2019

TECH HANDBOOK

NUTRONS 125

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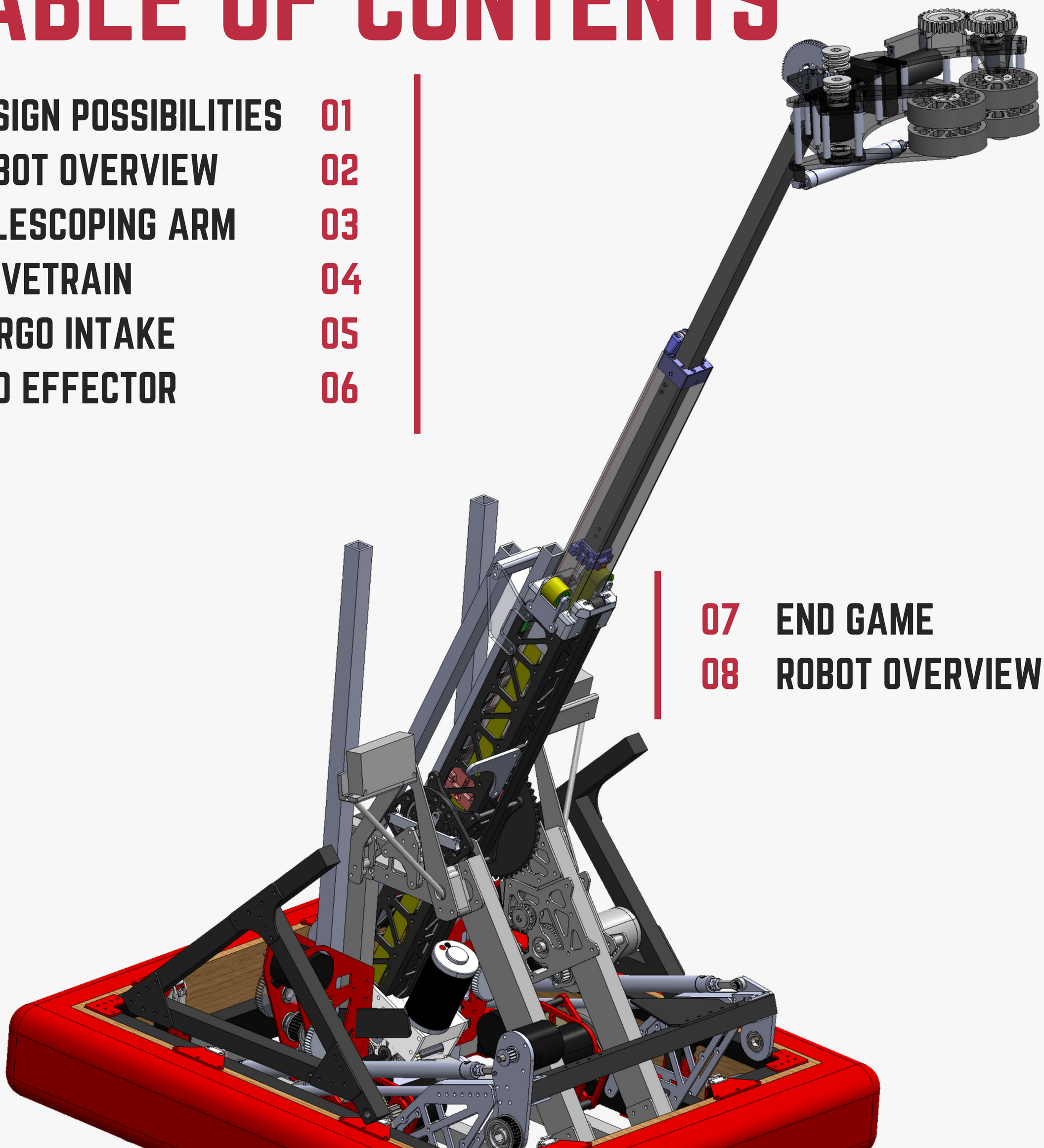


DESIGN POSSIBILITIES

NEED

- Drive
- Climb off HAB level 1
- Pickup cargo
- Pickup hatch panel
- Score on cargo ship
- Score cargo on rocket
- Place hatch on rocket
- Pickup and score cargo and hatch from different sides
- Scoring during sandstorm
- Climb onto HAB level 3

WANT

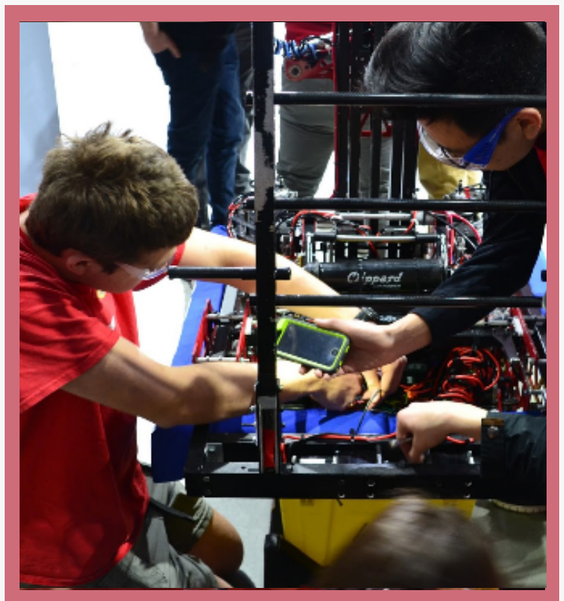
- Defend within frame perimeter
- Pick up hatch panel and cargo from floor

NICE TO HAVE

- Climb off HAB level 2
- Load hatch panel from different sides of the robot
- Launch cargo
- Assist HAB climb for other robots (level 2 or 3)
- Side by side scoring with another robot
- Score hatch panel and cargo over Defender
- Direct cargo to a specific side

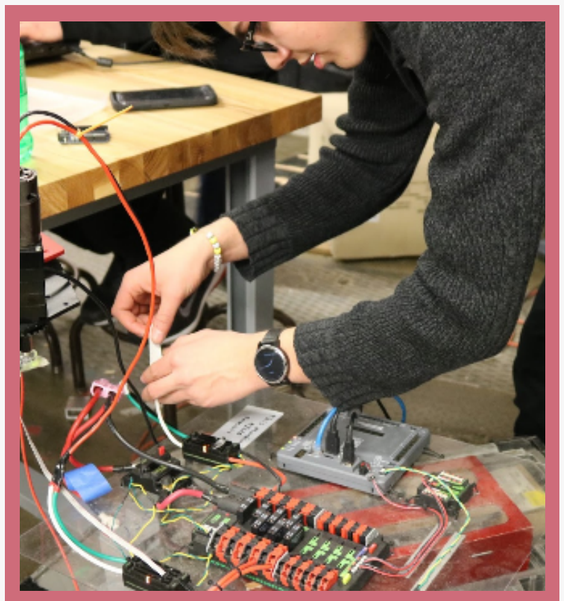
ASSIGNED SUBGROUPS

Our work was divided into:



MECHANICAL

- Drivetrain
- Hatch panel
- Telescoping arm
- Cargo intake
- A-Frame
- Climber



ELECTRICAL

- Wiring
- Pneumatics

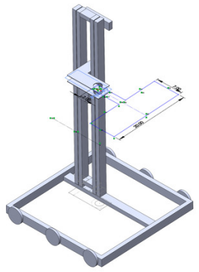
PROGRAMMING

- Robot
  - Vision
  - Drivetrain
  - Superstructure
  - Autonomous
- Scouting
  - Scoutmaster

NONTECH

- Awards Team
- Media
- Marketing/Design

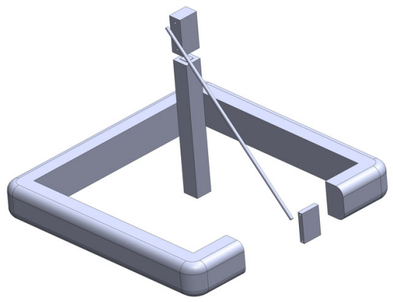
ROBOT ARCHETYPES



ROTATE ARM ELEVATOR

PRO
- Light
- Low goal cycles
- Decent ease and risk

CON
- Moves slowly
- Low end game height
- Not sturdy



TURRET FOUR BAR

PRO
- Score on all sides
- Large extension height.

CON
- Mechanical complexity
- Hard to wire
- Higher cost of materials

TELESCOPING ARM

PRO
- 200 degree rotation
- Score on two sides
- Extends to all levels of rocket
- Low cost of materials

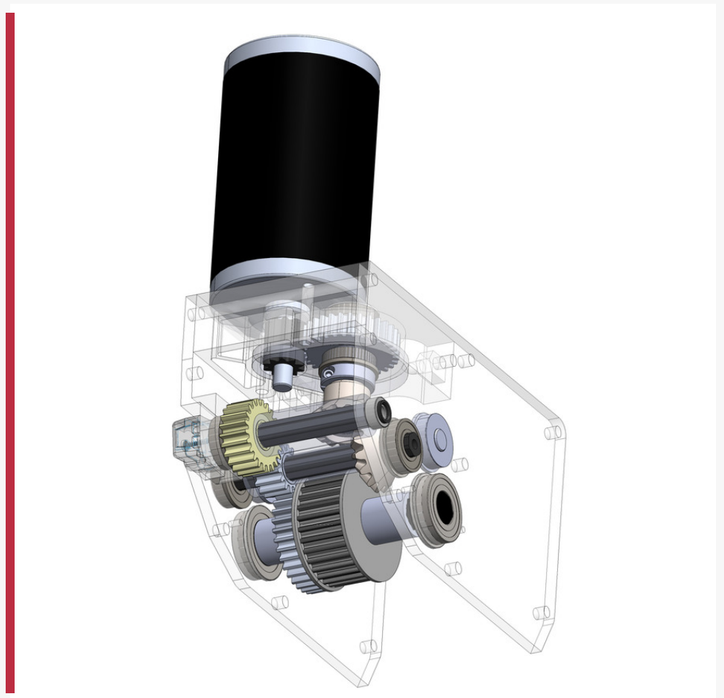
CON
- High control difficulty

DESIGN CONSTRAINTS
- Score High on Rocket
- Small and Light
- Tubing Selection: 1x1x1/16 + 2x2x1/16+ 3x3x1/8
- Cascade Arm System: 20mm belt + string (on different sides of arm)
- Low Drive Pulley to maximize elevator travel
- String Tensioner → ratchets for tension on each strand of string

TELESCOPING ARM

WRIST

- Be able to reach all desired angels for scoring
- Travel 180 degrees in under .5 seconds
- Powered by a BAG motor



TELESCOPING GEARBOX

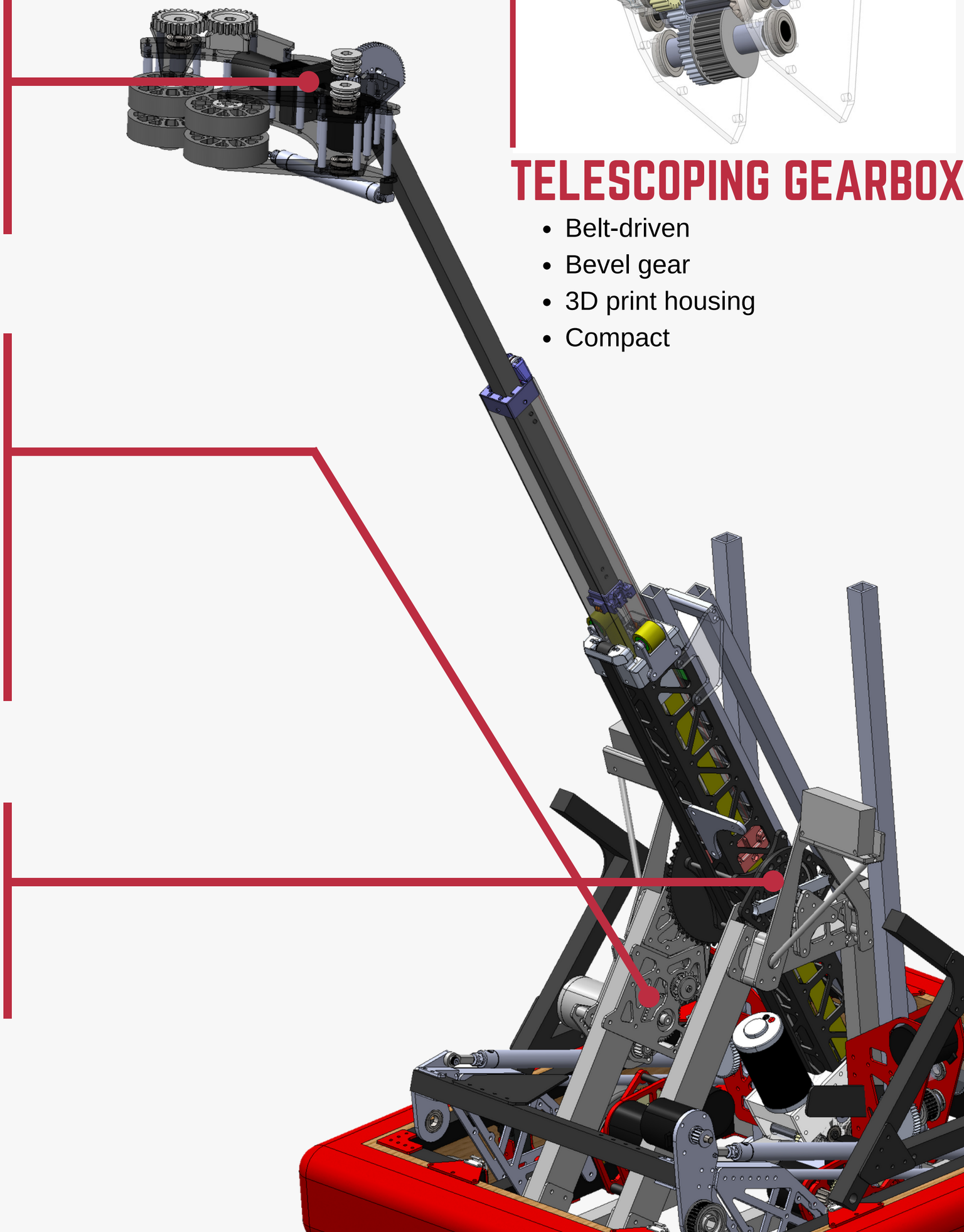
- Belt-driven
- Bevel gear
- 3D print housing
- Compact

ARM ROTATION GEARBOX

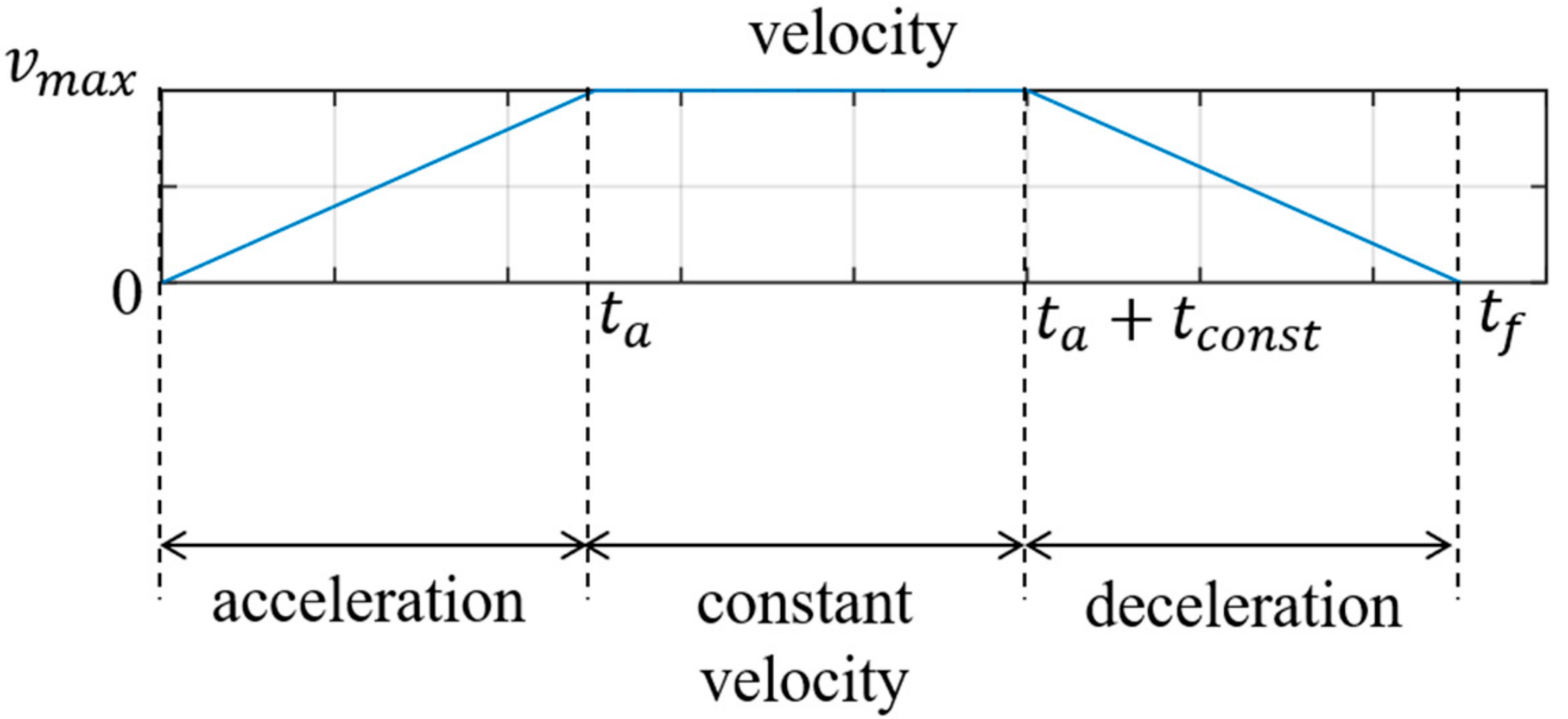
- Compact
- 100:1 Gear ratio
- Rotate the arm 180° in a second or less
- Gearbox must resist the motion of enough so that maintaining its position is much simpler than adding a brake system of sorts

A-FRAME

- Support the arm
- Clear space for cargo intake
- Mounts the climber



TELESCOPING ARM CONTROL



STATE MACHINE

- The pivot, arm extension, and wrist all use motion profiles to move between desired setpoints, and PID controllers to hold at those setpoints
- State transitions are handled automatically based on sensor and subsystem feedback
- Button inputs provide destination configurations (i.e., pivot angle, wrist angle, arm position)
- Positions to reach over defense and score

MOTION PROFILING

- Perform efficient movements between positions
- Closed loop control on velocity for pivot and arm

HOLDING POSITION

- PID loop to resist gravity and hold arm in desired position

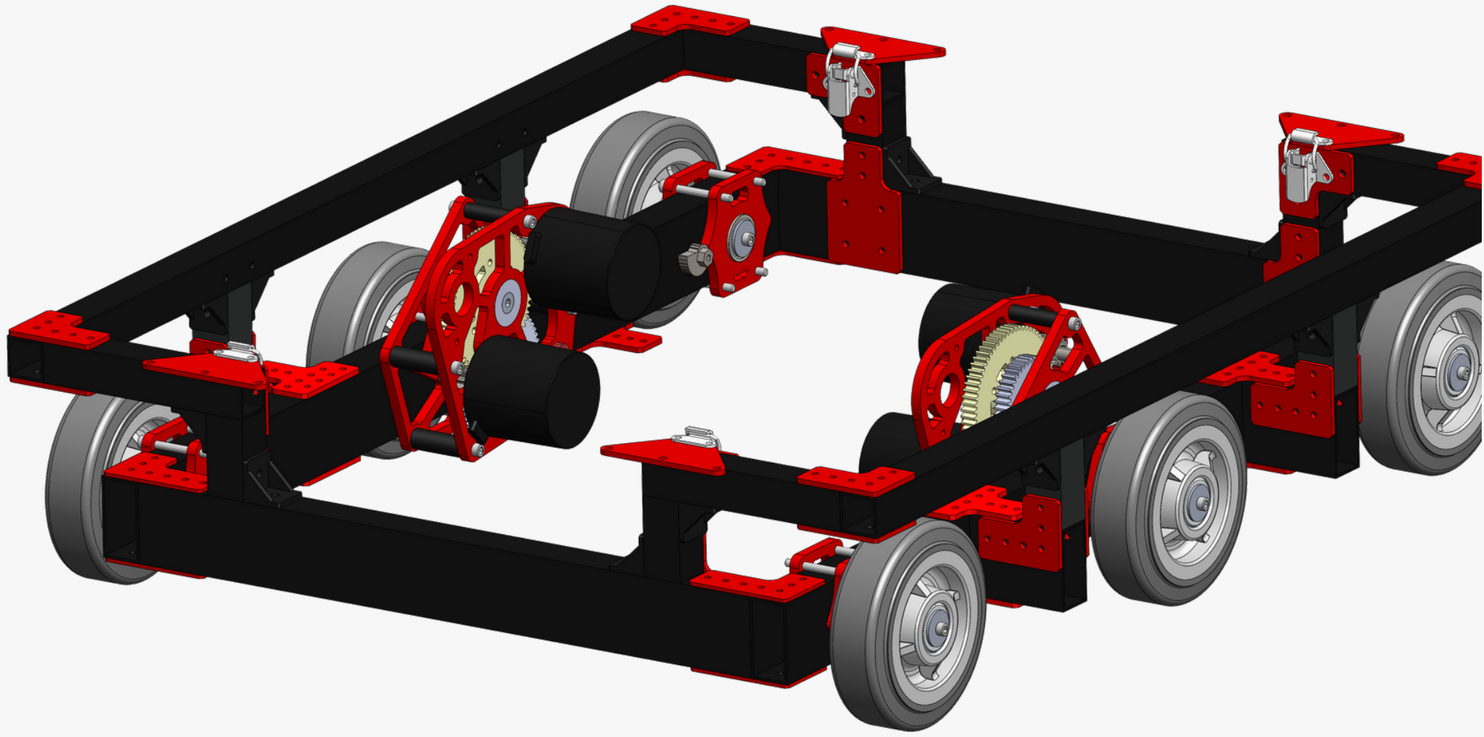
CARGO INTAKE

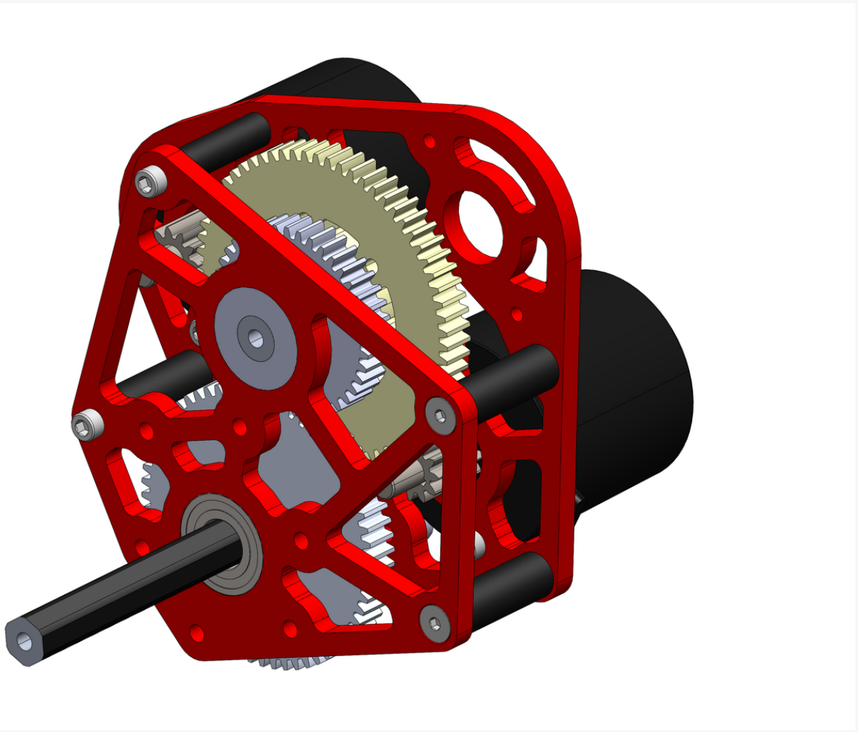
- State machine has collision detection to ensure cargo intake movement is coordinated with arm

DRIVE TRAIN

WEST COAST DRIVE

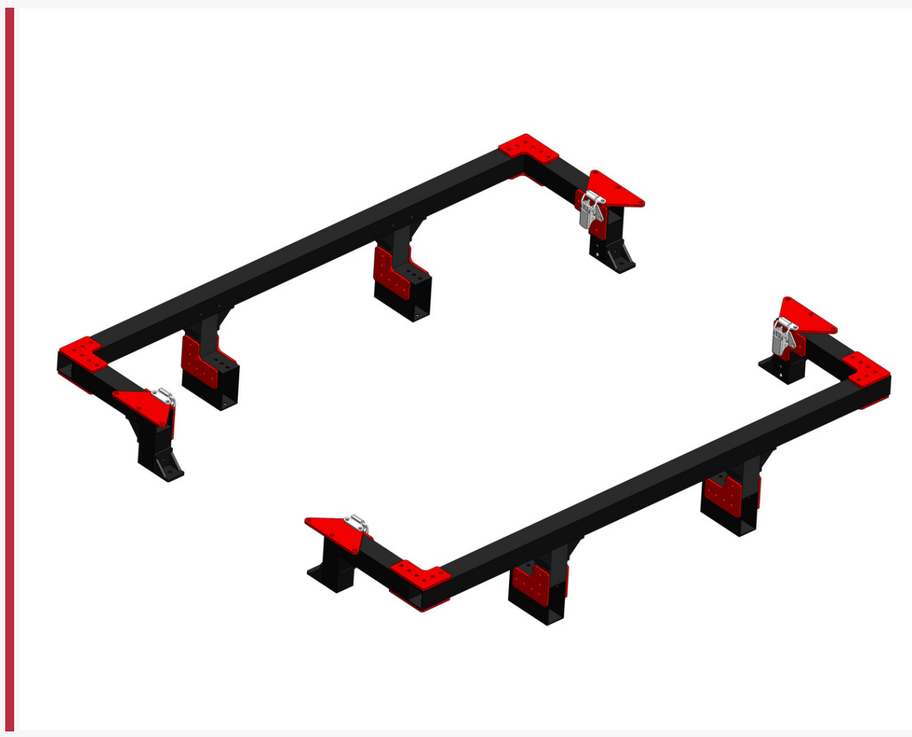
- Arcade drive style
- Familiar drivebase that is conducive to quick cycles
- Small Drivebase: 24.125” by 28” frame perimeter
- Six 5” diameter Colson traction wheels
- Has continuous vision alignment that can be toggled on and off
- Chain in Box Beam
  - Creates more room for the other subsystem
  - Driven with center wheel with a double sprocket to lessen stress when changing direction





DRIVETRAIN GEARBOX

- 2 Neo Motors
  - 9:1 ratio
  - Free speed: 13.8 ft/sec
  - Adjusted speed: 12.4 ft/sec
- Neos replaceable with MiniCims



BUMPER HALO

- Satisfies bumper rules by supporting bumpers all the way around the robot
- Latches to quickly attach bumpers

AUTO ALIGNMENT

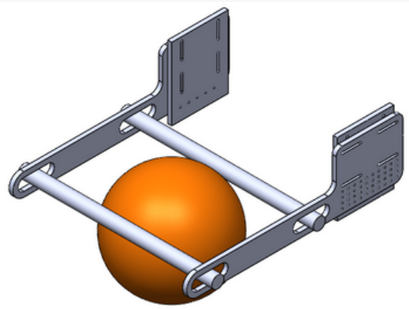
VISION

- Two limelights for doing vision alignment on both sides of the robot
- Switch which one is active based on which side of the robot the arm is going to
- Continuous vision alignment done using a PID controller on the drivetrain based on the angle offset of the vision targets
- Simple USB port for USB webcams to easily stream video to driver station
- Limelights used to indicate to the drivers when a game piece has been acquired

ASSISTED DRIVING

- If "drive-assisted" button is pressed, use PID loop to adjust drivetrain angle to target
- Used to align to rocket, cargo ship, and human player stations
- Speed reduced as we approach target

CARGO INTAKE PROTOTYPING



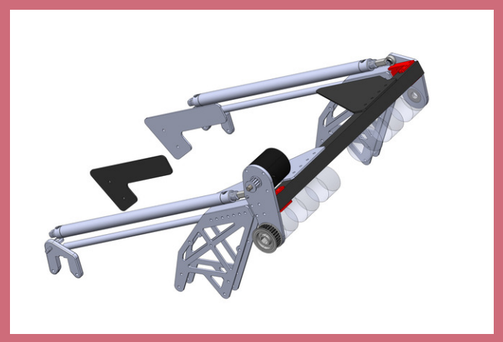
DUAL ROLLERS W/ MECANUM AND OMNI

PRO

- Provides more surface area when intaking
- Sturdy

CON

- Ball not held in place
- Launched after intake
- No stopping point for the ball
- Couldn't hand off ball to end effector



SINGLE ROLLER W/ OMNIWHEELS

PRO

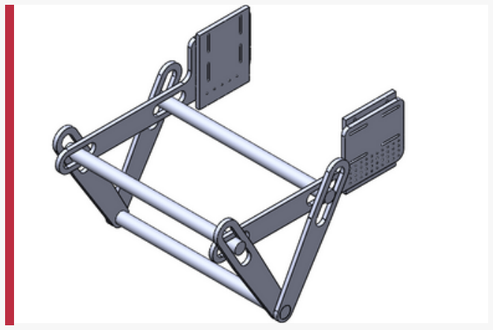
- Shaft and piston system
- Sturdy
- Good coverage
- Fed into arm

CON

- Facing the ball and hatch panel
- Catch the ball and hatch panel

DESIGN CONSTRAINTS

- Has to retract within bumper perimeter
- Not be hit by telescoping arm
- Handoff with end effector
- Has to quickly pick up the ball
- Pick up ball and hatch panel from depo
- Pick up ball and hatch panel anywhere from the field



TRIPLE ROLLERS W/ MECANUM AND OMNI

PRO

- Faster intake
- Sturdy

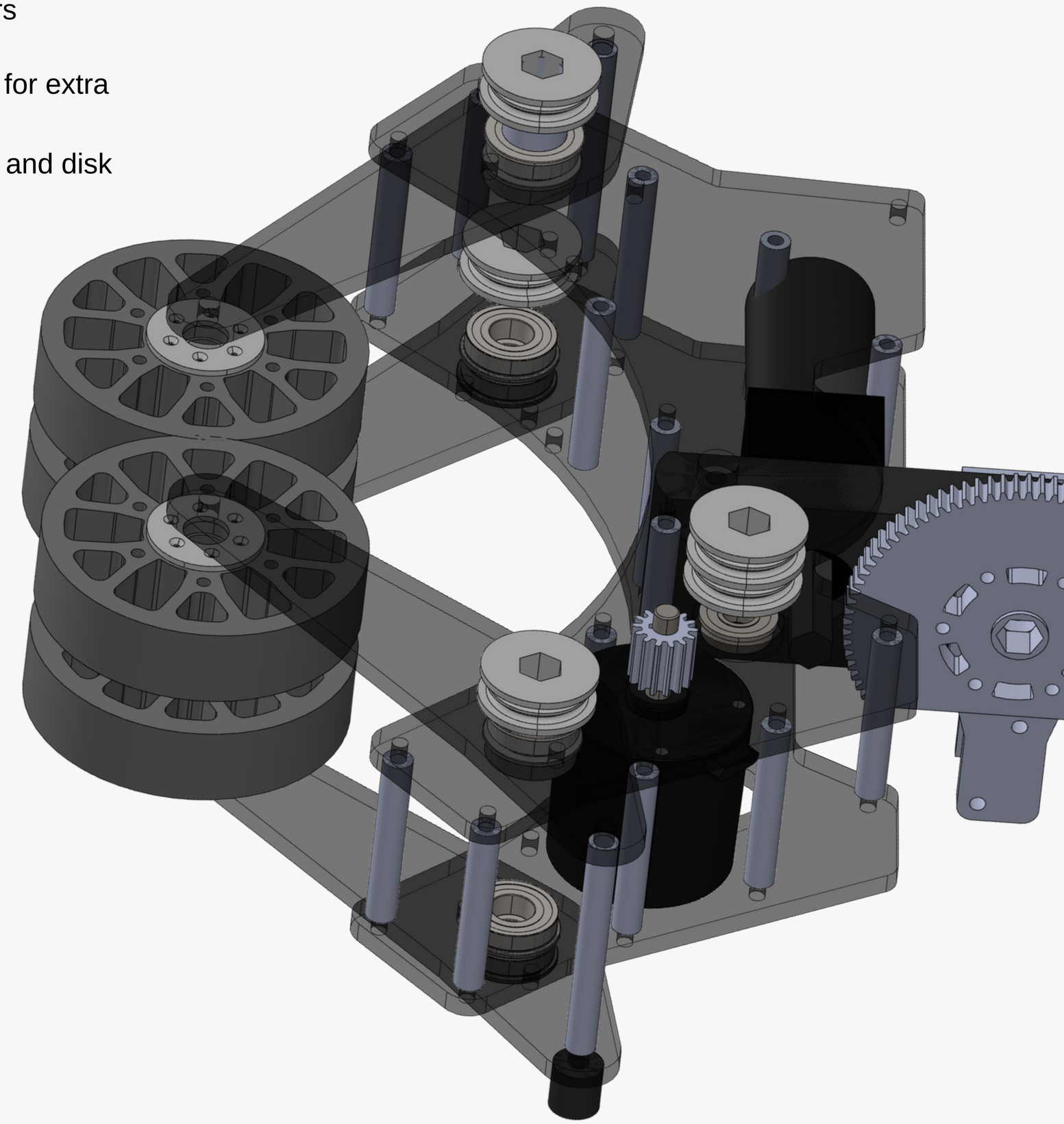
CON

- Shaky when intaking
- Different wheels caused inconsistency

END EFFECTOR

FEATURES

- Pulley driven, using chain and HTD belting
  - Allows system to minimize required motors
  - One NEO powers intake wheels
- Entire assembly can rotate forward and back for extra compliance
- Uses the same wheels to manipulate the ball and disk
- Wheels actuate in for disk, and out for balls
- Bag motor + VP gearbox to rotate wrist



DESIGN CONSTRAINTS

- Acquire and score both hatch and cargo
- Low current draw
- As light as possible
- Large angular compliance when scoring game pieces

CONTROL

- Current sensing to detect when game piece is acquired
- Based on desired game piece, actuate the pneumatics to open and close the wrist
- Position set points change whether or not cargo or hatch panel is detected to correspond with placement on the rocket

END GAME

DESIGN CONSTRAINTS

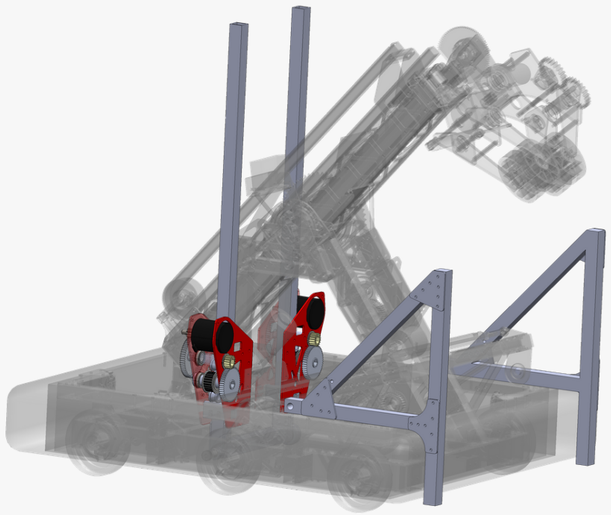
- Climb to third level of HAB in 15s or less
- Not take up space that any other subsystem needs
- Use Neo motors, to maximise system efficiency

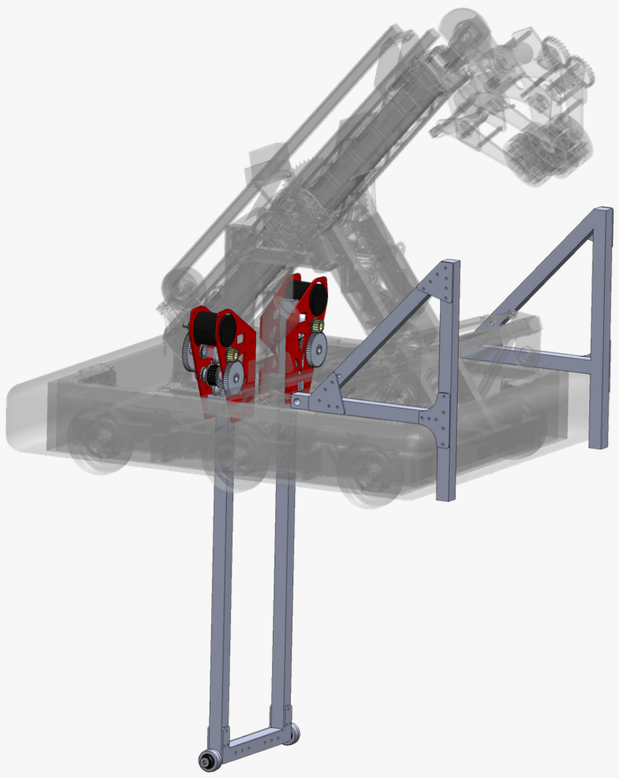
FEATURES

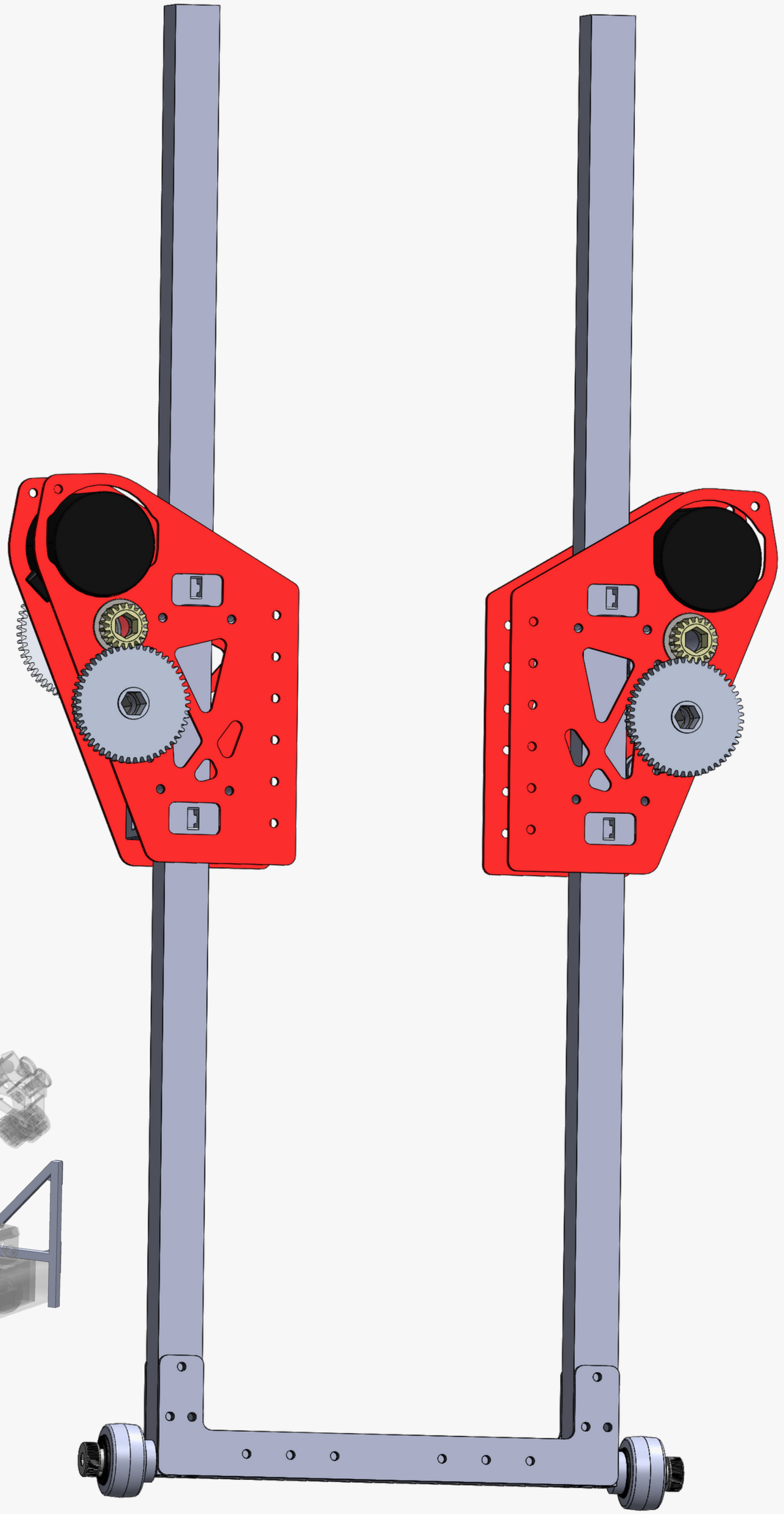
- Wheels on 1-way bearings prevent robot from slipping backward while allowing the robot to drive onto the platform
- Triangles are released by pneumatics to stabilize robot when climbing
- Latches ensure triangles stay put when climbing
- Robot falls forward after the triangles clear HAB Level 3 and drives onto the platform

CONTROL

- Using hall effect as a limit switch to know when the climber is at position
- Using ramping to decrease motor strain
- Using current sensing to know when the climber has been fully retracted







ROBOT OVERVIEW

END EFFECTOR

- Pulley driven, using chains and HTD belting
- Can rotate left and right
- Wheels actuate in for disk, and out for balls
- Rotating wrist

DRIVE TRAIN

- Familiar drivebase that is conducive for quick cycles
- Small Drivebase: 24.125” by 28” frame perimeter
- Six 5” diameter Colson traction wheels
- Chain in Tube

LIMELIGHT

- Vision camera for locking onto rocket

END GAME

- Climb to third level of HAB in 15s or less
- Not take up space that any other subsystem needs
- Use Neo motors, to maximise system efficiency

TELESCOPING ARM

- Score high on rocket
- Cascade arm system: 20mm belt + string
- Low-drive pulley to maximize elevator travel

CARGO INTAKE

- Dual rollers with Mecanum and Omniwheels
- More surface area touching the ball
- Intakes the ball

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