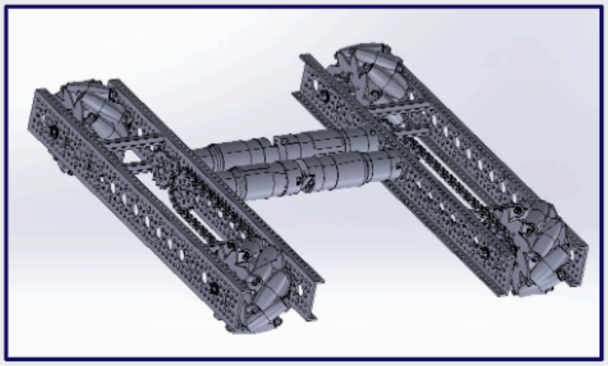
CYPHER

Design & CAD Models

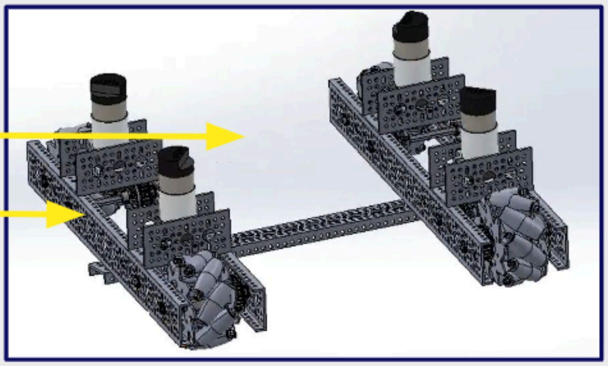
Chassis



Idea 1: H-Chassis Design
We used this classic chassis last year. It features
- \+ Uses less parts
- \+ A lot of space for odometry
- \+ Simple and straightforward
- \- Takes up space in center of robot

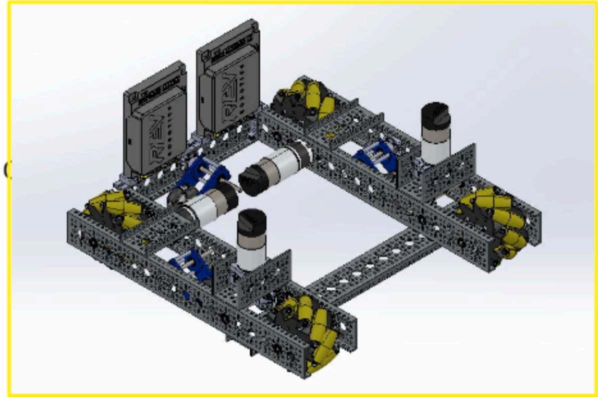
We discovered that because we need space in the center for our shooter mechanism, implementing this H-Chassis Design is physically impractical.

Idea 2: Bevel Gear Design
This design uses bevel gears and vertical motors
- \+ Large free space in center for other mechanisms
- \- Not enough space between sideplates for odometry
- \- Difficult to mount vertical motors
- \- Miter gears are expensive



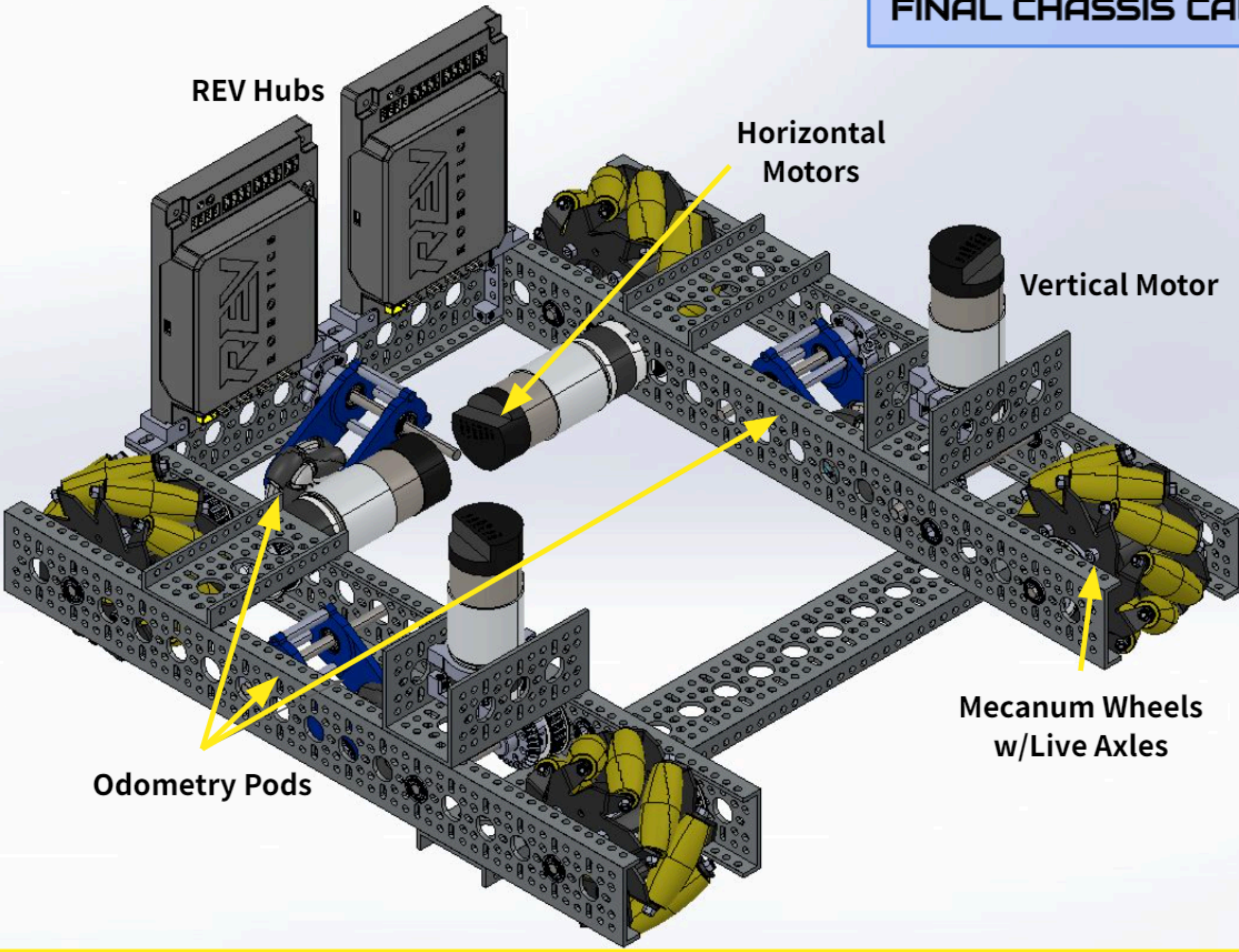
Though this design leaves lots of space for shooter and other mechanisms, there is basically nowhere to mount the wobble goal or battery. It also uses expensive parts and bulky mounting.

Idea 3: Hybrid Design (combination of H-Chassis design in back and Bevel Gear Idea in front)
Has benefits of both Ideas 1 and 2:
- Large free space in center for conveyor, storage, and shooter
- Allows for support structures in the back (e.g. to house wobble goal arm, battery, ring pusher)
- Less expensive because it uses less additional materials (only 4 miter gears instead of 8)

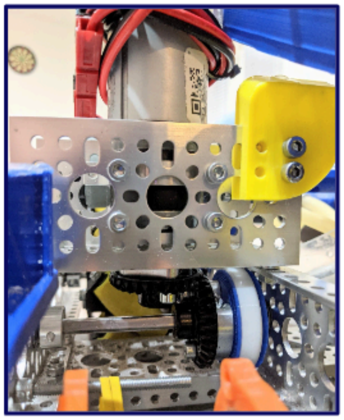


We ended up choosing the Hybrid Design because provides space for both the center mechanisms and the odometry between the sideplates, while also balancing material expenses.

FINAL CHASSIS CAD



Our final Hybrid Chassis features <u>Vertical Motors and Miter Gears in the front</u> and a <u>classic H-Chassis with Horizontal Motors in the back</u>



Close-up of Miter Gear / Vertical Motor System

Special Features of Our Final Chassis:

- Ample space in center and between sideplates
- 4 <u>mecanum wheels</u> for maneuverability (strafing)
- Live axles (faster)
- <u>3D-printed TPU belts</u> for inexpensive, adjustable, reliable transmission of power
- <u>Odometry</u> for accurate position on field
- Accessible REV Hub location, out of the way of other mechanisms

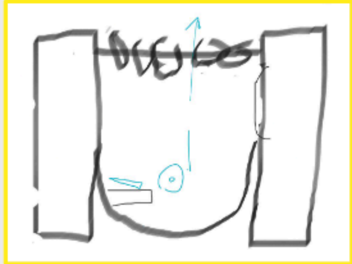
Intake

Brainstorm

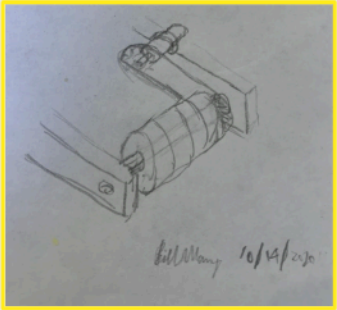
We wanted a really wide intake so that we can have a higher error tolerance.

Ideas:

- Long axle spanning across the entire front robot
- Surgical Tubing
- Compliant Wheel



*This sketch was created at one of our first virtual design meetings. We utilized *google drawing* to share our designs.



*Concept sketch depicting compliant wheel design made by one of our engineer

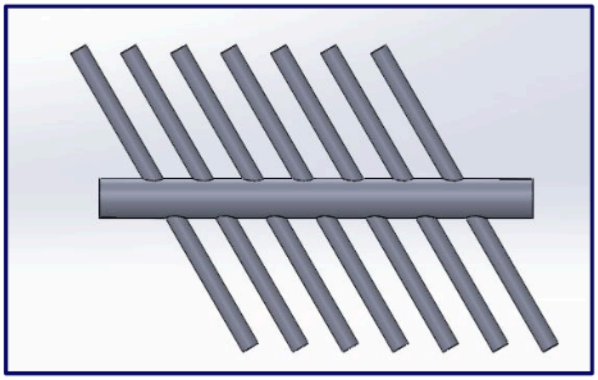
Prototyping

To test out the compliant wheel design, we created a prototype out of leftover parts from last season.

Results:

+ Very good friction
+ Simple design
- Not enough space for the ring to pass through
- Causes wobble

We decided not to use this design for two reasons. 1) We are using standardized gobilda parts, and the andymark wheels don't fit it well 2) Budget doesn't allow for more wheels



*A CAD that we made a while ago

2nd Iteration: Highly Radical Slanted surgical tubes design

Pros:

- Uses less surgical tubes
- Can intake rings vertically due to the height of this design

Cons:

- Leaves no space for sprocket
- Less strength in flat ring intake

<u>This design was never put into test due to space issues</u>

3rd Iteration: somewhat less radical surgical tube design with sprocket incorporated in the middle

This design is similar to the previous iteration. The only changes being the straight surgical tubing and the sprocket in the middle.

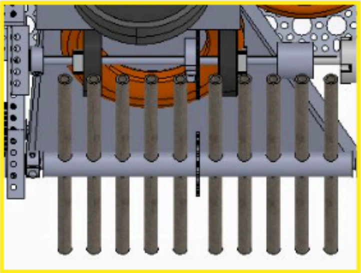
Pros

- Strong Horizontal intake
- Easy assembly
- Uses less parts

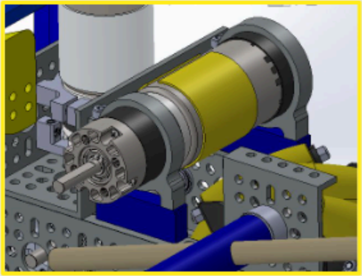
Cons

- Can't do vertical intake
- Difficulty manufacturing

Intake CAD

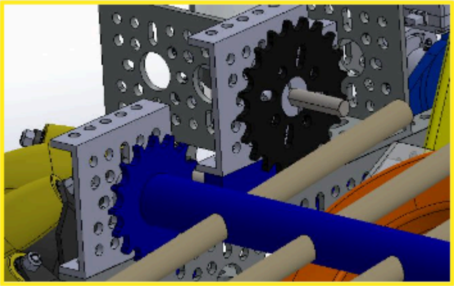


Motor Mount

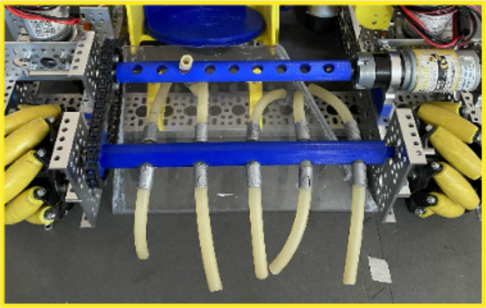


Due to the placement of the sprocket, we had to divide the long tube into 2 parts and manufacture it separately. This caused the tube to be very weak, and it broke a few times

Other changes we made



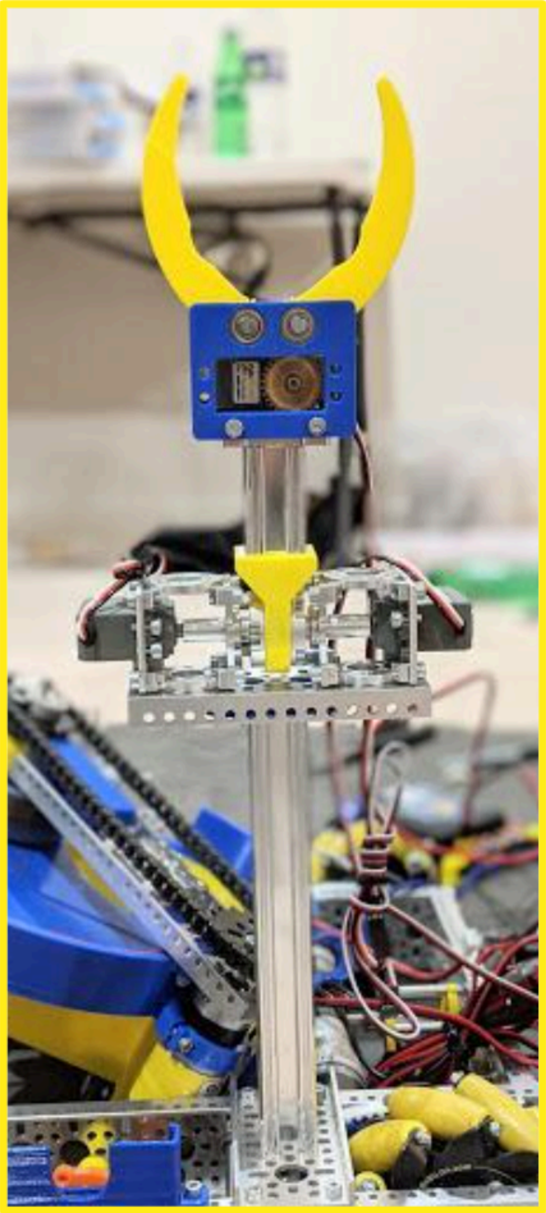
We ended up **moving the sprocket to the left side of the intake** so that we could manufacture this in one whole piece. This has saved us a lot of trouble afterwards.

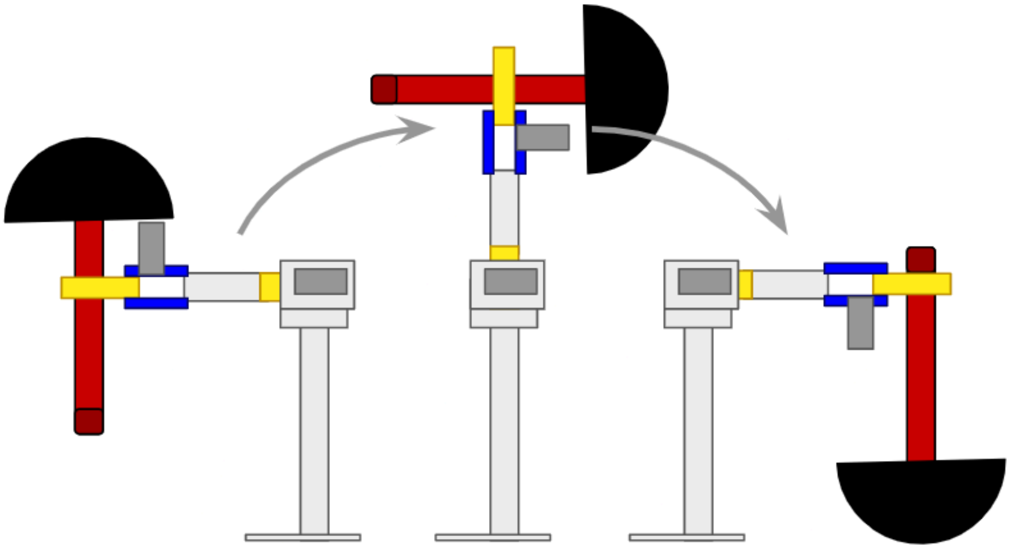


We changed it to **5 surgical tubes instead of 10** so that it won't constantly get stuck in the chains

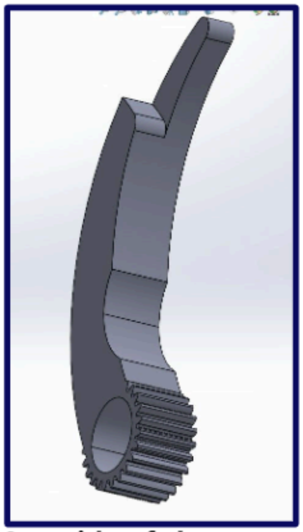
Wobble Goal Arm

To address lifting and depositing of the wobble goal, we decided to **CAD and 3D-print a custom claw, powered by three servos**, along with a a custom plate to mount the claw and servos. These parts were designed by one veteran builder and two members completely new to CAD, providing guided opportunities to learn and practice how to CAD.

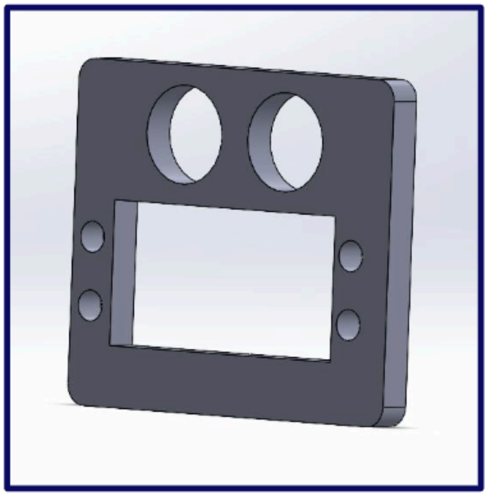




Side view of Wobble Goal Arm depositing the wobble goal



One side of claw



Custom plate for servo mounting and claw attachment

Conveyor System

Conveyer Info

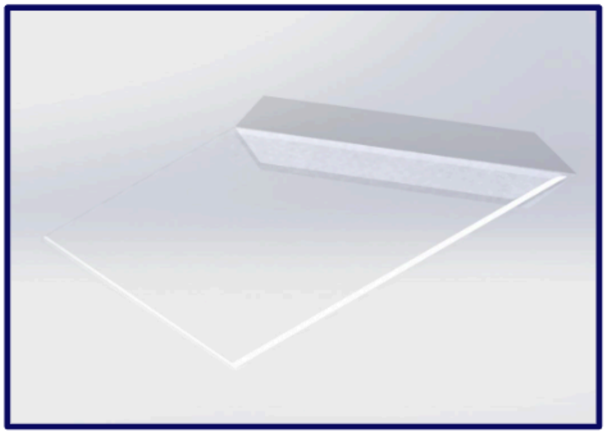
How do we connect our intake to the storage of our robot?
We can solve this problem by constructing a ramp along with a rod connected to a motor to push the rings up. Now we just have to decide where it will be placed and its material.

Placement:
The ramp should be placed so there is a gentle, steady slope between the ground and storage so the rod can easily push the rings up. It also needs to be low enough so intake can push rings directly from the ground to slide up the ramp.

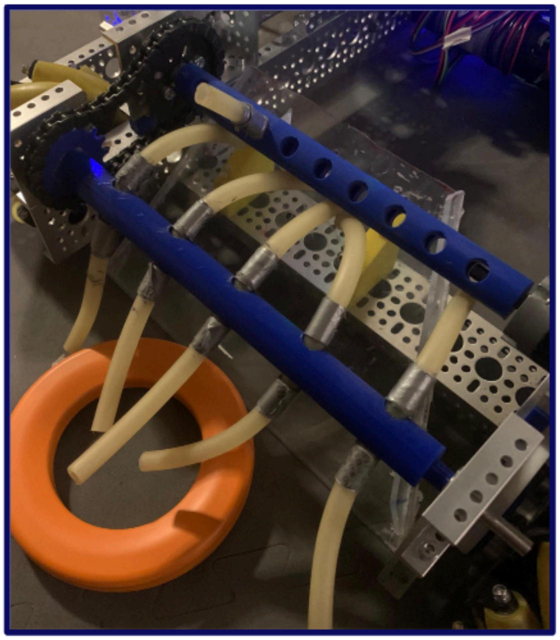
Materials:
Ramp material - We need something that is slippery enough for rings to slide up it, and polycarbonate fits this requirement.

Rod material - We need something that is low in cost and easy to assemble. Using a 3D printer is extremely cheap and simple to work with, so we can use that for the rod. Next, we need something that will push all the rings into storage. We first thought about using compliant wheels, but we realized surgical tubes are easier to use/mount and the tubes have a wide range of motion (because they flop around).

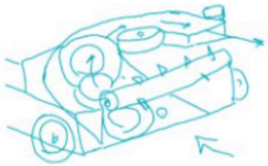
Ramp in CAD

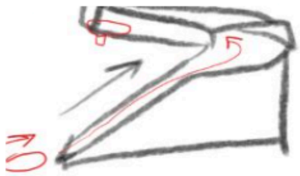


Conveyer in Real Life



Storage System

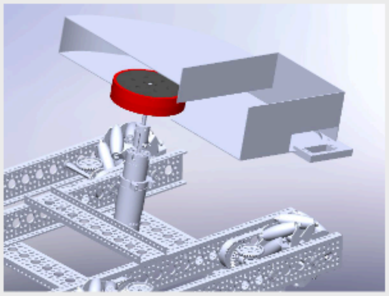


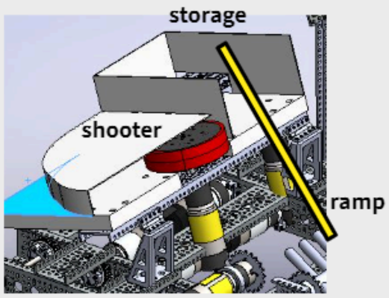


While brainstorming how to transport the rings from intake to shooter, we had two ideas:
Idea 1: conveyor directly **pushes rings up a ramp** into shooter, or
Idea 2: storage holds rings before pushing them into the shooter

*Because **Idea 1 required too much space,** using a longer ramp with a **limited capacity** of likely 1-2 rings, **we decided to add a storage system to our robot**.*

Our first storage design was a stationary "box" attached to the side of the shooter. It'd be made out of polycarbonate with a servo mounted on the side. Once rings were transported into the storage, a servo would push the bottom-most ring of the stack through the slit into the flywheel to be launched.



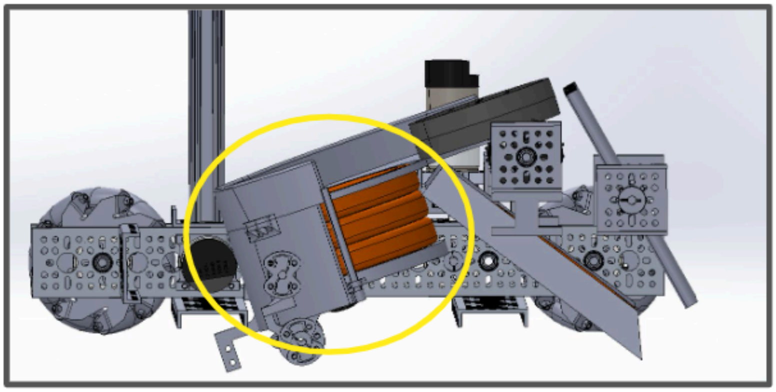


*This idea had initially sounded good, but when we added the storage CAD to the rest of the robot CAD, we realized that this storage made the **ramp angle impossibly steep**, and the **entire storage/shooter assembly (15") was too wide** for the chassis space (13"). **The physical implementation for this design was too impractical.***

We then had a discussion about redesigns, where several ideas were proposed:

1. **Remove the storage**
   - \+ Addresses wideness issue
   - \+ Decreases ramp angle
   - \- Only has capacity for up to 2 rings
2. **Shorten shooter and lengthen ramp**
   - \+ Decreases ramp angle
   - \- Potential shooter inconsistency: rings wouldn't have contact with shooter flywheel for enough time
   - \- Doesn't address wideness issue
3. **Store rings further down inside the robot, then lift storage up**
   - \+ Decreases ramp angle
   - \+ Capacity for 0-3 rings
   - \- Still did not address wideness issue
4. **Modify shooter design to be <90°**
   - \- Possible inconsistency if ring accidentally makes contact with shooter's flywheel

We ended up settling on a hybrid design between Ideas 3 and 4...

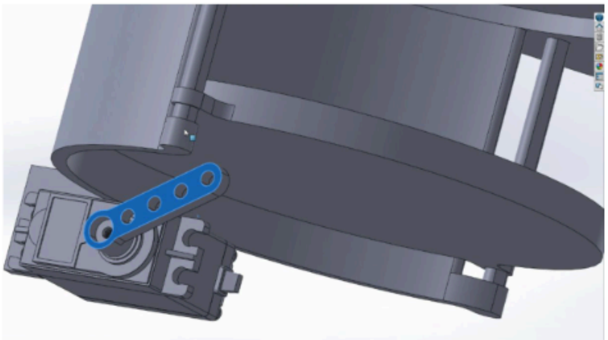


Our second iteration also had rings going up a conveyor ramp into the storage, but **we moved the storage to be under the shooter**, and the storage lifts the stack of rings upwards into the shooter.

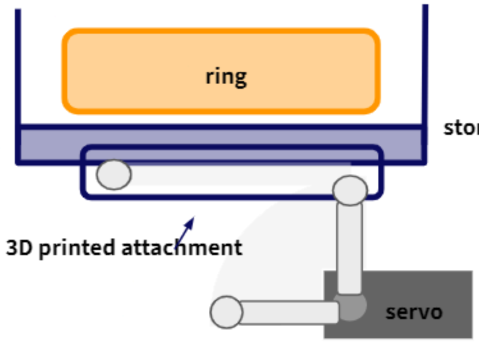
This lower design was much better:

- More compact storage system
- Much more reasonable ramp angle
- Can shoot 3 rings rapidly and consistently from one location (easier for drivers)

Next, we tackled the lifting mechanism:

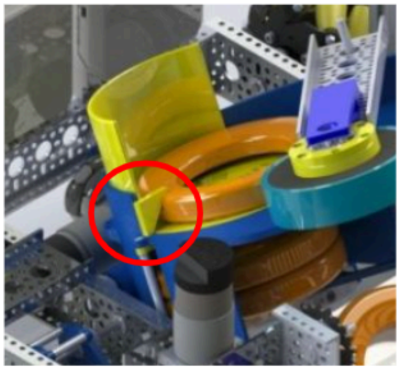


Using only a servo arm to push the baseplate wasn't long or stable enough.

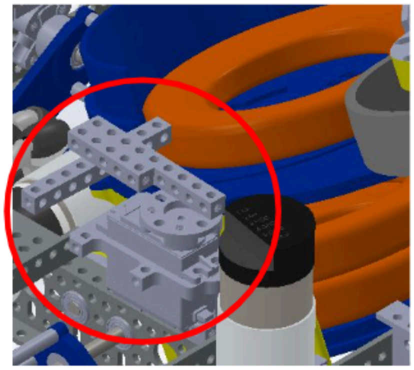


With a simple 3D-printed rail design, we could transform the servo's rotational motion into linear motion that pulls the baseplate up and down.

And finally, we revisited pushing the ring from storage into shooter



We wanted to use a 3D-printed part that would push the ring as it was lifted, but in real life, there was too much friction.

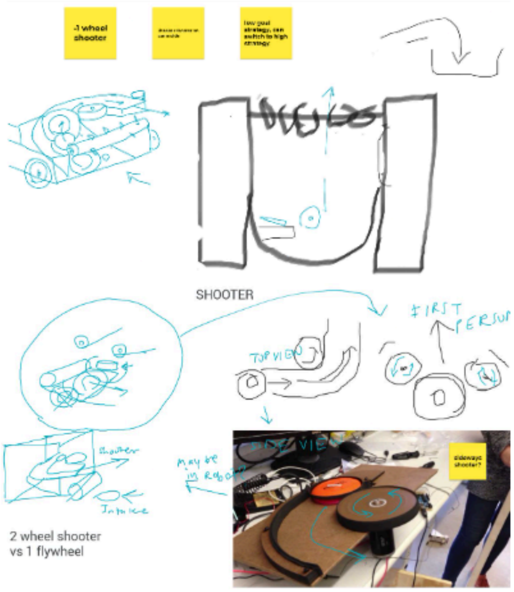


Our final design uses a servo double-arm mechanism to push rings very uniformly.

Once the conveyor brings a ring into the robot, the storage holds the rings while the robot aims, then lifts them up into the shooter.

- Capacity to hold **up to three rings** at a time
- Streamlined sliding rail mechanism powered by one servo

Shooter



When brainstorming, we were inspired by frisbee launchers and past FIRST competition shooters, discussing various factors:

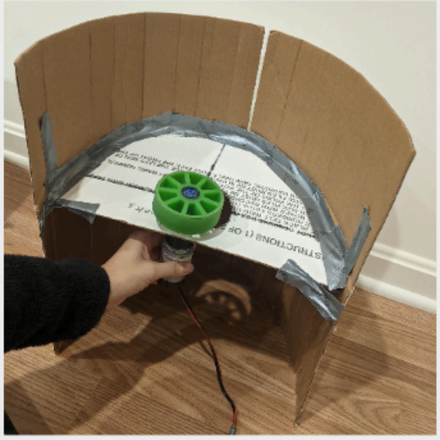
- 1 or 2 **flywheels**?
- Shooter on the same side as the intake or opposite?

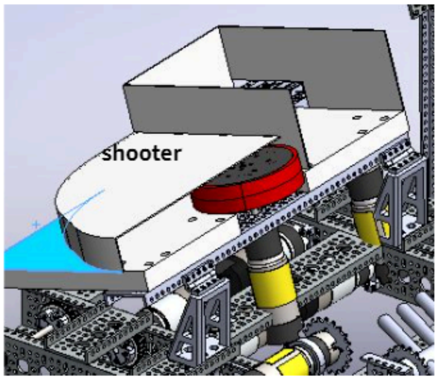
We decided on a ***1 flywheel shooter with a curved track*** *because:*

- **1 flywheel** would give the ring **spin**, making the ring fly straighter (similar to a frisbee because it's **flat and toric**)
- Coordinating **2 flywheels would be difficult for programmers** because they'd have to make sure they spin at exactly the same speed
- We can **intake and shoot from the same side**, eliminating the time taken to turn around every time we shoot

To test this one flywheel design before ordering parts, we built a simple prototype using a compliant wheel, motor and cardboard. **We experimented with various ring compressions by varying the radius** from the center of the compliant wheel and wall of the shooter:

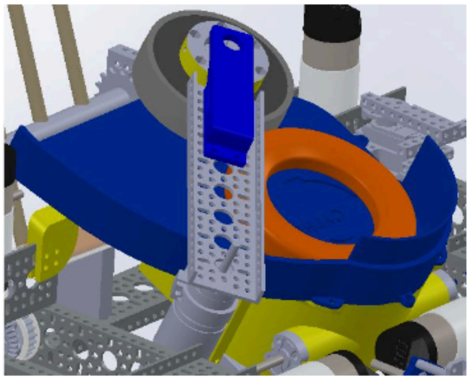
- **5 inches** - the ring did not reliably move through the shooter, not enough contact with flywheel, did not spin ring
- **4.5 inches** - the shooter was able to consistently spin the ring and move it through.





Initial Design:

- Storage attached to side of shooter
- Ramp too steep
- Motor hard to mount
- Base is too bulky



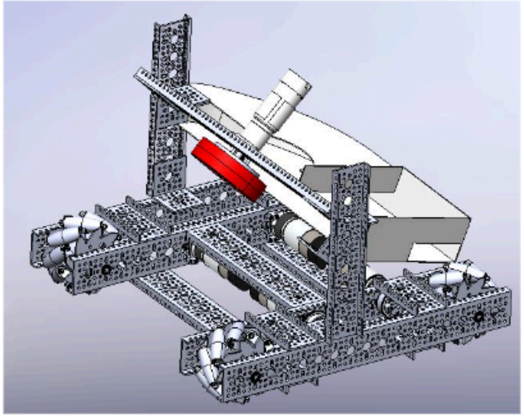
New Design:

+ Much more compact
+ Ramp less steep
+ Upside-down motor is out of the way of other mechanisms
+ Shoots accurately

Shooter

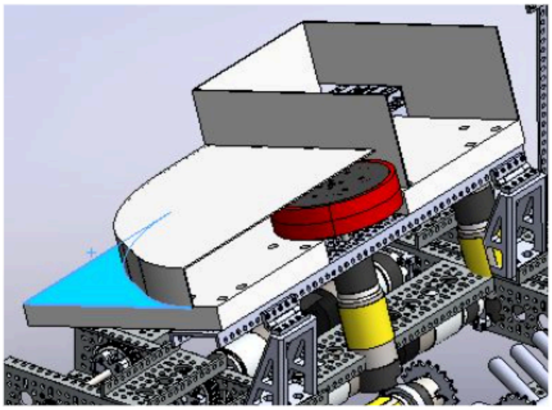
Mounting Options

Vertical Channel Mount



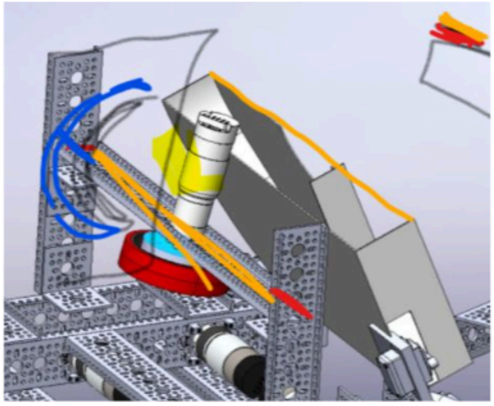
-Channel supporting flywheel motor may block storage

Triangular Mount w/ new shooter base



- + More compact
- + Storage entrance clear
- - Flywheel motor conflicts with chassis

Adjustable Slot



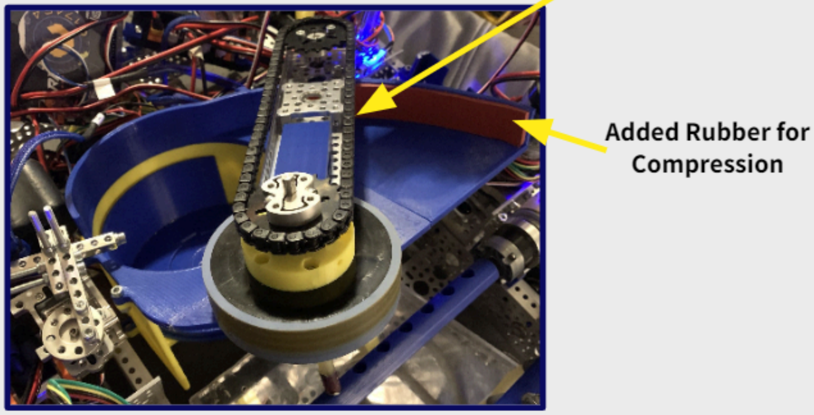
+ Easy angle adjustments
+ More compact than other options
- 3D printed part may break under shooter's weight

The original shooter design was too difficult to mount, so we decided to completely redesign the shooter:

- **Reduce the width** - We moved the storage below the main shooting platform and reduced the shooter to little more than a quarter of a circle
- **Move the motor away from the flywheel** - Mounting the motor upside down would be too unstable, so **we chained the flywheel to the motor,** attached to the side of the storage
- **More compression** - While testing, we discovered that adding compression made the ring fly straighter. We added some rubber on the side of the shooter for increased ring compression and traction

Final Shooter Design:

3D-printed mount (24° angle)



Motor chained to flywheel

Added Rubber for Compression