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MISFIRE

2017

Season

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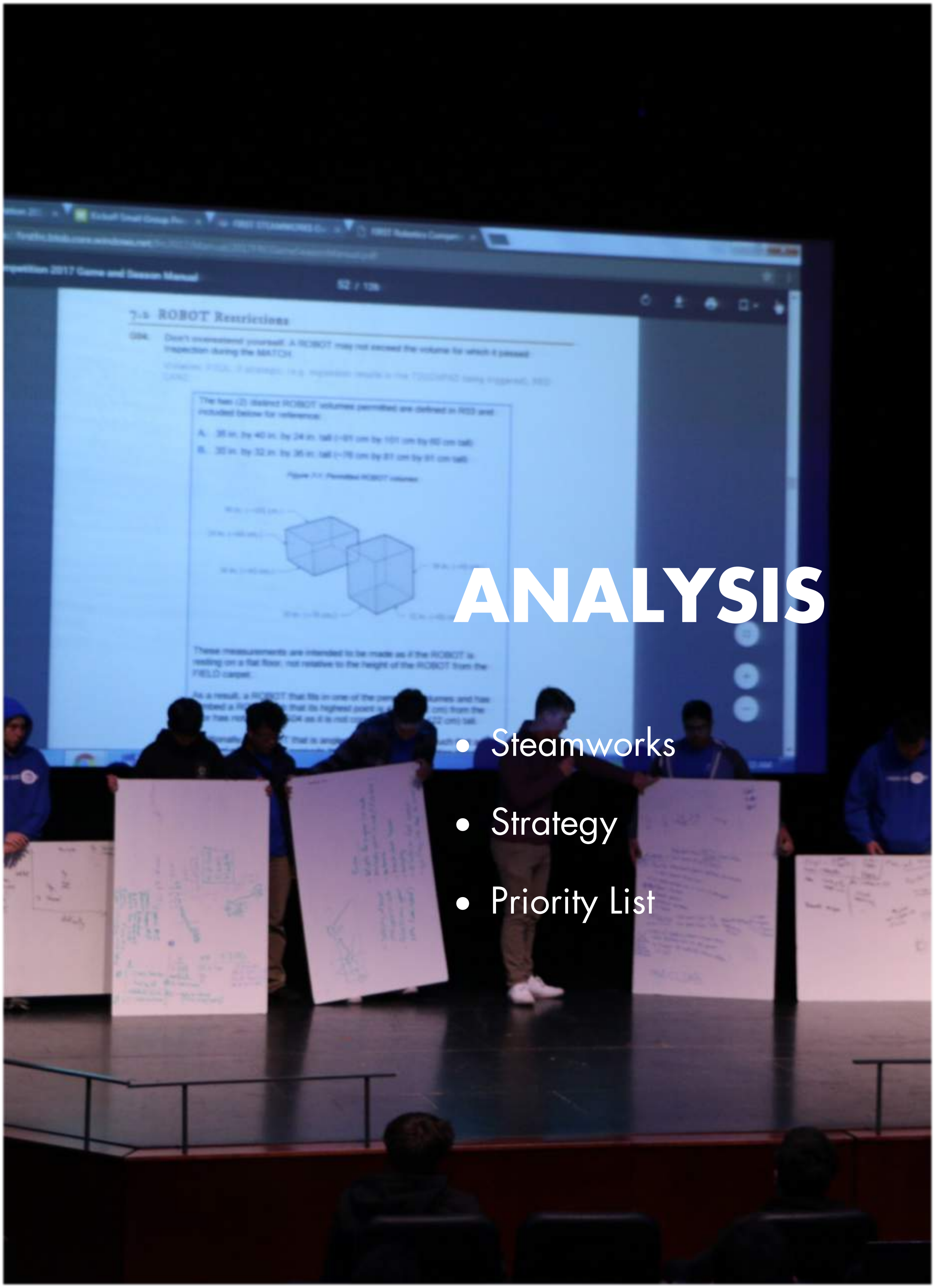
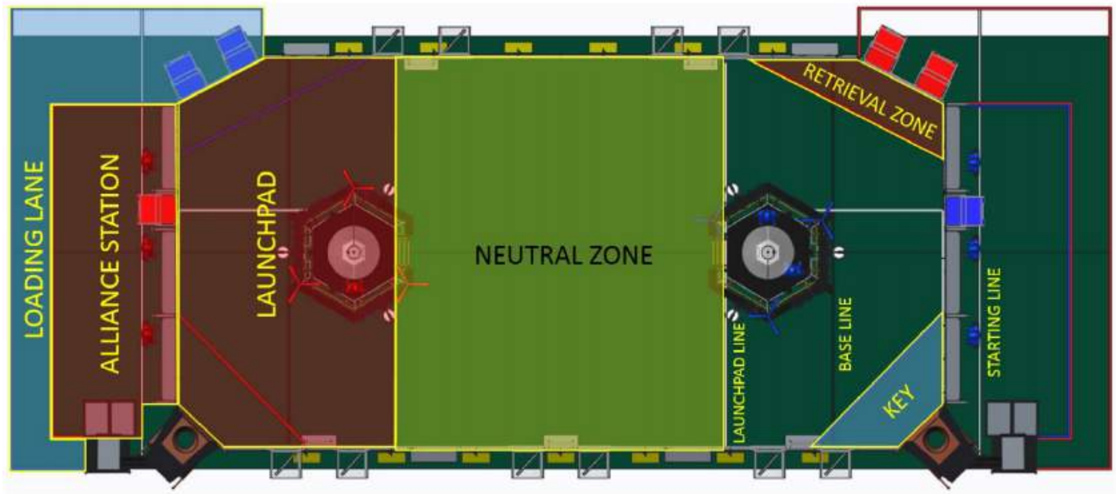


ANALYSIS

- Steamworks
- Strategy
- Priority List

ANALYSIS steamworks

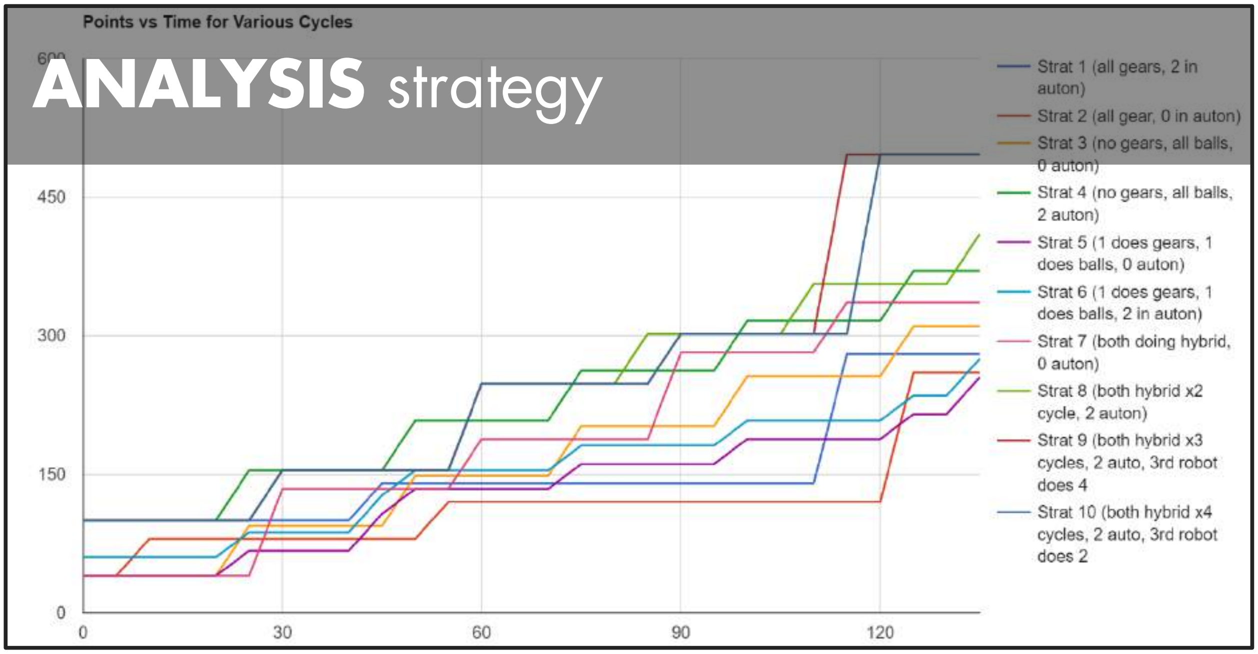


Action	Criteria	MATCH Points		Ranking Points
		AUTO	TELEOP	
AUTO mobility	For each ROBOT that breaks the BASE LINE vertical plane with their BUMPER by T=0	5	-	-
Pressure accumulation	For every three (3) FUEL counted in the Low Efficiency GOAL by T=0	1 + 1 kPa	-	-
	For every one (1) FUEL counted in the High Efficiency GOAL by T=0	1 + 1 kPa	-	-
	For every nine (9) FUEL counted in the Low Efficiency GOAL by T=0	-	1 + 1 kPa	-
	For every three (3) FUEL counted in the High Efficiency GOAL by T=0	-	1 + 1 kPa	-
	If ALLIANCE meets or exceeds a threshold pressure of 40 kPa	-	20 (Playoffs only)	1 (Quals only)
ROTOR engagement	For each ROTOR turning by period's T=0, that's not previously been scored	60	40	-
	If all four (4) ROTORS turning by T=0		100 (Playoffs only)	1 (Quals only)
Ready for Takeoff	For each TOUCHPAD triggered by a ROBOT at T=0		50	-

Game Analysis

In this year's game, gears stand out as strong sources of points, but the time spent scoring them loses significant value as each rotor is activated. While fuel scoring appears to be less rewarding than activating rotors, the 40kPa bonus provides an incentive to shoot for the high goal. Because gears are worth so much and many teams are likely to focus on them, fuel scoring is also important to serve as a tiebreaker. For hanging, fuel's apparent ease and value makes it an essential part of the game.

ANALYSIS strategy

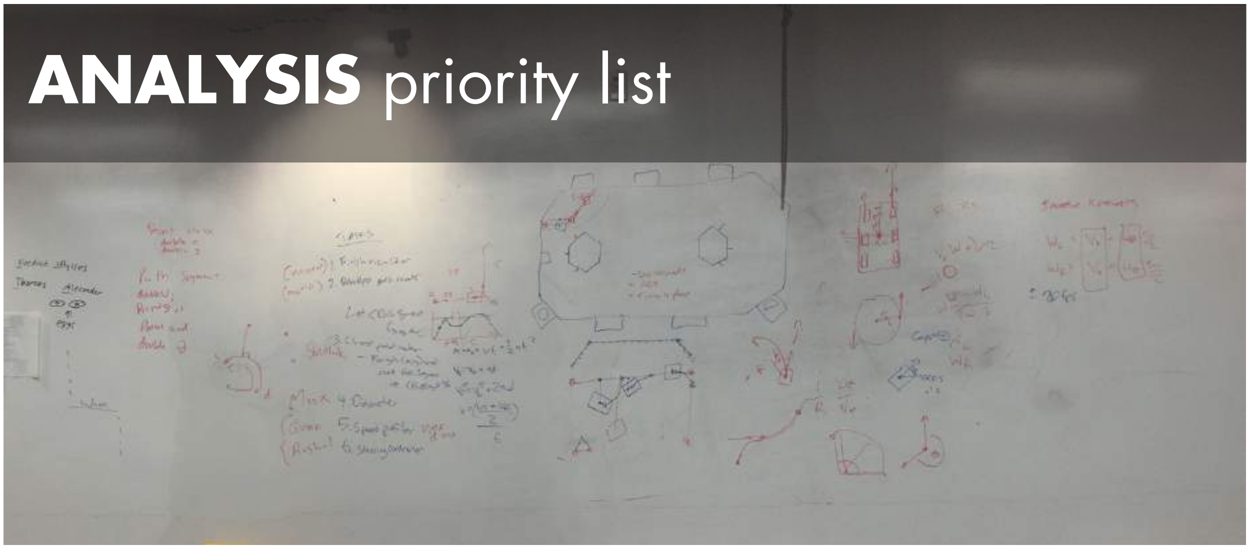


Looking at the various cycle times and point values for this game, we began calculating how much value each scoring cycle provides. We decided that reaching 40kPa was our priority and once reached, we would start scoring gears.

In planning our autonomous, we were primarily concerned with getting as close as possible to 40kPa. We have three autonomous strategies, differing by scoring a gear on the near, middle, or far peg from the boiler. In every strategy, we score a gear first before scoring fuel. Our optimal autonomous scores the near gear, then activates the hopper and shoots all fuel.

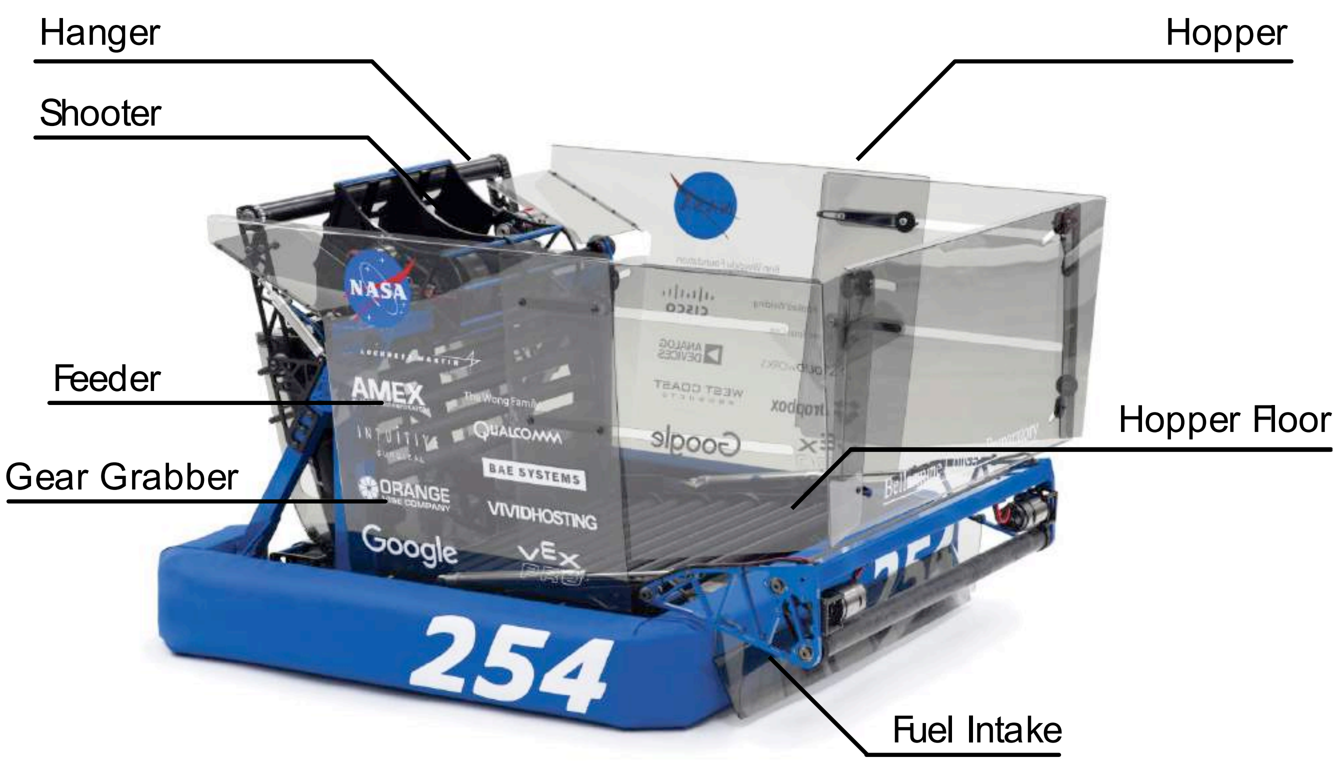
In teleop, to optimize scoring cycles, we will focus on scoring gears, and resume shooting once we have scored 4 rotors. We will hang every game, spending as much time as necessary to ensure we achieve those points. In overall strategy, we plan with our alliance partners to make four activated rotors difficult for the opposing alliance to achieve by defending the loading lane.

ANALYSIS priority list



1. Drivetrain
    a. Fast to cross field for rapid cycles
    b. Powerful low gear to fight through defense
    c. Strong, simple, and robust to take hits
2. Hanging
    a. Hang every match in under five seconds
3. Fuel Shooter
    a. 40 kPa autonomous
    b. Maximize fuel scored per second
        i. High firing rate with good accuracy
4. Gear scoring
    a. Pickup from floor
    b. Launch gear onto base of peg
5. Fuel Intake
    a. Pick up fuel while at full speed and against walls
    b. Large hopper to hold 120+ fuel
        i. Can receive fuel from field hoppers

MISFIRE


Hanger
Shooter
Feeder
Gear Grabber
Hopper
Hopper Floor
Fuel Intake
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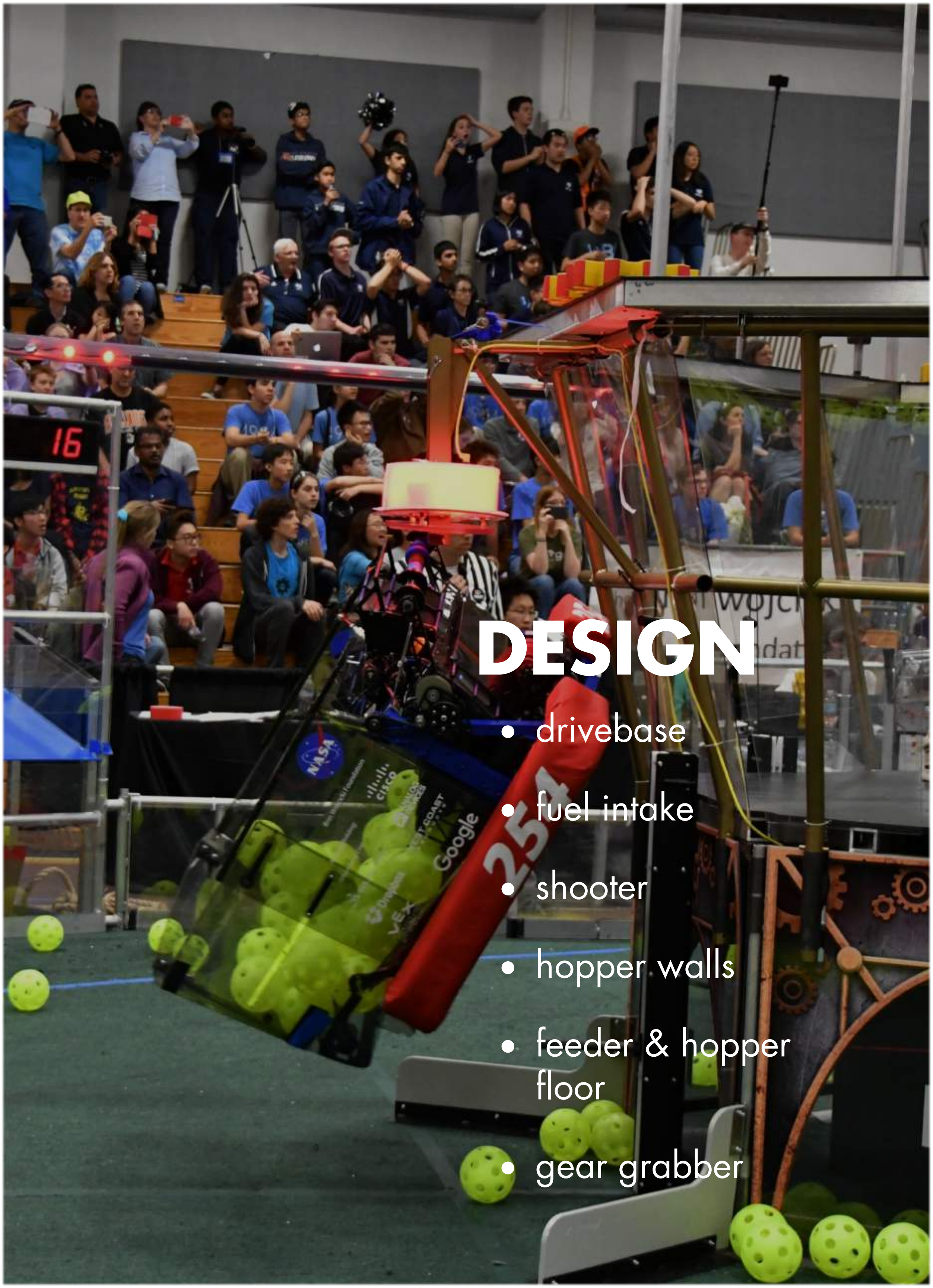


DESIGN

- drivebase
- fuel intake
- shooter
- hopper walls
- feeder & hopper floor
- gear grabber

DRIVEBASE prototyping

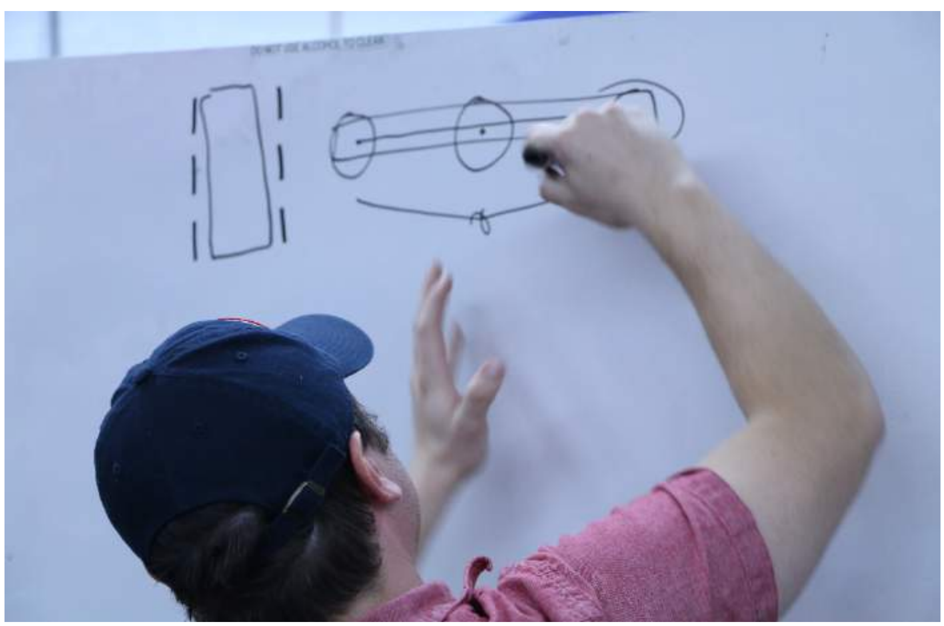
Goals:

- Simple, fast, agile drivebase
- Powerful to get out of defense
- Two speed gearbox - Able to shift to low gear for more torque

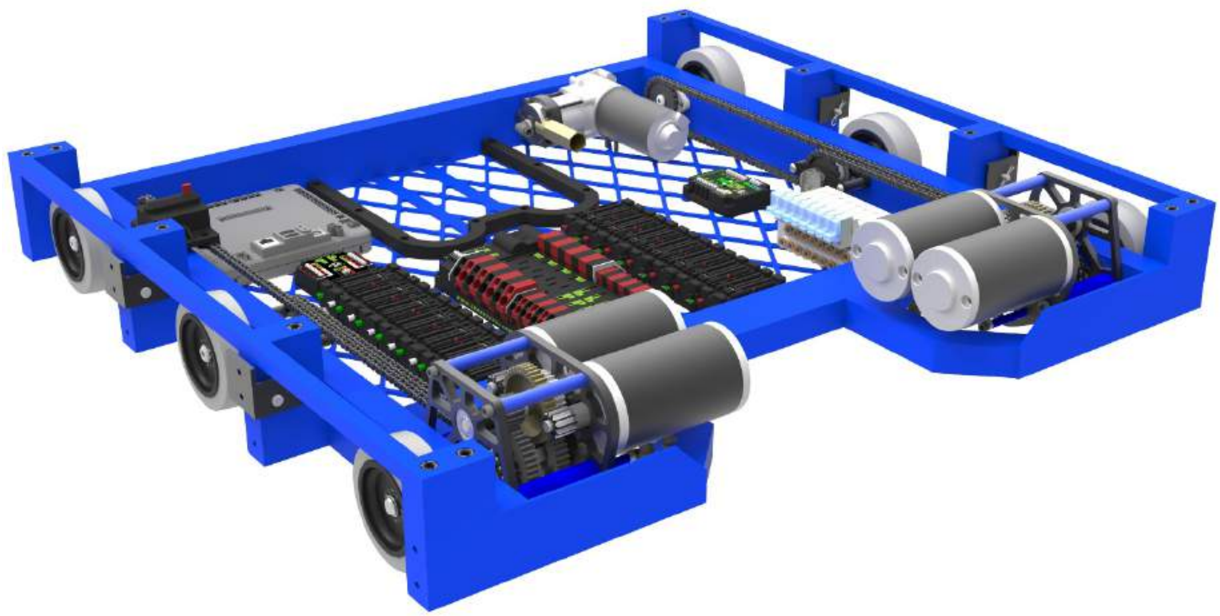
Prototyping

- Reused familiar West Coast Drive design
- Center drop to ease turning
- 3.25" wheels for minimum ground clearance
- Wheel option
    - Omni wheels (Used in 2015)
        - Excellent turning
        - Too vulnerable to defense
    - Custom hubs and tread (Used until 2014)
        - Great traction, but more manufacturing time
    - Colson wheels
        - Lightweight, thin, optimal size, and good traction
        - COTS - Less manufacturing time

6 wheel drive with center drop



DRIVEBASE west coast drive



- Chassis
  - West Coast Drive
    - Easy maintanence, experienced with this design
    - Welded 2"x1"x 1/8" wall tubes, 1/8" thick bellypan
  - Bumpers
    - Brackets attach with clevis pins
    - L-channel supports bumpers in rear
- Wheel base
  - 0.06" center drop and 10.75" wheel spacing
  - Balance robot stability and ease of turning
  - 3.25" wheels, allows 0.5" ground clearance
- Powertrain
  - Rear gearboxes to maximize hopper volume
  - 2 CIMs each, 2 Speed (shifting dog)
    - Low - 10.7:1 - 7.66 ft/s
    - High - 4.17:1 - 19.6 ft/s
  - Live thunderhex with 22T sprockets
    - Fixed CC, no tensioner

Simple West Coast Drive

FUEL INTAKE prototyping

Goals:

- Full width and can grab fuel against walls
- Surface velocity greater than robot speed so we can intake fuel while moving

Prototyping

- Surgical tubing belts with ramp
  - Pros
    - No dead spots between rollers
  - Cons
    - Lots of tubing, relatively complex
    - Requires a ramp for maximum efficiency
    - Slow
- Two surgical tubing rollers with ramp
  - Zip ties were helpful to propel fuel into the hopper and avoid dead spots, though unnecessary
  - Pros
    - Relatively simple
    - Easy to implement, we have experience with this in 2016
  - Cons
    - Potential dead spots
    - Requires a ramp

Ramp to carry fuel over bumper

FUEL INTAKE surgical tubing rollers

- Two rollers
  - 1.5″ diameter aluminum tubes covered in surgical tubing
  - Top roller is 1/16″ wall, bottom is 1/8″ wall
- Polycarbonate side plates
  - Deflects side impacts, rather than bending like aluminum
- Gearbox
  - Powered by two 775 Pros
  - 36T GT2 Pulley to 12T Pulley (3:1) Reduction
  - Surface speed: 40 ft/s
- Ramp
  - Average of 0.2″ of compression
  - 60° ramp angle

Polycarb side plates

SHOOTER prototyping

Goals

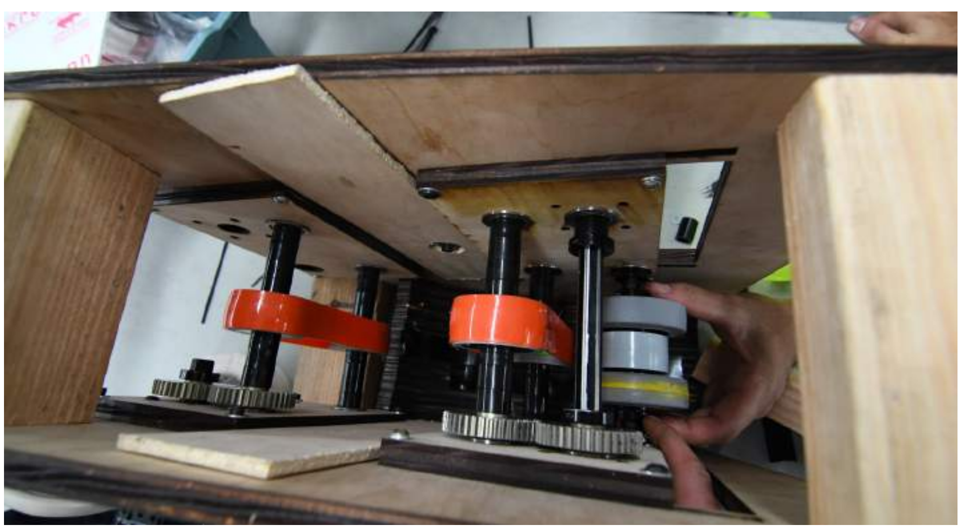
- Maximize fuel scored per second
- High throughput and accurate
- Minimize size to maximize hopper volume

Prototyping

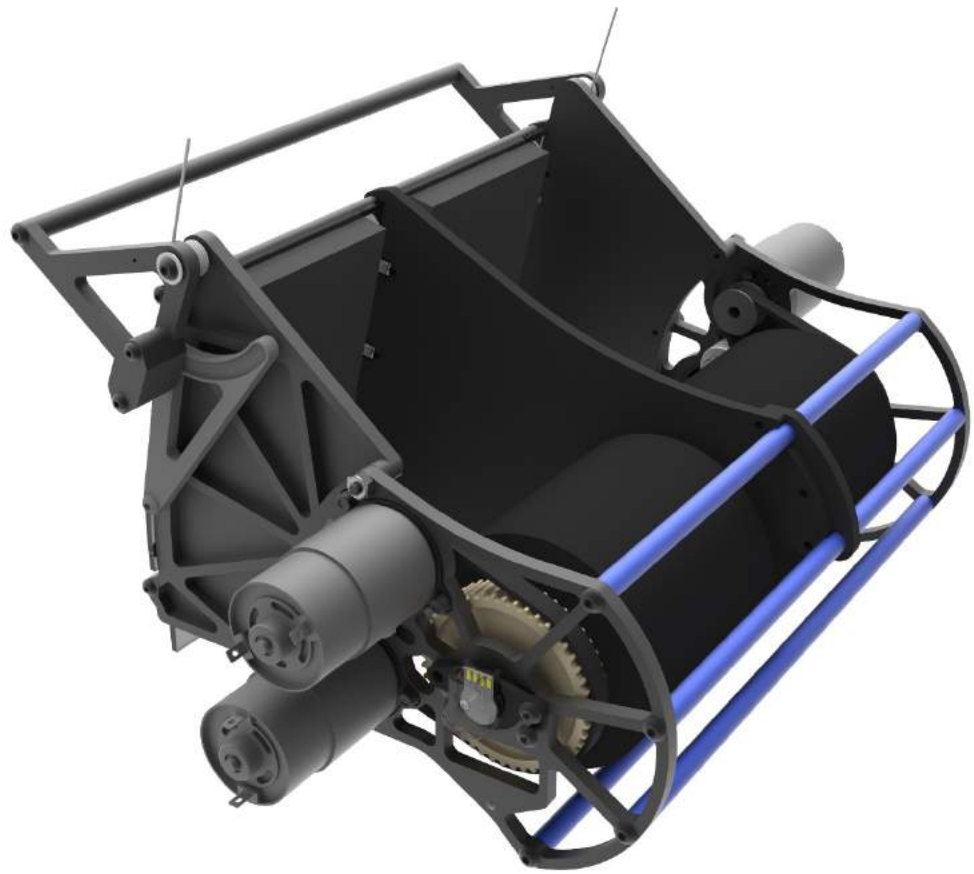
- Catapult
    - Accurate, but slow and could not package well
- Dual vertical flywheel
    - Fast shooting didn't offset low accuracy and unfamiliarity
- Double belted shooter
    - Despite no dead spots, lack of spin produced inaccuracy
- Dual horizontal flywheel
    - Accurate, but no spin and hard to package
- Backspin Flywheel
    - Original tests on 2016 robot incorrectly suggested ball spin was bad
        - But better controls and proper compression on future prototypes showed spin was good
    - Accurate, had high throughput, and easy to package
    - Most experience with this design (2012, 2014, 2016)

Laser cut prototypes

double belted shooter



SHOOTER twin backspin flywheels



- Aiming
  - Fixed hood at 14°
    - 0.5″ foam provides optimal compression
  - Laser cut, vibration-damped, delrin mount holds Nexus 5 with vision app to aim
  - Averages 15 fuel per second with 85% accuracy
- Power
  - Four 4″ Fairlane wheels
  - Four 775 Pros with 4:1 belted reduction
  - Wheel speeds: 3500 rpm
    - SRX Mag encoder

Quad 775 Pro shooter

HOPPER WALLS prototyping

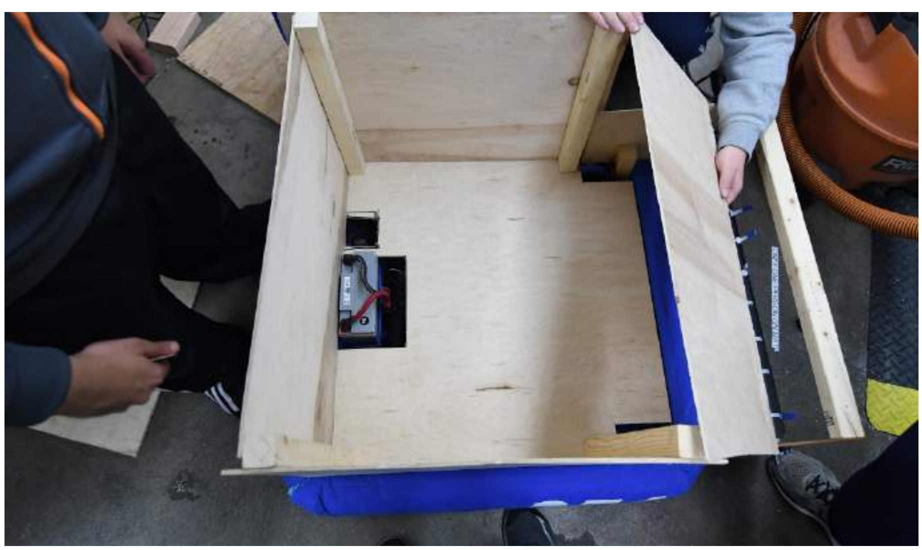
Goals

- Maximize fuel capacity
- Fuel won't get stuck while intaking or shooting
- Activate field hoppers and receive fuel from them

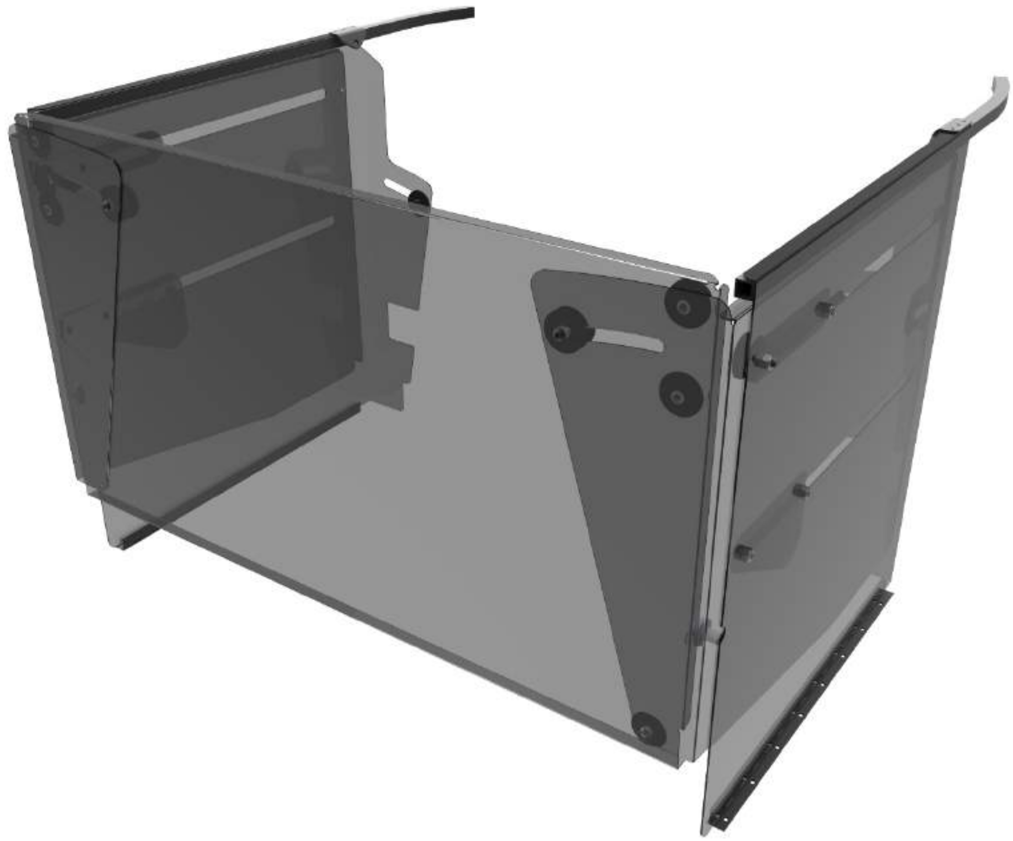
Prototyping

- Fixed box to test intake's ability to push fuel up
- Many revisions of laser cut polycarb used to prototype deployment
    - Forward expansion of ten inches to hold fuel above intake
    - Side expansions from frame perimeter to bumpers
- Funneling features in combination with hopper floor designs to facilitate fast feeding
    - Funneling now done with horizontal wedges in hopper floor rather than vertical angles in the walls

Fixed box prototype hopper



HOPPER WALLS expanding polycarb



- Expansion
    - Extendable forwards and sideways for maximum volume
    - Surgical Tubing tensioned expansion forward
    - Hinged pivots for sideways expansion
- Piston actuated expansion outward to also trigger hoppers from side
- Holds 140+ fuel

Expanding polycarb hopper

FEEDER & HOPPER FLOOR prototyping

Goals

- Fastest feeding possible
- No dead spots or jams
- Minimize complexity and motor usage

Prototyping

- Polybelt
  - Polybelt loops ferry fuel to the feeder then carry fuel up to the shooter
  - Difficult to service and high friction
- Rollers
  - Rows of surgical tubing rollers spin towards the shooter
  - Although heavy, was fast and reliable
- Zipper
  - Rollers merge fuel from four channels to two
  - Although fast, frequently jammed and was complex
- Funnels
  - Horizontal funnels guide fuel into the two vertical channels
  - Simple, uses powered hopper floor to funnel
- Top Roller Shelf
  - Adds compression and force pushing fuel into wedge

Roller floor with zip ties

FEEDER & HOPPER FLOOR rollers

- Feeder
    - Five 1” feeder rollers
    - Two 775 Pros, 3:1 belt reduction
    - Surface speed: 26 ft/s
- Hopper floor
    - Eleven floor and four top 0.875” rollers
    - Passive funnels with dividing plate
    - Two 775 Pros, 5:1 belt reduction
    - Surface speed: 14 ft/s

Rapid roller funneling

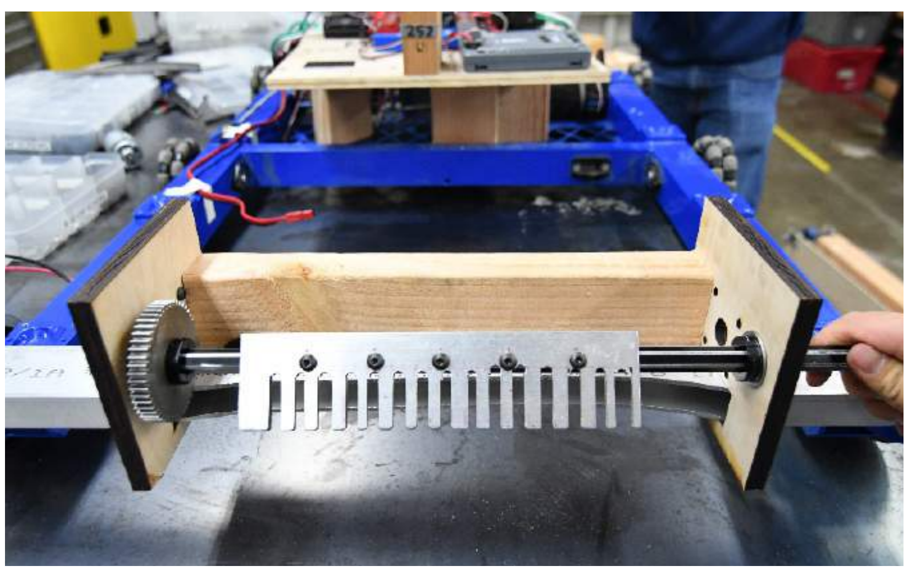
HANGER prototyping

Goals

- Low profile
- Minimize motors
- Quick to grab rope, quick to climb, won't fall

Prototyping

- Comb
    - Grabs knots, then reels in rope
    - Pros
        - Unlikely to fall once attached
    - Cons
        - More difficult to align and grab rope
        - Time-consuming to unwind after match
- Velcro
    - Velcro on hanger tube hooks onto rope with Velcro
    - Pros
        - Grabs onto rope extremely quickly
    - Cons
        - Preparing ropes is more complex



Spinning comb grabs knots in rope

HANGER velcro tube & ratchet strap

- Uses Velcro to grab rope
    - Velcro sewn near the end of ratchet strap
    - Rope has elastic and slack to ensure that strap has some wrap before the robot attempts to climb
- A one-way bearing in the pulley functions as a power-takeoff mechanism; when the shooter is driven in reverse, the hanger is engaged and spins
- Flange keeps rope centered to avoid climbing sideways
- Hanger extension helps trigger touchpad

Velcro-covered tube powered by shooter motors

GEAR GRABBER prototyping

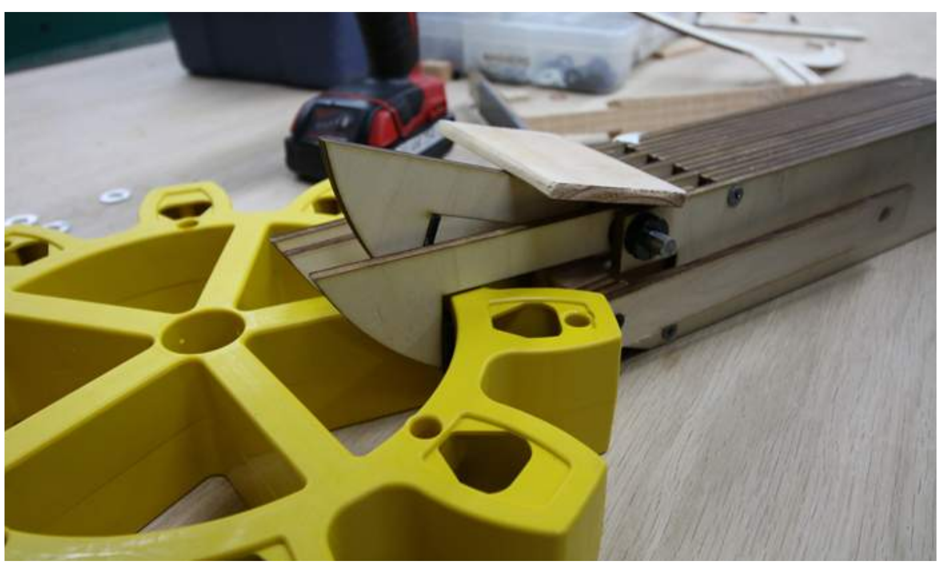
Goals

- Compact, fit into back of robot
- Pickup from floor
- Launch gear onto base of peg

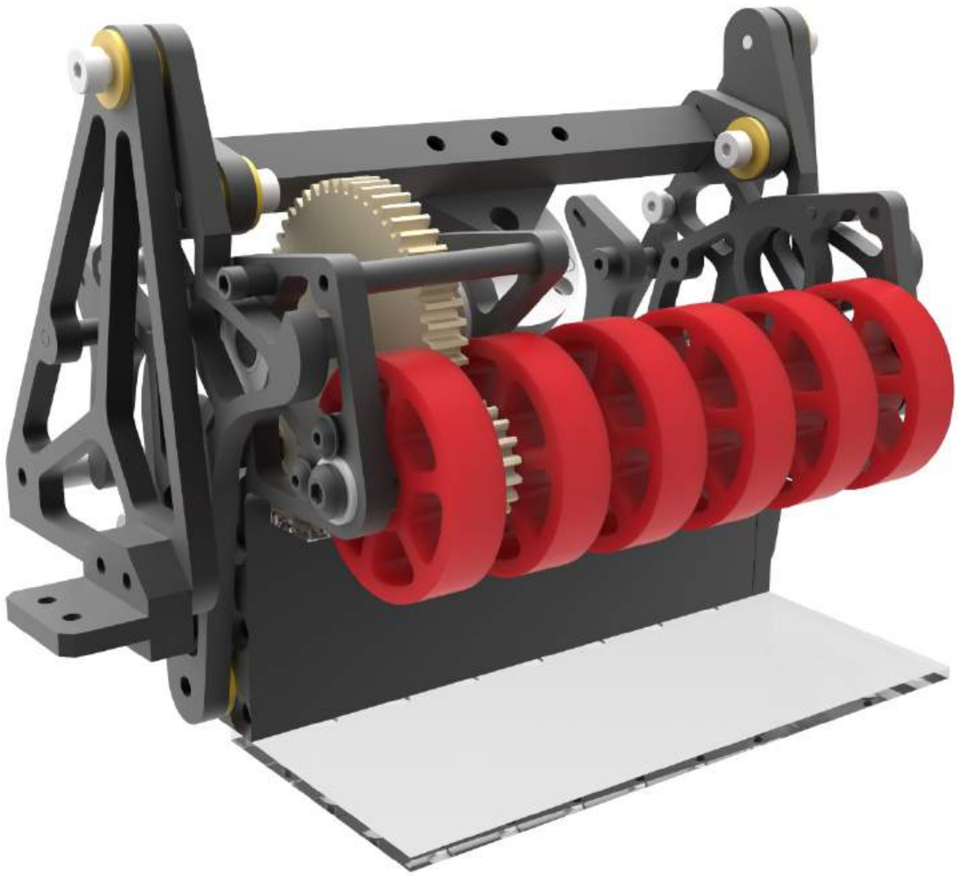
Prototyping

- Latching fingers
    - Claw and finger design hooks onto gears then a slider comes in from behind to grab onto the gear
    - Teeth are locked in position to prevent gear from flipping backwards
    - Polyurethane rubber prevent gear from slipping out
    - Multiple fingers allow grabbing gears at all angles
- Pivoting roller
    - Roller with conforming wheels and a ground scraping plate
    - Pros
        - Can grab gears at full speed, then pivot up for scoring
        - Can exhaust and pivot down to "flick" gear onto base of peg
    - Cons
        - Unable to package a wider design, requires a camera streaming to driver station to help alignment

Latching finger gear grabber



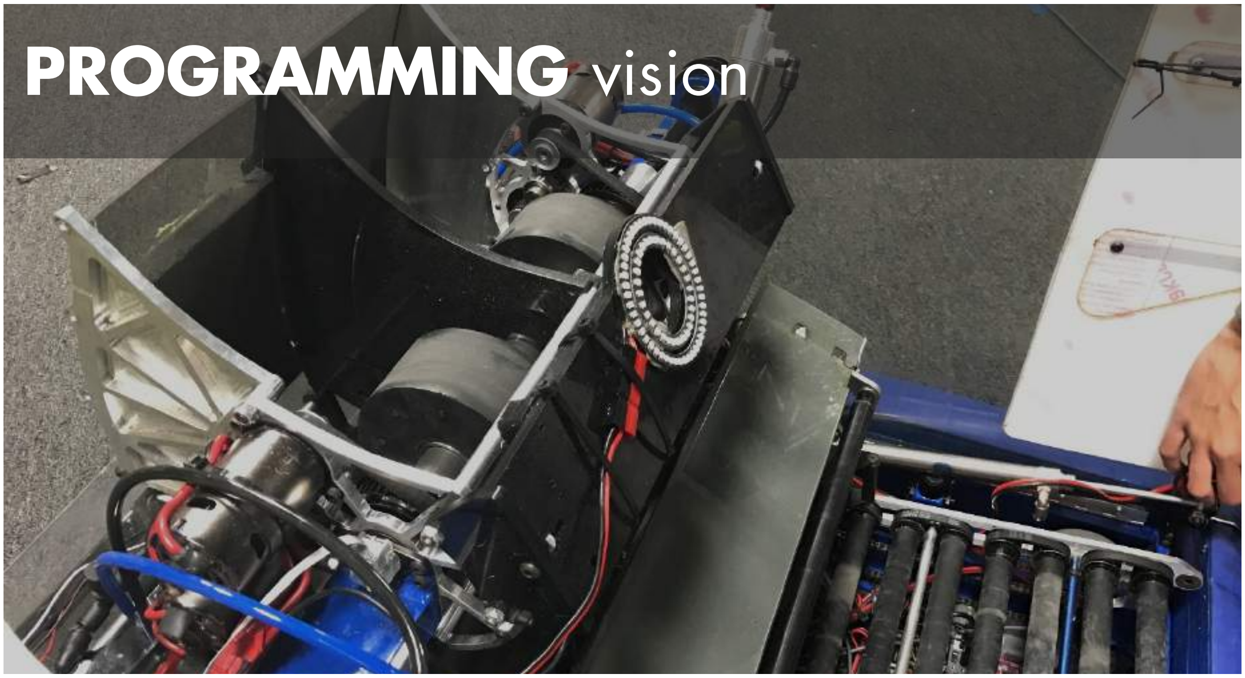
GEAR GRABBER pivoting roller



- Roller + plate
    - 2″ conforming WCP wheels on ½″ axle
    - 1/8″ polycarbonate bottom plate scrapes floor
    - Powered by a BAG motor with 2.4:1 reduction
    - Wheels always lightly powered for tight grip
- Dual pivot design
    - Pancake pneumatic cylinder pivots from a floor scraping grabber to a vertical scoring configuration
    - Second lower pivot is sprung to allow the wedge to conform to the floor without digging in
    - Exhaust and lower to flick gear onto base of peg

Pivoting roller and plate gear grabber

PROGRAMMING vision

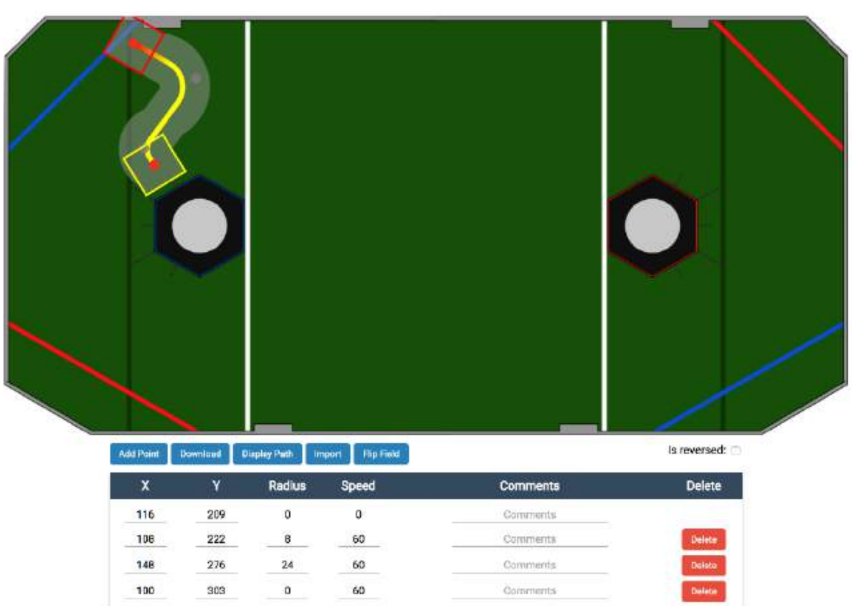


Nexus 5 Vision System

- Nexus 5 Vision System
    - Nexus 5 Android phone used to detect, track, and aim at the boiler
    - Complete vision solution: battery, camera, processor, and display are all packaged into one device
    - Runs our custom CheezDroid vision app
    - Sends the coordinates of detected targets to the RoboRIO via the Android Debug Bridge protocol over USB
    - The robot uses the output coordinates to calculate the angle and distance to boiler
        - A motion profiler smoothly turns to the desired angle within 0.75° of error
        - An Interpolating Tree Map determines the correct flywheel RPM for the current distance

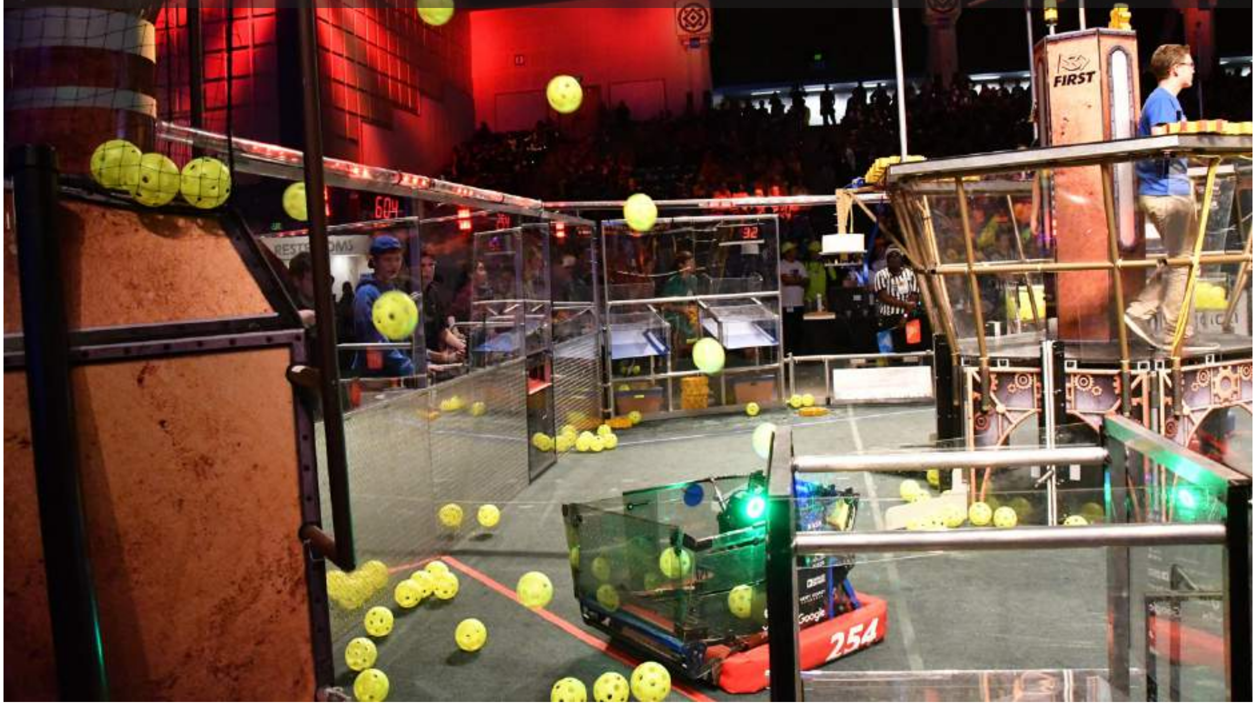
PROGRAMMING autonomous

- Autonomous Path Maker
    - A web app that provides a GUI for making autonomous paths
        - Displays preview of the path the robot will drive for visualization
    - Uses a system of waypoints connected by line segments with rounded corners for fast and simple path generation.
    - Exports Java files that can be directly loaded onto the robot
- Autonomous Navigation
    - Robot State Estimator
        - Encoders in drivetrain and gyro angle keep track of the robot's position on the field
    - Adaptive Pure Pursuit Controller
        - Steering controller that converts the waypoints output by the Path Maker into desired wheel velocities for the left and right sides of the drivetrain
    - Motion Profiler
        - Controls how fast the robot drives for smooth acceleration and to avoid jerk



Autonomous path maker

PROGRAMMING shooter controller



PID shooter control

- Shooter controller
    - Use PID to spin up to the correct RPM based on the distance from the target
    - Once RPM has stabilized around the setpoint, start gathering average kF samples
    - Once enough kF samples have been gathered, switch to pure kF control for essentially open loop shooting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