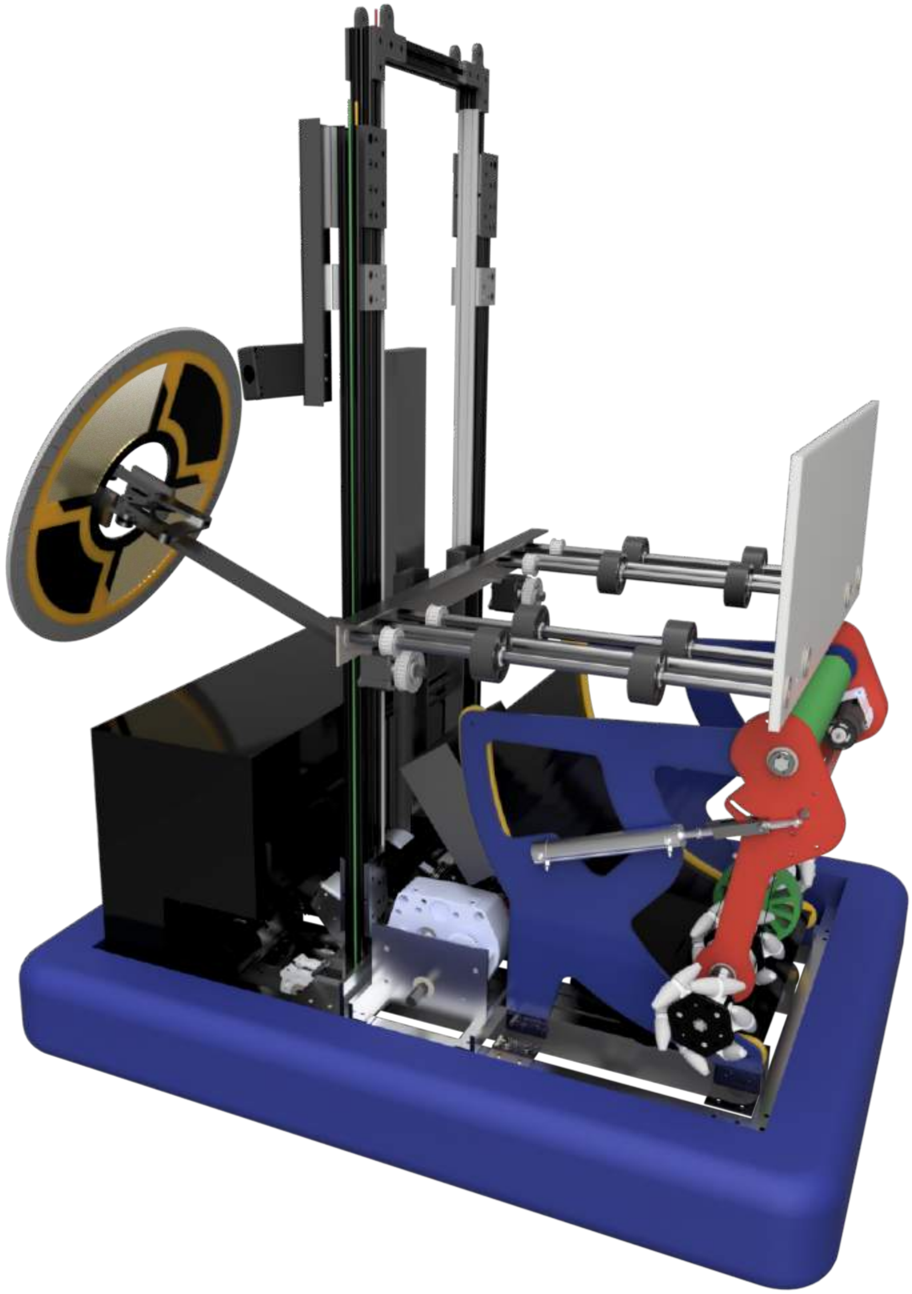

LC-417A

2019 Technical Binder

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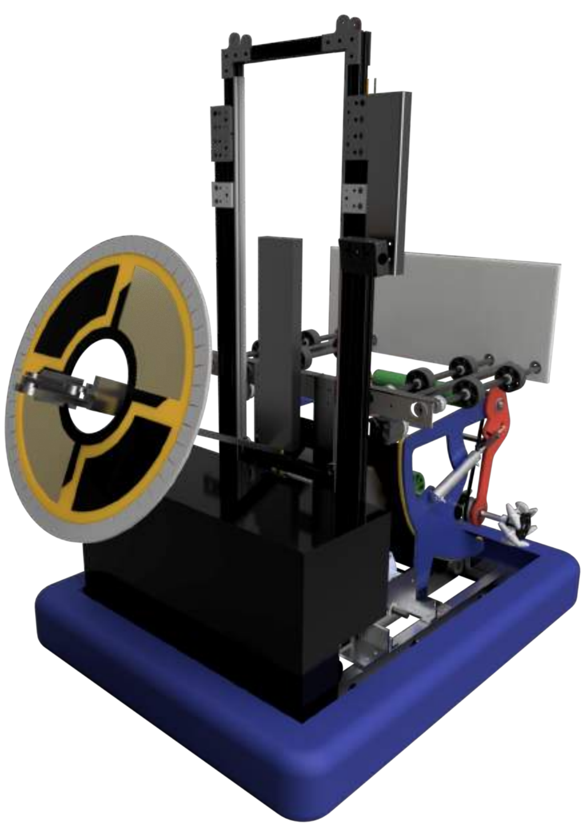
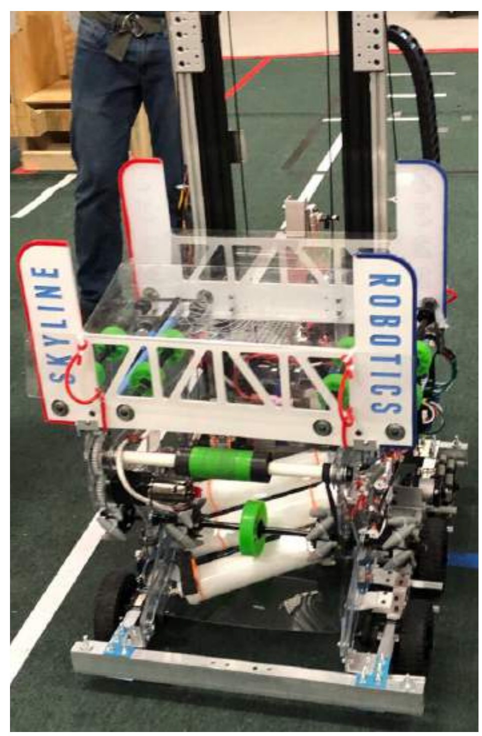
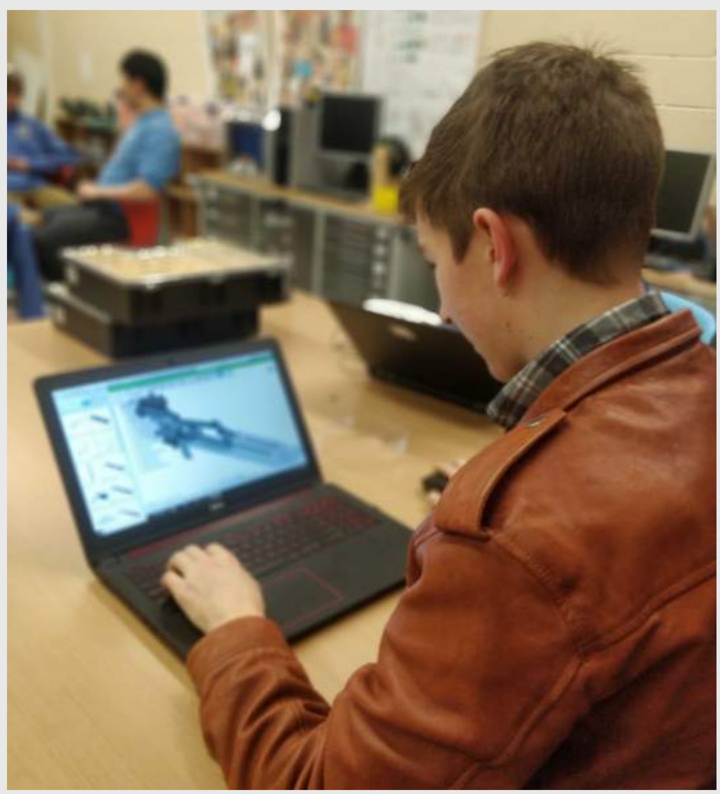




Design

- Chassis
- Hatch Manipulator
- Cargo Intake
- Sideways Outtake
- Lift
- Climber

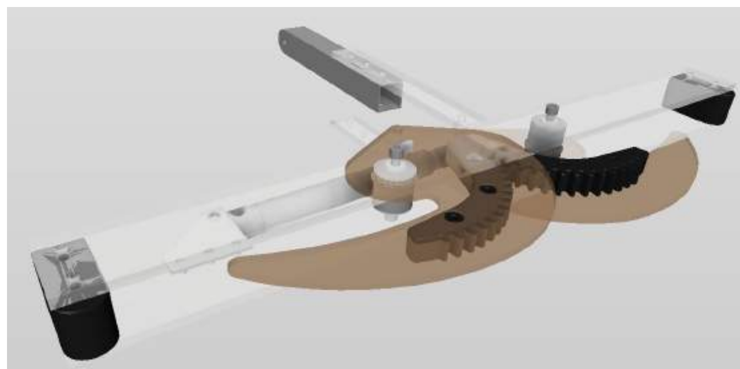


Chassis

- Design Constraints
  - Minimize weight
  - Maximize agility without sacrificing defense abilities
  - Maximize acceleration for short sprints & top speed for long sprints
- Powertrain
  - Raised VexPro Ball Shifter Gearbox
    - Two NEO Motors per gearbox
    - Main gear – 9.07:1 - 13.28ft/sec
    - Battery mount spaces gearbox
  - #35 Chain and 5mm HTD Belts
- Drivetrain
  - West Coast Style
  - 0.125” center drop
  - 4 x 6” pneumatic wheels to provide adjustable suspension
  - 2 x 6” omni wheels to improve maneuverability
  - Adjustable belt tensioning
- Bumpers
  - Two-piece set with side standoffs and corner attachments
  - Custom team-font numbers; we used our actual 3322 font to create more of a team identity

Hatch Manipulator

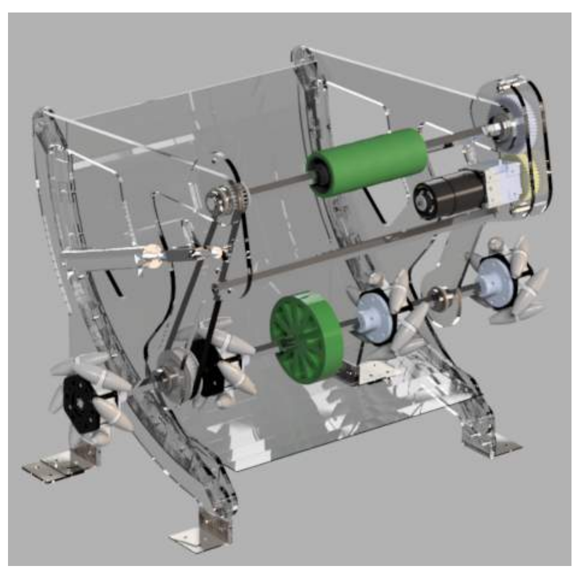
- Design Constraints
  - Use the same pneumatic actuations as the previous design
  - No dropped hatches
  - Auto align with hatch port
  - Withstand impacts with rocket and other components
- General
  - Polycarbonate construction for impact resistance
  - Geared fingers grab from the backside for secure resistance
  - Passive pivot allows for ±30° for placement
  - Finger geometry helps align the hatch on the port



- Fingers
  - When holding a hatch, the fingers form two semicircles that fit into the port to align it
  - When retracted, the fingers have a small profile to allow for more error in lineup
  - Surface of the fingers expands outwards in the hatch hole, aligning the hatch vertically and horizontally
- Actuations
  - Two 4” pneumatic pistons actuate system
  - 3DOF : One piston vertically actuates the assembly to fit inside the frame; One piston actuates the two fingers; Surgical tubing passively aligns the hatch parallel to the robot frame
  - 3D printed gears link the position of the fingers

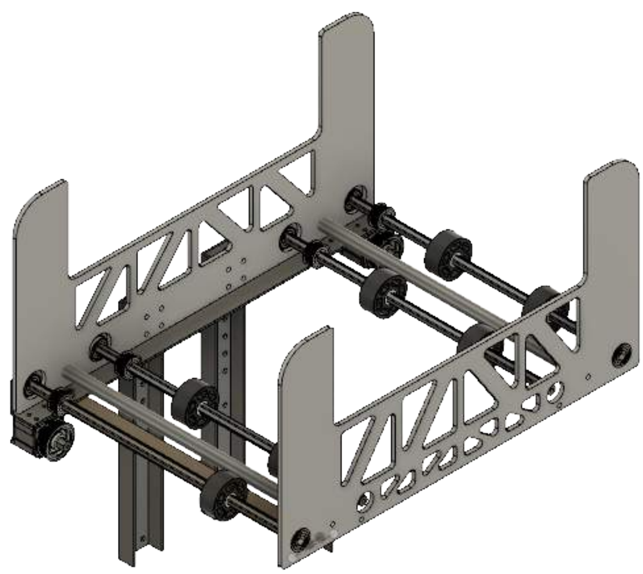
Cargo Intake

- Design Constraints
  - Never grab more than one cargo
  - Rapidly center a cargo
  - Come back into the frame perimeter during a match
  - Able to intake while moving
  - Pass off cargo to outtake
- Rollers
  - Consistent surface speed across 4” OD and 2” OD rollers (~40ft/sec max)
  - Mecanum Wheels to center cargo into ramp
  - One 775 Pro with 3:1 reduction
- Pneumatic Actuation
  - Two pneumatic pistons extend and store the front roller
  - Custom curved slot and surgical tubing allows for the front roller to pivot independent from pneumatics
- Ramp/General Structure
  - Mostly polycarbonate construction for impact resistance
  - Ramp passes cargo up to outtake for scoring
  - Back of ramp acts as pneumatics board



Sideways Outtake

- Design Constraints
  - Must outtake from the side
    - Strategy team ran human simulations and estimated we would have 20% faster cycles with a sideways outtake
  - Must outtake in 0.5 seconds
- Driving System
  - 775 redline motor
  - gearbox
  - three-pulley system
- Materials
  - 1/2” ThunderHex shaft & shaft collars
  - 2.25” compliant wheels
  - bearings
  - 1/16” and 1/4” polycarbonate
  - Aluminum L-channels
  - 1/2” churro



- Cool features
  - The outtake needed to accept a cargo from the intake; however, if the entering space was large enough for a cargo to pass through, the cargo would become stuck in the middle and not be able to be passed to the sides
    - Solution: 1/16” polycarb roof connected to the walls by surgical tubing exerts optimal compression onto the cargo to allow it to pass to the sides

Lift

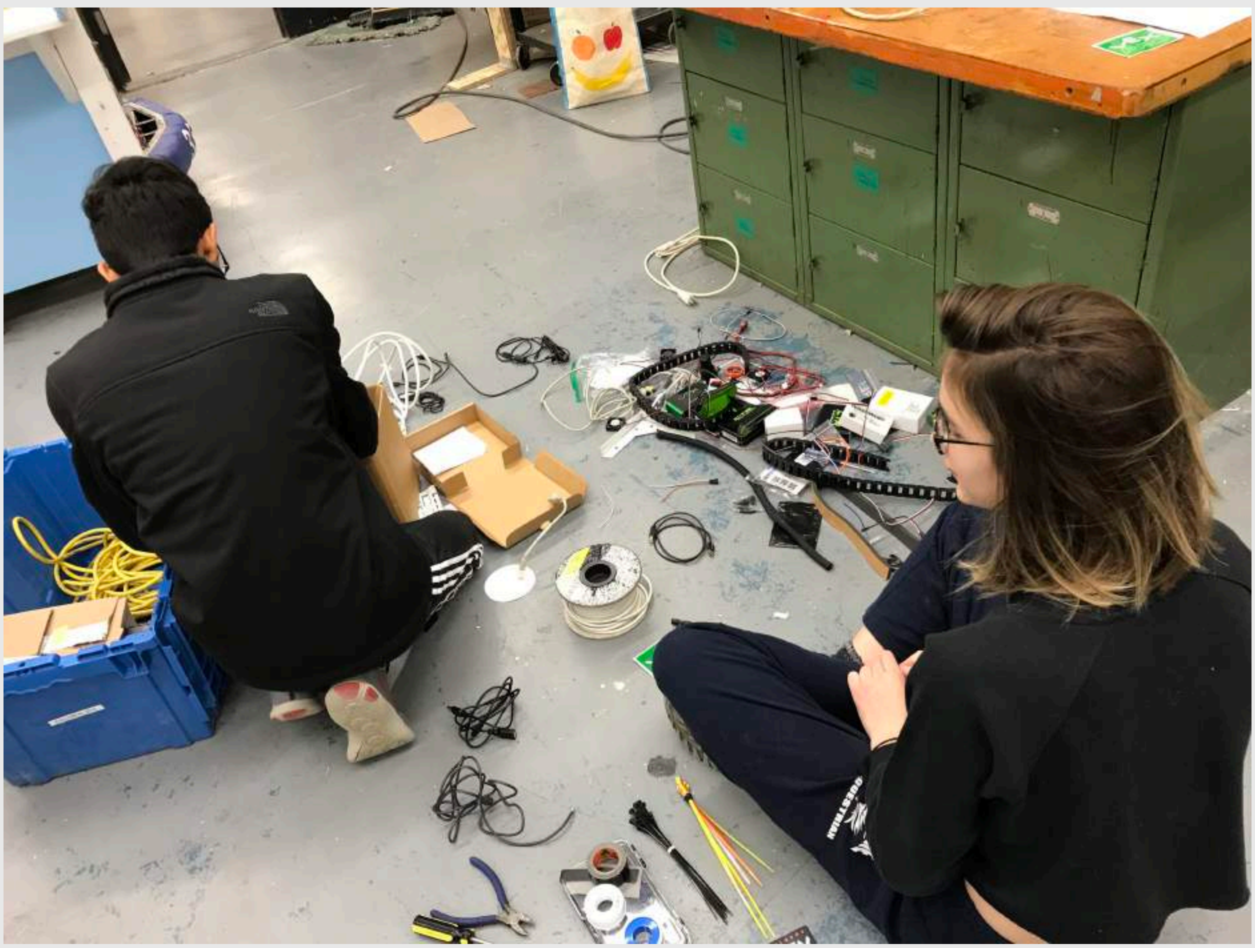
- Design Requirements
  - Must be able to reach maximum robot height in well under 1 second
  - Structurally stable
  - Consistent carriage movement
- Features and Abilities
  - Frame assembled with 80-20 aluminum extrusion
  - Two Neos on a 9.171:1 Gearbox
  - Tensioned kevlar-nylon 1/8” cable
  - Dual winch drive system
  - Linear speed of 38in/sec under 65lbs of load
    - Full travel achieved in 0.6 seconds
  - Encoded setpoints for automatic travel
  - Limit switch for resetting encoder error

Climber

- Design Constraints
  - Added to robot between week 3 and week 6 competitions
  - Under 15lbs
  - Must not interfere with existing systems
  - BOM cost under $250
  - Be installable in under 2hrs
- Weight control
  - Extreme lightening holes in all metal components
  - Plastic bushings instead of bearings
  - Driven by a single motor
  - Rope instead of chain
- Overall Design
  - Four bar mechanism
  - Driven by one NEO motor
  - Gear ratio 1750:1 at beginning of climb, 850:1 at end of climb
  - Uses a cam pulley to have the most torque at the start
  - Two pneumatic pistons massively reduce torque needed

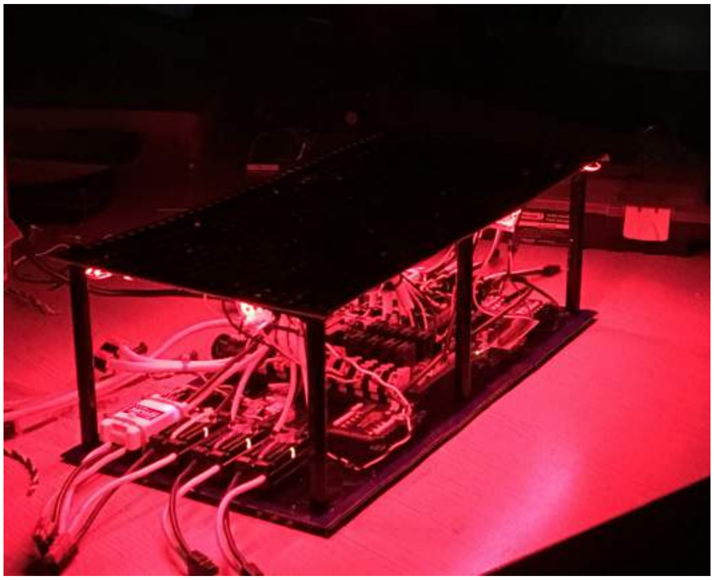
Electrical

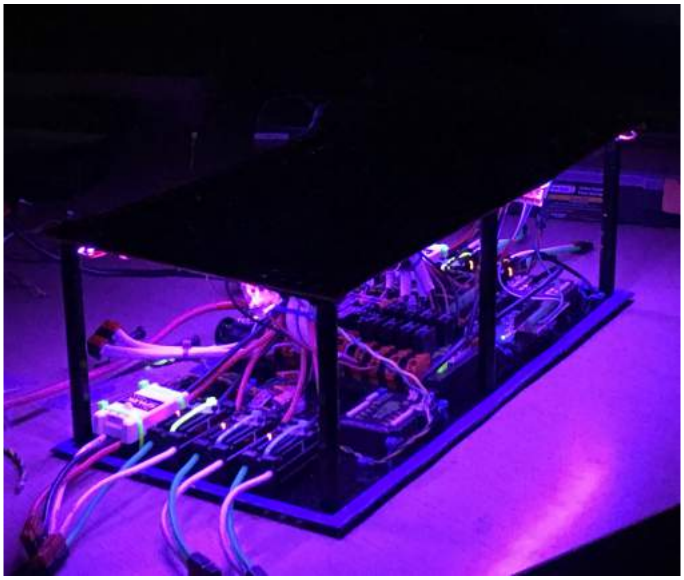
- Electrical Board
- LEDs
- Fans



Electrical

- Electrical Board
  - Two layers (called taco)
  - Color coordinated zip-ties
  - Outlined in red and blue tape
- LEDs
  - Change colors against black colored electrical board
- Fans
  - Small square fans to cool down





Programming

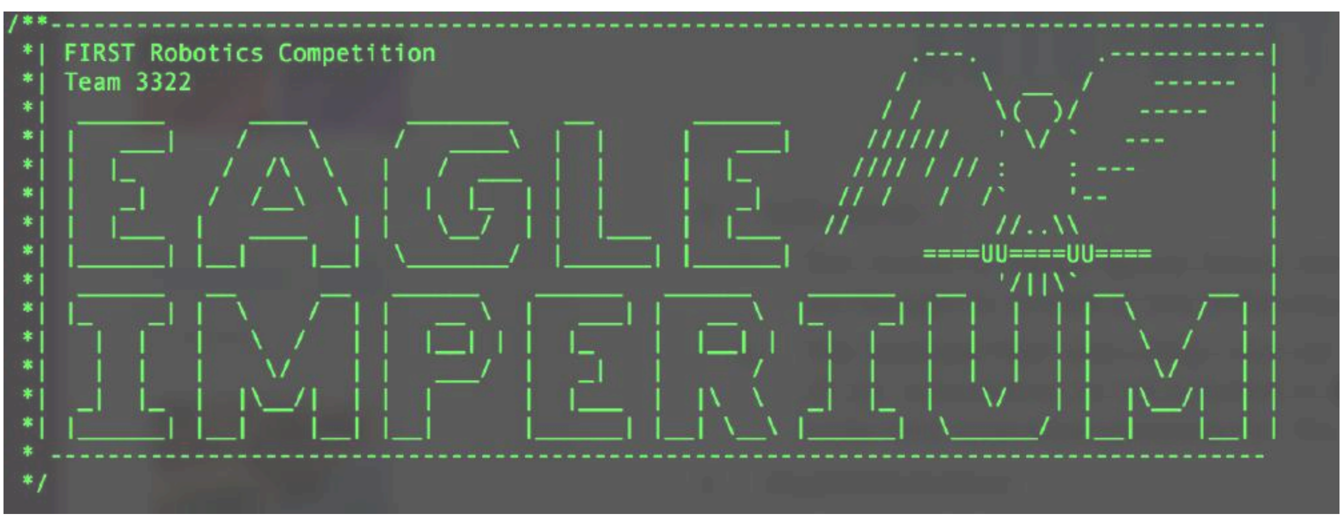
- PID
- Auto-Outtake

PID

- Two different PID Controllers on the drive train to control different modes of driving
  - Drive straight PID
    - To accommodate for potential weight differences and mechanical issues, we created a PID that adjusts the speed of each set of drive wheels
    - Code actively checks if there is turning input from the controller; if none, it will activate drive straight PID
    - Helps create a more consistent driving experience
  - Limelight PID
    - To assist with aligning with hatch placement, we used the limelight vision system to calculate the angle to the target; it then feed into the PID which helps drive to the robot into range
    - While the driver holds down a button, the PID controller receives information from the driver about speed; the PID controls each set of wheels to turn smoothly into the target
    - Helps reduce cycle time and efficiency
- Elevator PID
  - We used buttons to create setpoints for the PID to have the elevator got to each level of the rocket and cargo ship automatically

Auto-Outtake

- Influences
  - The reveal of Deep Space shows white lines on the ground, so we thought to create a line-following feature on the robot
  - We realized that auto-align was not optimal given the designs of our subsystems, so we created a drive-by feature to reduce cycle time and ease precision for the driver
- Implementation
  - We attached two infrared sensors to the bottom of the chassis on both sides which detect the white line as the robot drives over it
  - Originally, we planned on having the ball automatically outtake to the side the infrared detected; however, for more consistent results, we chose to stop the robot and have the driver's controller vibrate on the side that was detected



EAGLE IMPERIUM

Thank you mentors!