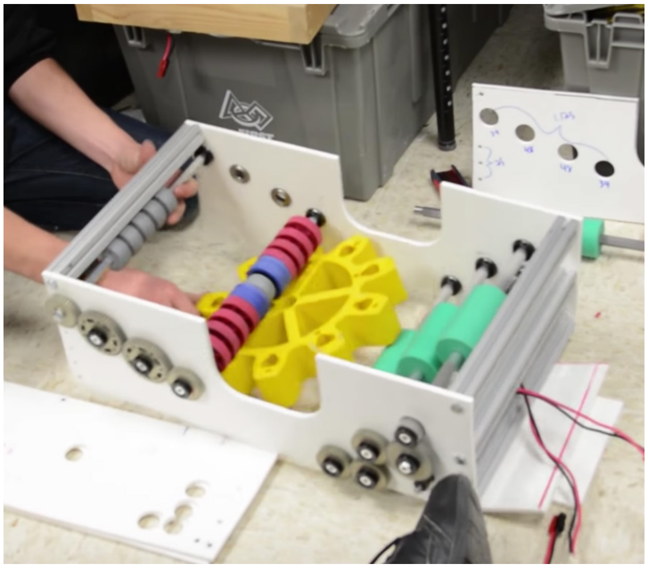


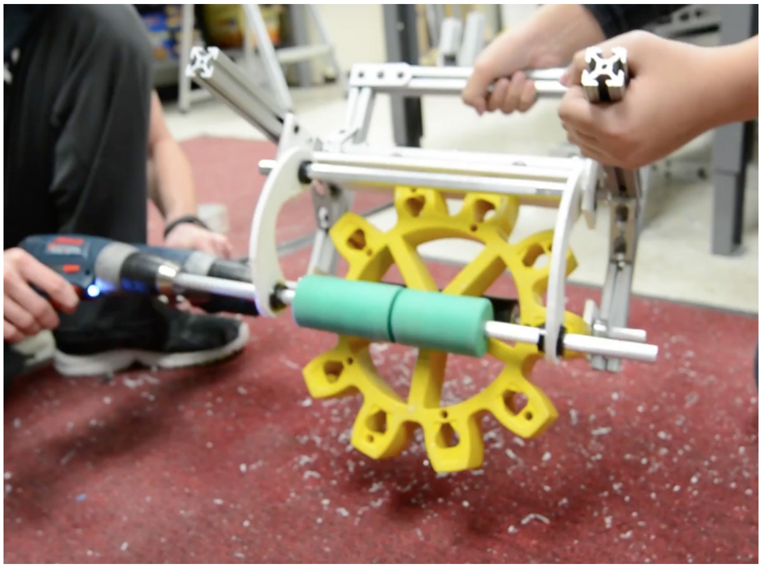

Allen-Bradley

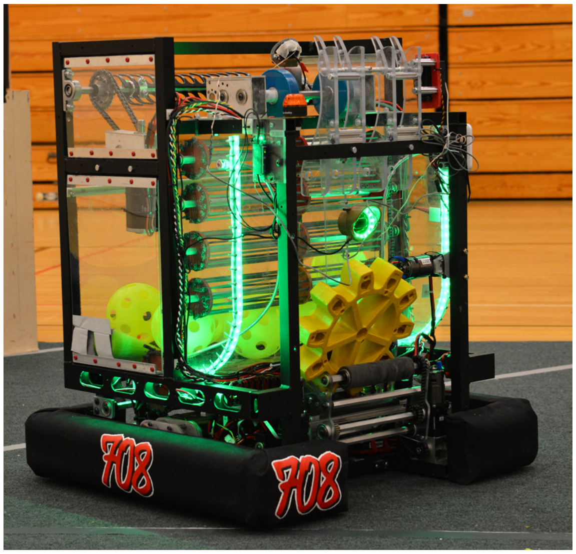
Gear Claw

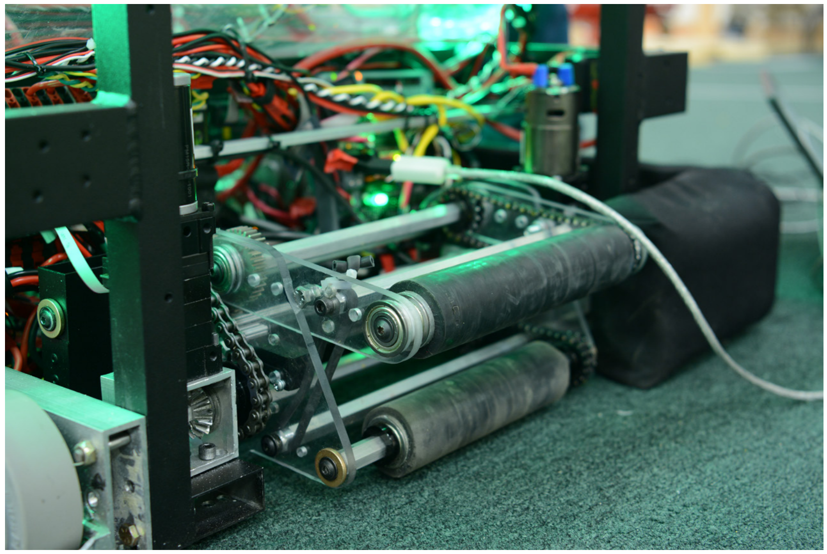
One of the most important components of our robot this year is the ability to pick up certain things off the ground, namely gears and fuel. This year one of the main components on the robot is the gear intake system, which we call the gear claw. The goal of the gear claw is to pick up a gear from the ground and be able to place it on the peg on the Airship so the pilot can pull up the gear and start a rotor spinning. The gear claw allows us to have a quick transition from the floor to the robot and onto the peg. In the beginning of the season, our team had decided to make a 2 in 1 system including both the ball intake and gear intake, to consume less space on the robot. It was designed with rectangles of polycarbonate sheets with 3 rollers. The first roller was intended to pick up fuel off the ground and feed to the shooter, while the second roller was meant to kick fuel up into the hopper, and the third was supposed to pick up a gear off the floor and stand it upright so that we could easily place it on the peg.

When we started the building process, we realized that the idea was not going to work. At first, the gear intake and ball intake were combined. As we continued prototyping and designing, many updated versions of this 2 in 1 intake were made to make the intake run more efficiently. However, after completing many iterations, we realized that separating the 2 would be more efficient and easier for the drivers.

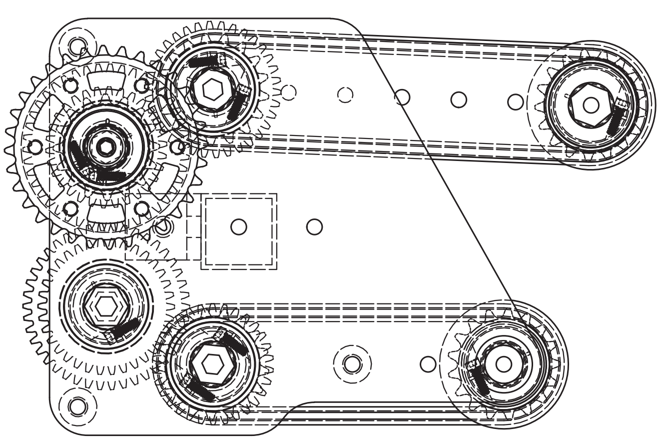


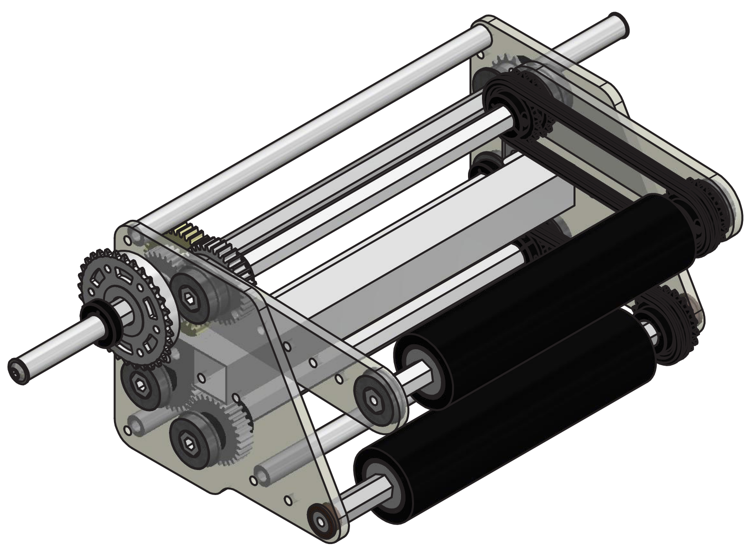






The new design was updated to use 3 rollers, similar to a conveyor belt. Overall, there were 8 versions of the gear claw built. The conveyor belt design was made with a chain that rotated on (2)42 tooth gears, (2)34 tooth gears, and (2)30 tooth gears. We have also attached 2 motors including the BAG motor and VEX 775Pro motor to make the chain and gears run more efficiently. Our final gear claw was made with 2 surgical tubing rollers to suck a gear into the intake, a chain link to power rollers and another to pivot the gear up, and a mechanical hard stop so that the gear claw does not drag on the ground. We have also placed a fiber optic laser sensor to detect when the gear is in place.

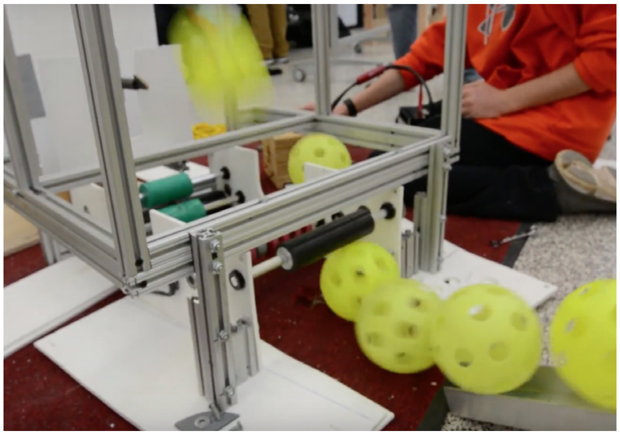


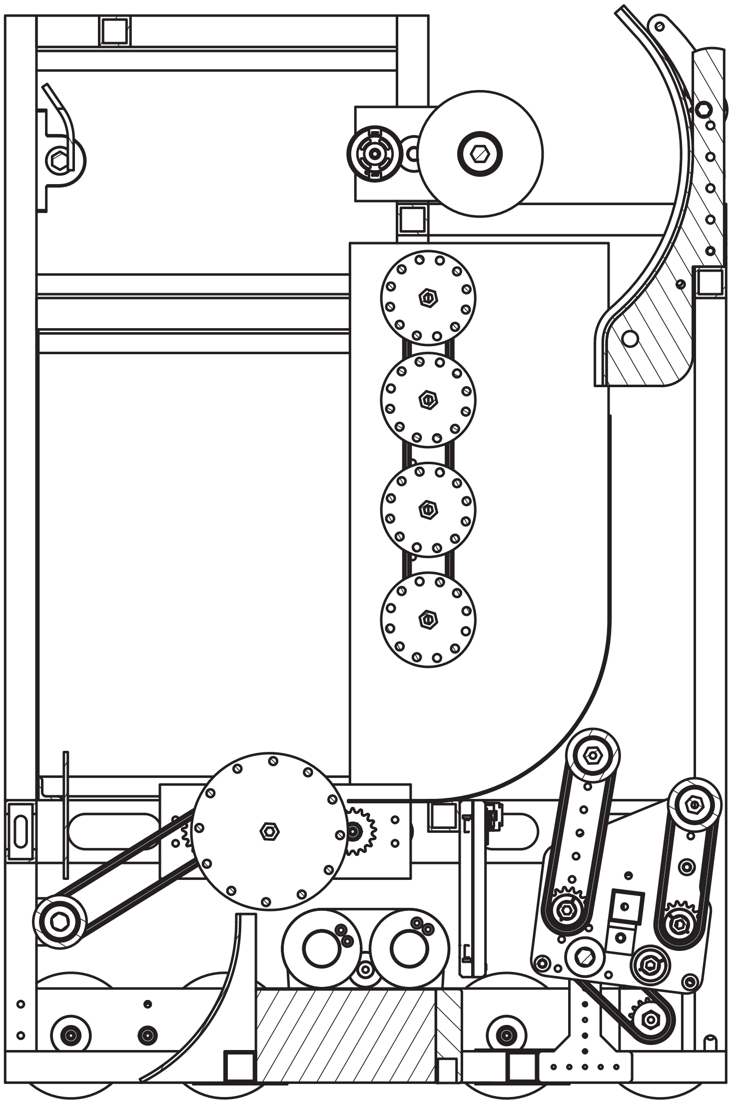


Fuel Intake / Hopper / Feeder

As indicated in the Gear Claw subsystem design section above, the robot needs to pick up both gears for the Airship and fuel for the boilers from the ground. As stated above, in our original design, we had both the gear and ball intake as one mechanism.

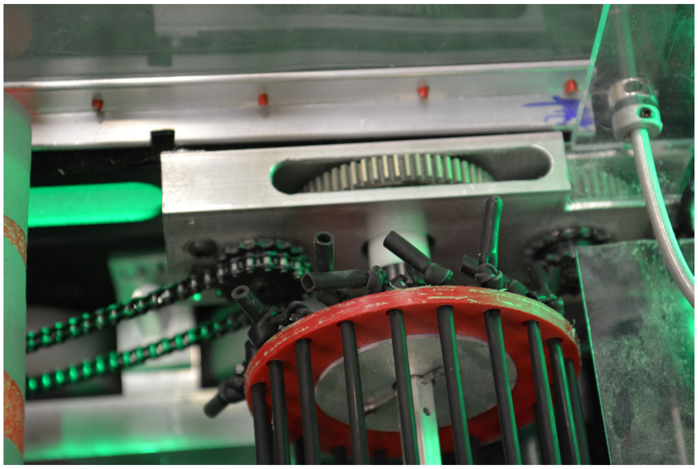
We quickly began prototyping a smaller more efficient way of picking up the “fuel”. Our current design includes a ramp, with a curved slope that takes the “fuel” to a large roller made from red polycarbonate and surgical tubing. The fuel then goes into the hopper where it waits until we are ready to shoot the “fuel” into the boiler.





The new ball intake is placed on the front of the robot, where the old one would have taken up the whole bottom of the robot and we wouldn't have had any room for our electrical components. The current dimensions of the ball intake are 13" wide, 7" tall, and 7" deep. Other than size differences, we have also changed the gear system on the original model to a chain system along with simplifying the roller that the ball hits first to give it the momentum it needs to go up the ramp and into the hopper.

The hopper uses passive walls to keep about 40-50 balls in the robot. When the robot is ready to shoot the fuel into the boiler, the feeder system is activated which is made up of 5 custom surgical tubing rollers and a clear j-shaped backing called the banjo. This system takes all the fuel to the dual shooters, allowing us to shoot fuel into the top of the boiler in a short amount of time.



Climber

During the last 30 seconds of the FIRST Steamworks match, pilots in the airship are able to release ropes for each robot on the alliance to be able to climb and thus be “Ready for Takeoff!” For each robot that is “ready for takeoff,” the alliance gains 50 points. We determined that, although not our highest priority, being able to gain this 50 point boost at the end of every match would be vital to our strategy.

After the prototyping process, there were 2 viable solutions to completing this task. The first was a roller that grabs onto and then coils up the rope, lifting the robot up to the plate and displacing it the minimum ½ inch. The second prototype was a repurposed model of our climbing mechanism from FIRST Stronghold. In the updated version, a lead screw would move a hook up to a large (~3 in.) knot on the rope. The hook would the run in reverse and lift the robot off the ground. The group decided that the second option was more developed and wanted to continue designing this.

A relatively completed version of this design was implemented and almost moved into the manufacturing process. However, as the rest of the robot progressed, there were several issues

identified. This design took up a lot of space. In the model, it interfered heavily with the design of the gear claw. Another issue was weight, which we as a team knew was beginning to be problematic. With the high weight of the lead screw design along with the prime real estate that it used, the group had to move back to the drawing board.

Realizing that there was a significant amount of horizontal space open at the top of the hopper, the group began to re-look into the roller design. A more developed prototype was made by drilling and tapping holes for ¼-20 bolts in a helical pattern on an aluminum tube. This prototype was able to grab a small knot in ½ in. rope very effectively. This roller, including the bolts, had a diameter of about 4 inches. This was another issue, however, because its placement on the robot might block the flow of balls coming in from either the human player station or the hoppers located around the field.

In order to combat this issue, the group decided to mount two rakes (yes, the lawn tool) 180° apart on hex axle. Eventually, the two rakes would be reduced to one in order to save more weight. U-bolts are used to hold the rake in its location. This hex axle was then lathed down to be ½ and fit into two pillow blocks mounted on the sides of the robot. There is a sprocket on the axle that is connected by a chain to the custom made gearbox that powers this mechanism.

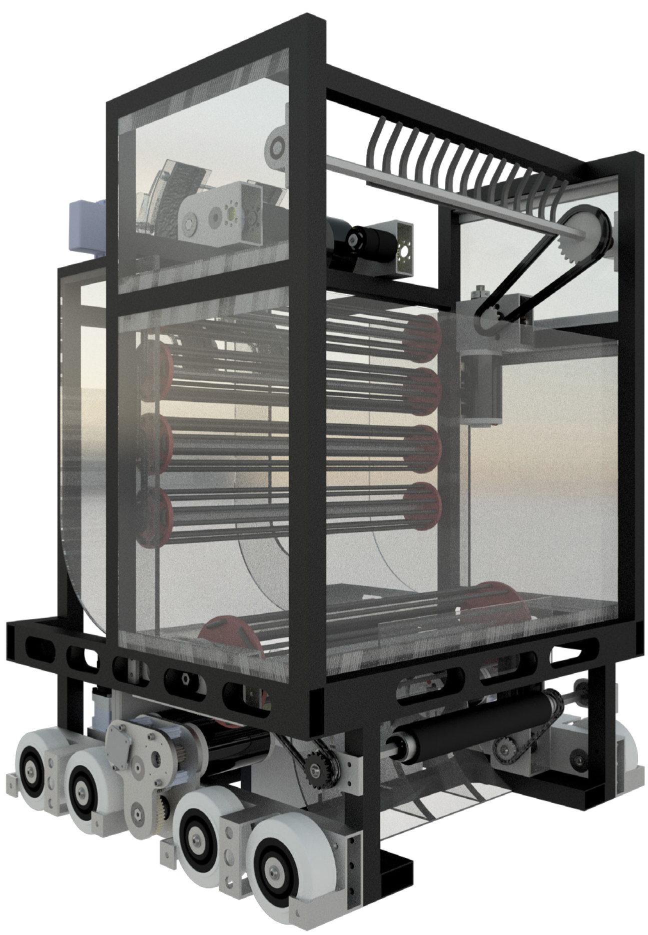
The gearbox is powered by a CIM motor and has a 30:1 reduction by use of a worm gear. Using the worm gear also ensures that the mechanism will not back drive and the robot won't fall back down, even when it is not powered.

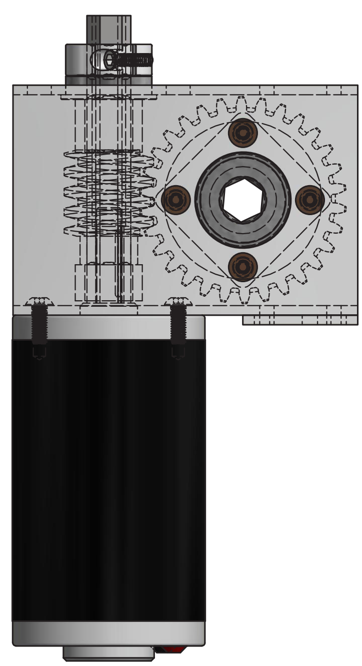
After being mounted to the robot and tested another issue was found. As the robot climbed higher up the rope, it would slow down until ultimately stall out before it would hit the plate. Two things were done to rectify this. The chain ratio that connects the gearbox and the axle was changed from a 1:1 to a 2:1, which makes the overall ratio 60:1. We also changed our rope of choice from a ½ inch nylon climbing rope to a much smaller diameter paracord. This was done because as the rope would coil up, the moment arm would essentially become longer and require more torque to be able to climb. The smaller diameter rope does not coil up as large and allows us to move up the rope faster.

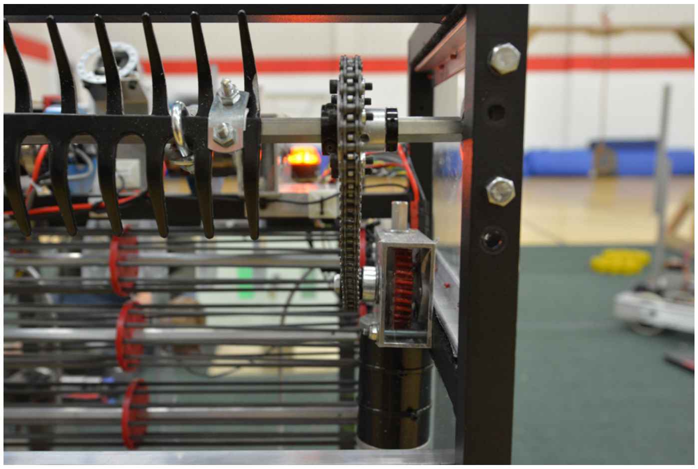
Climber

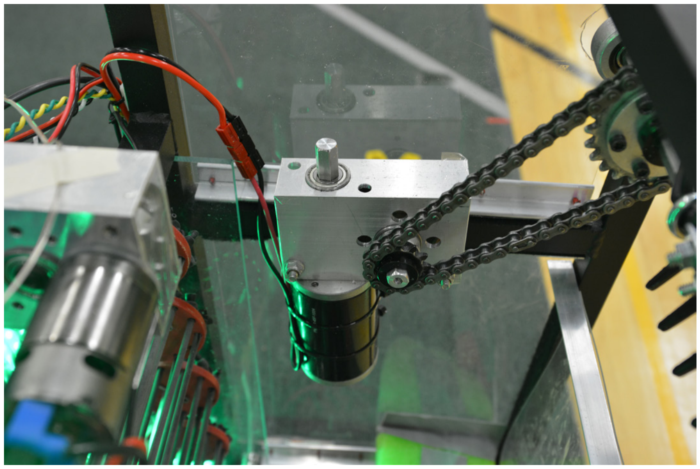
Using the skills from several Boy Scout students and alumni, we decided to tie 2 large monkeys fists into the paracord. One serves as the connection to the davit, and the other is the knot that the rake grabs on to. It required ~30 feet of paracord to be tied down to its final configuration.

Overall, the simple design of our effective climber is a testament to how well our team is able to adapt in order to come together and make a great machine.









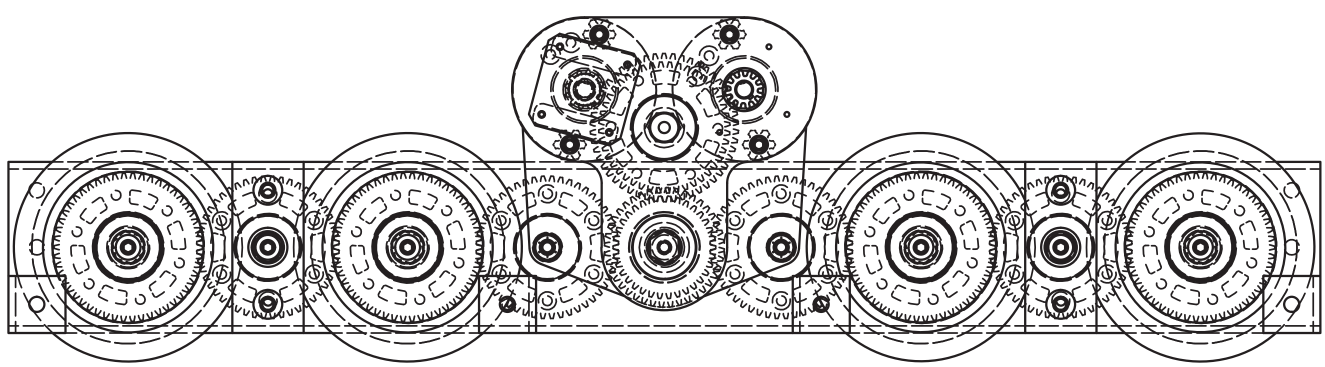
Custom Gearboxes

Every system on the robot this year uses a custom gearbox, except the shooter feeder for which we used a versa planetary. The fuel intake uses a bevel-drive gearbox which connects to a motion-inversion gearbox, which powers the sawmill. The bevel gear makes it possible to change the operating angle.

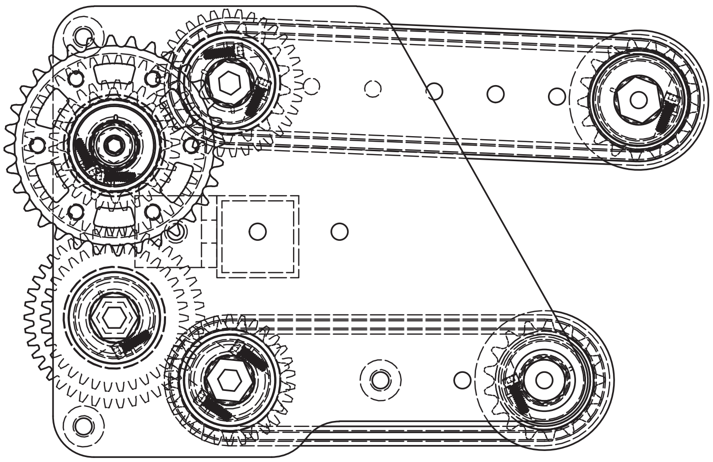
The climber also uses a worm drive gearbox and the gear intake uses 2 bevel-drive gearboxes. The worm drive is self-locking which helps our robot stay hanging on the rope and not fall.

The shooter uses a custom gearbox. This gearbox has a stage so that gearing can be swapped for customizable speeds.

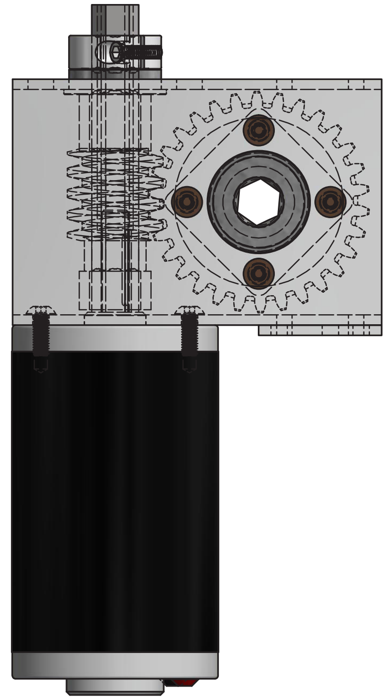
Custom gearboxes are a huge help to our robot as we would be able to make them fit in unusual spots where store bought ones would not properly fit. This way the custom gearboxes helped save a lot of space on the robot. They also helped us design into corners so that the robot was nice and square. The gearboxes were also more preferable by our team as we could set speed, reduction, and torque as we wanted versus not being able to change it by using store-bought gearboxes.



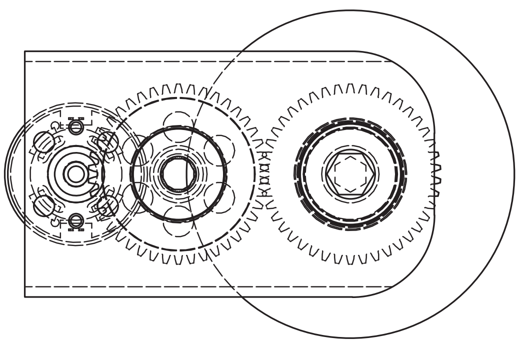
Drivetrain



Gear Claw

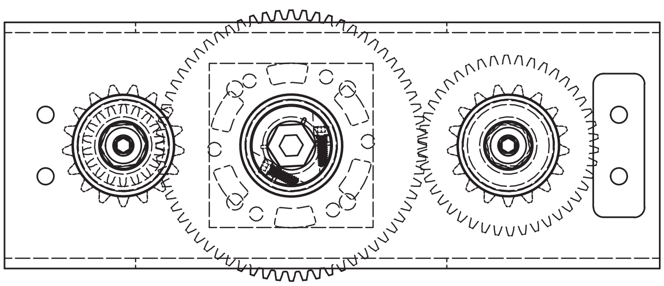


Climber Worm Gearbox



Shooter Gearbox

Gear Claw Bevel Gearboxes



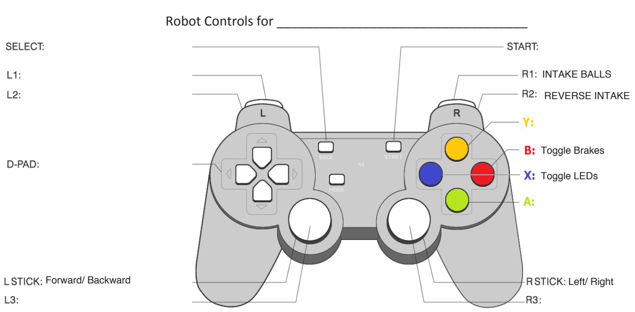
Intake / Hopper Motion Inversion

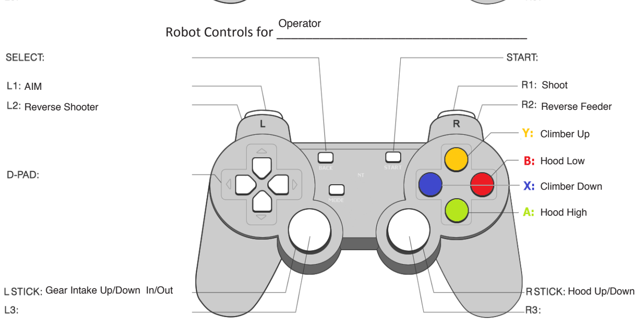
Software

During the off season, our software team created a template software solution based on 2016's code and placed this solution in the GitHub repository which allows us and others use use this code as a baseline in the 2017 software solution. Utilizing these templates helped the software team begin early with the fundamentals already structured.

A major change in 2017 for software was the way vision processing is done. In past years, vision processing was completed on the Driver Stations using RoboRealm. This presented lagging in our vision processing and communication of data back to the RoboRio. This year our new vision processing software, GRIP, provides an OpenCV interface to set up filters to find the retroreflective tape on the boiler and lift targets and generates a java file which is compiled directly into the software solution. This means the vision processing is running directly on the RoboRio and uses data from image contours and various formulas to determine the distance of the robot from the target, calculate the target's center, and identify whether the robot sees the target. The targets center is found by using the X coordinate sent to the RoboRio as a pixel point on the screen.

In the first couple weeks of the 2017 season, software taught new team members about the FRC process. This included learning about hardware components and sensors, how to set up personal computers with Eclipse and Java, and lessons on how to code in Java. In the next step, the students created a testing workspace with the sample FRC robot project to learn how to use the WPI Libraries, compile a robot project, publish it to the RoboRio. Once the sample robot project was available on the robot, the students learned how to use the FRC smartdashboard and were able to run the robot in autonomous mode and use the joysticks to control the robot in teleop mode.





Once all students progressed through this initial series of tasks, students learned to write pseudocode, which is a way to organize ideas and methods in English. This helped students identify the tasks the robot needed to complete without

RoboRIO	RoboRIO	PDP	PDP	CAN Talons	CAN Talons	PCM	PCM
Port	Use	Port	Use	Device ID	Use	Port	Use
PWM 0		0-40A	Climber	11	DT LEFT Motor M	Solenoid 0	light switch
PWM 1		1-40A	Shooter M	12	DT Left Motor S	Solenoid 1	
PWM 2		2-40A	Shooter S	13	DT Right Motor M	Solenoid 2	
PWM 3		3-40A		14	DT Right Motor S	Solenoid 3	
PWM 4	Hood Servo	4-20/30A	Intake Ball	21	Climber	Solenoid 4	camera1
PWM 5		5-20/30A	Intake Gear	31	Intake Ball	Solenoid 5	camera2
PWM 6		6-20/30A	Feeder	32	Intake Gear	Solenoid 6	
PWM 7		7-20/30A	Hopper	41	Shooter M	Solenoid 7	
PWM 8		8-20/30A		42	Shooter S	Pressure Switch	Pressure Switch
PWM 9		9-20/30A		51	Feeder	Compressor	Compressor
Relay 0		10-20/30A		61	Hopper		
Relay 1		11-20/30A					
Relay 2		12-40A	DT Left Motor M				
Relay 3		13-40A	DT Left Motor S				
Digital I/O 0	DT Encoder A - right	14-40A	DT Right Motor M				
Digital I/O 1	DT Encoder B - right	15-40A	DT Right Motor S			**Item**	**Quantity**
Digital I/O 2	DT Encoder A - left					CAN Talon	11
Digital I/O 3	DT Encoder B - left					Talon	
Digital I/O 4	Shooter Encoder A					Relay/Spike	
Digital I/O 5	Shooter Encoder B					Solenoid	4
Digital I/O 6	Climber cutoff switch					Encoder	3
Digital I/O 7						Limit Switch	1
Digital I/O 8		**Key**	**Color Coding**			Gyrometer	1
Digital I/O 9		**DT = Drivetrain**	Drivetrain			Infrared Sensor	1
Analog 0	DT Distance Sonar	**M = Master**	Shooter			Sonar	1
Analog 1	Intake Gear IR sensor	**S = Slave**	Climber			Pressure Switch	
Analog 2			Intake Gear			Compressor	
Analog 3			Intake Balls			Potentiometer	
RSL	RSL		Feeder			RSL	1
			Hopper				

worrying about the Java syntax.

The software team then divided into different groups defined by the subsystems such as the climber, shooter, drivetrain, vision, and intakes. Each group then decided the requirements for each different subsystem, the actions the robot needed to perform, and what sensors or manipulators need to be included. The software team as a whole reconvened and reviewed each requirement and then went on to write code within the subsystems.

When each group wanted to test their code they could run it on the Portable Control System. In previous years, our Portable Control System, a box with many electrical components including motors and sensors which served as a test bench, also known as BomBox, was changed to an actual test robot which helped us to more properly test more functions within the code. Our software team used GitHub for organizing and managing code. Each group published a separate branch in the GitHub repository after going through a code walkthrough with their mentor. Then the software team as a whole then compiled all the branches into a central branch.This central branch is called the master branch which currently runs on the robot.

The software team planned and wrote several different autonomous modes. Our robot has two cameras, one axis camera forward facing for vision processing of the boiler, the other is a rear facing USB to allow vision processing of the lift.

LEDs

This year we added LEDs to our robot. LED is an abbreviation meaning Light Emitting Diode. The lights run on a serial port to Arduino. The Arduino is a secondary brain of the robot specific to the LEDs. The LEDs change color based on what action the robot is doing.

At the base of the robot, there is a light that shows blue or red based on which alliance we are on. When the front light is blue that means we are connected to the blue alliance, and when the light is red it means we are on the red alliance. When the front light turns white it means our robot is not connected.

On our robot, there is a chain of LEDs which we call the banjo lights. These lights are on the banjo which is shaped in a J located on the hopper. When the shooter is searching for the retroreflective tape on the boiler, the light moves back and forth along the chain. When the banjo light is white this means the robot is locked on the target.

The robot gear claw has a fiber optic sensor which when blocked allows the robot to sense when a gear is picked up. The LED strand turns green indicating to the driver that the robot is loaded with a gear, which helps as the drivers may not always see the gear in place.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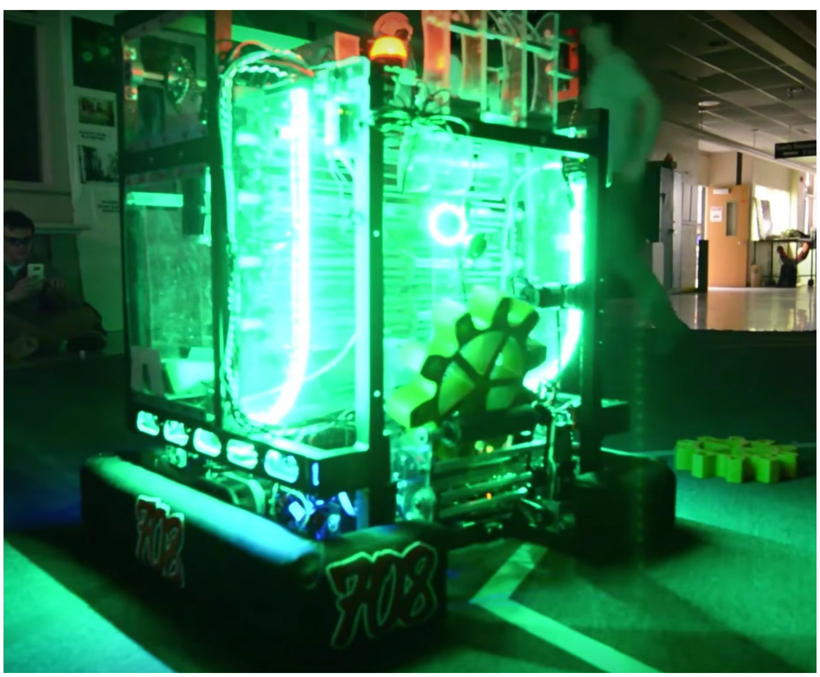
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Electronics

Standard on every FRC robot is an electrical system that gives the robot the ability to be powered, process commands, and sense its surroundings. The heart and brain of the robot can be found in our electronics system. Considering we chose to build our robot in the taller of the two size options, we had to make a few adjustments when it came to how we were going to lay out the electrical systems.

This year, a majority of our electronics are at the bottom of our robot. This is because we needed the maximum amount of space possible for our hopper/ feeder and intake systems. Along with this, another reason for having a majority of our electrics at the bottom is for stability. This configuration is very different from last year, as it is more condensed and takes up less space than ever before.

Other than the configuration of the electrical systems being different, we also added LED strips to our robot to represent what our robot is doing at the time. Using a combination of Anderson Power Poles and various quick-disconnect connectors, we are able to have a modular electronics system and robot. This allows mechanical modules, such as the drive rails, to be removed along with the associated sensors and motors. This feature of our robot improves serviceability.

We came across multiple problems when it came to our electrical systems. Almost all of these problems can relate back to the amount of space that was available for our electric systems. The largest problem was that there was minimal space for the battery. Even now we have to move a piece of our robot to access our battery and to change it out. Along with this, the platform that the battery sits on gets in the way of some of the wires for the PDP so we had to zip tie some of them together to compact them and to pull them away from the platform.

Team 708 has implemented many sensors, including encoders for the drivetrain, shooter, and gear claw, an ultrasonic sensor to measure distances from the front of the robot, and a fiber optic beam break sensor which indicates if the robot possesses a gear, to name a few. Fitting all of these components in a small space was a challenge and moreover, fitting the appropriate wiring was even more difficult.

We have quite a lot of motors this year. In total, we have 12 motors and 1 servo. These motors are located all over the robot. There are two VEX 775Pro motors on the shooter, one BAG motor and one VEX 775Pro on the gear claw, a CIM motor on the fuel/ball intake, and a CIM motor on the climber. Other than these motors we also have motors powering our surgical tubing rollers and our drivetrain. The two electrical systems we are using this year are a PDP and a RoboRio and an Arduino controlling the LEDs. These systems are connected to the “brain” of the robot and are located on the back side of the hopper.