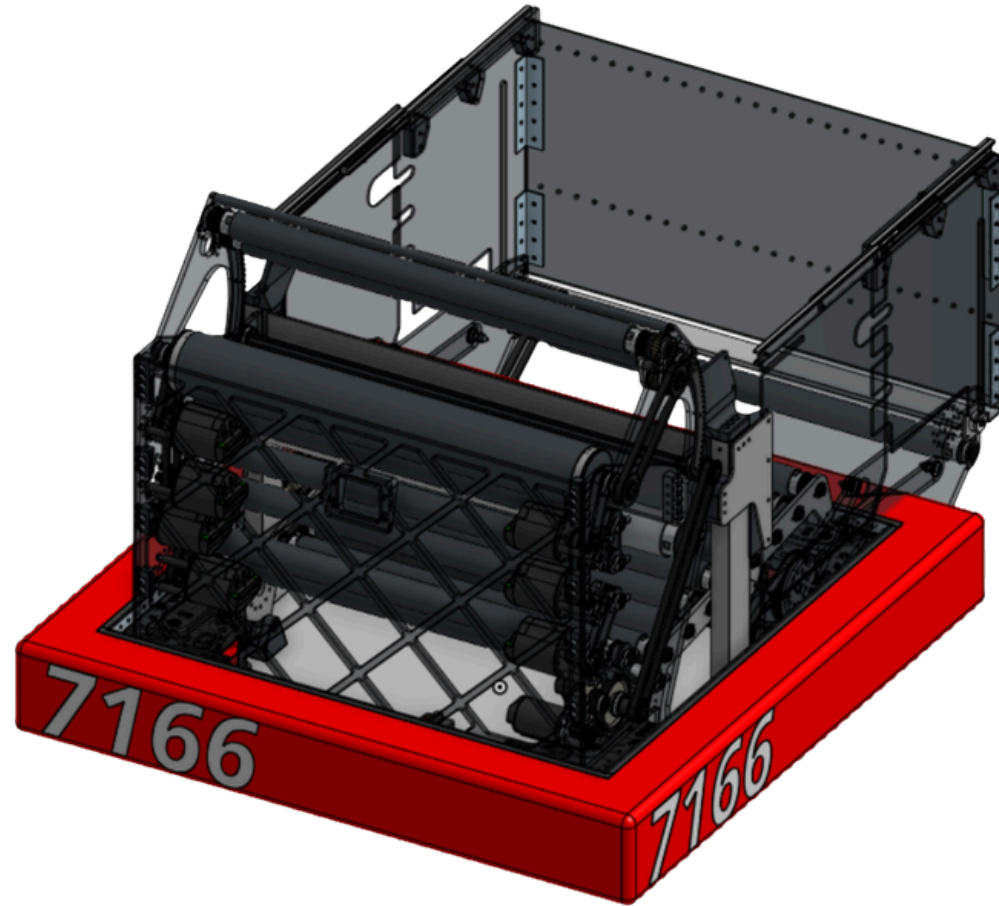


Robot Design Process

Red Thunder



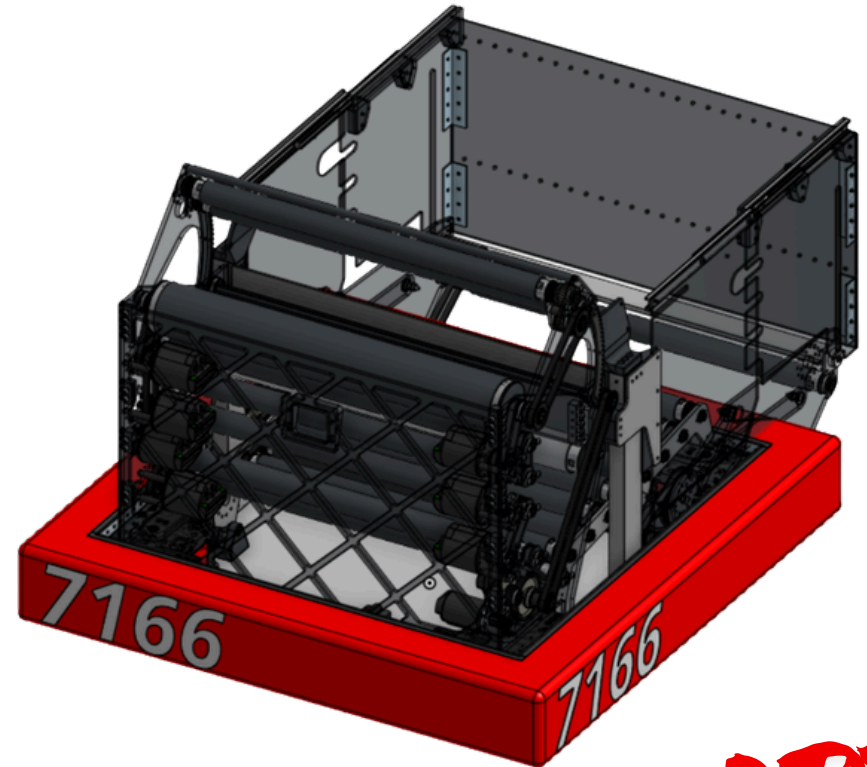
REBUILT™

PRESENTED BY **HAAS**
Gene Haas Foundation



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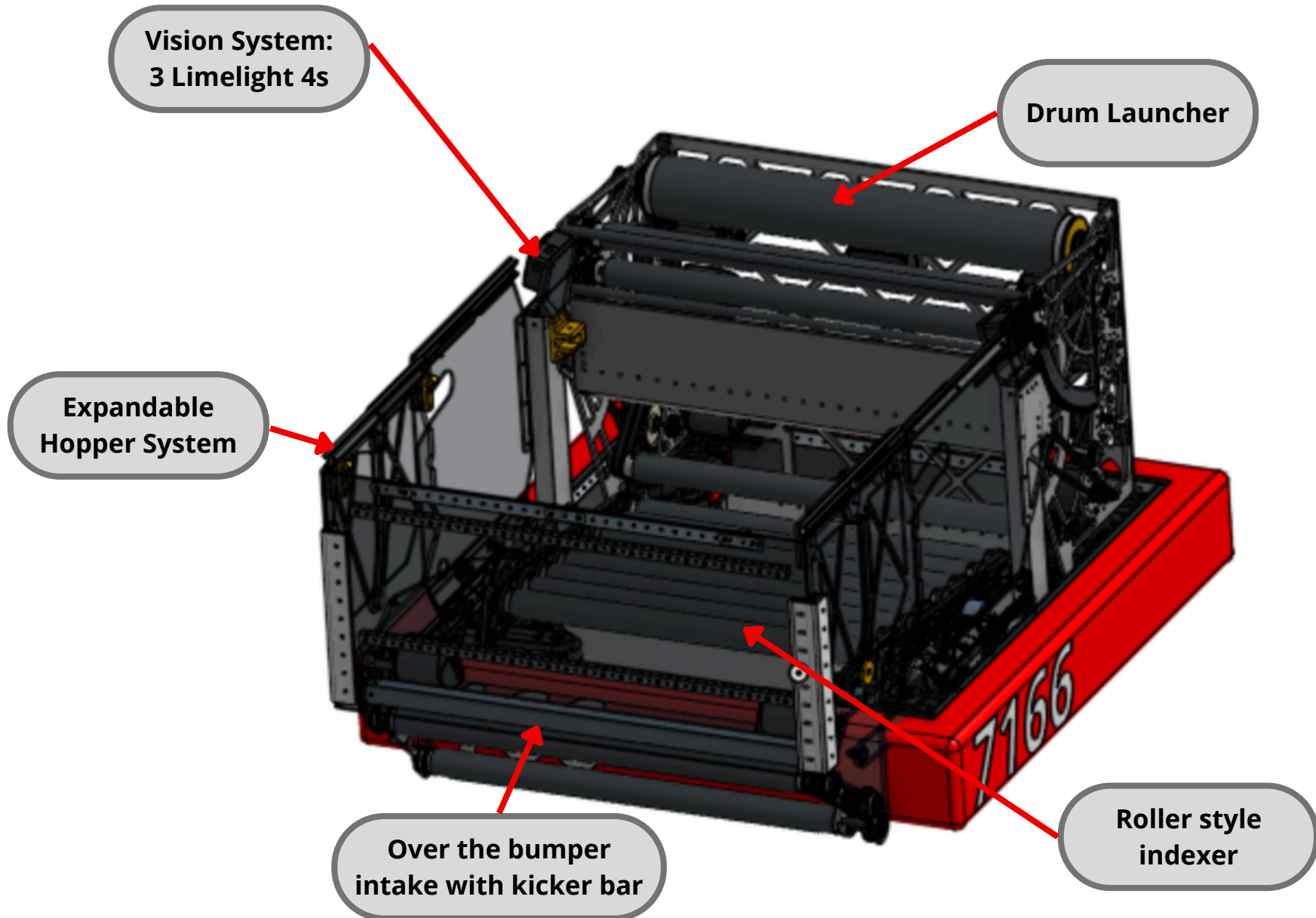


**SHORT
Round
2.0**



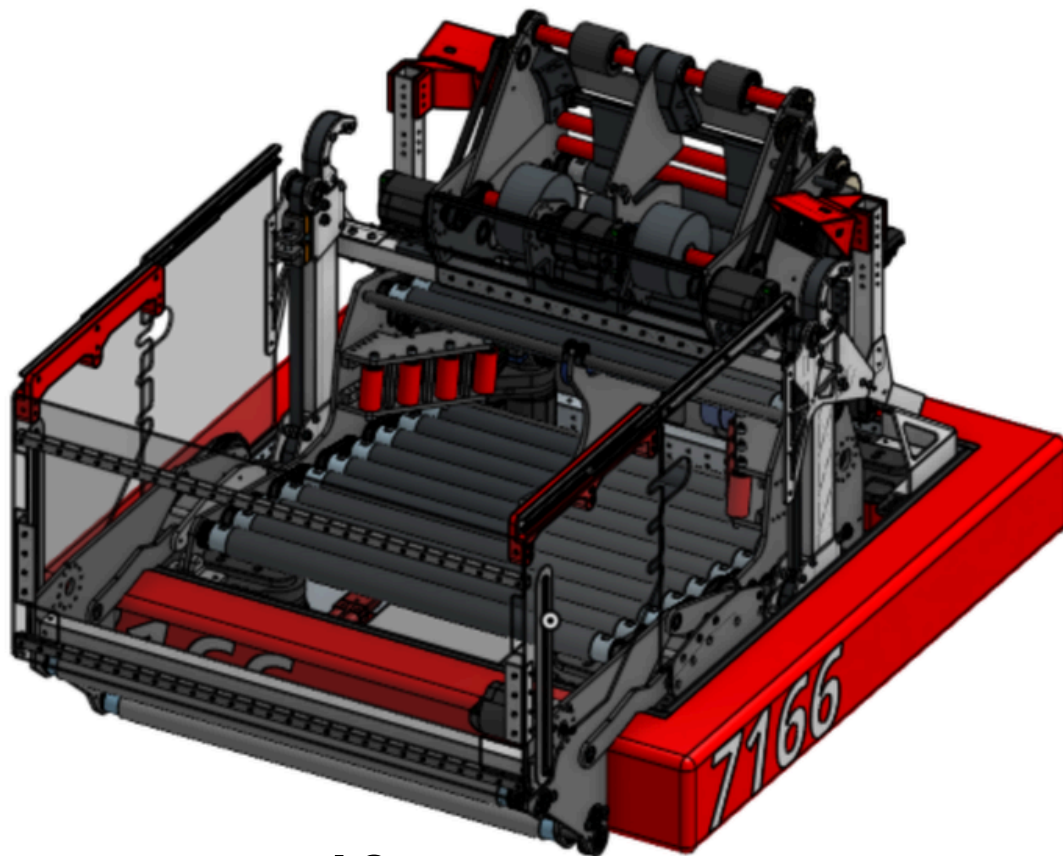


Meet Grapefruit - Key Features



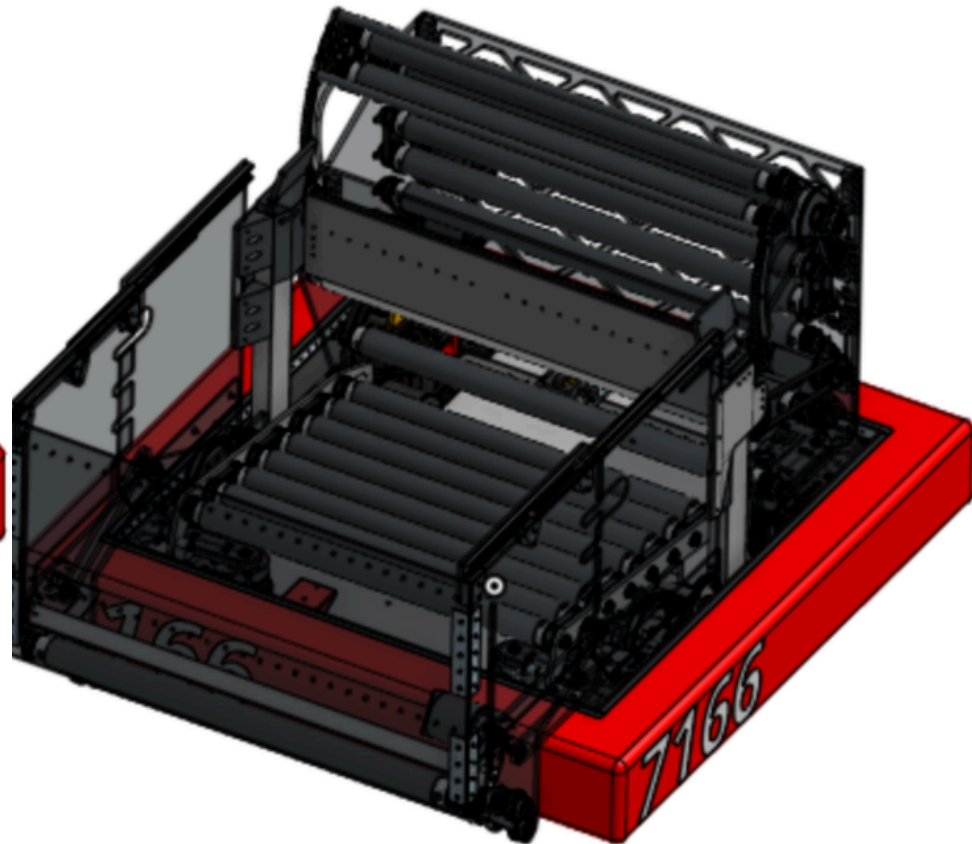


What's Changed? 1.0 vs. 2.0



1.0

- Dual lane launcher
- Intake and launcher face same direction
- Guides to funnel Fuel into launcher
- Center lane divider
- 10 polycarb rollers = indexer



2.0

- 3" aluminum drum shooter
- Intake and launcher face opposite directions
- Intake 4-bar geometry revised to take more impacts
- 8 polycarb rollers = indexer

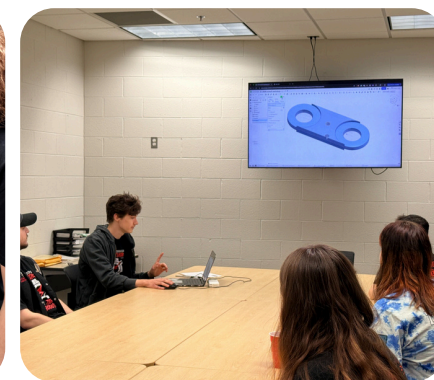


Discussions

- What is the meta?
- What will robots on FIMstein and Einstein do?
- How will defense affect scoring?
- How do we capitalize during active shifts?
- How important is an L3 climb?
- How many cycles are needed to be competitive?

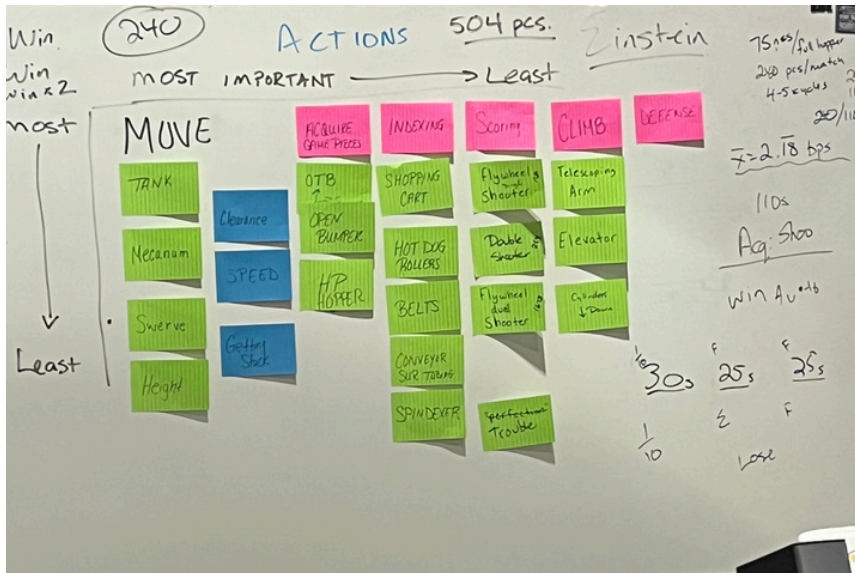
Agenda

- Host 5234 and 10629 – offer workshops and team building activities
- Team livestream of game reveal
- Small group to large group game manual reading
- Strategy Dictates Design





Strategy Dictates Design

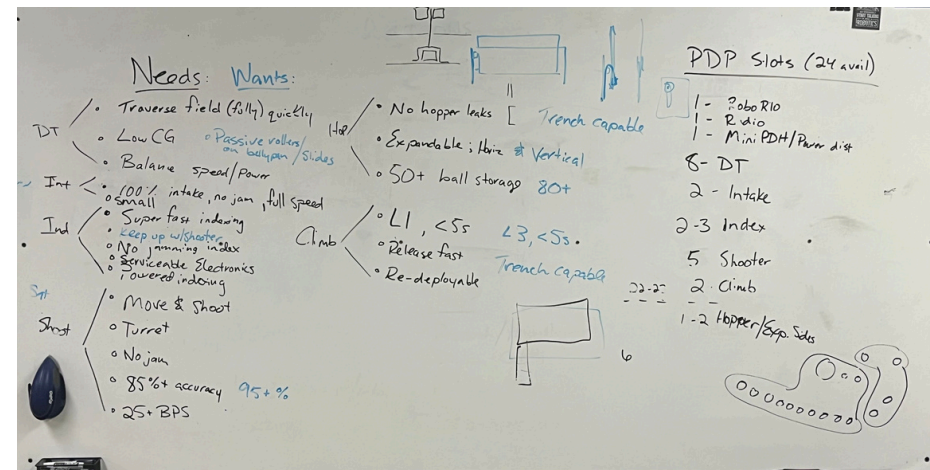


Agenda

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Discussions

- What is the meta?
- What will robots on FIMstein and Einstein do?
- How will defense affect scoring?
- How do we capitalize during active shifts?
- How important is an L3 climb?
- How many cycles are needed to be competitive?





Needs and Wants Strategy

The strategy department analyzes the results of Strategy Dictates Design in detail, while factoring in the team's season expectations and goals that were selected during Leadership Seminar in the summer.

They use this information to build pictures of what game strategies may look like at all levels of gameplay (district events, FIM State Championship, Worlds), and how strategies may differ between qualification match play and playoffs.

By the end of Week 2, the strategy group delivers a **"robot must be able to do"** list which outlines functions which they have determined necessary for our team to compete at a level consistent with expectations and goals.

The "Needs" list provides design and prototyping with requirements to work and measure against.

Other Functions	
Climb L1	NEED
Climb L3	Want
Drive over bump	NEED
Drive under trench	NEED

Fuel Based Functions	
Shoot fast	NEED
Shoot from anywhere	Want
Index quickly	NEED
Intake quickly	NEED



Design & Prototyping Process

Our design and fabrication teams begin with brainstorming discussions and sketching. All ideas are encouraged during this process, but due to the time constraints of the build season, not every idea can be tested. Ideas are measured against our Needs and Wants list. The group decides which ideas will move on to the prototyping phase.



Why Prototype?

Prototyping allows us to:

- Test our ideas to determine if they are worth pursuing and adding to the robot, and
- Figure out what we can change to improve.



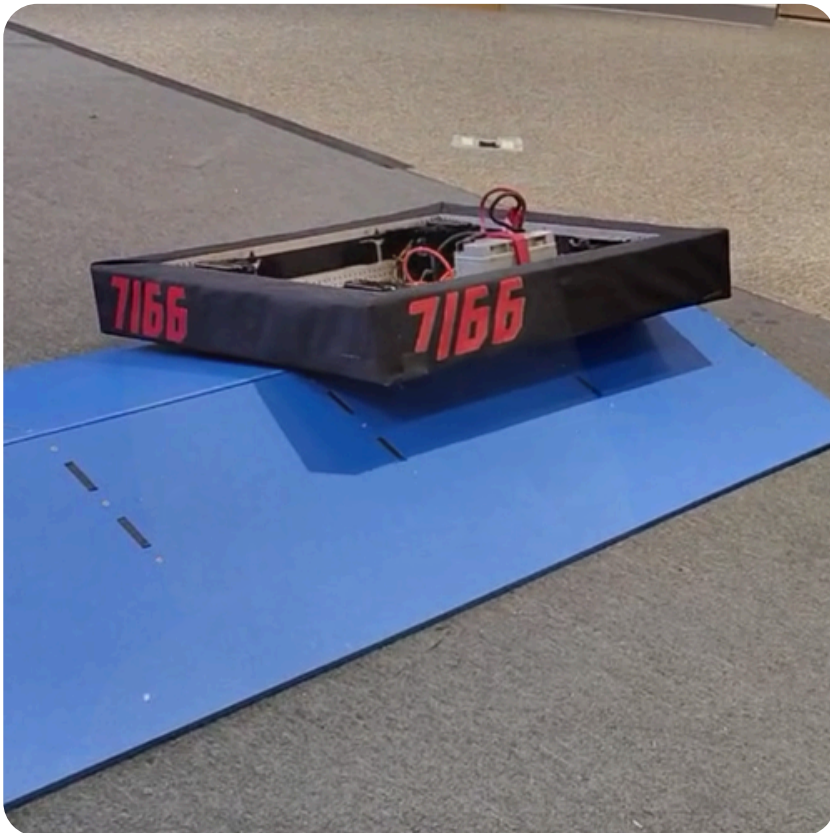


Build Season Timeline

	Design	Fabrication	Software
Week 1	Research/Prototyping	Prototyping	Simulation
Week 2	Research/Prototyping	Prototyping	Simulation
Week 3	Comp Bot	Prototyping	Simulation
Week 4	Comp Bot	Comp Bot	Simulation
Week 5	Comp Bot	Comp Bot	Simulation
Week 6	Comp Bot v.2	Comp Bot	Comp Bot
Week 7	Comp Bot v.2	Spare Parts/Iterate	Comp Bot
Week 8	Comp Bot v.2	Spare Parts/Iterate	Comp Bot



Drivetrain & Chassis Development



Strategic Requirements

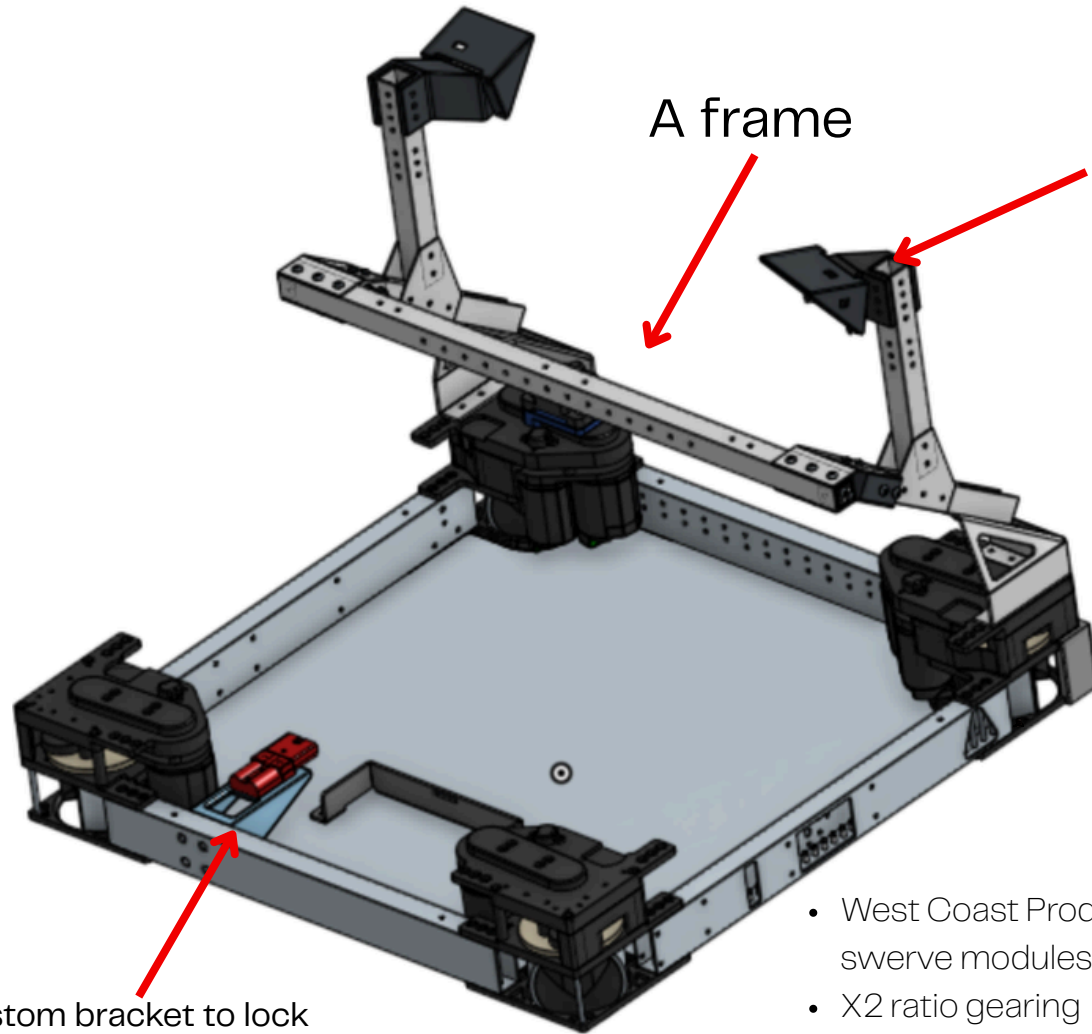
- Optimize for short cycles between Neutral Zone and Alliance Zone
- Minimal size
- Ability to maneuver quickly to avoid defense

Challenges

- Robot will need to have the ability to travel over the bump
- Needed to determine subsystem mounting locations before all prototyping was completed
- Packaging everything into one small robot
- Improve wiring skills (CRESCENDO)



Drivetrain & Chassis Final Design



Custom bracket to lock the battery terminal Anderson connectors in place

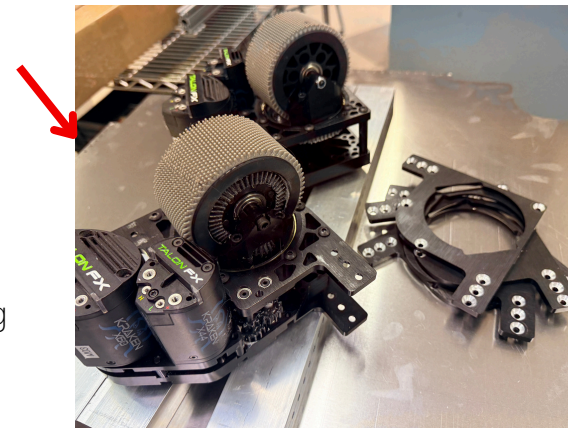
A frame

Custom mounting brackets for Limelight 4

Overview and Specs

- Solid 1/16" aluminum belly pan for structural support
- Minimal protrusions under belly pan to avoid getting stuck on the bump
- 27.500"x27.500" frame
- 1.063" from the belly pan to floor
- 35.4 pounds

- West Coast Products X2St swerve modules
- X2 ratio gearing
- Drive Motor: Kraken X60, 17T pinion
- Steering Motor: Kraken X44
- Countersunk bottom mounting plate to reduce drag over Bump

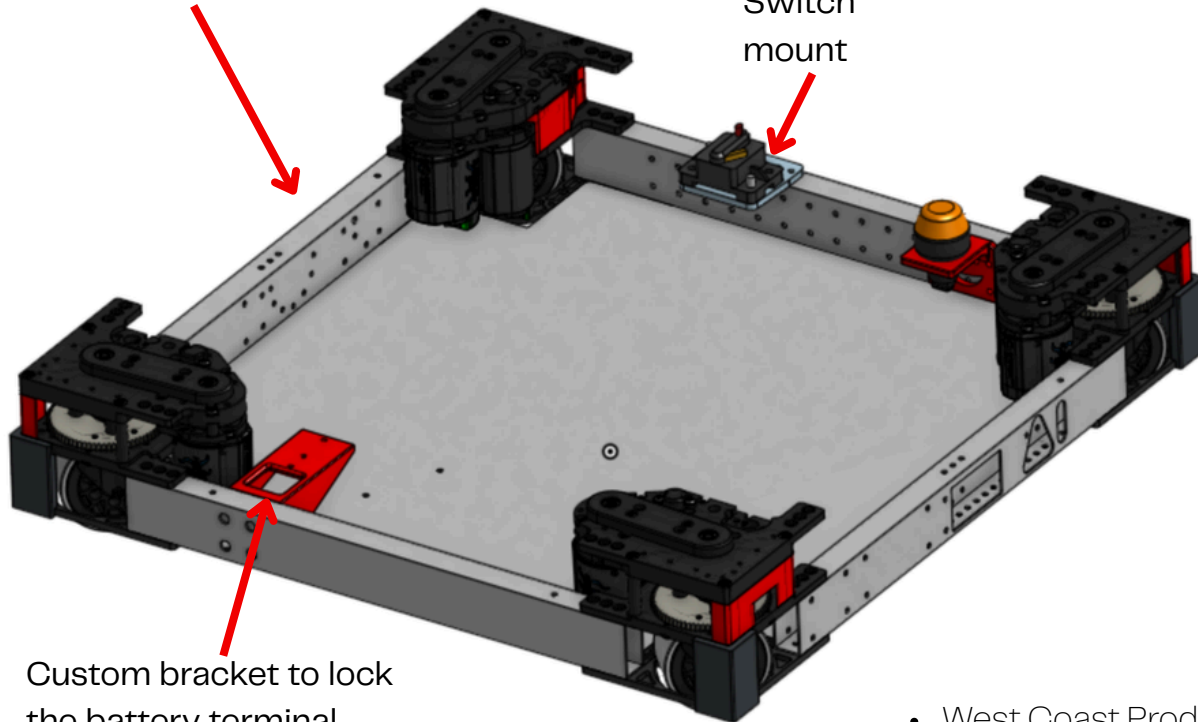




Drivetrain & Chassis Iterations

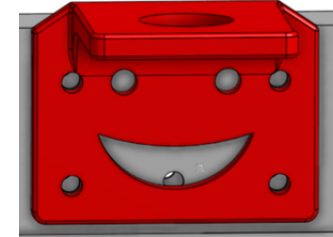
mounting holes for 1x2 tubing and indexer

Power Switch mount



Custom bracket to lock the battery terminal Anderson connectors in place with quick pull pin

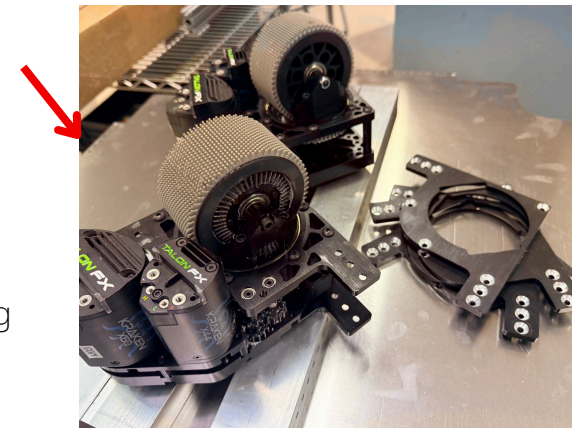
Our happy little RSL mount



Overview and Specs

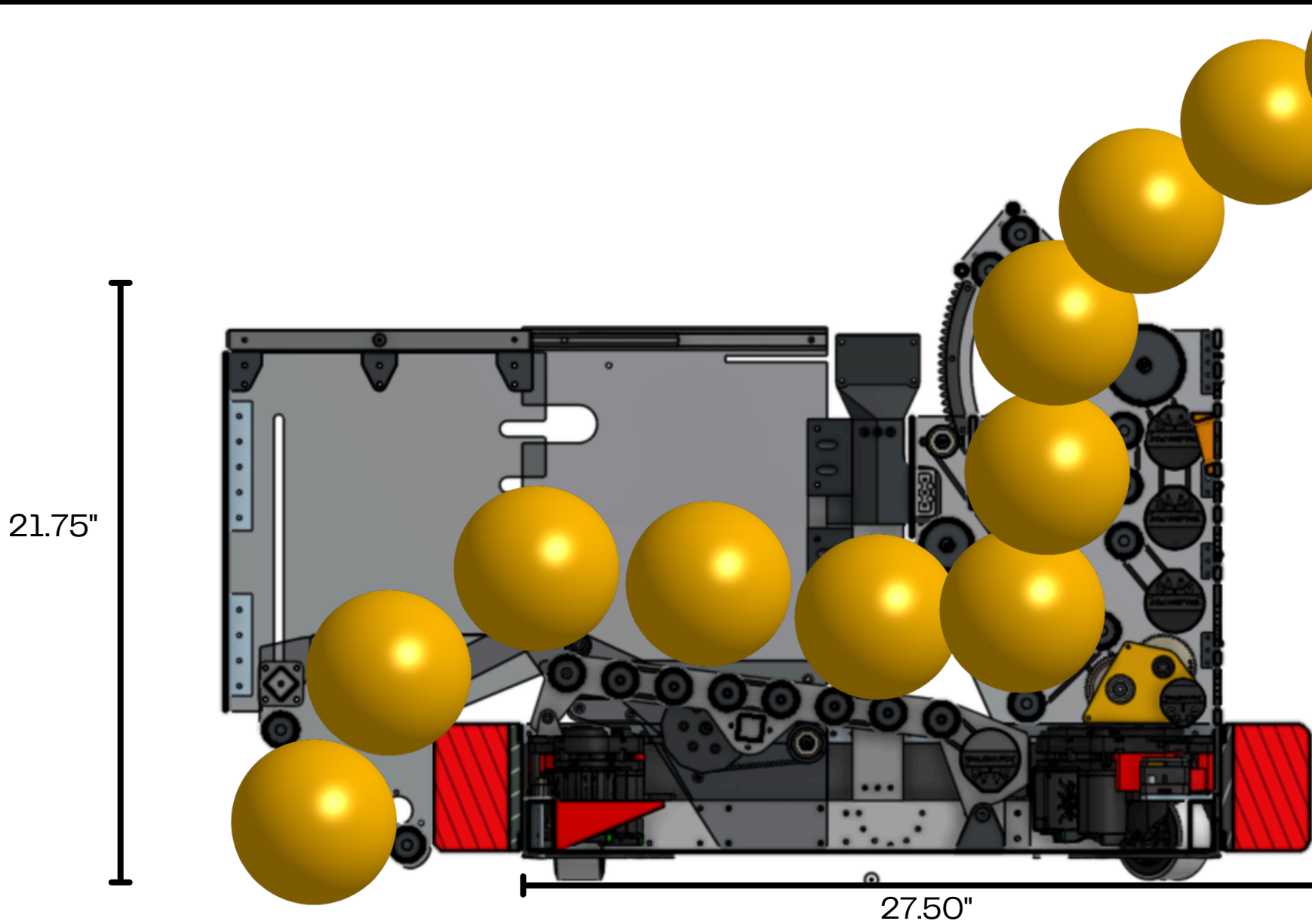
- Solid 1/16" aluminum belly pan for structural support
- Minimal protrusions under belly pan to avoid getting stuck on the bump
- 27.500"x27.500" frame
- 1.063" from the belly pan to floor
- 31 pounds

- West Coast Products X2St swerve modules
- X2 ratio gearing
- Drive Motor: Kraken X60, 17T pinion
- Steering Motor: Kraken X44
- Countersunk bottom mounting plate to reduce drag over Bump





Game Element Acquisition & Scoring





Intake Requirements



Strategic Requirements

- “Touch it, own it.”
- Intake from the ground while on the move
- Pick up at 100% speed without jamming
- Be robust to survive impacts

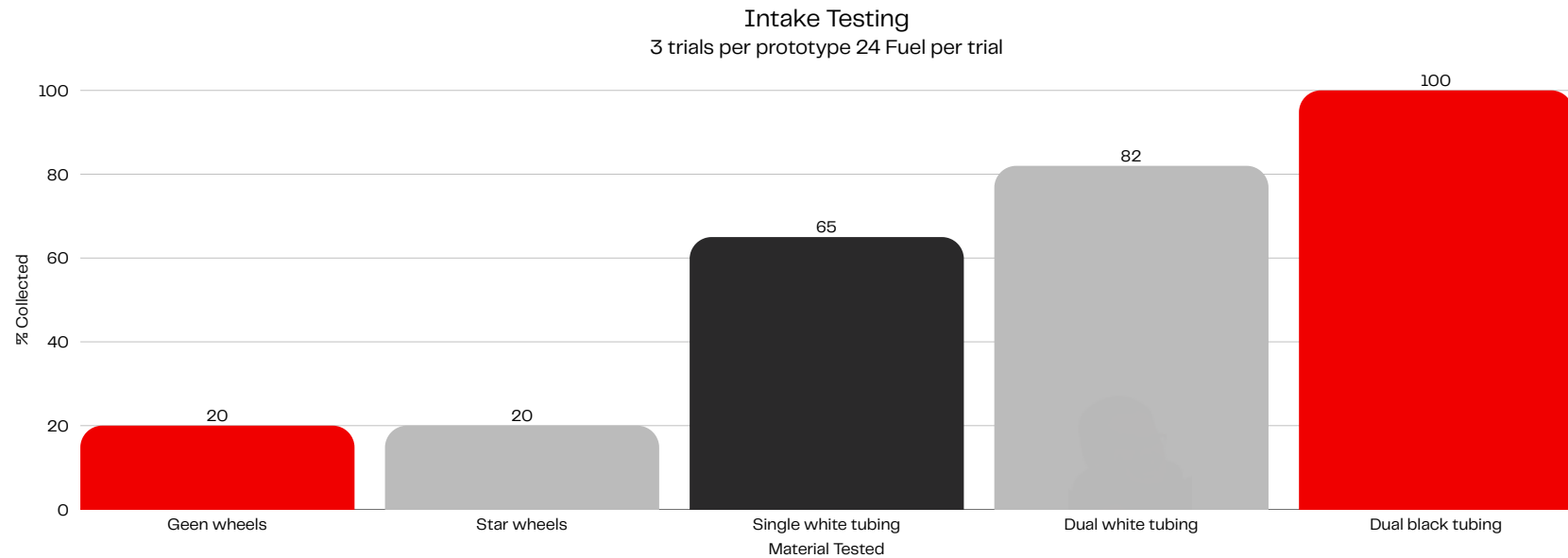


Challenges

- Packaging
- Over the bumper intakes are susceptible to breakage
- Quick actuation (in and out)
- Constant compression when intaking



Intake Prototypes



Single powered roller, green compliant wheels

- Didn't meet our standards in performance
- Fuel often got stuck between the roller and bumper
- Didn't meet our requirement of "touch it, own it"



Single powered roller, star compliant wheels

- Improved results over green compliant wheels
- Fuel got stuck between the wheels and bumper.
- Didn't meet the requirement of "touch it, own it"



Intake Prototypes



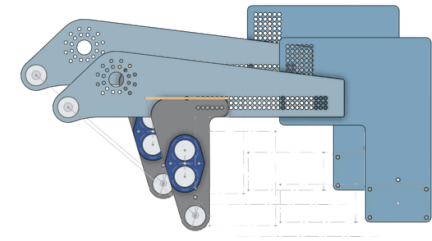
Single powered roller, polycarb, and white silicone tubing

- First meaningful improvement in acquiring game pieces.
- While Fuel getting stuck between the roller and bumper was still an issue, the issue was reduced.
- Came closer to reaching our requirement of touch it own it



Dual powered rollers, polycarb, and white silicone tubing

- Reached our requirement of touch it own it
- Didn't have the issue of Fuel getting stuck
- Massive improvements in acquiring game pieces over the other prototypes



Dual powered rollers, polycarb and black silicone tubing, slapdown intake

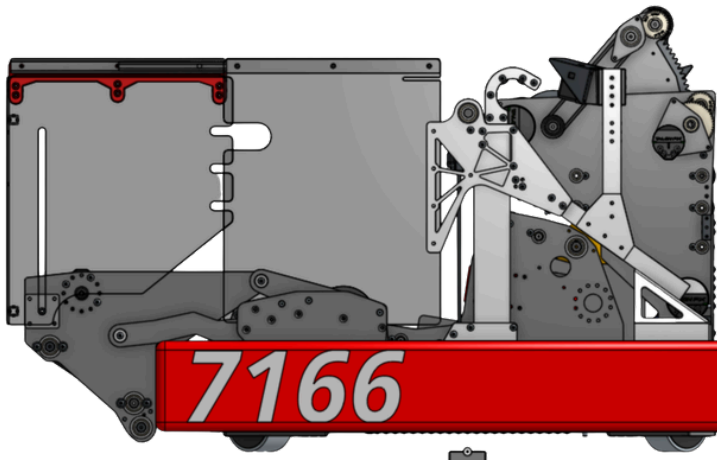
- Successfully took in 100% of the Fuel it touched
- Actuated fully
- Didn't jam
- Trouble with having the actuation of the hopper linked to it
- 50A durometer silicone (black) worked the best during testing



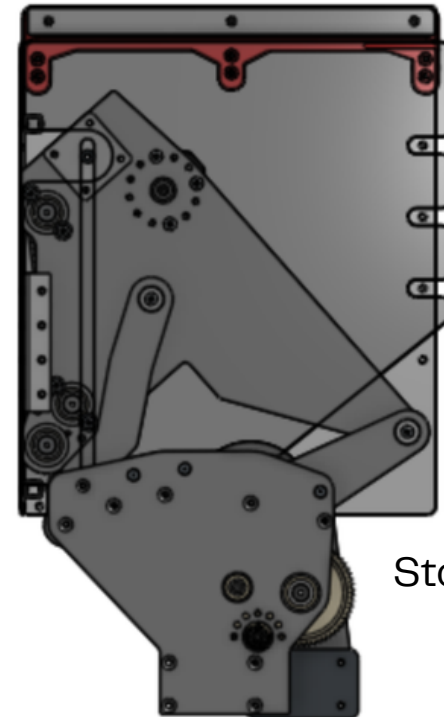
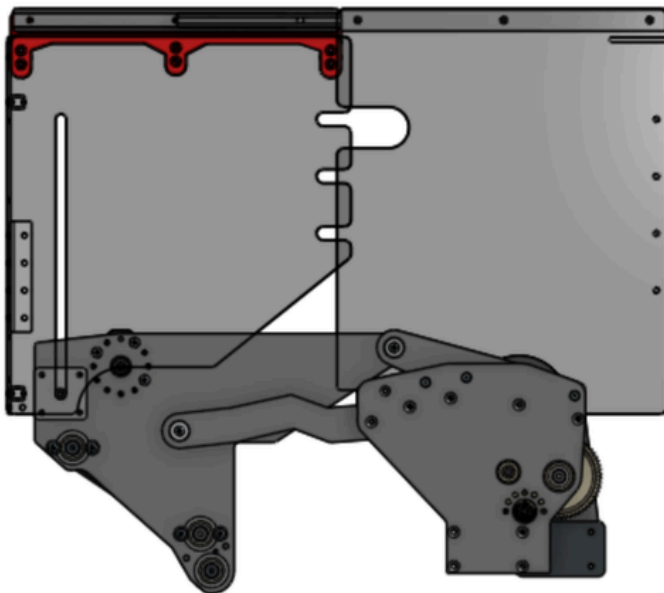
Intake Final Version

Overview and Specs

- 4-bar actuation
- Actuator: 53:1 gear ratio + one Kraken X44
- Rollers: 1.5:1 + one Kraken X60
- 9/16 Fuel compression between the rollers
- 11.7500" actuation distance from frame
- 10 pounds
- Stowed, 27.500" wide, 12.400" long, 20.500" tall
- Deployed, 27.500" wide, 23.000" long, 20.500" tall
- Upper and lower .063" wall, 1.25" diameter polycarb rollers with 50A durometer silicone sleeves



Deployed



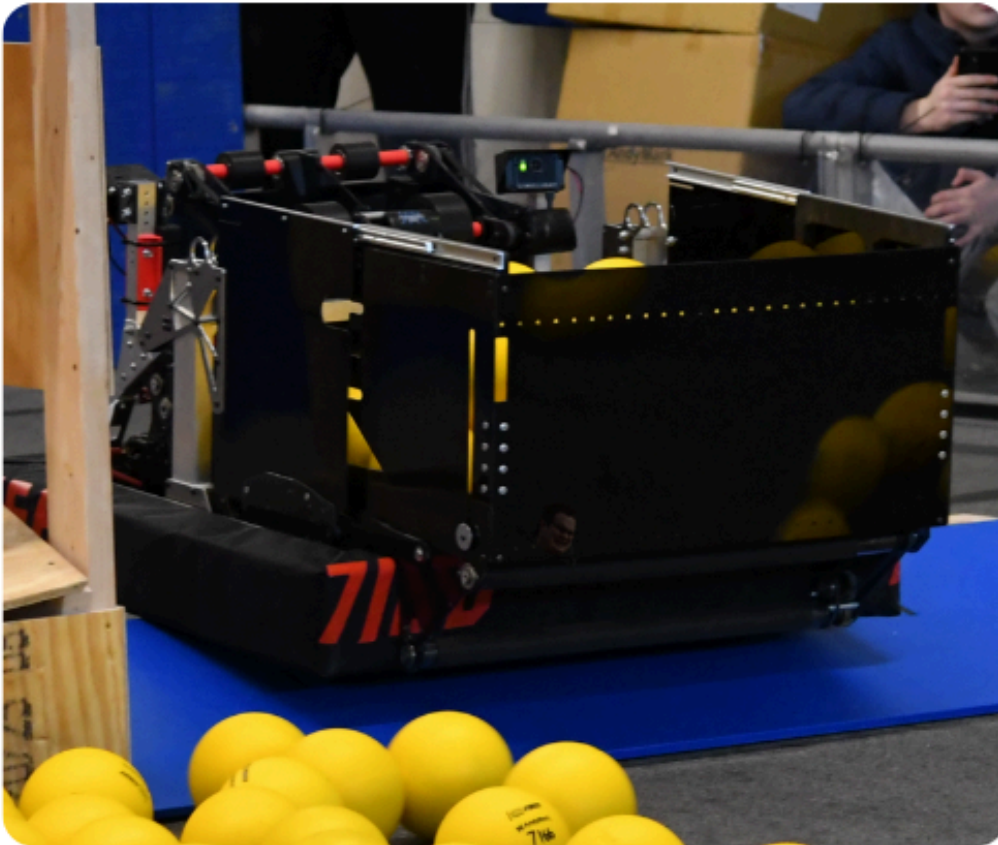
Stowed



Hopper Requirements

Strategic Requirements

- Fit under the trench
- Hold at least 50 Fuel
- Expand with the intake

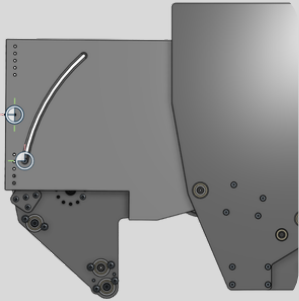


Challenges

- Articulating the hopper using the intake
- Having it not jam when actuating
- Keeping it from hitting other subsystems

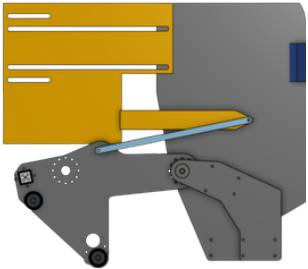


Hopper Prototypes



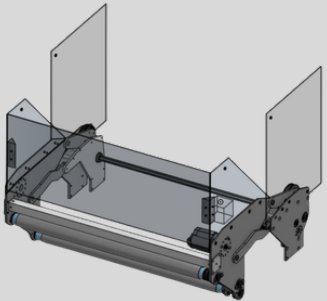
Rotating Hopper

- Rotates with intake to allow it to be stored easily
- Space efficient



Train Linkage

- Train Linkage to pull the hopper in and out
- It wasn't structurally sound
- The Train Linkage hit the climber



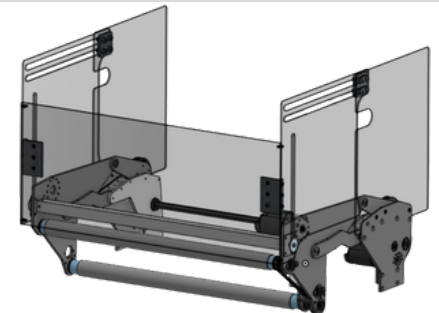
Attach to 4-bar Linkage

- 6 inch gap allowed the Fuel to fall out
- Sturdier than the Train Linkage
- 3mm polycarb



Two Horizontal Pinslots, and One Vertical Pinslot

- Holds the Fuel in without any spills
- Jams when polycarb bends
- Used intake rotation to pull itself in

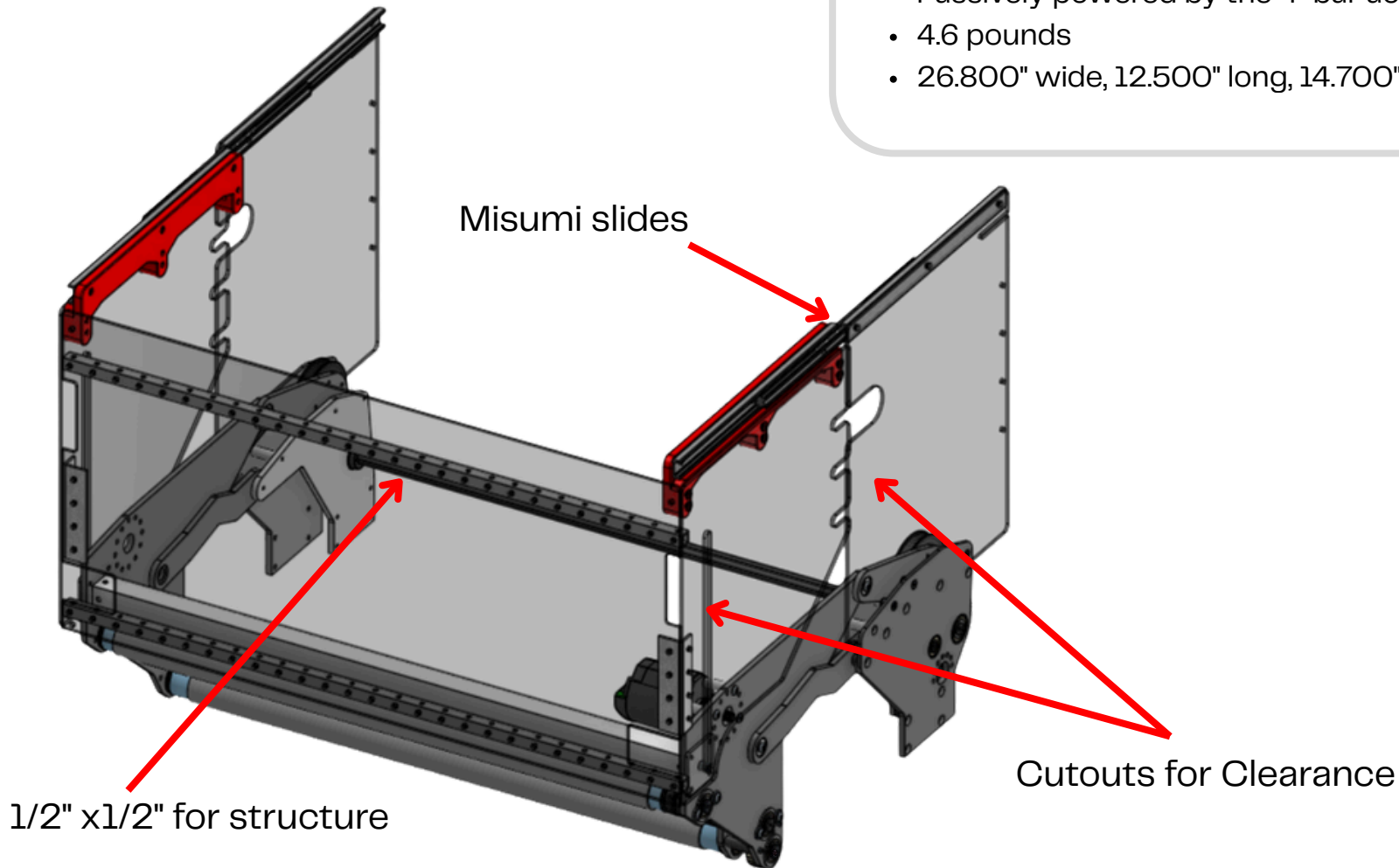




Hopper Final Version

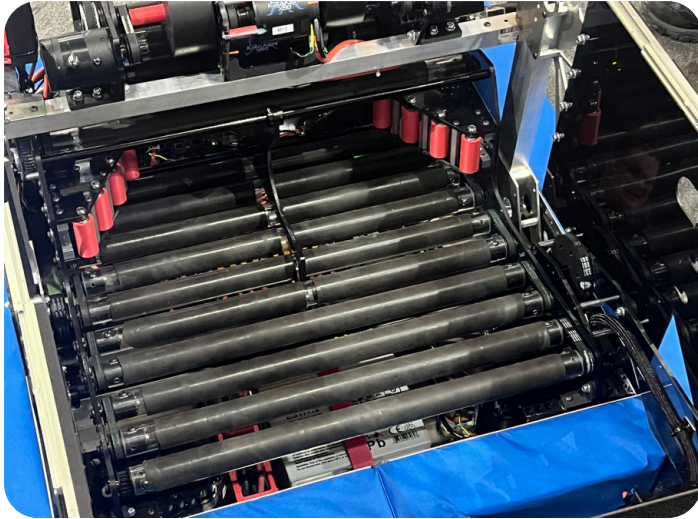
Overview and Specs

- Expands 12" past the robot perimeter
- 1/2"x1/2" polycarb square tubing for structural support
- 2x Misumi SAR330 slides for smooth actuation
- Passively powered by the 4-bar actuation
- 4.6 pounds
- 26.800" wide, 12.500" long, 14.700" tall





Indexer Requirements



Strategic Requirements

- Move Fuel to the launcher quickly
- Do not create Fuel jams
- Powered
- Serviceable

Challenges

- Packaging - how to combine wiring, battery, and indexer so everything is serviceable
- Needs to be modular/removable
- Static electricity will develop - how to counter this?





Indexer Prototypes



Spindexer with offset exit

- Turbo-like shaped with the exit
- 24" diameter
- Worked, but created enough static to turn off the robot



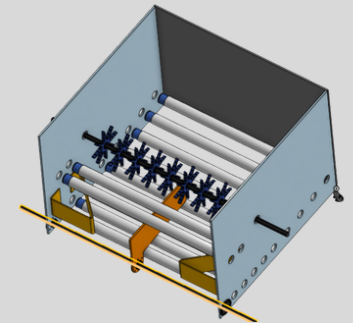
Spindexer with centered exit

- Centered exit with powered compliant roller
- 18" diameter
- Improved performance over the first spindexer
- Still had issues with static



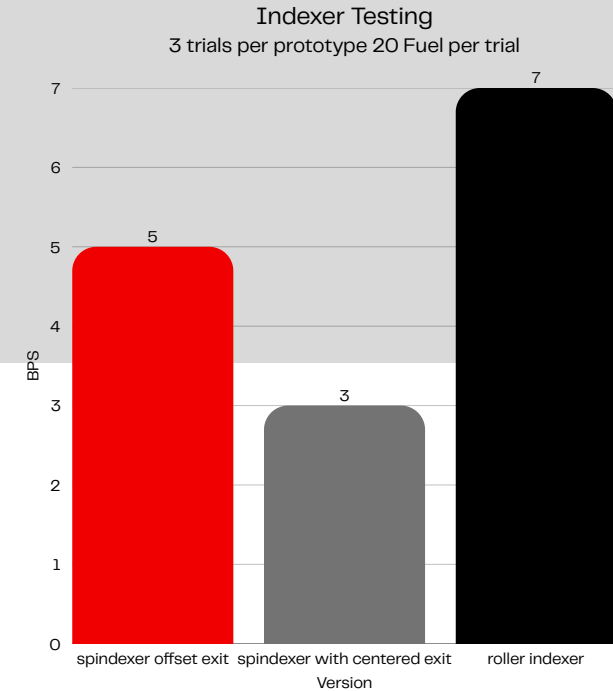
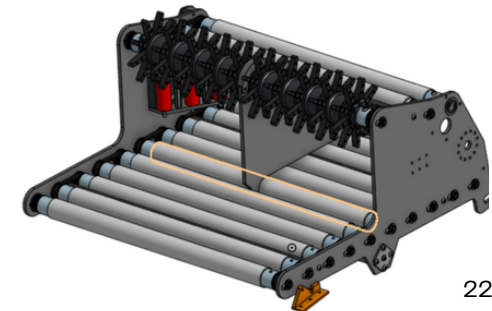
Polycarb rollers with black silicone sleeves indexer

- Polycarb rollers spaced 1.5" apart
- Top roller with star wheels
- Center divider



Modular polycarb roller with black silicone sleeves

- Passive angled rollers to align fuel
- Completely modular
- Top roller with star wheels
- Powered by 1 Kraken X60
- Created some static but not enough to turn off robot



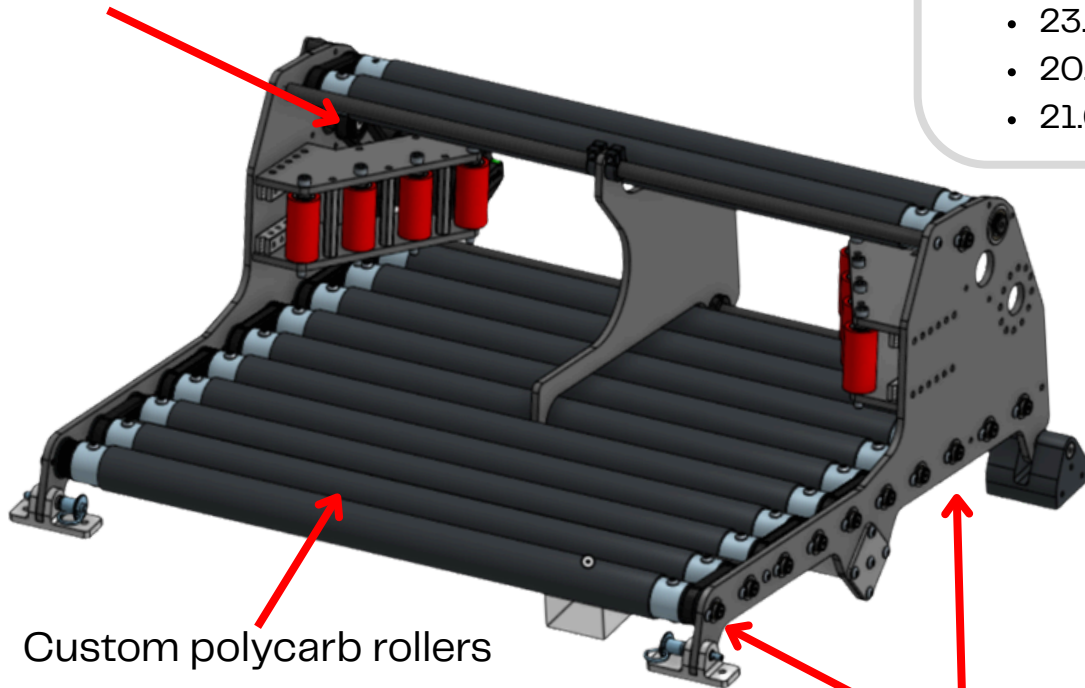


Indexer Final Version

Overview and Specs

- Completely modular
- Powered by one Kraken X60 with a 1:1 gear ratio to the rollers
- Passive angled rollers for Fuel alignment
- Custom tube inserts to mount rollers
- Center lane divider
- 23.000" wide, 22.300" long, 10.900" tall
- 20.7 pounds
- 21.00" long 1.25 Diameter Roller

Passive rollers



Custom polycarb rollers

Custom mounts
allowing indexer
to be modular





Indexer Iterations

ISSUE AT FIRST EVENT:

Fuel periodically jammed when moving from indexer to the launcher.

- Adjusted geometry and incline to help with Fuel movement
- Removed center lane divider
- Reduced rollers from 12 to 8
- Removed passive rollers
- Removed upper rollers from the indexer

Overview and Specs

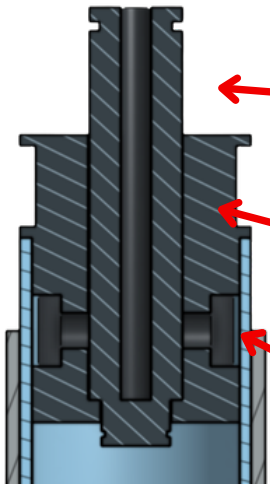
- Completely modular / removable
- Powered by one Kraken X60 with a 1.5:1 reduction
- Custom tube inserts to mount rollers
- 21.755" wide, 19.576" long, 7.619" tall
- 8.453 lb
- 20.125" long x 1.25" diameter Roller
- 7 deg incline





CUSTOM TUBE INSERTS

Section view



Hex shaft with a retaining snap ring

3d printed tube insert with integrated 18t pulley

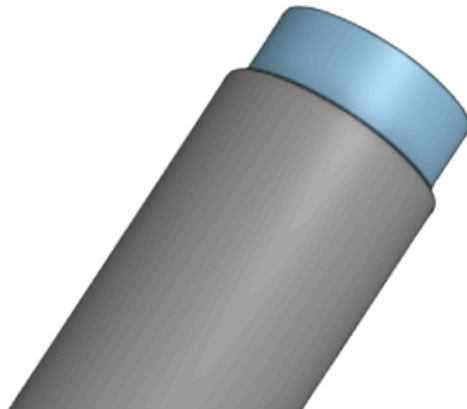
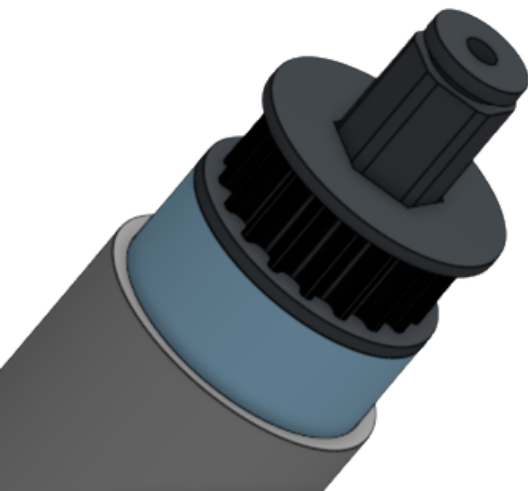
Pocket for square nuts to bolt the tube inserts to the tube

Exploded view



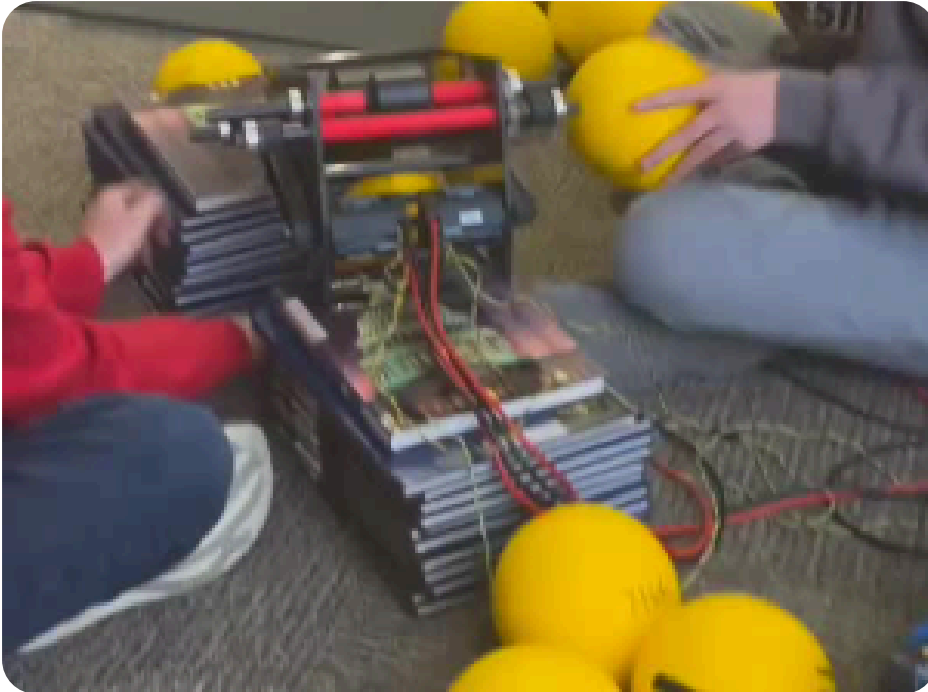
The Problem

- Commercially available solutions are expensive
- In CRESCENDO, screws were backing out in the rollers but were inaccessible
- Needed to optimize our silicone tube mounts





Launcher Requirements

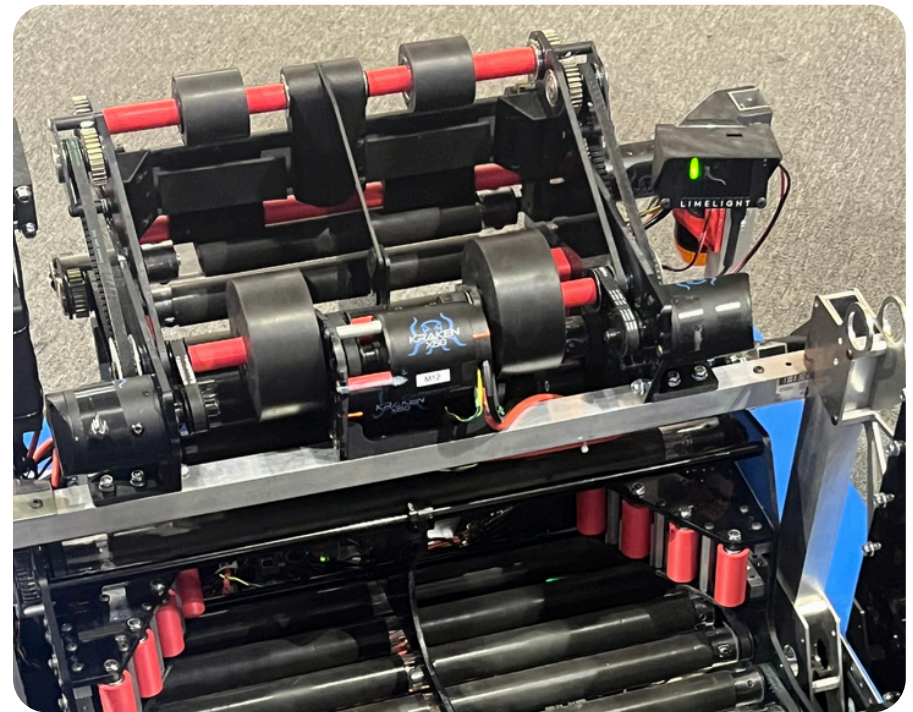


Challenges

- Space efficient/packaging
- Being able to shoot accurately and quickly
- Feeding Fuel to it at a high speed

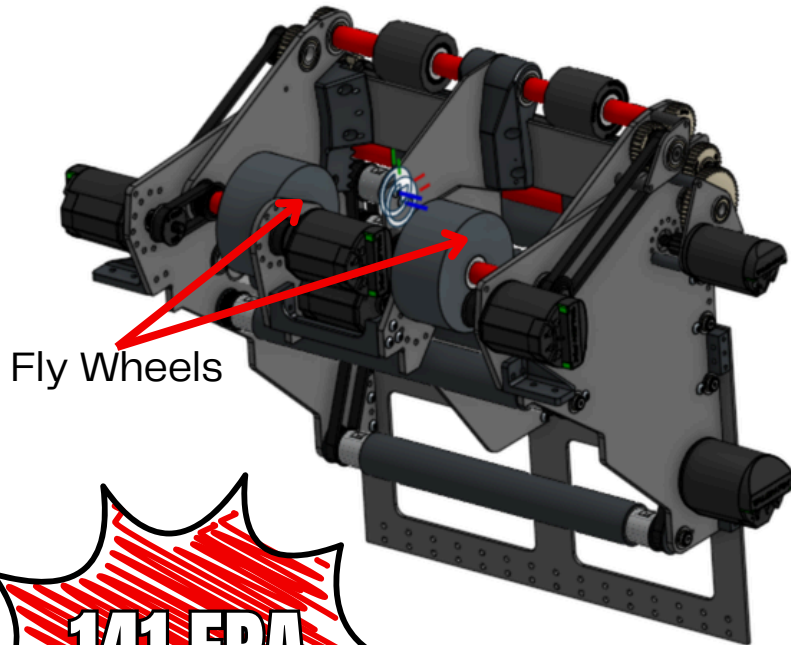
Strategic Requirements

- Able to run without jamming
- Be over 85% accurate
- 25+ BPS (Balls Per Second)
- Able to move while shooting





Launcher

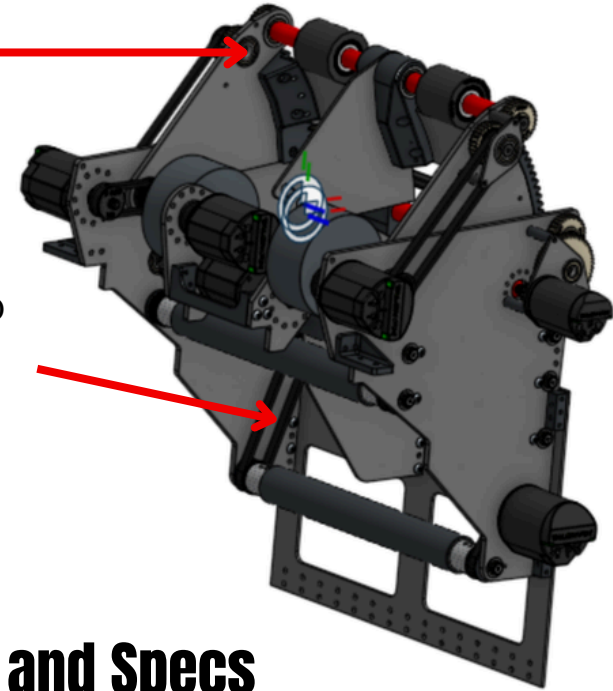


Fly Wheels

141 EPA

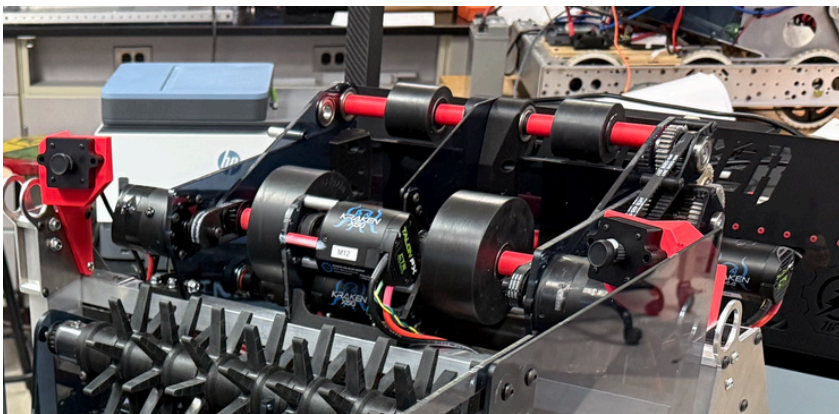
Adjustable
Hood

Indexer to
launcher
Transfer



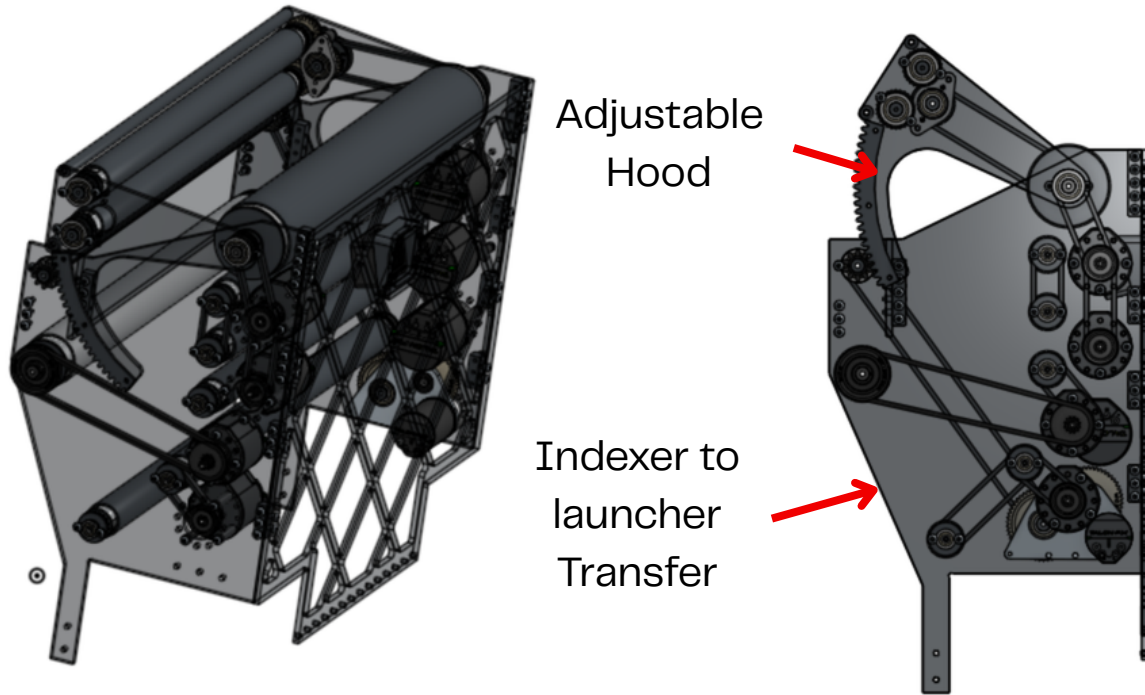
Overview and Specs

- Two launcher wheels and two backspin wheels powered by 4x Kraken X60s with a 1:1 gear ratio
- Adjustable hood powered by a Kraken X44 with a 8:1 gearbox ratio
- 2x 4" diameter Neopren Farline wheels
- 2x 2" diameter Neopren Farline wheels
- As a design team, we did the math to allow us to have our prototype be our final version
- 21 pounds
- 21.75" wide with motors, 16.400" wide without motors, 12.000" long, 19.700" tall





Launcher Iterations



Adjustable
Hood

Indexer to
launcher
Transfer

Overview and Specs

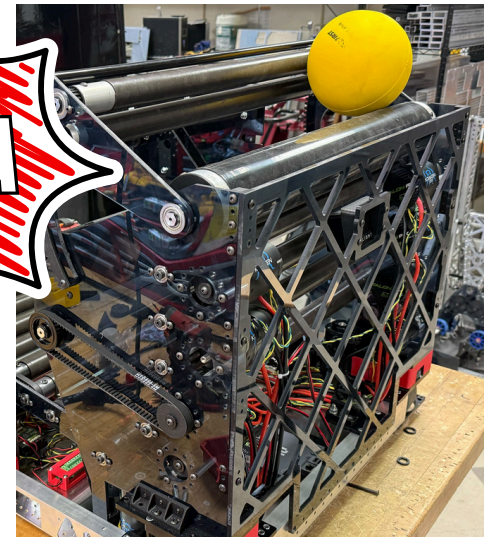
- One 3" dia x .063" wall, Aluminum drum full width shooter
- Two 1.25" dia x .063" wall, Aluminum full width upper rollers
- Powered by 4x Kraken X60s 1:1
- Adjustable hood powered by a Kraken X44 with a 8:1 ratio
- 7x 1.25" Polycarbonate rollers
- 1x 2" Polycarbonate roller
- 16.347 pounds
- 25.000" wide, 12.015" long, 20.519" tall

ISSUE AT FIRST EVENT:

Although our EPA was 141.6, we believe we need more throughput to compete at higher levels of REBUILT.

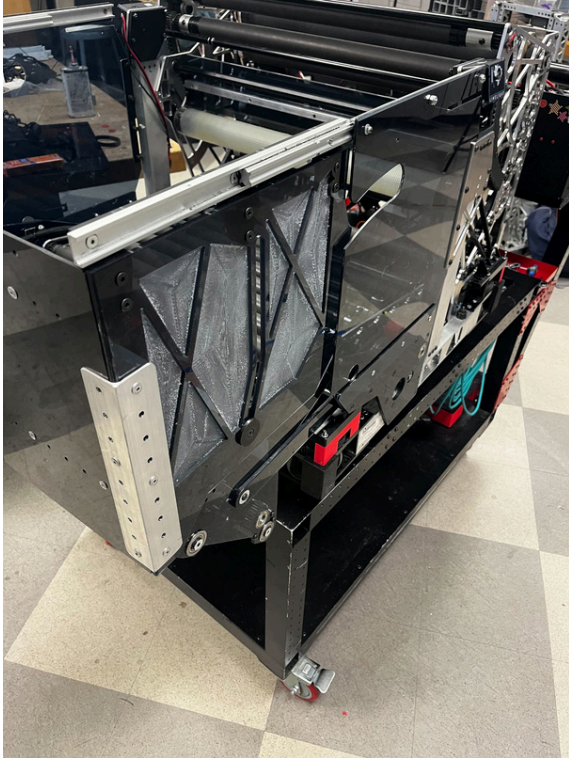
- Completely changed launcher from 2-lane shooter to full 4-Fuel width drum
- Rotated launcher 180 so we can pick up and shoot without needing to rotate chassis
- Included a series of rollers to transfer Fuel from indexer to launcher
- Needed to increase BPS to compete at higher levels of game play (States and Champs)

170 EPA



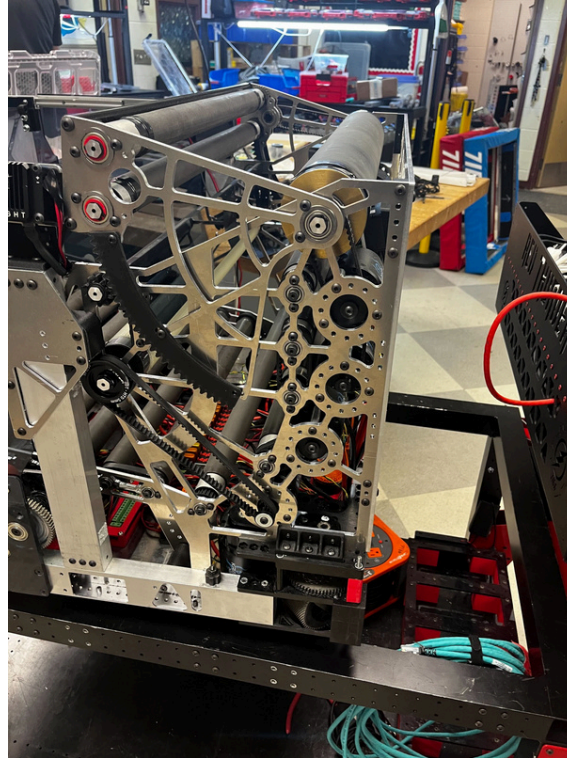


Prep For States



Intake/Hopper

- redesigned to fit smaller bumpers
- thickened side panels from 3mm to 6mm
- added 7075 aluminium angles
- added a piece of maple in the 1x1 to make a composite beam



Shooter

- Recut all panels to be 3/16 aluminium
- changed fuel compression from 1 inch to 1/2 inch.
- added brass tube inserts
- increased hood angle range
- added lightening pattern to save weight



Indexer

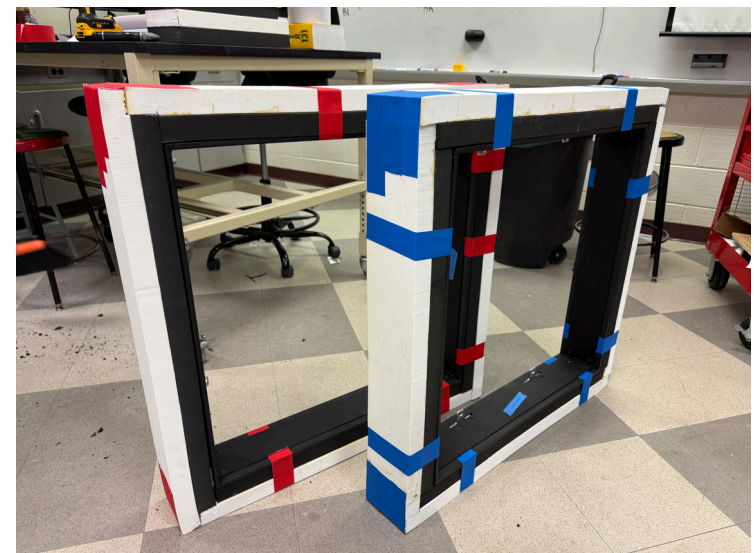
- Recut panels to be 3/16 Aluminium
- added lightening pattern to save weight



Bumpers

Overview and Specs

- **Backing:** Copolymer Polypropylene, provided by sponsor Pro-MEC Engineering Services, Inc.
- **Padding:** two-layer EVA Foam, protecting the robot against hard and soft hits
- **Fabric:** X-Pac VX21 Ripstop, found to be the most durable during the trials and development
- UHMW angle on the underside to aid in traversing over Bump – low coefficient of friction
- Fabric Mounting uses screws and plates instead of staples or glue
- **Mounting:** Custom hardware provided by sponsor Gridiron Manufacturing + WCP Bumper Mount hardware
- 34.500" x 34.5", 5.00" tall, 2.750" thick
- 15.5 pounds





Sponsors



AND OUR 50 FOR \$200 SPONSORS