Engineering Notebook

1532E
SPACE MONKEY MAFIA
BEMIDJI, MN, USA

1532E

Team Number

Space Monkey Mafia

Team Name

Bemidji Area Schools

School

09-19-2022 04-05-2023 1 of 1

Start Date End Date Book #

v1.0.8.29.22

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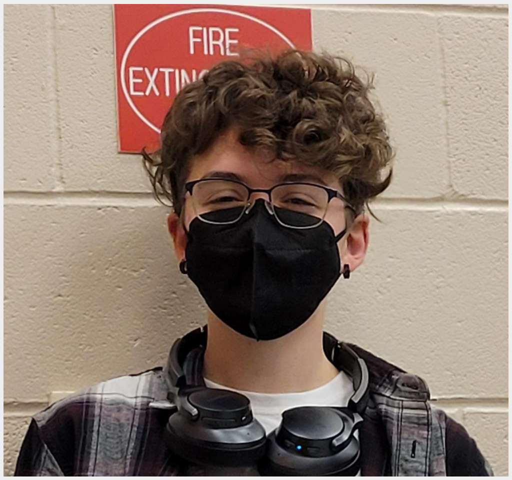
Team Profiles

Section T

Quinn Burrow

Programmer / Driver / Scout

9th grade - 5th year of VEX



Aster Burrow

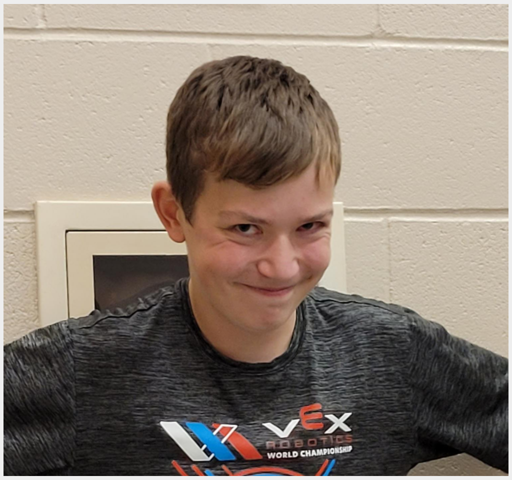
Builder / Programmer / Designer

12th grade - 4th year of VEX

Kaden Haugen

Builder / Driver

9th grade - 4th year of VEX



Sam Stalboerger

Designer / Scout

9th grade - 3rd year of VEX

Project Team Profiles - 1

Name Aster Burrow and Quinn Burrow Date 09-23-22

Calendar

Section C

Sept. 2022

1	T -
2	F -
3	S -
4	S -
5	M - Holiday - Labor Day
6	T - School - First Day
7	W -
8	T -
9	F -
10	S -
11	S -
12	M -
13	T -
14	W -
15	T -
16	F -
17	S -
18	S -
19	M - Robotics - meet with team members and begin strategizing
20	T -
21	W - Robotics - More team members arrive, establish basic design plans
22	T -
23	F -
24	S -
25	S -
26	M - Robotics - Discuss design and challenges, more members arrive
27	T -
28	W - Robotics - Finalize design and start work on drivetrain
29	T -
30	F -
31	

Project Calendar

Name Aster B.

Date 09-19-22

Oct. 2022

1 S - Robotics - No team members were able to attend
2 S -
3 M - School - No School; Staff Development Day
4 T -
5 W - Robotics - modify drivetrain for stability and work on logo concept
6 T -
7 F -
8 S -
9 S -
10 M - Robotics - Added disk guards
11 T -
12 W - Robotics - Began making intake
13 T -
14 F -
15 S -
16 S -
17 M -
18 T -
19 W - Robotics - Continued work on the intake. Built a flywheel ratchet prototype
20 T - School - No School; Education Minnesota
21 F - School - No School; Education Minnesota
22 S -
23 S -
24 M - Robotics - add extra wheel to intake, intake is done
25 T -
26 W -
27 T -
28 F - Robotics - build basic shape of shooter
29 S -
30 S -
31 M -

Project Calendar
Name Aster B.
Date 10-01-22

Nov. 2022

1 T -
2 W - Robotics - assemble flywheel and ratchet mechanism
3 T -
4 F - School - No School
5 S -
6 S -
7 M - Robotics - add second motor to flywheel
8 T -
9 W - Robotics - build indexer, switch flywheel to blue cartridges
10 T -
11 F - School - End of Term 1
12 S -
13 S -
14 M - Robotics - build roller mech, prototype string shooter for endgame
15 T -
16 W - Robotics - practice matches with 1532F, tune flywheel, work on endgame
17 T -
18 F -
19 S - Robotics - Fisher Robotics Competition
20 S -
21 M - Robotics - begin work on new catapult setup, rework indexer for size
22 T -
23 W - Robotics - Time for auton programs (unfinished as of Dec.2)
24 T - Holiday - Thanksgiving; No School
25 F - School - No School
26 S -
27 S -
28 M - Robotics - Checked size of robot, worked on intake/indexer
29 T -
30 W - Robotics - finish string catapult, minor adjustments to the robot
31

Project Calendar
Name Aster B. Date 11-01-22

Dec. 2022

1 T -
2 F -
3 S - Robotics - Pioneers Robotics Competition in Thief River Falls
4 S -
5 M -
6 T -
7 W - Robotics - Start to rebuild the intake for efficiency
8 T -
9 F -
10 S -
11 S -
12 M -
13 T -
14 W - Robotics - Test the robot, learn the flywheel is misaligned, discuss 6m drive
15 T -
16 F -
17 S -
18 S -
19 M -
20 T -
21 W -
22 T -
23 F - Holiday - Winter Break Starts; No School, Kaden takes the robot
24 S -
25 S -
26 M -
27 T -
28 W -
29 T -
30 F -
31 S - Aster receives the robot from Kaden

Jan. 2023

1 S -
2 M - Holiday - Winter Break Final Day; No School
3 T -
4 W - Robotics - Flywheel works, intake is broken. Attempts to fix it failed
5 T -
6 F -
7 S -
8 S -
9 M - Robotics - Fixed the intake, but it is oversized
10 T -
11 W - Robotics - Start to modify the robot to fit the size requirements
12 T -
13 F - Kaden - Run into issues fixing the robot, decide to rebuild to catapult
14 S - Kaden - Build 6m drivetrain, start building catapult
15 S - Kaden - Build catapult mechanism
16 M - School - No School; MLK Jr. Day | Build catapult mechanism
17 T -
18 W - Robotics - Change placement of rubber bands and gearing of catapult
19 T -
20 F - School - End of Term 2 | Robotics - NW MN Competition in East Grand Forks
21 S - Aster - Rebuild to linear flywheel, build drivetrain
22 S - Aster - Start working on the linear flywheel/intake
23 M - Robotics - Work on the intake and plans for expansion
24 T -
25 W -
26 T -
27 F -
28 S -
29 S -
30 M - Robotics - remove wiggle room in intake, wiring, space flex wheel rows
31 T -

Feb. 2023

1 W - Robotics - code and test, curve intake polycarb, foam for flywheel, add roller
2 T -
3 F -
4 S - Robotics - Rum River Competition
5 S -
6 M - Robotics - re-gear drive, test, work on expansion
7 T - Kaden - paint the robot's side guards
8 W - Robotics - attach expansion, test w/paint, move roller mech
9 T - Kaden - build expansion
10 F - Kaden - build expansion
11 S - Robotics - Lumberjack Robotics Competition
12 S -
13 M - Robotics - work on auton, lower expansion power
14 T -
15 W - Robotics - take expansion off to tweak intake
16 T -
17 F -
18 S -
19 S -
20 M - School - No School; Presidents' Day
21 T -
22 W - Robotics - finish fixing intake, begin reattaching expansion
23 T -
24 F -
25 S -
26 S - Aster - fully reattach expansion, switch to double-acting pistons, final wiring
27 M - School - No School; Staff Development Day | Robotics - expansion & auton
28 T - Robotics - Sam and Kaden drive practice, scrimmages with 1532F
29
30
31

Mar. 2023

1	W - Robotics - final testing and packing, scrimmages with 1532F
2	T - Robotics - State Robotics Competition - Start
3	F -
4	S - Robotics - State Robotics Competition - End
5	S -
6	M -
7	T -
8	W -
9	T -
10	F - School - No School
11	S -
12	S -
13	M -
14	T -
15	W -
16	T -
17	F -
18	S -
19	S -
20	M -
21	T -
22	W -
23	T - Received Worlds invite
24	F - School - End of Term 3
25	S -
26	S -
27	M - Robotics - Fixed intake
28	T - Robotics - Weighted flywheel
29	W - Robotics - Made pneumatic disk stop
30	T - Robotics - Regeared drive base
31	F -

Apr. 2023

1 S -
2 S -
3 M - Robotics - Worked on promo bot, finished logo
4 T - Robotics - Cancelled due to weather
5 W - Robotics - Cancelled due to weather
6 T - Robotics -
7 F -
8 S -
9 S -
10 M - Robotics -
11 T - Robotics -
12 W - Robotics -
13 T - Robotics -
14 F -
15 S -
16 S -
17 M - Robotics -
18 T - Robotics -
19 W - Robotics -
20 T - Robotics -
21 F -
22 S -
23 S -
24 M
25 T - First day of Vex Worlds 2023
26 W -
27 T - Last day of Vex Worlds 2023
28 F -
29 S -
30 S -
31

Project Calendar
Name Kaden Haugen
Date 04-01-23

Daily Log

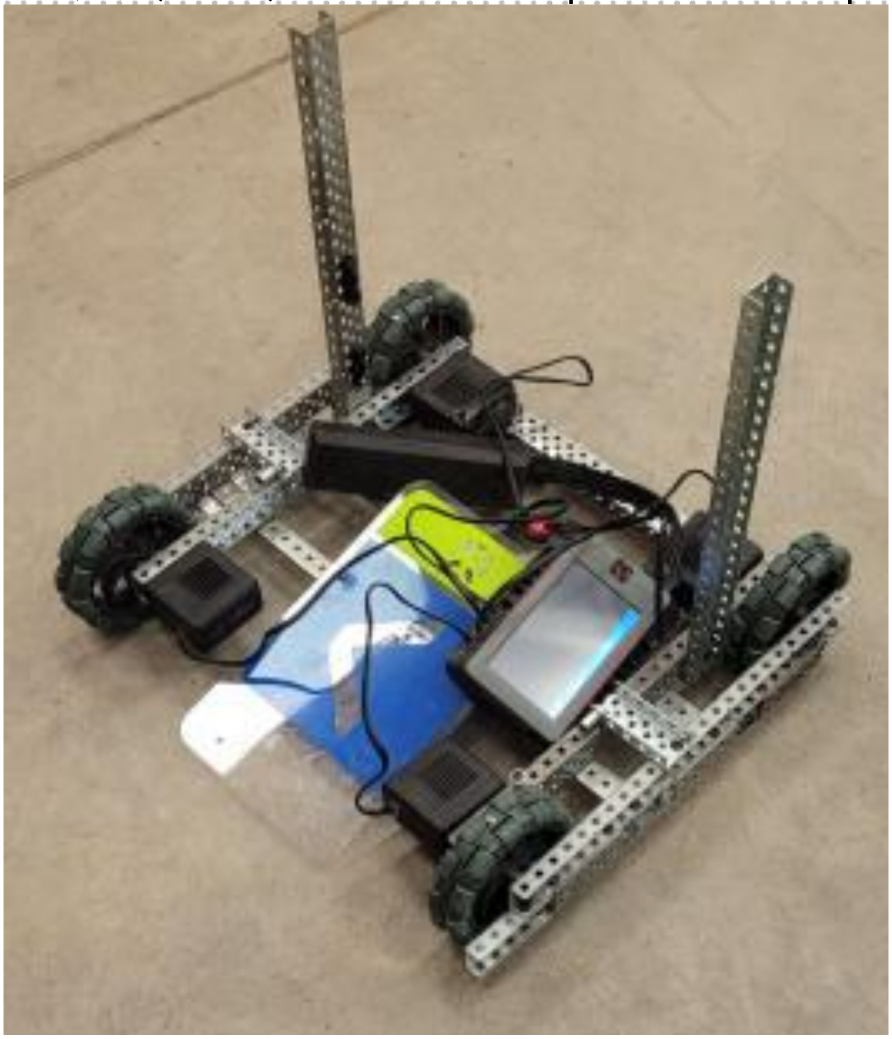
Section DL

On September 19, we met for the first time and discussed plans and strategies for the robot. We specifically focused on how to maneuver the rollers (discussed in detail on pg E1) and the possibility of adding a flywheel to shoot discs into the goals. The flywheel was not designed.

We also acquainted a prospective member, Ronik, with the mechanisms used in VEX. He drove a 4-motor drivetrain around and learned about gear ratios.

Quinn began laying out basic code for the rollers and drivetrain as well, he also started to plan out what we'd do for skills and autonomous (explained on pg P1, P2, and P3)

Quinn, Aster, and Ronik were present for this practice.



The practice bot Ronik drove on Day 1.

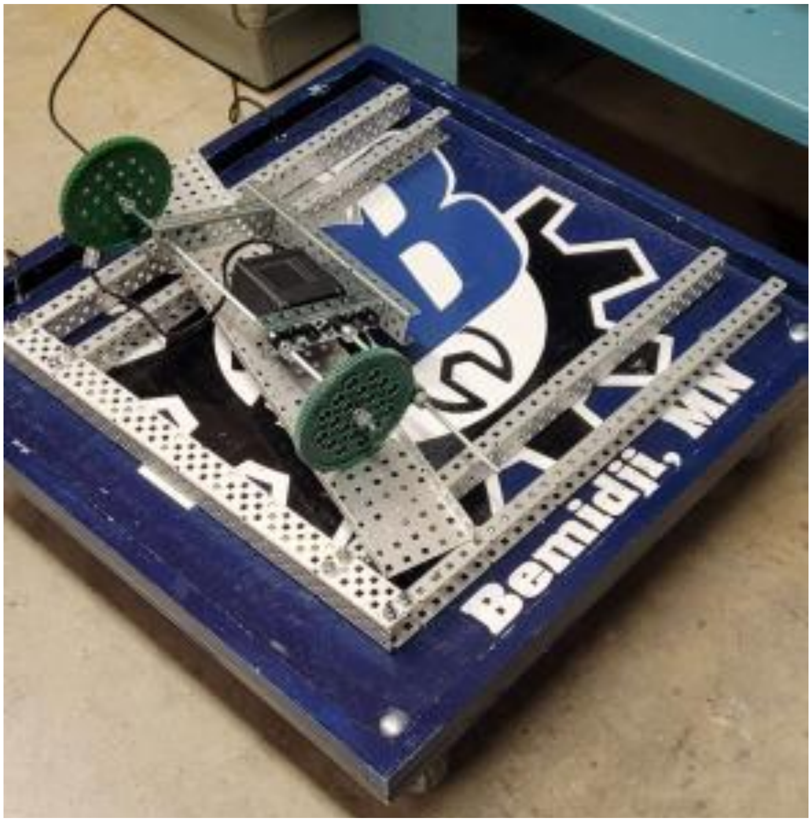
Project Daily Log 1 - Sept. 19

Name Aster Burrow and Quinn Burrow Date 09-24-22

On September 21, we discussed the design of the robot to work with the game. We decided to build the drivetrain with an open front end for disk intake, higher wheels for less clearance for disks to be caught underneath the robot, and a 2-motor omni-wheel drive. We considered putting together an x-drive drivetrain with omni-wheels at 45 degree angles, but decided against putting it in the initial design of the robot. Testing with x-drive is possible in the future because its increased speed and maneuverability would be beneficial for shooting and defense in this game. Kaden started to build the drivetrain, but did not finish. A more in-depth discussion of the drivetrain is on page E3.

We also discussed possible disk shooting designs. We are currently considering a flywheel or a catapult to launch disks into the goals. Designs were sketched for the flywheel, and research was done on both designs. We plan on choosing a design on Monday. Pictures and descriptions of the shooter designs are on page E2.

Quinn has begun coding the robot and has planned out a potential button and wiring map on pages W1 and W2.



A picture of the progress on the robot by the end of the day.

Project Daily Log 2 - Sept. 21

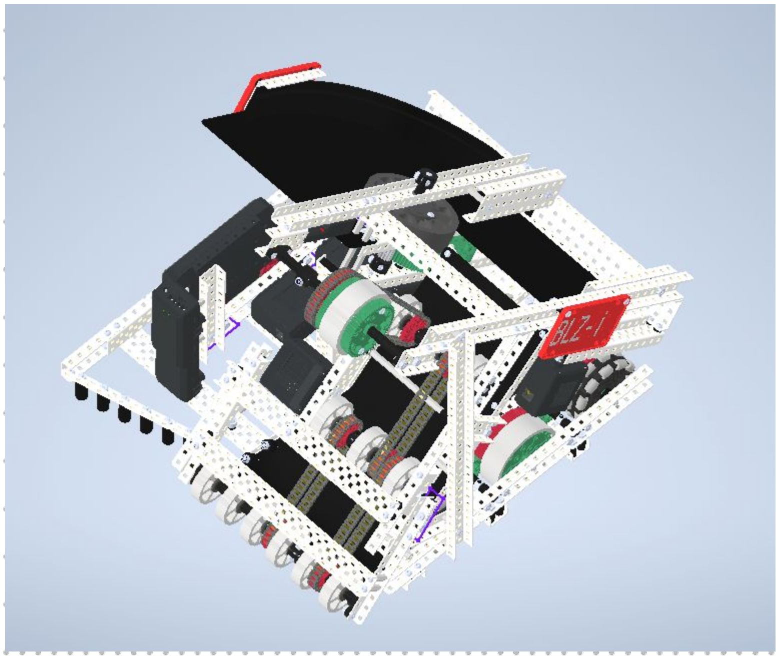
Name Aster Burrow

Date 09-24-22

On September 26, we discussed the design in more detail. We decided to take inspiration from Harvard-Westlake's BLZ-i robot (1) for ideas. We made a list of modifications we would like to make from that design. The list is:

- Make wheel guards out of spacer rollers
    - Spacer rollers are spacers hanging down on a bolt with room to move freely. They would deflect disks without the extra weight or waste of material that an extra lower guard bar would take up. Discussed on page E5.
- Make a flywheel ratchet vs. direct attachment of motor for less stress
- Put a vision sensor on the roller controller to automate it
    - This may require that the roller controller would be in a different position on the robot so that there is room to position a vision sensor above it comfortably.
- Put pneumatics on the indexer
- Create an expansion device for endgame (E7)

BLZ-i has made us consider design choices we have made thus far, such as the size of our wheels and how to build the flywheel. If the wheels are made to be smaller than the 4-inch omni-wheels we are planning on using, there will be less space between the robot and the floor, making it harder for disks to get under the robot. An in-depth description of the flywheel design and its changes is on page E4.

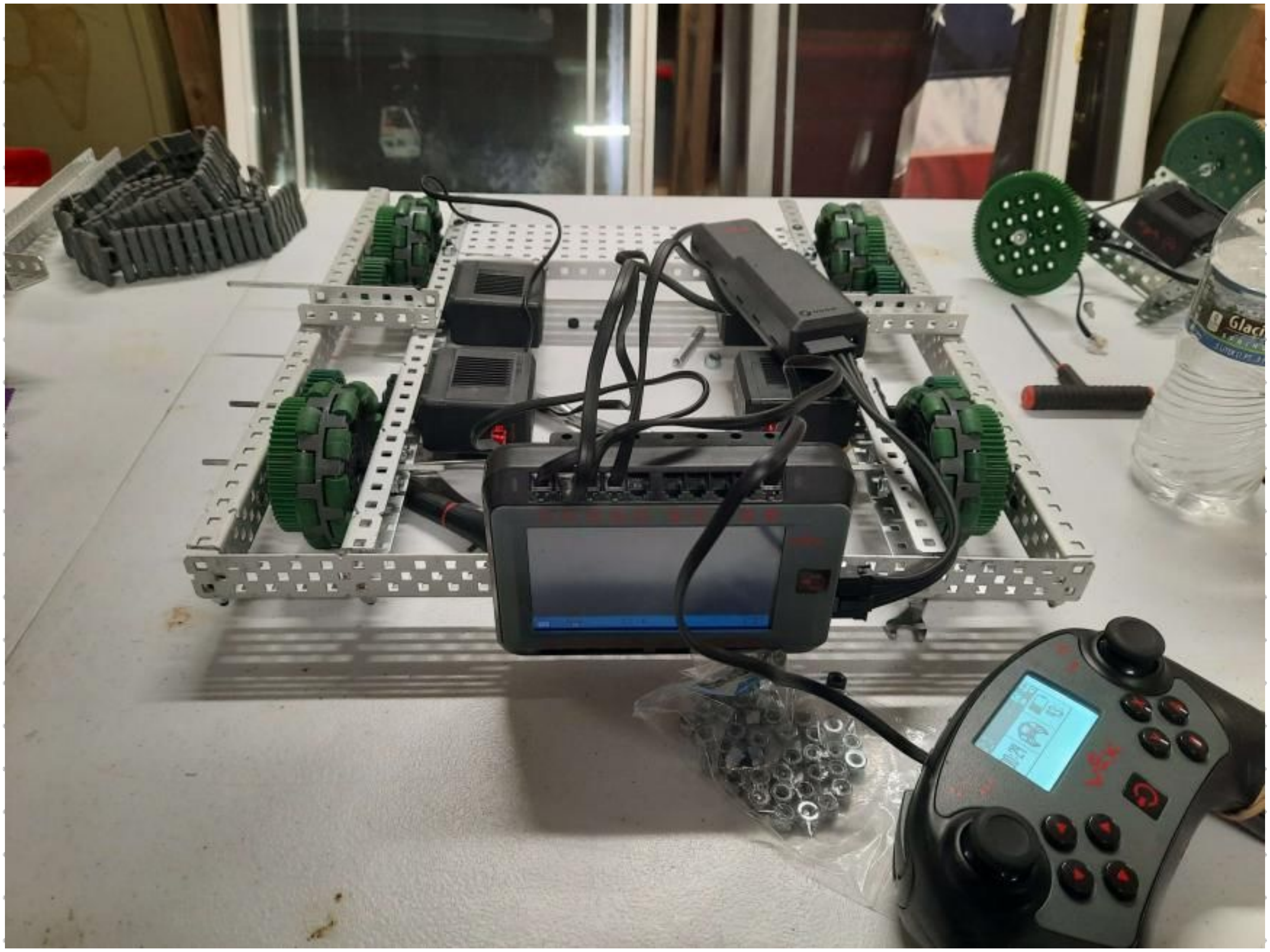


A picture of BLZ-i, the robot we are taking inspiration from.

1 - https://www.vexforum.com/t/harvard-westlake-robotics-blz-i-reveal/104867

On September 28, we finalized the design plans for the robot and continued to construct the drivetrain. The finalized design plans are on page E8.

The drivetrain was not finished during practice, but was taken home by Kaden over the weekend and finished by October 5, our next meeting date.



An image of the robot as of October 1.

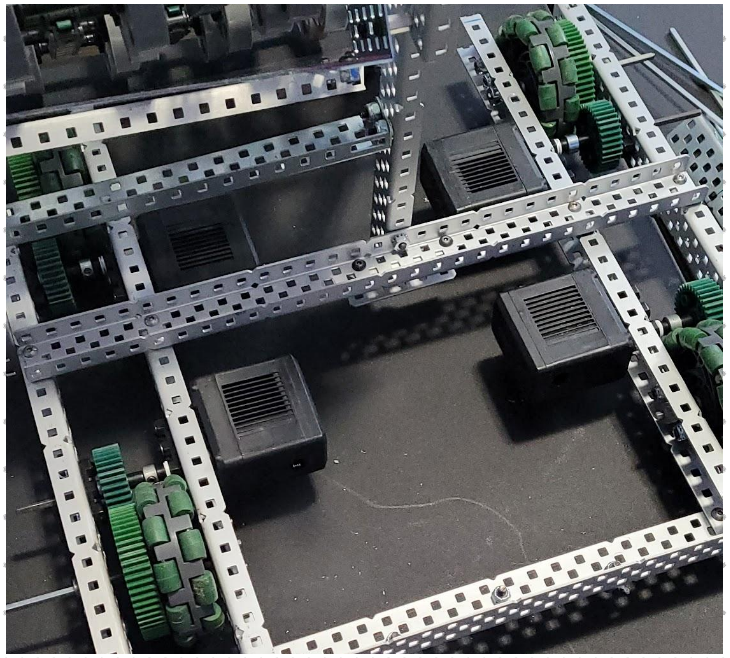
Project Daily Log 4 - Sept. 28

Name Aster Burrow Date 09-29-22

On October 5, we modified the drivetrain to increase stability and space for the intake. Instead of a piece of 1x5x1 c-channel near the front of the drivetrain, there is a piece of 1x2x1 c-channel that spans the entire robot in between the wheels. This allows more space for the intake and greater overall stability, as the wheel assemblies are held to exact distances by the c-channel.

By the end of the practice, we had a stable drivetrain and were beginning to discuss the intake.

A picture of the bar installed across the drivetrain for stability

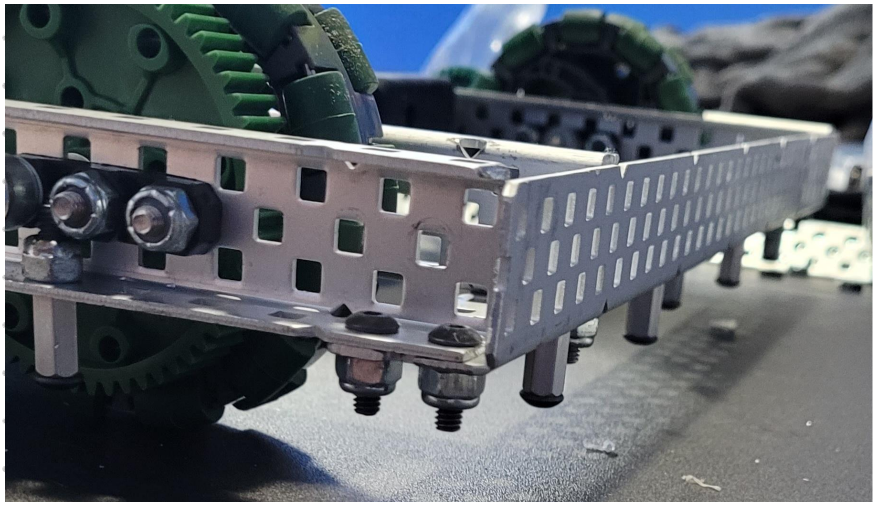


On this day, we named our team Space Monkey Mafia and began to work on a logo as a side project. The initial concept for the logo is in the image below.

Project Daily Log 5 - Oct. 5

Name Aster Burrow Date 10-07-22

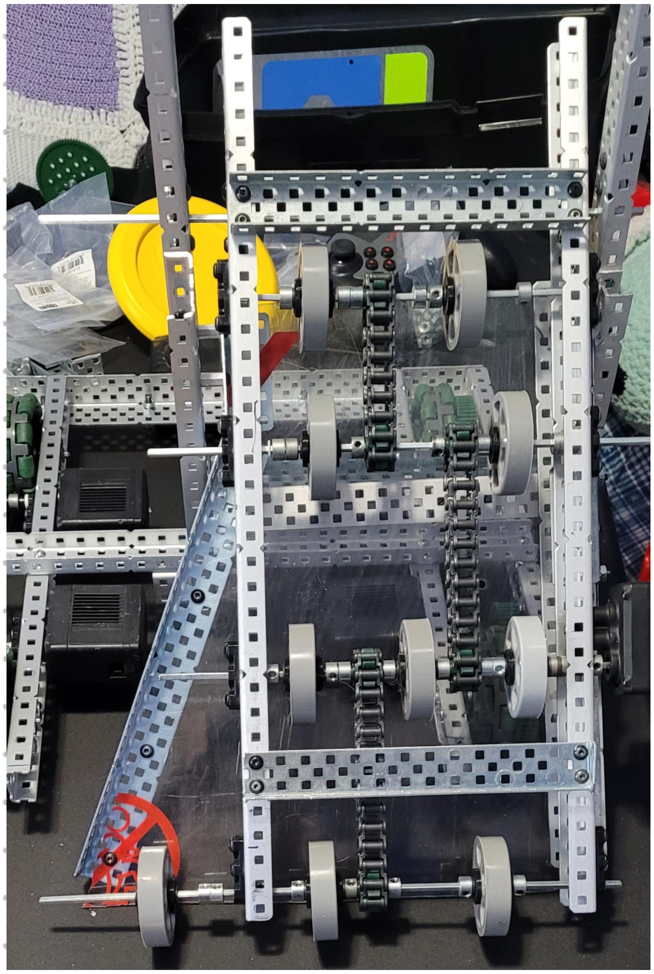
On October 10, we added guards around the base of the drivetrain to prevent disks from getting underneath the robot. The guards are made of short standoffs with screws running through them into the C-channel of the chassis. They are positioned approximately 6 holes apart, though they really just need to be less than the diameter of a disk apart.



A picture of the placement of the disk guards.

On October 12, we began the construction of the intake, which is largely based on the intake on Harvard-Westlake's robot, BLZ-i (1), because we chose to build a 90 degree flywheel and saw their intake as the best possible configuration for it. Our intake pivots at its top to allow disks to be more easily taken in.

A picture of the initial configuration of the intake.



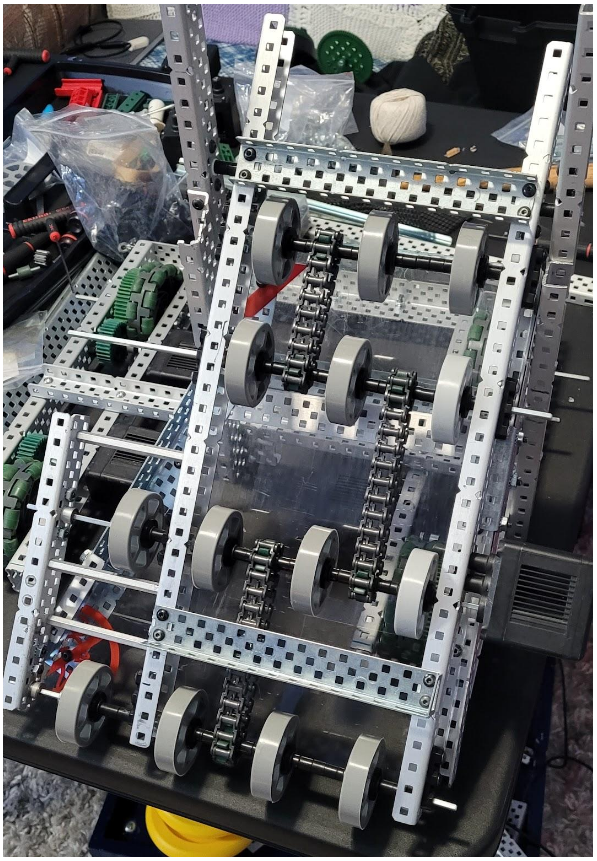
Project Daily Log 6 - Oct. 10 & 12

Name Aster Burrow

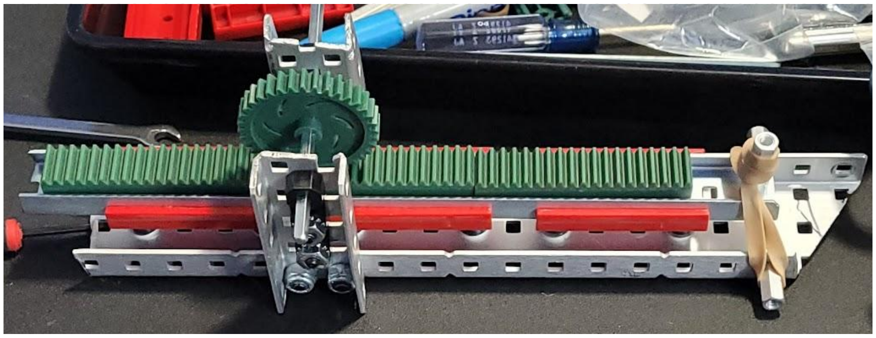
Date 10-22-22

On October 19, we continued to work on the intake, adding more flex wheels, making the structure more stable, adding an extension to one side to increase contact with disks in the intake, and adding stops to prevent the moving section of the intake from slamming into the polycarbonate and dragging on it.

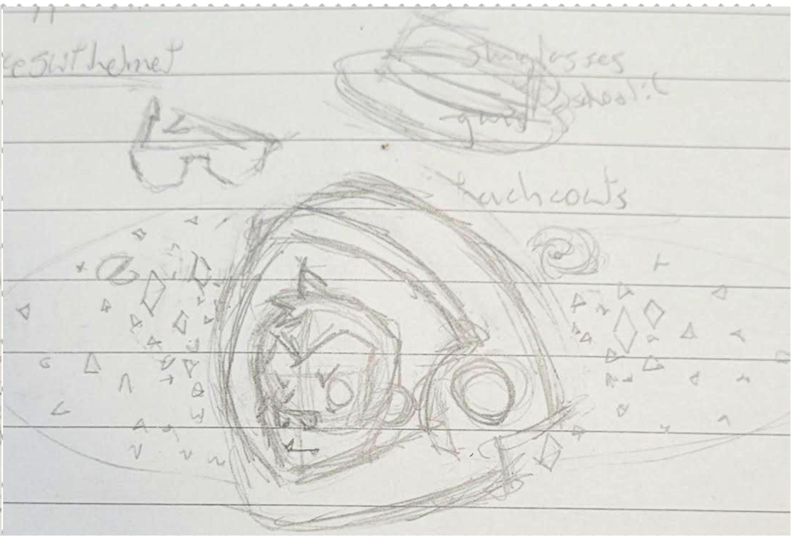
A picture of the intake as of October 22, 2022



We also began to conceptualize the string-shooting punchers. Below is a basic design for testing.



We continued the team logo discussion and came up with concepts to work on in the future. Pictures of the concepts are shown below.



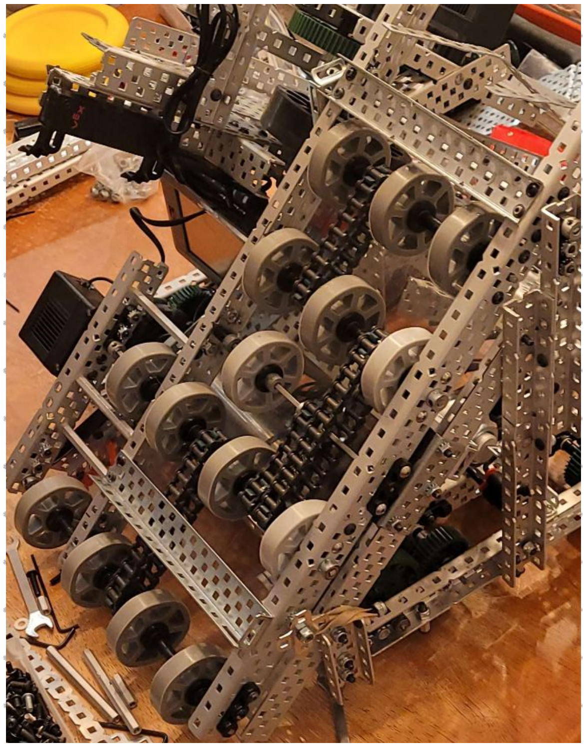
Project Daily Log 7 - Oct. 19 & 22

Name Aster Burrow

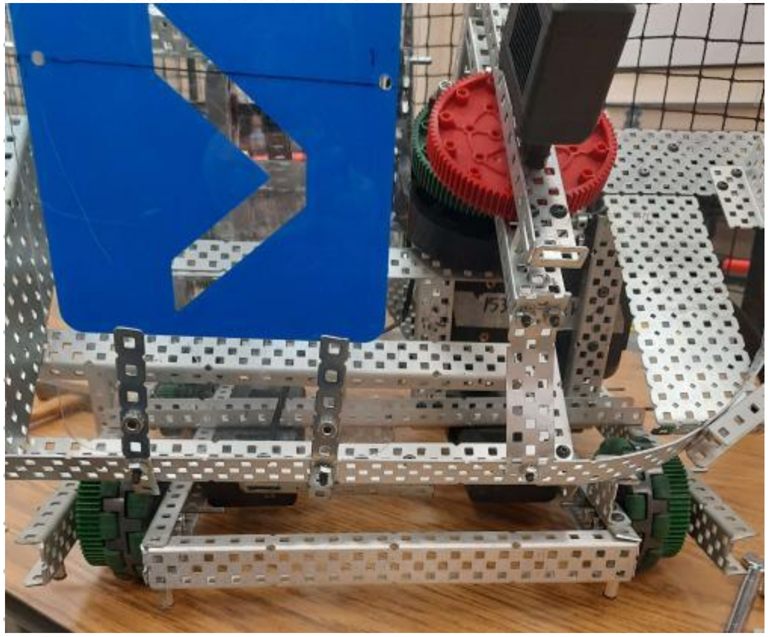
Date 10-22-22

On October 24, we noticed an issue with the intake where the disk would get stuck in a certain place and be unable to load into the indexer area. To accommodate for this, we added another flex wheel to the intake that is positioned 1 hole lower than the rest of the assembly to catch disks that get stuck there.

An image of the intake with the extra wheel added to it.



On October 28, we built the basic shape of the shooter, which allows space for an indexer and the flywheel itself. Motors will be mounted on top of the structure.



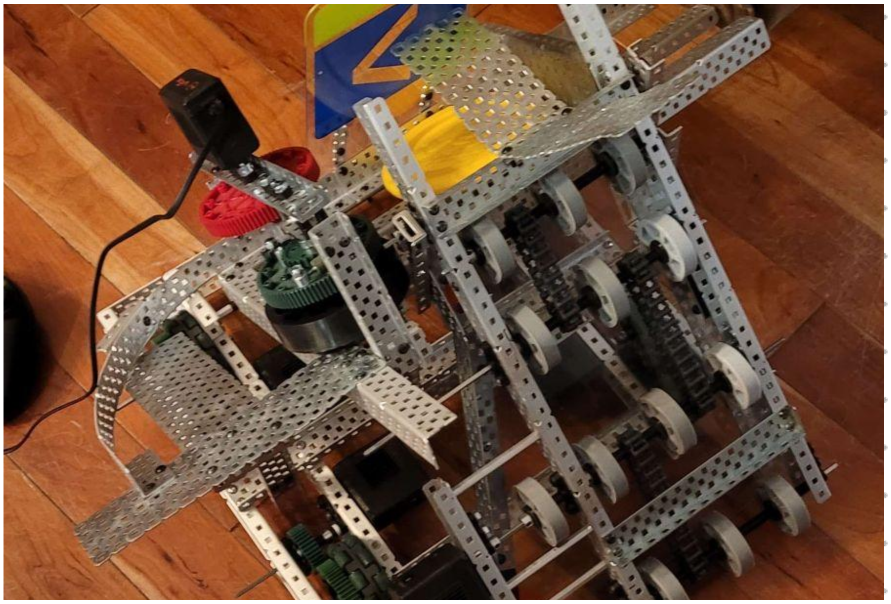
An image of the general shape of the shooter from the back. It is partly obscured by a temporary back plate.

Project Daily Log 8 - Oct. 24 & 28

Name Aster Burrow

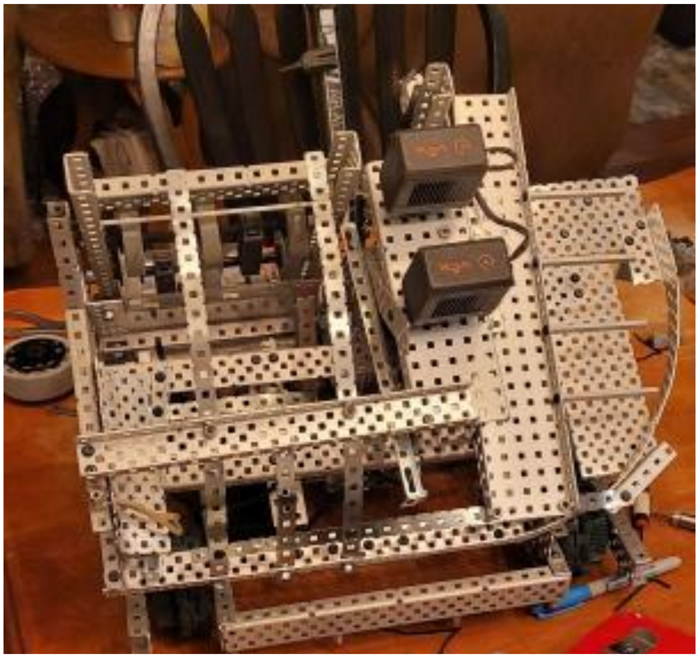
Date 11-15-22

On November 2, we assembled the flywheel and ratchet mechanism with 1 directly run motor attached with a 12:84 gear ratio. We found that the flywheel took a long time to get up to speed and that the disk could not travel very far, as it hit the ground at 5 feet.



An image of the assembled flywheel.

On November 7, we added a second motor to the flywheel. It now shoots disks to 14 feet on the ground and around 6 feet to the goal. We noticed that the flywheel now takes less time to speed up, but the wait time is still an issue. On this day, we addressed sizing concerns by removing an inch off of the back of the robot and chopping our excess parts. The robot is now within the 18” cube size requirements. While doing this, we added some extra pieces for the stability of the shooting mechanism and for guiding disks from the intake to the indexer.



An image of the parts that have been added to the robot for stability and guiding disks.

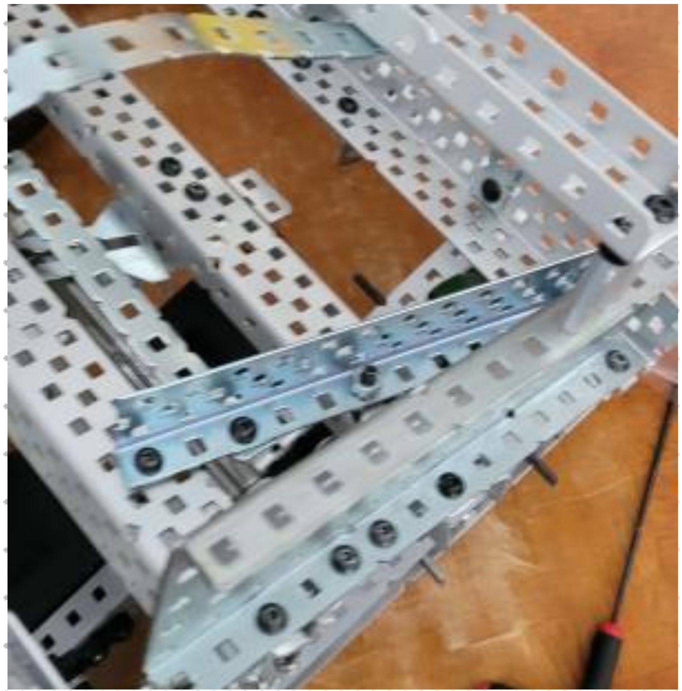
Project Daily Log 9 - Nov. 2 & 7

Name Aster Burrow

Date 11-15-22

On November 9, we built the first iteration of the indexer and changed the flywheel motors from directly running to blue cartridges. The indexer has issues with running multiple disks at once and gets stuck, but can reliably run two disks in the queue. We switched the motors to blue cartridges for the added torque, as we needed the flywheel to speed up faster. It now reaches maximum speed at around 2 seconds compared to around 6 and shoots slightly farther.

A close-up image of the indexer. The lighter blue-tinted piece of steel is its arm, the leftmost screw in that piece is the pivot point, and the next screw down is attached to a piston to pull it back and forth.



Project Daily Log 10 - Nov. 9

Name Aster Burrow

Date 11-15-22

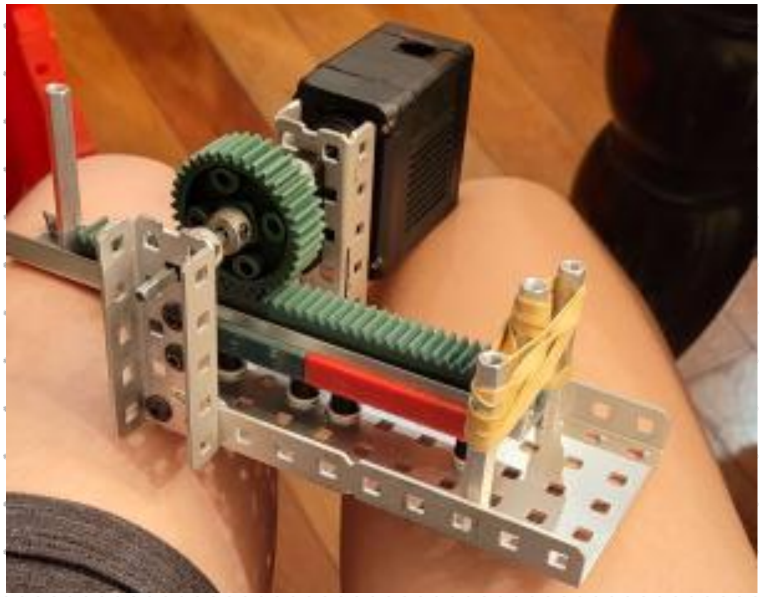
On November 14, we built the roller mechanism, prototyped the punchers further, and tried to troubleshoot the indexer.

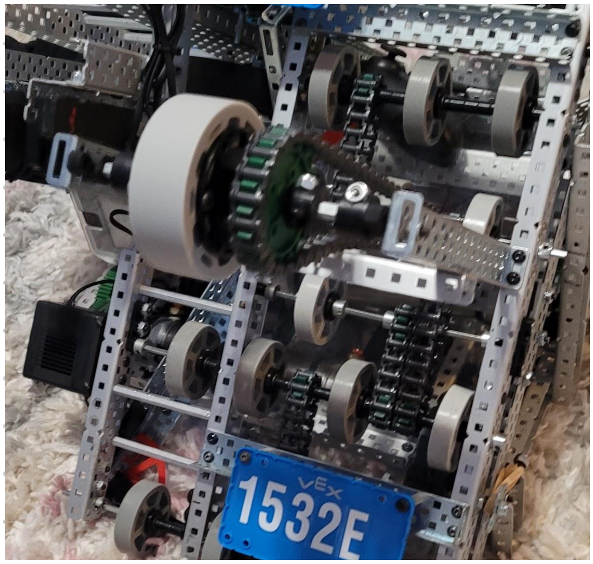
The roller mechanism is running off of the intake to conserve motor usage and utilizes a 3” flex wheel placed slightly lower than the roller to better control its movements and avoid slipping on the roller.

The punchers have gotten slightly wider to allow for space for the winch we are planning to punch, but they were shortened and need the motor to be further back to allow it to pull the rubber bands further and hit the winch harder, as it is barely travelling under the current force. We are planning to use 17 feet of string for field coverage, which seems to work with the yarn we are testing with.

We tried to make the indexer work with three disks in the queue, but were unsuccessful. The third disk continued to get caught in between the guide for the intake and the indexer. We are planning on working on it after the Fisher competition, as we believe it will work well enough for a first competition.

An image of the puncher without the teeth shaved off the gear. It is currently running off of a green cartridge, but needs a red one for the torque. The track must also be extended and the motor must be placed further back. We are planning on putting 17’ of string on it for maximum field coverage.





An image of the roller mechanism.

Project Daily Log 11 - Nov. 14

Name Aster Burrow

Date 11-15-22

On November 16, we continued work on prototyping the string shooters, ran some practice matches with our sister team, 1532F, and tuned our flywheel to shoot at a specific distance.

For the string shooters, we ran them with a red cartridge motor and realized it was unable to pull back far enough to shoot more than a few inches. To remedy this, we extended the track, added a larger gear to the motor, and moved the motor further back. We plan to test it as soon as possible.

We also received our legal string and realized the winch could only hold 5 feet of it, which would not work for expansion as we need to cover as many tiles as possible. We are planning on either making our own holding device with gears and a shaft or making a pocket underneath the string shooter to contain the string.

During our practice matches, we realized our shooter's distance, while impressive for what it is, is incredibly difficult to aim. We decided to run the shooter at 500 rpm instead of 600 rpm so that we could aim reliably from the low goal markers on the field, which would supply us with a stop we can butt up against for fast unloading. The current shooter settings require more testing, which we are hoping to do in the two hours before matches begin at Fisher this Saturday.

Project Daily Log 12 - Nov. 16
Name Aster Burrow
Date 11-17-22

On November 18, we tested our string puncher and decided to go in a different direction for endgame expansion.

Before testing the puncher, we added a baseball glove-like structure to hold excess string, as the winch we currently have tied to the end of the string can only hold 5 feet of paracord.

When testing the puncher, we found that it could only shoot up to 5 feet of string and barely fit within the sizing limits. The motor could not handle more rubber bands on the puncher and there was not enough space to gear it for torque. As we were aiming to shoot diagonally on the field, we decided to move in a new direction with the endgame.

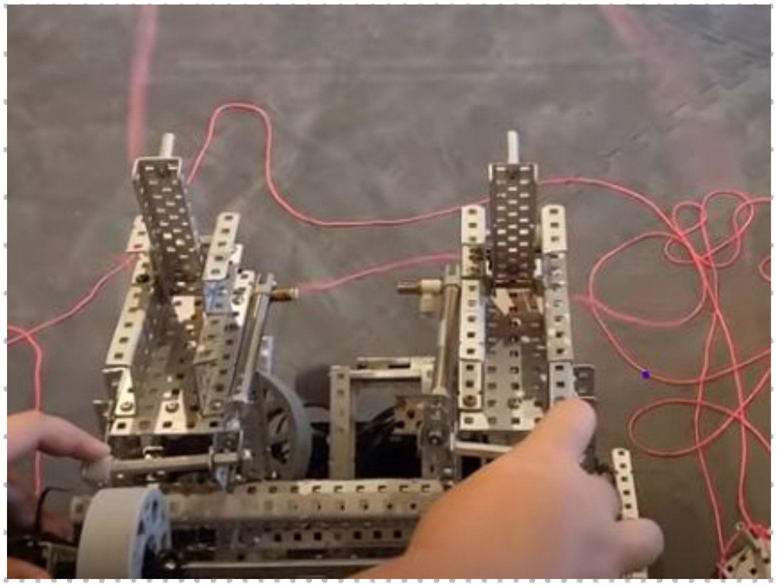
While thinking of a new design for endgame, we decided we wanted something similar to the puncher, but more powerful. The device that most completely fit our needs was a catapult. We had a basic design for a catapult, but were looking for ways to release them that did not take up much space. For this, we turned to Youtube. For our catapult, we were inspired by https://www.youtube.com/watch?v=1oB_EFhmjn0&ab_channel=ConnorHoward and https://www.youtube.com/shorts/UJsOMYRsEcg. From these designs, we decided we wanted:

- A separate storage area for string
- To keep the winch as a counterweight
- To load the catapult with rubber bands
- A long arm on the catapult to account for the weight of the string
- To release the catapult by actuating a piston that is attached to a long screw or a standoff
- To add more counterweights in the future for maximum coverage

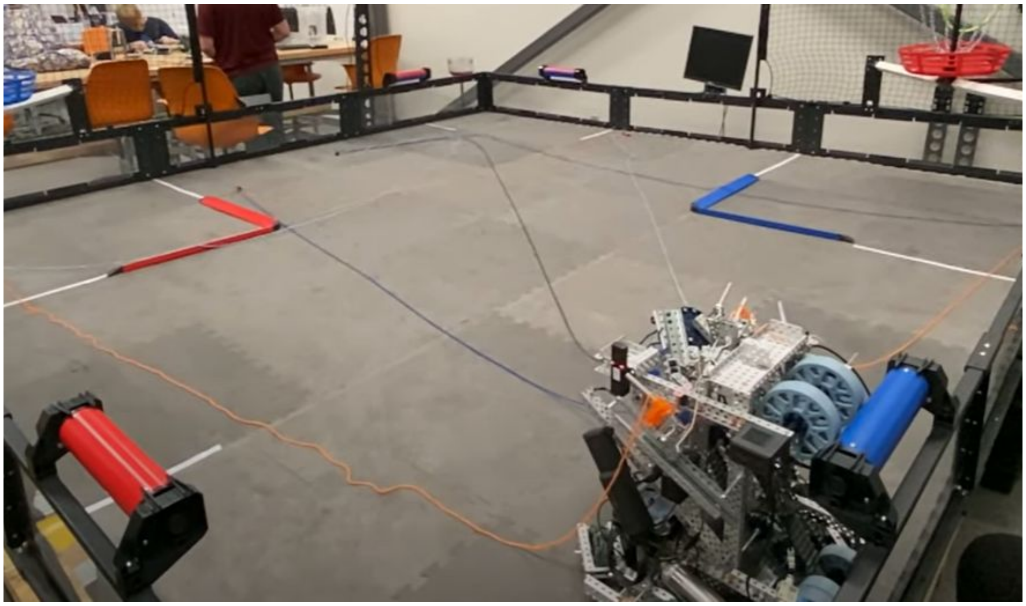
Continued next page

After deciding these things, we realized we did not have a piston or solenoid to release the catapult. Instead, we had to substitute a motor in a space that would not allow for it. For this reason, we decided not to implement the catapult for the Fisher competition. More work will be done on the catapult when we have access to more materials on Monday.

As the building and scrapping of the catapult happened quickly, we did not have a chance to take a picture of it. It was mounted above the shooter to take advantage of the existing 45° angle. The pivot was located directly above where the disks leave the shooter, and the arm extended back to the other end of the robot. The string was stored in the cup structure where the counterweight sits for the time being, but we had plans to move it later on. We could not use the catapult because the motor we were using to release it would have stuck out ¼" too far on the back of the robot.



A screenshot from the second linked video. It shows two string shooters that are released by actuating pistons.



A screenshot of the first linked video. It shows a robot that has shot string in five directions across the field with the string spooled around long standoffs.

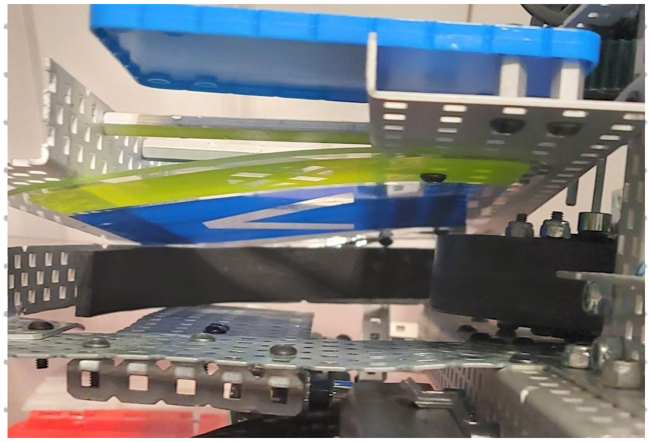
Project Daily Log 13 - Nov. 18, Night Before Competition - continued
Name Aster Burrow Date 11-20-22

At the Fisher event, we made modifications to our flywheel, placed third in qualifications, were the third seed alliance, lost in the semifinals, and won the design award. We are now qualified for the state competition.

When shooting the flywheel, we noticed the speed was pulsating oddly and was causing issues with consistent shooting. We determined that the issue was sensors in the motor after troubleshooting on VEX forum and in unofficial VEX discord servers, and decided to switch our control over motor speed from RPM to voltage. The motors run at 9.6 volts during matches to easily allow us to shoot from the low goal perimeter.

With the flywheel, we were also having issues with disks going out at odd angles and getting jammed in the middle of the flywheel track. The issue appears to be the uneven surface created by the numerous screw heads on the floor of the flywheel, but we did not have a quick enough solution for that, as we had no way to nicely cut polycarbonate at the competition. We did, however, have a cleanly cut piece that was slightly too large for the bottom of the intake, as it would run into the flex wheel, but perfect for the top. We did not have any issues with jamming after installing the plate.

The flywheel had one more issue; it struggled to keep tension between the disk and the flex wheel in the 90-degree curve. We had tried numerous times in the past to bend the track in, but it tended to cause issues in other parts of the robot with alignment. We decided to add a strip of foam to the corner instead, and the flywheel runs perfectly now.



Two images of the flywheel with a plate of polycarbonate attached to its top and a piece of foam on its curve.

Continued next page

Project Daily Log 14 - Nov. 19, FIsher Competition

Name Aster Burrow

Date 11-20-22

During this event, we also made an autonomous that rolls one of the rollers. This was made during the beginning stages of the robot but could not be tested due to the robot needing as much work as it could get.

The only changes made to the code was timing and driving onto the roller while rolling. We saw driving while rolling kept the robot on the roller so we put it in our autonomous.

```
rightDrive.spin(forward);  //roll
 leftDrive.spin(forward);
 intake.spin(reverse);
   task::sleep(800);
   rightDrive.stop();
   leftDrive.stop();
   intake.stop();
```

After this competition, we plan on adding another roller and scoring disks to get an autonomous win point. Most of this will most likely not happen in time for our next competition in Thief River Falls but it will be worked on in the next few weeks.

We also plan on changing from timing to distance as it will be more accurate and possibly faster to test. This will not be done or incorporated in our autonomous' until after our competition in Thief River Falls as we do not have enough time to finish the transition and see it as reliable.

Continued next page

Project Daily Log 14 - Nov. 19, FIsher Competition

Name Quinn Burrow Date 11-20-22

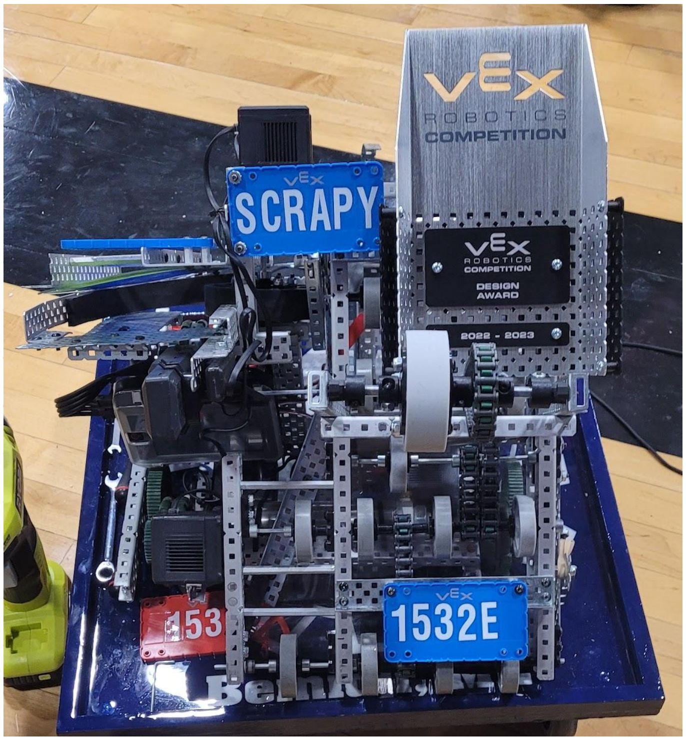
During our qualification matches, we realized the importance of the rollers. As each one scores 10 points, the equivalent of two disks in the high goal, they can entirely change the outcome of a match. For this reason, and the unpredictable state of our shooter in the early matches, we focused on defense and rollers during matches.

After going through the rules, we noticed that possession of disks is defined as when a disk would turn if the robot it is contacting turns. We interpreted this to mean that straight plows are legal, and proceeded to plow disks out of the opponents' low goal near the end of most matches. Although those disks only score one point each, they can add up quickly.

Moving on to the elimination rounds, we still did not have a shooter we could trust. It could make shots, but it was a 50/50 chance with driver error, as Kaden was not used to running it at the time. For this reason, we seeked out an alliance partner with a reliable shooter, and found it in 9821A, synthWave. They had x-drive, a straight flywheel, and a roller mechanism. They filled in what we didn't have, and we made it to the semifinals with them. We lost by two points, but we worked together very well. We hope to find a similar alliance at the Pioneers event on December 3rd.

During our Skills runs, we were able to score 59 points in Driver and 0 points in Autonomous. We were unable to score more driver points because our indexer jammed and we did not have a set plan for Skills. We could not score any points in Autonomous because we were not aware that the rollers start fully on blue for Skills and ran a code that would work if the rollers were neutral. We plan to develop a better Skills plan and a completed Autonomous in the near future.

At this event, we won the Design Award. We were not a contender for the Excellence Award, as we were 8th in Skills and needed to be in the top 5 to be considered. We are now qualified for State and will be focusing more on the long-term improvement of our robot than the short-term for competitions.



A picture of our robot after the Fisher competition with the Design Award.

Project Daily Log 14 - Nov. 19, FIsher Competition - continued

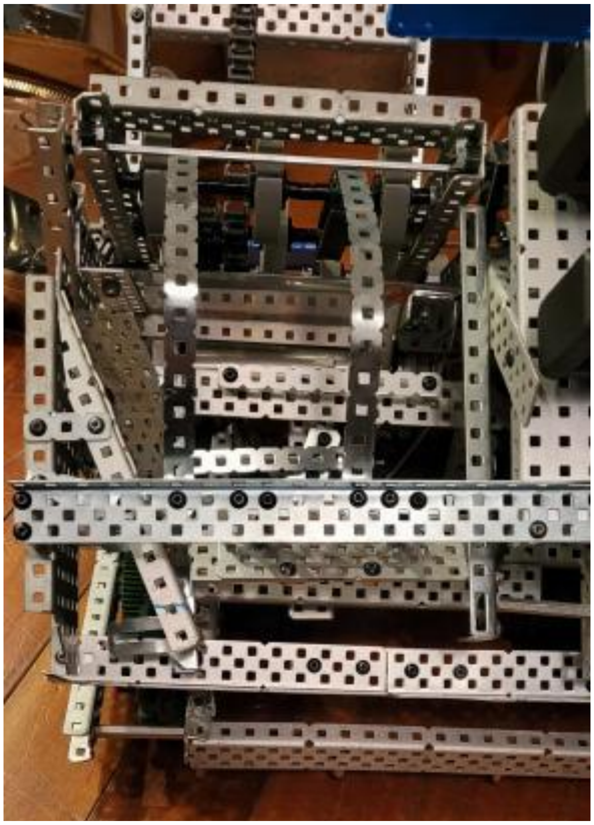
Name Aster Burrow

Date 11-20-22

On November 21, we reworked our indexer to better meet the sizing requirements, began to rework the catapult design from before Fisher to fit on the robot, and ran timed and untimed practice driving times for our less experienced drivers.

At Fisher, we had noticed that the robot was scraping the edges of the allowable size limits, especially around the intake and indexer areas. To make the size more comfortable, we decided to reattach the bar that holds the second and third disks up from the top support bar instead of from the back of the track that contains the disks. We still need to cut some pieces when we have access to a Dremel, but when the pieces are cut down, we should be further inside of the sizing limits.

To make the indexer more reliable, we added a piece of 1x9 flat stock propped up by two short standoffs right behind the exit area of the intake to keep the second and third disks more stable when the bottom disk is pushed into the flywheel.



Two images of the new indexer space.

Continued next page

As for the string catapult, we added a base plate for it above where disks exit the flywheel to take advantage of the 45-degree angle. It is going to be released by a standoff attached at a 90-degree angle to a piston that is held in place by a short piece of slotted angle. The string will be stored next to the catapult and will be enclosed in some sort of cage to protect it from defense from other robots. We are unsure of how far we want to shoot it so far, but having it shorter than 17’, the length of the diagonal of the field, is a necessity, as our weight may fly over the edges of the field with the right amount of force.

During practice, we also had our team members (besides our main driver, Kaden), practice driving. We all ran at least one match, but the most notable was Quinn’s run, as they scored 61 points. Our previous skills run with Kaden had a score of 59 points. These practice runs are part of a larger goal for our team: make sure every member is well-rounded in every aspect of our team. This will allow our small team to function, even if we are short on members for a robotics meet.

As a side project, we’re planning to build a robot out of Cortex parts for use as a secondary cart for our robot. Our current robot cart works well, but its wheels are small and we thought it would be an interesting project to do for fun. We decided to name it Brass Monkey to keep our current theme of song references and animal names going.

An image of the unfinished catapult.

Project Daily Log 15 - Nov. 21 - continued

Name Aster Burrow

Date 11-23-22

On November 23, we gave the entire practice to Quinn for tuning their autonomous programs. While he was doing this, we considered ways we could improve our robot before State.

In terms of general improvements, we decided we wanted to have these things:

- **Faster and more reliable intake**
  - Disks have gotten stuck near the top in the past and we need to resolve this issue to be a more reliable and efficient team.
- **Faster and more reliable indexer**
  - We can do this by adjusting the amount of space the disk has to move around and reducing how far the indexer arm has to travel to push disks into the flywheel.
  - Disks have piled up oddly in the indexer in the past, and we need to take some time to watch it run and understand exactly what causes it.
- **Stronger or different roller mechanism**
  - We have noticed that it is somewhat difficult for our current roller mechanism to control the roller when the screw head on the roller is stuck between the indicator lines. To make turning the roller faster, we want to try and gear it for more torque, and if that doesn't work, take an entirely different approach. For the different approach, we've been looking at passive roller mechanisms, which are shafts with flex wheels held taut by rubber bands and are forced underneath the rollers to turn them. A ratchet mechanism allows the wheels to spin freely when leaving the roller. An example of this mechanism can be found here https://www.youtube.com/watch?v=-8SHYrqKBvk.
- **Second controller to work as a 'switch board'**
  - This would allow us to easily switch between close and far-range shooting, flip the direction of the drivetrain if necessary, and have a more clear-headed driver to decide when to fire our expansion devices, as the main driver tends to be more occupied by defense and scoring points in other areas.
- **Secondary expansion device to be mainly used in Skills matches**
  - Our current expansion is a counterweight that is flung by a catapult, but we want to create a device that will cover more area and therefore gain more points. For this, we plan to shoot off a net for endgame that will cover most of the field. It would be stored underneath the flywheel/indexer setup, as there is a lot of space there due to previous plans to create a wall mechanism for endgame. This device would be mainly used in Skills because there are normally robots all over the field that could block the net.

Continued next page

Our match autonomous during our competition in Fisher was just rolling one roller, we decided it would be better if we rolled two instead. We also plan on making an autonomous that scores a win point but, we don't think it could be finished before our next competition in Thief River Falls.

The two roller autonomous was ready to be tested in the morning and the only things edited was times and directions.

The new autonomous wasn't fully finished, but we were able to get it to roll the first roller and go to the next. All that needs to be done is to make it stop at the right time and turn to the roller, this will most likely be finished on Wednesday.

```
-----------------------------------------------------------------
rightDrive.spin(forward);  //roll
  leftDrive.spin(forward);
  Intake.spin(reverse);
    task::sleep(800);
    rightDrive.stop();
    leftDrive.stop();
    Intake.stop();

  rightDrive.spin(reverse); //drive off roller
  leftDrive.spin(reverse);
    task::sleep(150);
    rightDrive.stop();
    leftDrive.stop();

  rightDrive.spin(forward); //turn
    task::sleep(300);
    rightDrive.stop();

  rightDrive.spin(reverse); //back off roller
  leftDrive.spin(reverse);
    task::sleep(320);
    rightDrive.stop();
    leftDrive.stop();

    rightDrive.spin(forward); //turn to roller
      task::sleep(815);
      rightDrive.stop();

rightDrive.spin(forward); //go to roller
    leftDrive.spin(forward);
      task::sleep(1300);
      rightDrive.spin(forward);
        task::sleep(500);
        rightDrive.stop();

    rightDrive.spin(forward); //roll
    leftDrive.spin(forward);
    Intake.spin(reverse);
      task::sleep(300);
      leftDrive.stop();
      rightDrive.stop();
      Intake.stop();
-----------------------------------------------------
```

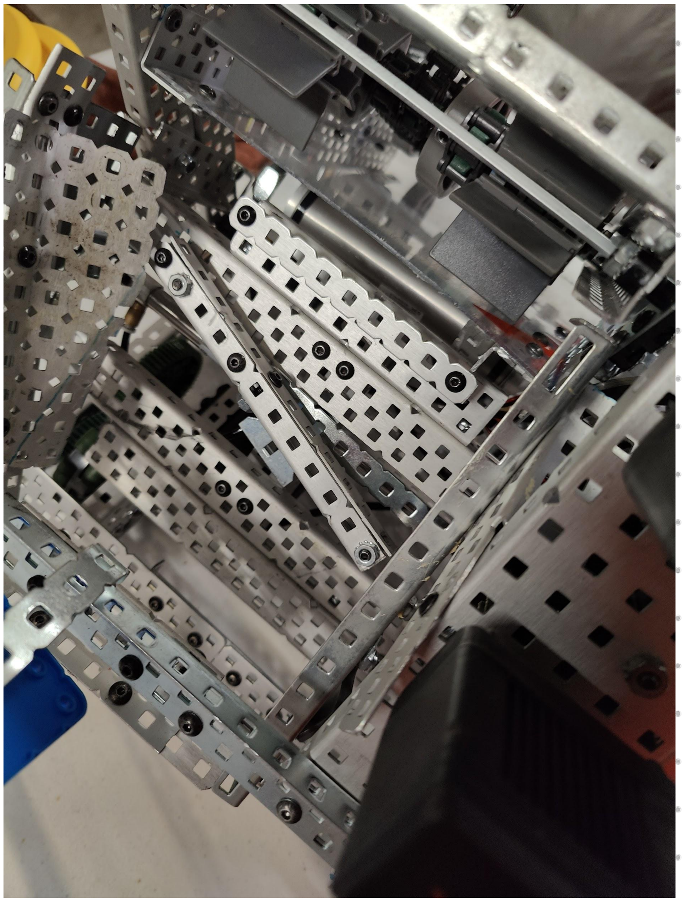
Our current autonomous

Project Daily Log 16 - Nov. 23 - continued

Name Aster Burrow and Quinn Burrow

Date 11-26-22

On November 28th, we started with the simple goals of driving and making sure the robot is going to fit within size properly. This way we can avoid having the same situation as at Fisher where we had to remove our whole expansion but quickly found more issues. We were having many issues with our intake jamming which was fixed with some minor tweaks to the disk guides that keep the disks in the robot instead of them flying off the back. After adjusting them a little bit, our intake is now feeding into the “magazine” properly which was where we found another issue. Whenever I would run our indexer it would either feed 2 disks or jam on its return stroke. By this point we were at the end of our in school practice so I brought the bot home to continue the work. After getting set up I discussed the issue with Aster and Quinn who were not at practice today due to FIRST overlapping in our Discord server and Aster suggested switching our indexer to 2 pieces of 1 x 1 aluminum angle screwed together to make a box so I started on that. After I made the piece to replace the indexer I began removing the original one, which was difficult due to the tight space in which it was built, but I eventually got it off and set to work on installing the new one. I used all of the same mounting holes as the original one, however, I had to add a small spacer to the main pivot point due to the screw heads on the bottom causing the indexer to sit a bit higher. I got it mostly reinstalled today, however I have not had a opportunity to test it yet.



A picture of the new indexer arm extended.

Project Daily Log 17 - Nov. 28

Name Kaden Haugen

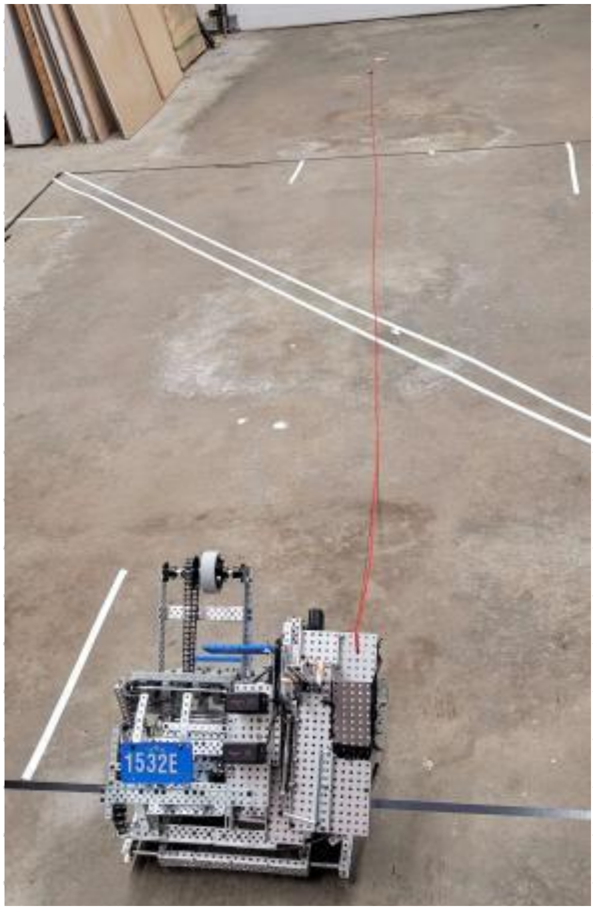
Date 11-28-22

On November 30, we adjusted parts of the robot so that it would run more efficiently.

We adjusted the guards on the indexer so that disks could not get caught in it and jam the entire system. Adjusting them is a matter of slightly bending the guides and testing by loading disks to see if the disk passes freely. We plan to add pieces to secure the guards to their correct positions in the future when we have more time.

We also tuned the flywheel, as it had been behaving oddly and was slightly slower. To compensate for this, we raised the voltage to 10 v. As we did this, we noticed that the flywheel, while shooting straight and fairly powerfully, was not reaching the goal. To combat this, we bent the exit point of the disk track in the flywheel area slightly upward so the disks would exit at that angle. It works well in practice, but it has yet to be tested in a competition setting.

We finished our string catapult and learned that using a nut from an air tank as a counterweight works much better than a winch, as the weight helps the string travel further. The string can shoot the entire length of the diagonal of the field and a bit more, and it has enough force to bounce off of the field perimeter when fully extended. We estimate that, on its own, the string launcher can earn our alliance 15 points in a match at minimum.



An image of the string catapult fully extended with the red string load installed. The string was trimmed after this shot.

Project Daily Log 18 - Nov. 30

Name Aster Burrow

Date 12-2-22

At the Pioneers competition, we worked on autonomous programs, tuned our shooter perfectly, fixed our expansion device, and lost in the quarterfinals.

As we are already qualified for the State competition, it was not important to us to qualify for awards or win the event, although it would have been fun. We set out to improve our robot at Pioneers, and we completed this goal in the actions listed above.

For autonomous programs, we decided it would be a good idea to program a simple roller autonomous for matches when the other team needs the roller that is easier to access. On the field, there are two rollers that robots can start in front of, and two they can start next to. This program is for the second option. It starts the robot on the edge of the autonomous starting limit line facing into the field and moves it in a rectangle to hit the roller and turn it. We found that this program would also work as a rudimentary code in a Skills challenge setting. A screenshot of the program can be found on page P5.

At this event, we were able to perfectly tune our shooter to shoot 3/3 disks into the high goal from the corner of the low goal area. The voltage is set to 11.8 on both flywheel motors. To shoot, the gap in the front of the robot that the intake doesn't occupy must be lined up with the corner of the low goal perimeter. We have acknowledged the potential need for a lineup aid device, such as a vision sensor, but we have not had the opportunity to discuss it in depth. We hope to do this at our Wednesday practice, as none of us will be able to be present on Monday.

In our last qualification match, our expansion device almost hit a referee. It was an inch away from hitting him, but he was luckily unharmed. To prevent such a close call from occurring again, we have tied a foot of the string to other parts of the structure above the flywheel. This will prevent the string from leaving the robot and keep it from getting close to leaving the field again. Due to this adjustment, there is less string for the counterweight nut to travel with and the same amount of force as before, causing the nut to bounce back a tile or so. We plan to remove rubber bands as soon as we have the opportunity so that the nut shoots smoothly without bouncing back and losing tiles.

Due to our pairing with a rookie team, we were unable to advance past the quarterfinals. Although the loss wasn't important to the advancement of our team to State, we hope that the experience of working with us was helpful to our alliance partner, 5300E, in learning about the experience of competitions and working with other teams.

Continued next page

Project Daily Log 19 - Dec. 3, Pioneers Competition
Name Aster Burrow Date 12-05-22

After Pioneers, we decided we wanted to make improvements to our robot, such as:

- **Intake with a stationary section at the top and a moving one at the bottom**
    - This is to resolve an issue we have found with maintaining pressure on disks at the top of the intake, as they tend to hover underneath the last wheel set unless another disk pushes it along.
    - This would replace our current system of a fully mobile intake that swings on a shaft to catch disks
- **More expansion devices to cover more area**
    - For this, we are considering a net device such as the one discussed on page DL20, although it would likely be a winter break project to save drive time.
- **Current expansion device at a less extreme angle to prevent the counterweight from leaving the field**
- **Check on the flywheel motors for wear**
    - We've noticed that they have required more voltage recently to run. This may be the fault of a bad battery, which we intend to check with a multimeter when we have access to one
- **Better roller mechanism**
        - Our driver has had issues with quickly lining up with the roller in recent matches. We've decided to consider adding a second flex wheel to the roller mechanism to make it easier to run into the roller and leave.

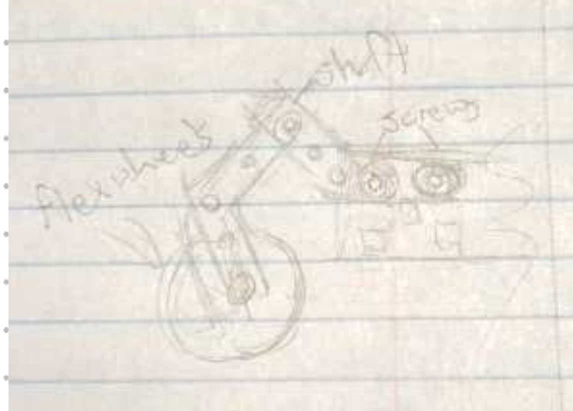
Project Daily Log 19 - Dec. 3, Pioneers Competition - continued
Name Aster Burrow Date 12-5-22

On December 7, we decided to rebuild our intake out of necessity to keep the device running efficiently during matches.

Before the rebuild, our intake swung freely on a shaft at the very top of the intake. There were a few issues with this design:

- Due to the hinge point being at the top, if there were multiple disks in the intake, there would be excessive pressure on disks at the top of the intake. We decided to move the flex wheels on the intake up a hole for this reason, but that meant that if only one disk was going up, it could not be reliably pushed into the indexer due to a lack of pressure.
- Because of how quickly we had to build the intake to be functional for our first competition, we did not realize that the mounting bars for the flex wheel half of the intake were slightly offset from one another. This caused some sizing issues, as one side of the flex wheels stuck out slightly further than the other.
- Due to the placement of the hinge shaft, it was fairly easy for disks to get caught between it and the top row of flex wheels. It was easily fixed by running the intake backwards, but it took an extra second that could have been spent scoring points.

To keep the correct amount of pressure on disks in the middle and top of the intake while the bottom is running, we decided to change all of the intake except for the bottom row to being stationary. This means that it is directly mounted on the bottom part of the intake to keep it properly aligned. For the bottom row of the intake, we decided to keep the moving idea to make it easier to take disks in. The hinge shaft will be positioned above the flex wheels so that disks cannot feasibly be caught between the the shaft and the flex wheels. This will be done with angle gussets positioned somewhat like this:



There will likely have to be a center bar placed to reinforce the shaft, but we plan to do rudimentary testing before adding more in case this plan doesn't work out. To keep the shaft from tilting or flexing in any way, another shaft will have to be run through the piece for alignment.

To start off today’s practice we ha a very long discussion about the benefits of running a 6 motor drive instead of our current 4 motor system. However we couldn’t think of a practical way to run this sort of drivetrain. With all of the benefits it would add in a competition setting including but not limited to. Added torque, added speed, and all around better maneuverability. This system would be ideal however it would be next to impossible to do without severely crippling one of our other key mechanisms. We also discussed building a transmission to share a motor with one of the drive motors and the intake with hopes we could get another pneumatic cylinder before state however Aster pointed out the fact that we were already skeptical about our air capacity the way it is. If we ran a system like that we would not have enough air to shoot by the end of a match.To conclude this discussion we decided on the fact that there wasn’t much we could do at the time and that we instead would have to put more work into sheer driving ability to overcome the advantage that other teams would have with the extra drive power.

Later in the day we decided to spend some time running the robot to try and find any issues that may have been caused during the previous competition or during transport. We noticed a major loss in rpm in the flywheel in comparison to the way it was running pre competition we did some looking into it and determined that this was caused by poor alignment of the flywheel itself. It was at a noticeable angle with large amounts of resistance to the point where it was difficult to turn even by hand which explained why we were having such a hard time shooting throughout the pioneers competition.So we noted that this issue should be a top priority to be done over winter break.

We spent the rest of this practice discussing what should be done to the robot over winter break. We decided that Aster and I would try split the time with the robot between the two of us. By the end of practice we determined that we needed to 1. Align and build the new intake (Kaden), align the flywheel and test the motors (Aster) and build a new roller mech (Kaden).

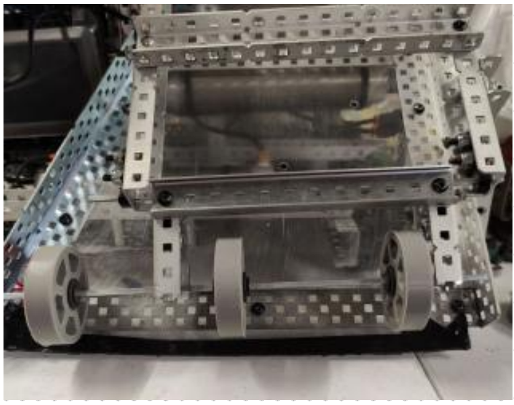
Project Daily Log 21 - Dec. 14

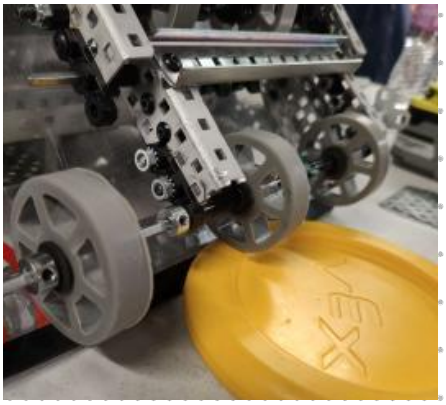
Name Kaden Haugen Date 12/14/22

For my portion of winter break with the robot I was responsible for rebuilding the intake and prototyping a roller mech so I began with the rails to run the shafts through for the upper part of the intake however due to the difference in mounting locations for the rail on the flywheel side I had a very hard time aligning it. The process of aligning the rails took me a entire day of work due to the tight space and the delicacy required due to the nearby electronics. After completing the rails I started making the lower pivoting part of the intake using a design Aster recommended I use. (see design below)

However with this design instead of picking up the disks the whole section would twist. I spent several hours trying to make this design work although in the end I ended up making my own design where the whole pivoting piece was one solid piece held together by a piece of linear slide rail instead of just the shaft like the previous version. This version seemed to work nicely and picked up the disks pretty efficiently.

(Lower pivot point)





After the lower pivot point was complete I started working my way up adding a second lower row of flex wheels and a singular top flex wheel to boost the disks up into the magazine. After some testing I concluded that the current setup didn't have enough torque due to it jamming at the top of the intake so I decided to add an extruding gear reduction system featuring a 3.33:1 gear ratio and that seemed to smooth the whole intake while still having an impressive intaking speed. Around this time I was getting to the end of my time with the robot having neglected my responsibility to prototype a roller mech but by then I had to hand the bot over to aster for his share of the break.

Project Daily Log 22 - Winter break, Kadens portion of the work.

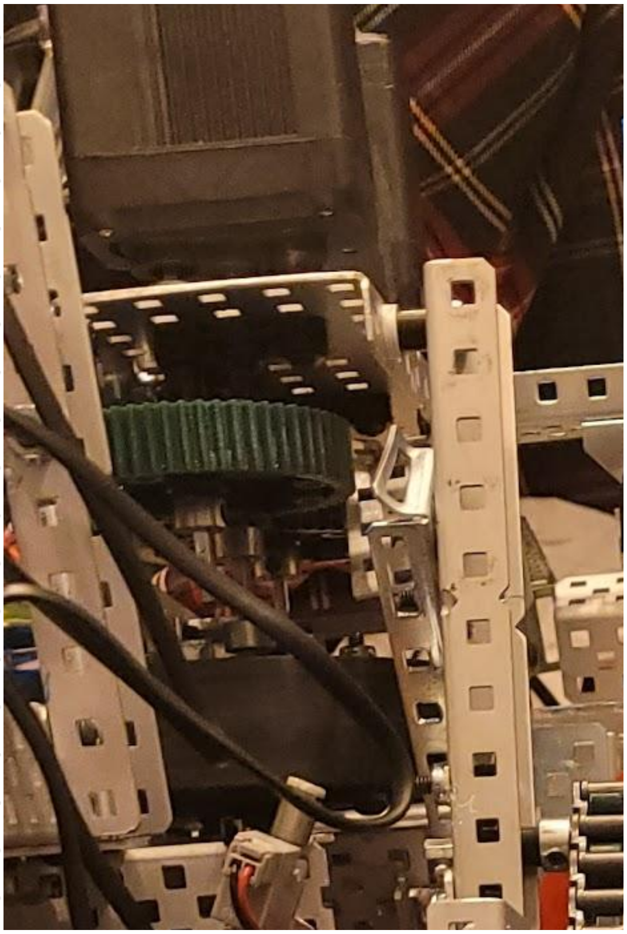
Name Kaden Haugen

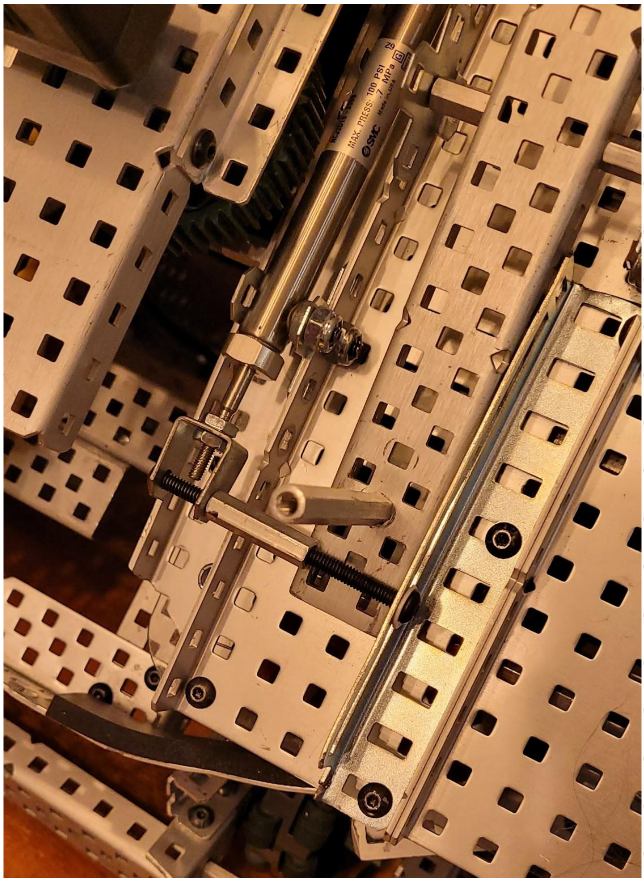
Date 12/23/22 - 12-31-22

I had the robot from December 31st to January 2nd. During this time, I realigned the flywheel, fixed our expansion mechanism, and tried to work on the intake.

Over time and adjustments, the flywheel motors became misaligned to the point that the flywheel itself could barely spin. To remedy this problem, I placed 1 large spacer and 3 plastic washers in between a bar on the intake and the flywheel motor piece. This fixed the issue and we are now shooting normally again.

A picture of the spacing between the flywheel motor plate and the left side of the intake.





We were finally able to buy the nuts for the threads on the pneumatic pistons, so I was able to fix our expansion mechanism. Before, the screw was fastened to the piston with a zip tie and it had trouble moving along its track. With the new attachment, which is held by two nuts, the bar slides much more smoothly and the piston has no issues extending and retracting.

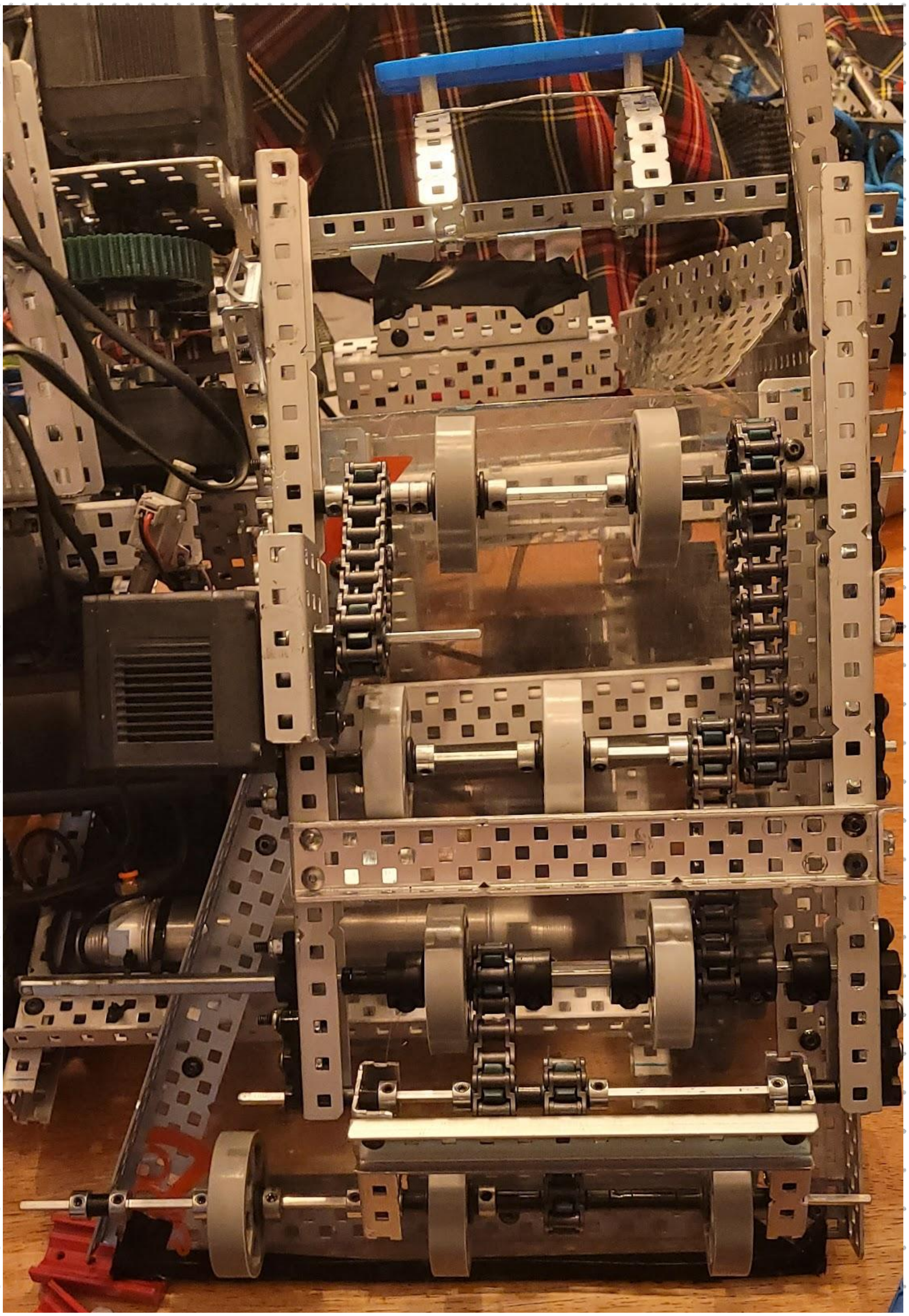
Continued next page

Project Daily Log 23 - Winter Break, Aster's portion of the work.

Name Aster Burrow

Date 12/31/22 - 1/2/23

When I received the robot, I noticed that the intake was severely misaligned and wanted to fix it so it would run smoother in the future. I made my best attempt to fix it, but my efforts amounted to almost nothing. The intake is smoother at some points, but it catches at others, especially under the intake motor. I considered rebuilding the intake but I ran out of time and winter break ended. This is the end result.



Project Daily Log 23 - Winter Break, Aster's portion of the work - continued

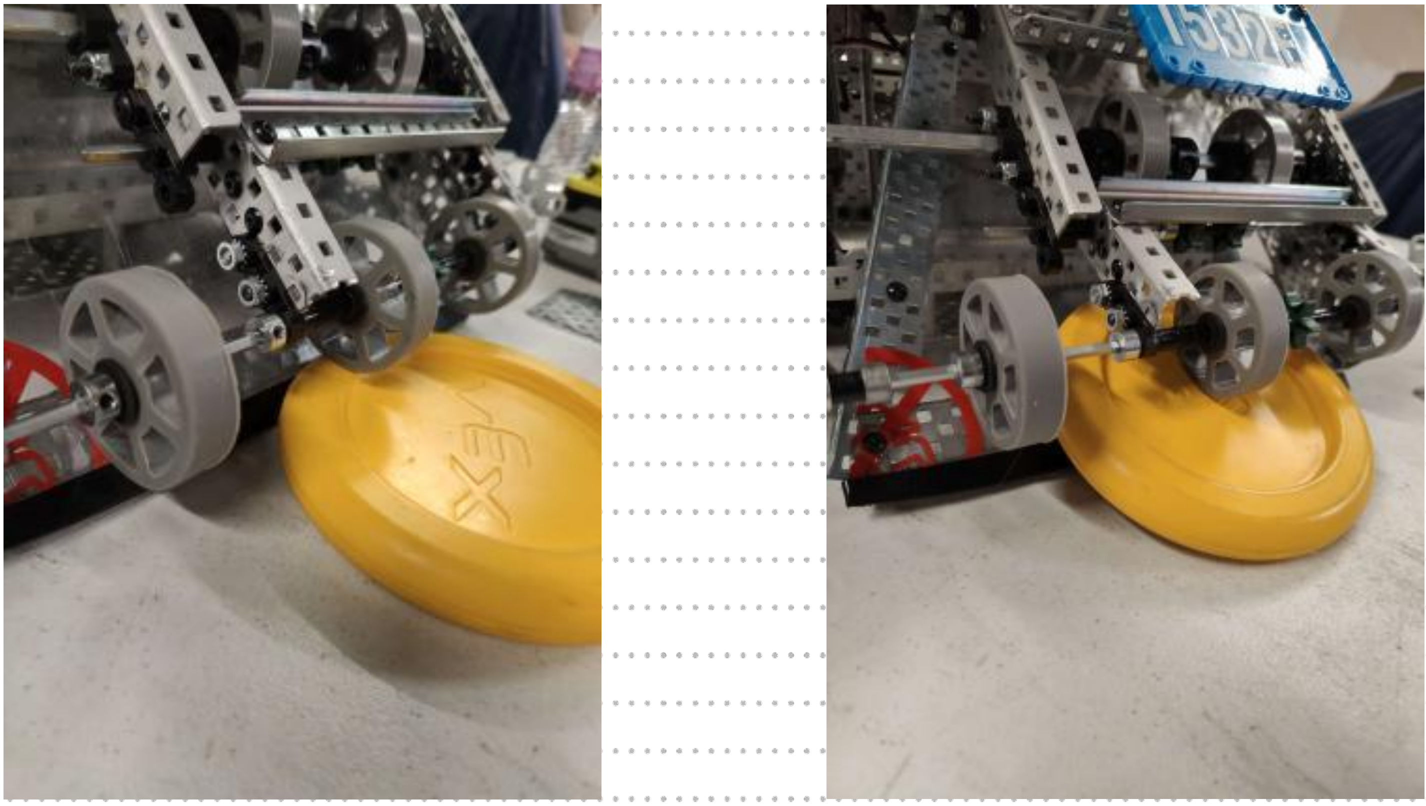
Name Aster Burrow

Date 12/31/22 - 1/2/23

After we returned from winter break Aster spent the first part of practice explaining what all he did over his section of winter break. The first thing we did after Aster explained what all he did is test the flywheel. We found that it was exponentially better than before. You can simply hear the fact that it is spinning faster and it is shooting at least 3 times farther than it was pre alignment.

We after testing the flywheel with disks already in the robot re attempted to intake more disks and found a major problem. When I built and tested the entail I was on a warped folding table which made it seem that the intake was working as it should however when we tested it on the field the bottom row of flex wheel was to high to effectively pick up the disks. After realizing this we had a major moment of irritation that all the effort that we had put in led to these issues but we quickly got over it and began discussing a potential solution.

The first thing we decided to try was simply moving the bottom row of flex wheels down a hole to do this while it wasn't the proper way to do it we just hung them with with a overhanging bearing for testing purposes. After doing this we saw some minor improvement however we also discovered that the approach angle of the intake was too harsh and the intake couldn't easily push the disks up it without outside force. To solve this we decided to prototype some curved flat iron to reduce the harshness of the angle however this yielded little to no results. Around this time we were getting to the end of practice and decided to pack up and discuss the issue at a later date.



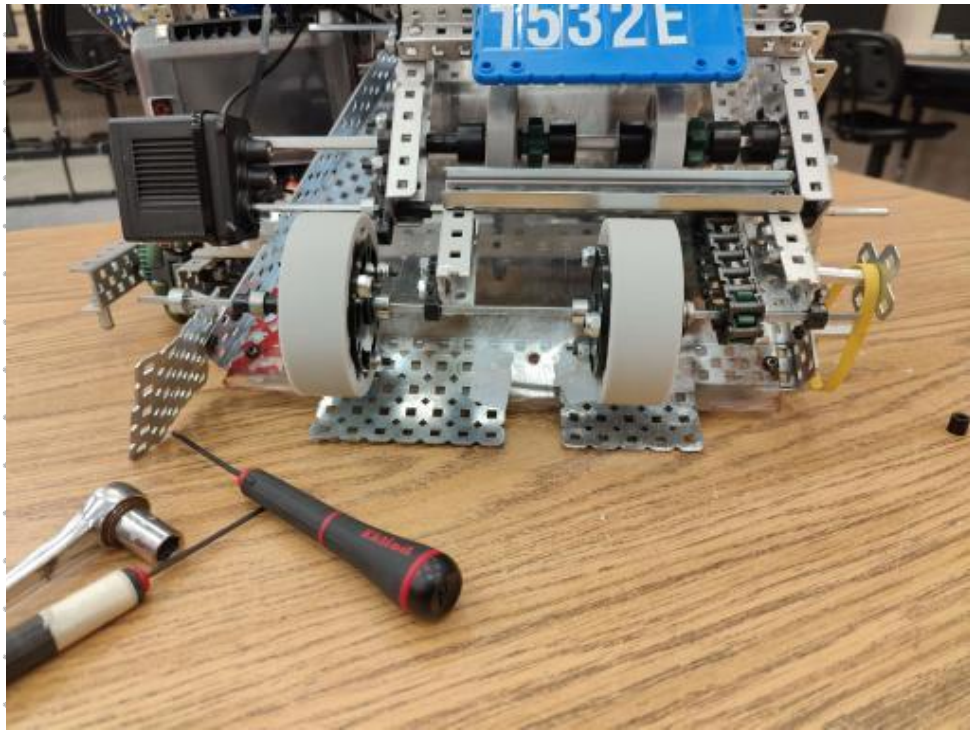
(The two main places the disks were sticking at.)

Project Daily Log 24 - Jan. 4

Name Kaden Haugen Date 1/4/23

In today's practice we aimed to address the issues being caused by the approach angle of the intake. The first thing we did is tried prototyping some different approach angle dappeners although this once again yielded little to no results. Our next thought was that the flex wheels may not be getting enough grip so we decided to add a rubber band with slight pressure to the bottom left part of the pivoting section of the intake. After adding a spot to place the rubber bands we put them on the robot and while this added some grip it still wasn't enough to consistently lift the disks into the intake.

Our next thought was "what if we try a bigger flex wheel so there is more surface area touching the disks" so we decided to try that. We put two 3 inch flex wheels where the bottom row of 4, inch and a half flex wheels went. With this we were getting much more grip and pulling the disks up around 45% of the time. It seemed like the disks were still getting stuck on the approach of the intake so we decided to bolt on the approach angle dampeners we had made at the last practice and it was sucking the disks up perfectly. As soon as the disk touched the flex wheels they would immediately get pulled into the intake.



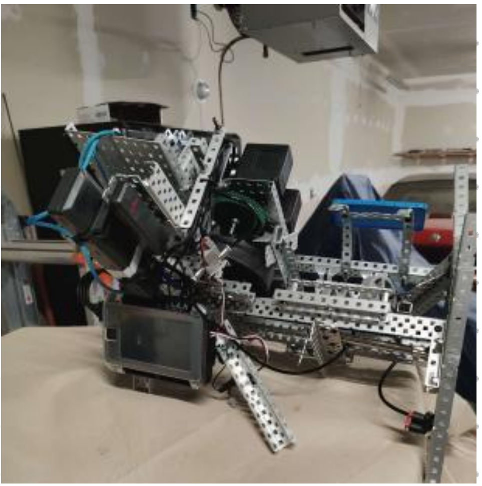
(updated intake design)

However our coach pointed out the fact that this was probably oversized to we decided to measure it and it turned out to be around ¾ of an inch over size. At the time we had no idea what to do and were nearing the end of practice so we decided to pack up and work on it on Wednesday.

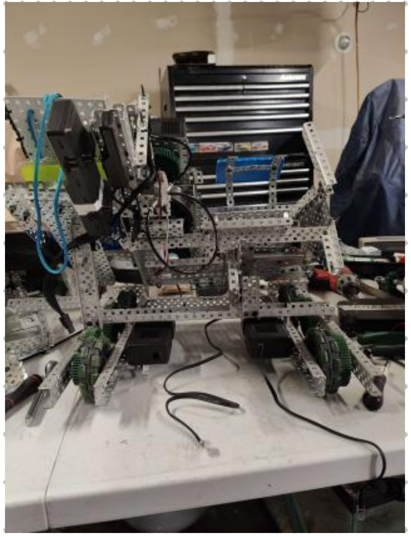
Project Daily Log 25 - Jan. 9

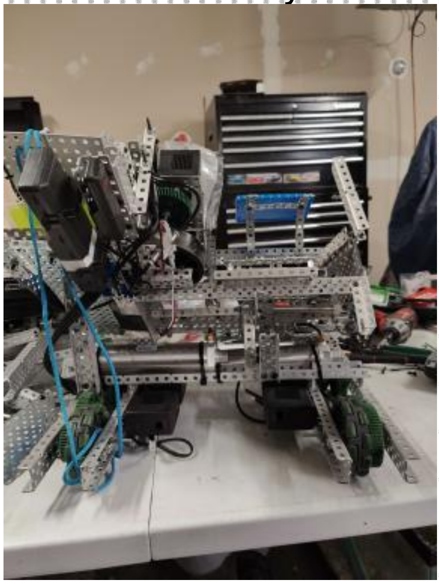
Name Kaden Haugen Date 1/9/23 Page DL32

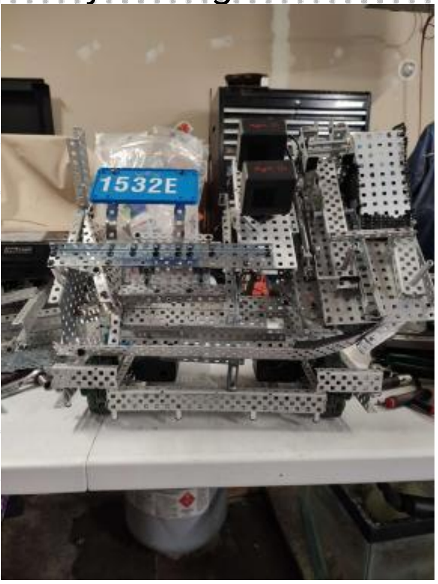
Today we were tasked with making our intake fit within 18 inches. To start we discussed the pros and cons of this particular design and whether or not it would be worth it to try and make it fit within size with all of the benefits it added we decided it would be worth it to thy and make it work. Our initial thought was to attempt to move the entire intake in and just put it at a steeper angle. We all decided that this was the way to go so we began the process of moving everything back. In order to do this we had to remove the entire upper assembly of our robot as shown below.



While being able to easily remove the upper assembly of our robot was not a part of our original design it did work out quite nicely as it was held on by 6 screws and was able to be lifted straight off. After removing this we were able to remove the front wheels and bearings and cut the inch of material off of the chassis and move the front motors back. While if we wanted to move them back an inch we only would have had to move them back 2 holes technachly I decided to move them back 3 just to be safe. After getting all of that done I decided to start remounting the upper assembly and let me just say it was much harder than taking it off. With everything moved back 2 holes I had to either find a new mounting location or use standoffs to mount the upper assembly back on the robot which was no easy task but eventually I had gotten it remounted as shown below.







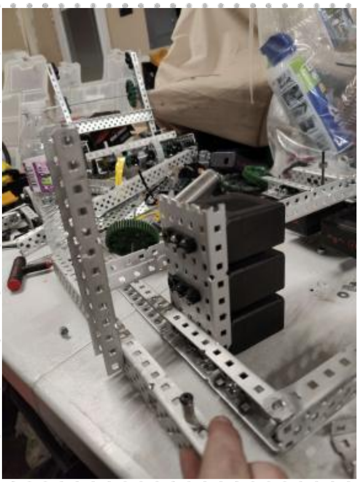
Project Daily Log 26 - Jan. 11

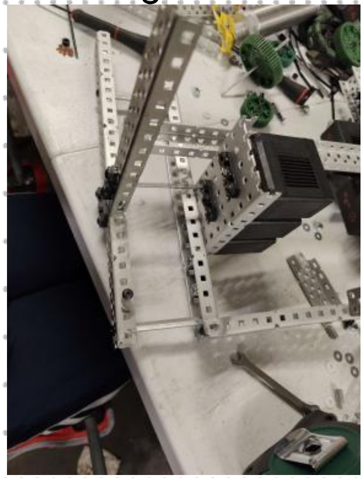
Name Kaden Haugen

Date 1/11/23

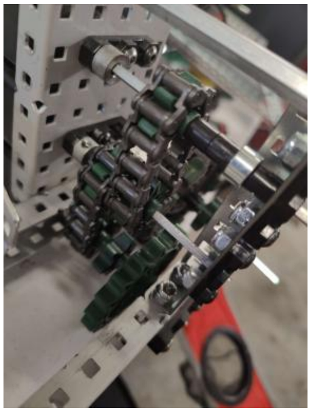
Today my goal was to reattatch the intake and get the robot operational again however that wasn't exactly what happened. I began by trying to decide where to remount it but ran into some issues. If I wanted to save as much space as possible we world have to redesign the whole thing and the robot wasn't made for that type of intake however that was the only way we could fit it within size. After some discussing while I'm not exactly sure why we decided to build a whole new robot less than a week before EGF.

The first thing we did was discuss different designs over discord. We spent a long while doing this but eventually decided on a catapult bot with 6 motor drive. I started on the new base while Aster researched different designs soon enough we had decided on a frankenstein design with inspiration from 2 or 3 different teams after we made a decision I continued working on the base and Aster began working on ancode for said new base. We essentially went with the same chassis design as our old bot had just with 2 motor pods in the back instead of the motors driving the wheels directly as shown below.





I originally intended on using normal high strength gears to drive it but we didn't have enough gears in the box to do this and the reload so we decided to just use chains. If we wern't under such heavy time constraints I would have waited until monday and gotten the proper gears but this simply wasn't an option. Aster had just finished the code at this point so I tested it on the left motor pod as I hadn't finished the other one yet. I eventually finished the right pod but didn't finish the drive terrain as it was nearly 2 AM at this point and I had to keep working the next day. More pictures from tonight:

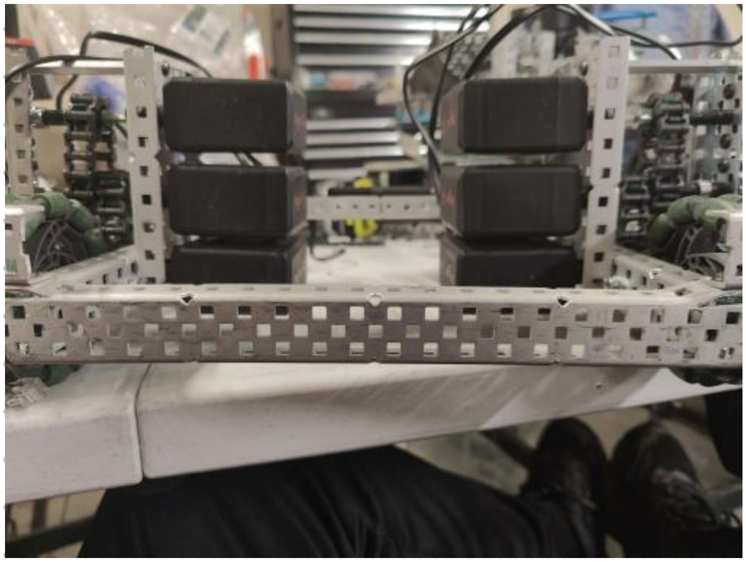


Project Daily Log 27 - Jan. 13

Name Kaden Haugen

Date 1/13/22

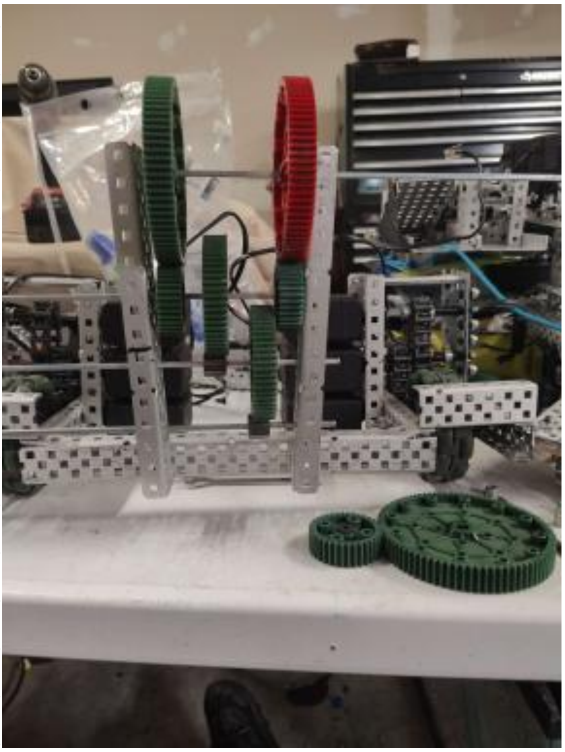
My main goal for today was to finish the drivetrain and build the reload mechanism for the catapult. Most of the drivetrain was just a copy of the other side so that wasn't too complex however it still took me most of the day due to the sheer complexity of it. I eventually finished it and test drove it and it was ungodly fast too fast honestly. I had just grabbed gears that fit without thinking but it turns out I unknowingly geared the drivetrain at 600 RPM. I didn't have the right gears to fix it so I just decided to leave it be until I could get the gears to fix it. (Motor pods shown below)



Motor pods

1532F reload

The next thing on my agenda was to make the mounting /reload for the cata itself. I did some research and spoke with a member of our sister team 1532F He shared their gear ratios and send me a few images that gave me a good starting point (Image shown above right side) after considering different gear ratios I eventually decided to go with an extremely low gear ratio figuring we could always up it later if it is to slow because we would rather have a slow reload then a non functional one.



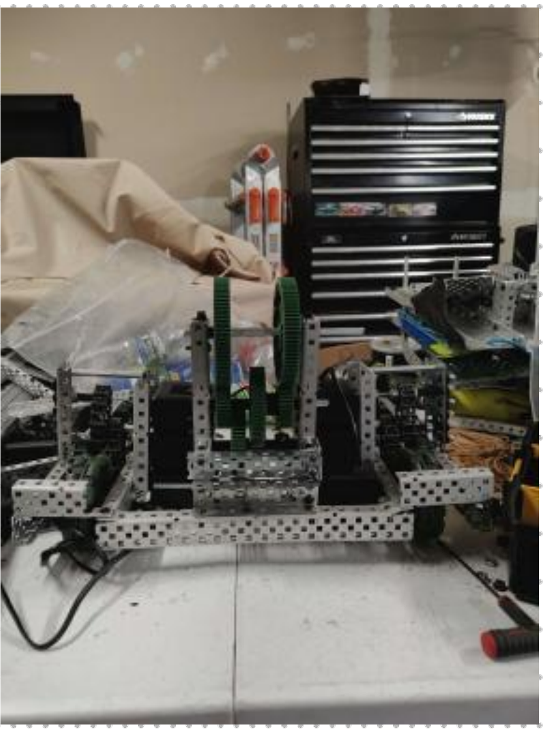
Reload prototype

After I put the reload together I began working on the disk throwing arm I decided to use some 3x1 aluminum C channel and started trying different angles. I spoke with 1523F again and they said you want the arm to be roughly flat when it hits the stops for the best throw so I kept that in mind while designing it. I decided on a angle I liked but decided to call it a day as it was around 1 AM at the time and I had another whole day of working ahead of me.

Project Daily Log 28 - Jan. 14

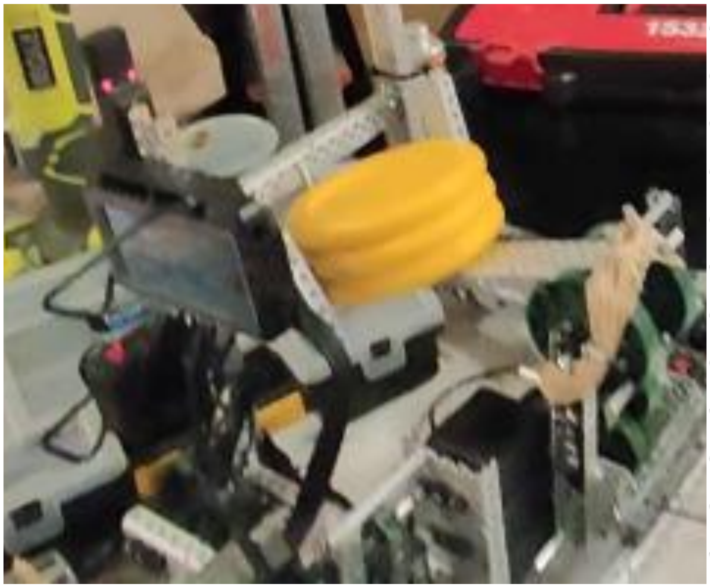
Name Kaden Haugen Date 1/14/23

Today my goals are to finish the catapult and get it shooting. The first thing I did was look over the angle I had decided on yesterday but I had decided I didn't like how exposed the back of the reload id with how violent this game is. Someone could hit me just right and cripple our whole robot. While I was irritated about the lost time I believe it was worth it due to how much more protected the rear on the robot is now.



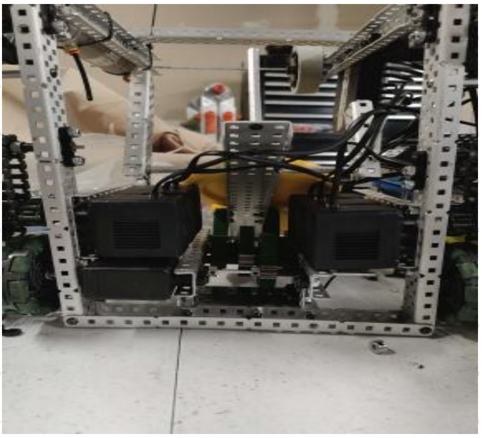
Rear of the robot after moving the reload in.

Prototype with 3 disks in it



After moving the reload in I had to choose a new angle for the cata arm but that was not too hard. Once I got this done I started trying to decide on a basket to hold the disks on the cata. I prototyped with some aluminum angle but our sister team 1532F showed us a example from another team. I no longer have the image but it consisted of 2 standoffs on either side of a piece of 1x3 aluminum C channel with polycarbonate retainers attached to the standoffs on each side with a taller standoff in the front to hold the disks in. I thought this was a pretty good idea so I quickly started prototyping with my own version of this design. After awhile I had a simple yet seemingly effective prototype.

I was running low on time for the day but I noticed one major issue we may have at our next competition. While the 3 motors in the motor pods isn't ideal now the reload motor is right next to them which I fear will cause major overheating issues and a potential motor failure which would be worst case scenario.



The motors in close contact of each other

Project Daily Log 29 - Jan. 15

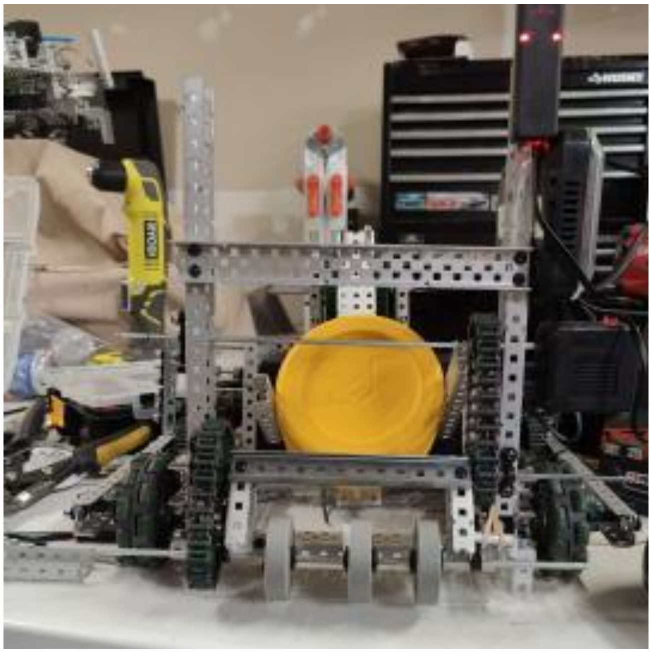
Name Kaden Haugen

Date 1/15/23

Today's goal is to finally get the robot shooting and to try tune the catapult tuned properly. To begin the day I cut the extra material off of the back of the catapult arm so that when we set off the catapult the extra material will not damage other components. After this I began marking out how much material I need to take off of the slip gears. I started off by using a marker and left a mark where the teeth needed to make contact with the rest of cata gears. After this I took a portion of the material off of the slip gears and decided to test them. When I tested the catapult I first found out that I needed to take more teeth off of the slip gears but I decided to test it one more time and apparently I didn't take enough material off of the slip gears and it caught causing me to catch them and all of this torque snapped one of the 60 tooth gears.

The gear I broke.

After getting an earful from our coach for breaking another gear (you don't wanna know what I did last year) I replaced this gear and took a lot more material off of the slip gears I got it firing pretty well. Now I needed a way to load said catapult so I started on the intake and roller mech. I started my putting an aluminum cross member across the bottom of the robot so I would have a place to mount the polycarbonate and I added to upward facing pieces of C channel so I could tie the roller and intake together. I decided to mount the motor in the middle so I can fit some gear reduction to the roller and gear increasion to the intake. I decided to use a 600 rpm motor so that I could spin the intake fast to save time while picking up disks. I am not sure if this will affect the roller or not but we shall see I suppose. After all this I cut some polycarbonate for the disks to slide on while in the intake and mounted a row of flex wheels on a pivot. I tested it and found that I would need another row of flex wheels but I would have to save this for another day as I had to pack up for robotics tomorrow.



The robot with the new intake.

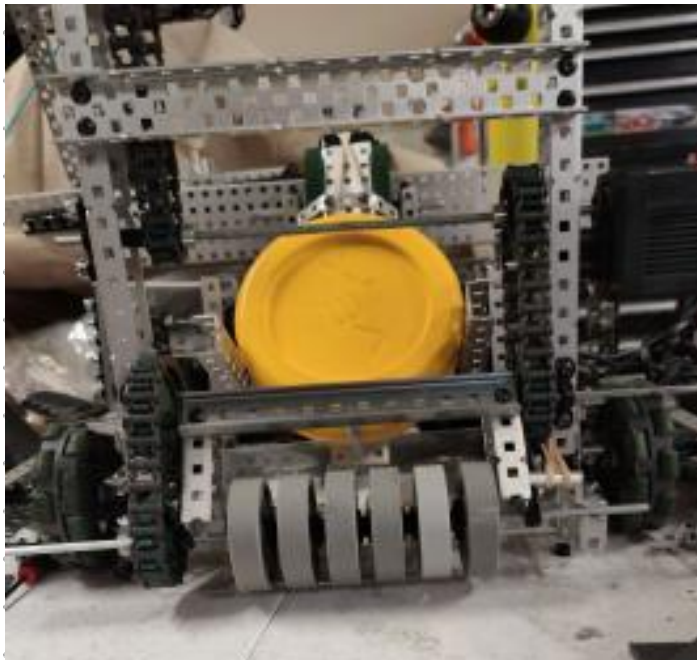
Project Daily Log 30 - Jan. 16

Name Kaden Haugen

Date 1/16/23

Our primary goal today is to tune our catapult although we also hope to finish the intake. The first thing we did today was relocate the place w mount our rubber bands to st the recommendation of Eric of 1532F and it seems to help the robot shoot by quite a bit. We spent most of the day adjusting the catapult to shoot in the basket as much as possible. Currently if we line up right we are shooting 2 out of 3 disks in the basket which I say is pretty good considering the fact that we did all of this in a week. One big issue we were having was how slow the reload was moving. I geared it extra low not sure how many rubber bands we would need but this came to be an issue.With how slow it was there was no way we could get more than 2 or 3 shots in the basket per match.with these issues we decided to move the motor up a row dropping a lot of the reduction which sped up the reload by a lot but not too much to the point where we couldn't draw it back with the rubber bands on although we may have to add a 'break' command to the code.

The next thing I needed to do was get the intake and roller mech working properly so I decided to try a few different things before spending all the time it would take to add a second row of flex wheels. The first thing I tried was some 6 tooth gears with flappers on them, I tried a few different sizes of flapper but none of them made a difference. Next I decided just to try adding more flex wheels which seemed to help quite a bit however it was still catching on the front retainers for the disks so I cut around a half inch off of it. Now with 4 flex wheels and the retainer trimmed down it was getting the first disk in 100% of the time and the second one around 50% and the third one around 5%. Now this simply wouldn't do so I added another flex wheel which bumped the second disk up to 100% as well and the third up to 33% so after that I added another flex wheel so that the whole bottom row was just flex wheels and this worked perfectly getting all 3 disks in 100% of the time.



After finishing the intake all I had to do was swap the gears in the drivetrain to something lower as the robot was way too fast to handle and had no torque. This only took me about 15 minutes and now everything seems to be performing as it should. I can't believe we actually got this thing done in time for the EGF tournament.

New intake design.

Project Daily Log 31 - Jan. 18

Name Kaden Haugen Date 1/19/23

On January 20th, we went to the East Grand Forks tournament. To put it frankly, it did not go well. We lost every match and placed last overall. Our catapult did not work at all and had broken teeth on the slip gears before the competition even started. Our driver, Kaden, had no experience whatsoever driving a 6-motor drivetrain and was unable to adjust during the competition. Our robot was too light to properly utilize the power we devoted to the drivetrain and failed to do anything in the roller fights we built it for. There were no guards to keep the robot from getting stuck on disks and we spent nearly every match stuck on them. Our drivetrain was severely misaligned and the chains connecting the top two motors of each drive assembly to the bottom motor snapped during every match. We were not ready for this competition in any way, shape, or form, and it was painfully obvious when we tried to compete.

The state of the robot made it clear that it could not be worked with without a full rebuild. The drivetrain was misaligned and couldn’t handle the strength of the catapult. The teeth on the gears of the catapult were snapping under the strain of test runs. The intake was unable to load disks unless the catapult was incredibly specifically placed. It was clear that something had to change, and I decided to move forward with a new plan to attempt to save us the time for drive practice and programming.

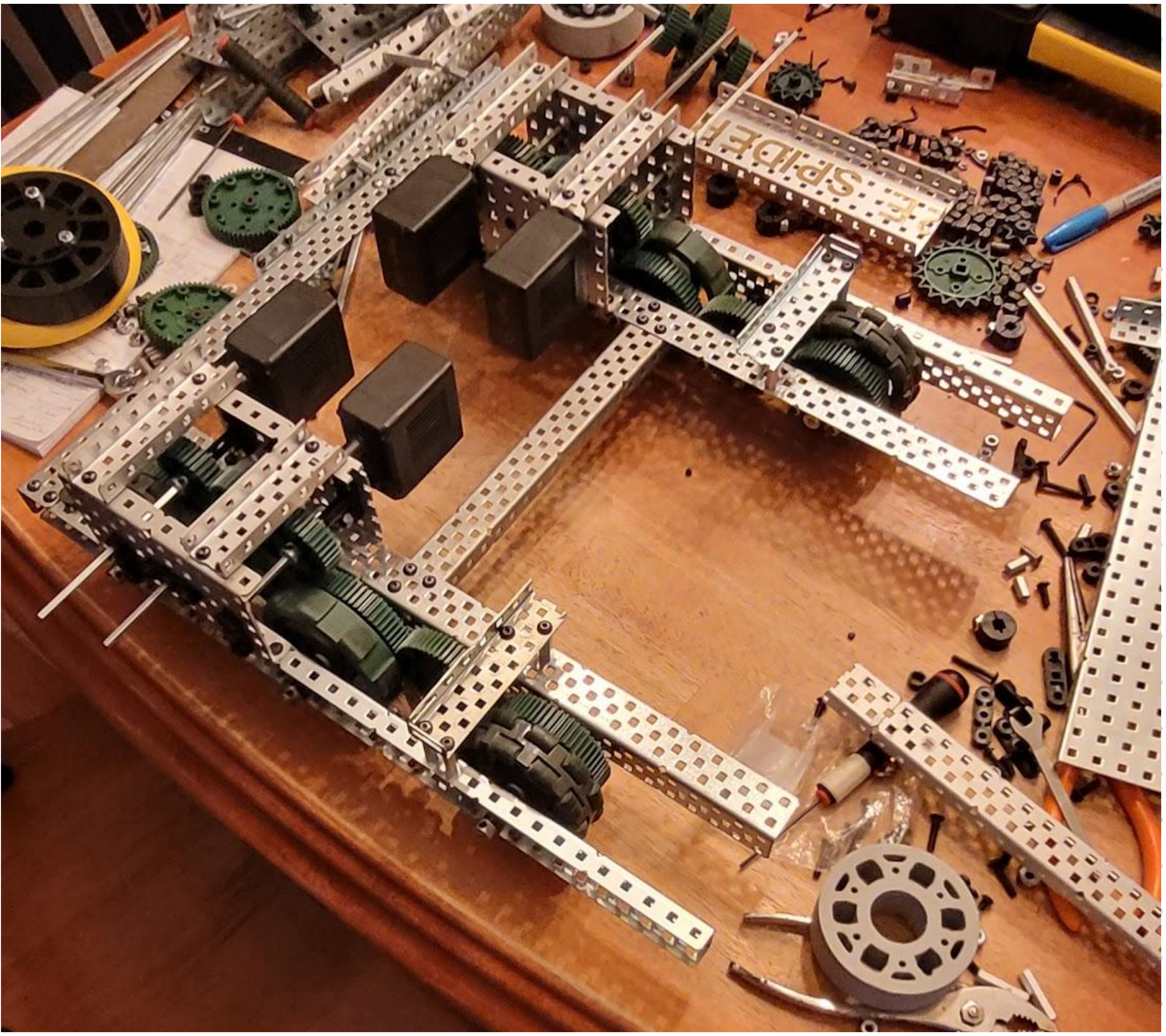
I talked to my coach about a new design: a simple linear flywheel based on the past successes of our sister team, 1532F, and other teams at the competition. The discussion of this design can be found on page E10.

After this competition, I took the remains of the failed catapult home to begin building the new robot.

Unfortunately, no pictures were taken at this event because we were too stressed by the robot failures and trying to salvage the thing.

Project Daily Log 32 - Jan. 20, East Grand Forks Competition
Name Aster Burrow
Date 01-23-23

On the day after the competition, I put together the drivetrain. As I stated on the previous page, the drivetrain will have 4 motors and six wheels to increase traction while keeping our motor count low. The drivetrain will also be 15” by 15” to keep the robot well within the size restrictions while having enough room to securely mount our superstructure. It is entirely made of steel in order to increase the weight and overall pushing power of our robot in roller fights. The end result of the drivetrain looked like this:



The front ends of the drivetrain still need to be cut down, but I decided to leave them long for the time being in case we decide to keep the length. In this picture, the drivetrain is 15” wide by 17.5” long.

The drivetrain is currently geared with 5 60t high-strength gears on the wheels and 3 36t high-strength gears on the motors, which have green cartridges. This means the drivetrain is geared to run at 120 rpm. I decided to experiment with this gearing to see if it would help with our driver’s tendency to drive violently and get stuck on disks. The motors are all mounted in the back to save space for the intake in the front, as we had issues with the front drive motors getting in the way of the orbital flywheel’s intake previously.

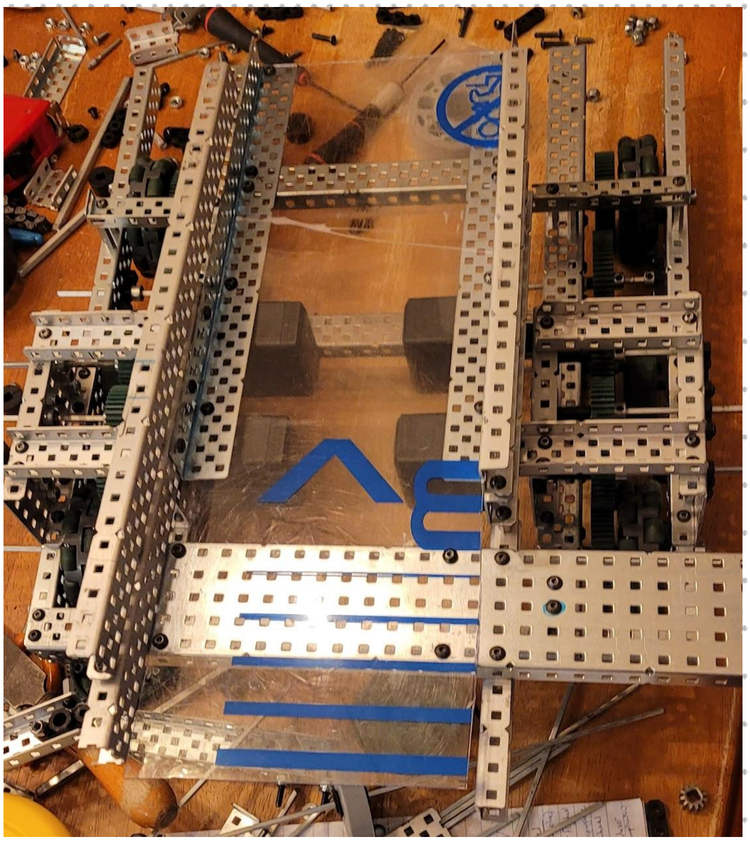
Project Daily Log 33 - Jan 21, weekend after EGF

Name Aster Burrow

Date 1-23-23

On January 22, I worked on the linear flywheel. As I stated on the East Grand Forks page, it is supposed to be a simple setup with an intake that runs directly to the flywheel. This way, we won't have any issues with indexers and sliding pieces stopping the robot from properly working.

The overall assembly is intended to be compact and functional. For this reason, the intake is 13 holes wide for the entire length of the shooter assembly. This width leaves one hole of space on each side of a disk in the intake, which means that screws have less of a chance to catch disks and reduce the efficiency of the flywheel. The assembly is also approximately 2.5 disks long so that up to two disks can be comfortably queued in the intake to be shot.



An image of the shooter assembly without the flywheel or intake put together.

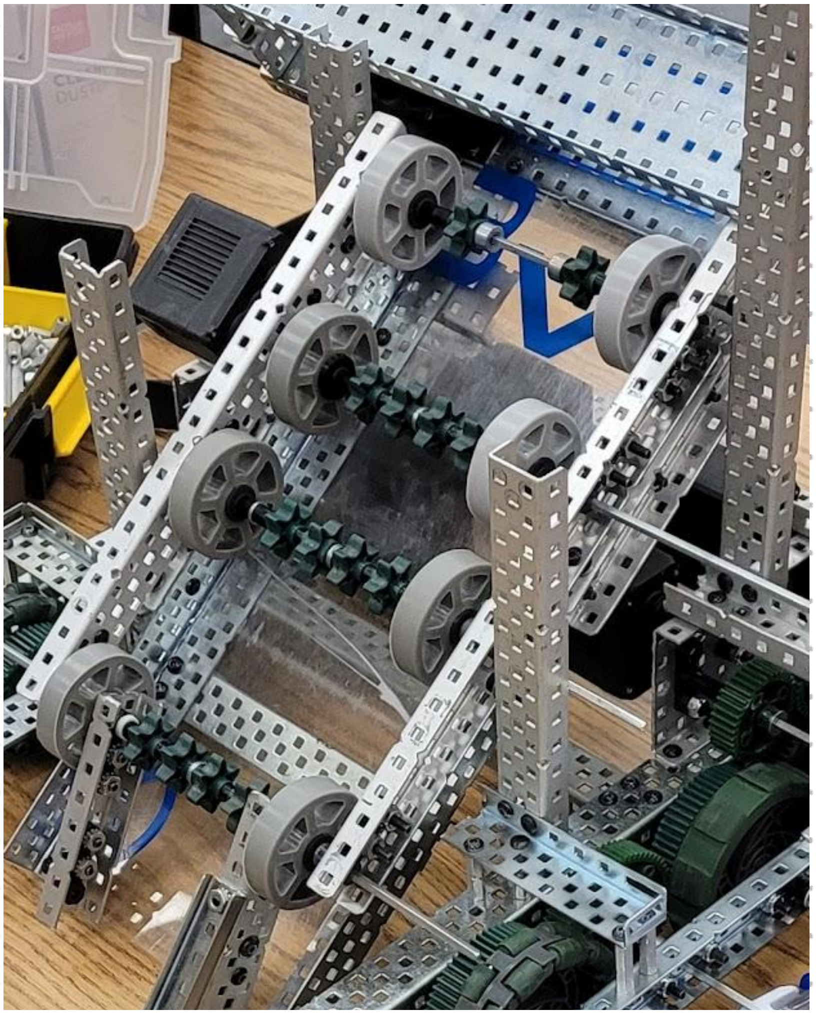
The flywheel consists of two motors mounted underneath the shooter assembly driving one 4" diameter flex wheel. There will have to be a piece of foam across from the flex wheel to keep pressure on disks as they exit the robot. The motors have blue cartridges and have 36t gears driving one 12t gear, resulting in a 3000 rpm output. This is the same gearing as the orbital flywheel, which worked well, so we hope that reusing the gearing will achieve the same outcome.

The entire assembly is mounted at a 40 degree angle. This angle was chosen based on the experiences of other teams on vexforum. They said that a 30-35 degree angle would be good for long range shooting while a 50 degree angle would be better for filling the goal, so I decided to shoot for the center and try out a 40 degree angle. This angle is easily adjustable, as the assembly is held up by 4 screws on 4 pieces of vertical C-channel attached to the drivetrain.

Continued next page

On Sunday, I also started to work on the intake. I decided to put 5 rows of 2” diameter flex wheels on the intake with 4 stationary rows and 1 free-moving row at the bottom to catch disks, as many other teams in my school and online have used the design and succeeded. The rows are approximately 4 holes apart, but the bottom stationary row is 7 holes apart. There is not a reason for this and the spacing may change in the future depending on the success of the current design. The intake is driven by one 200 rpm motor and is connected by double chains in an attempt to eliminate the risk of one chain snapping and the entire intake failing, which is an issue we encountered with the orbital flywheel’s intake at times. The wheels on the intake are placed so that they catch the edges of disks instead of the center to simplify the process of grabbing the disks and eliminate issues with wheels slipping on the centers of the disks. The height of the flex wheels is set by spacers and washers separating the main body of the shooter from the pieces holding the wheels. There is one small black spacer and three plastic washers separating the assembly to keep pressure on the disks and also keep them from being caught in place. On Monday, I hope to finish the intake with the free-moving row of flex wheels.

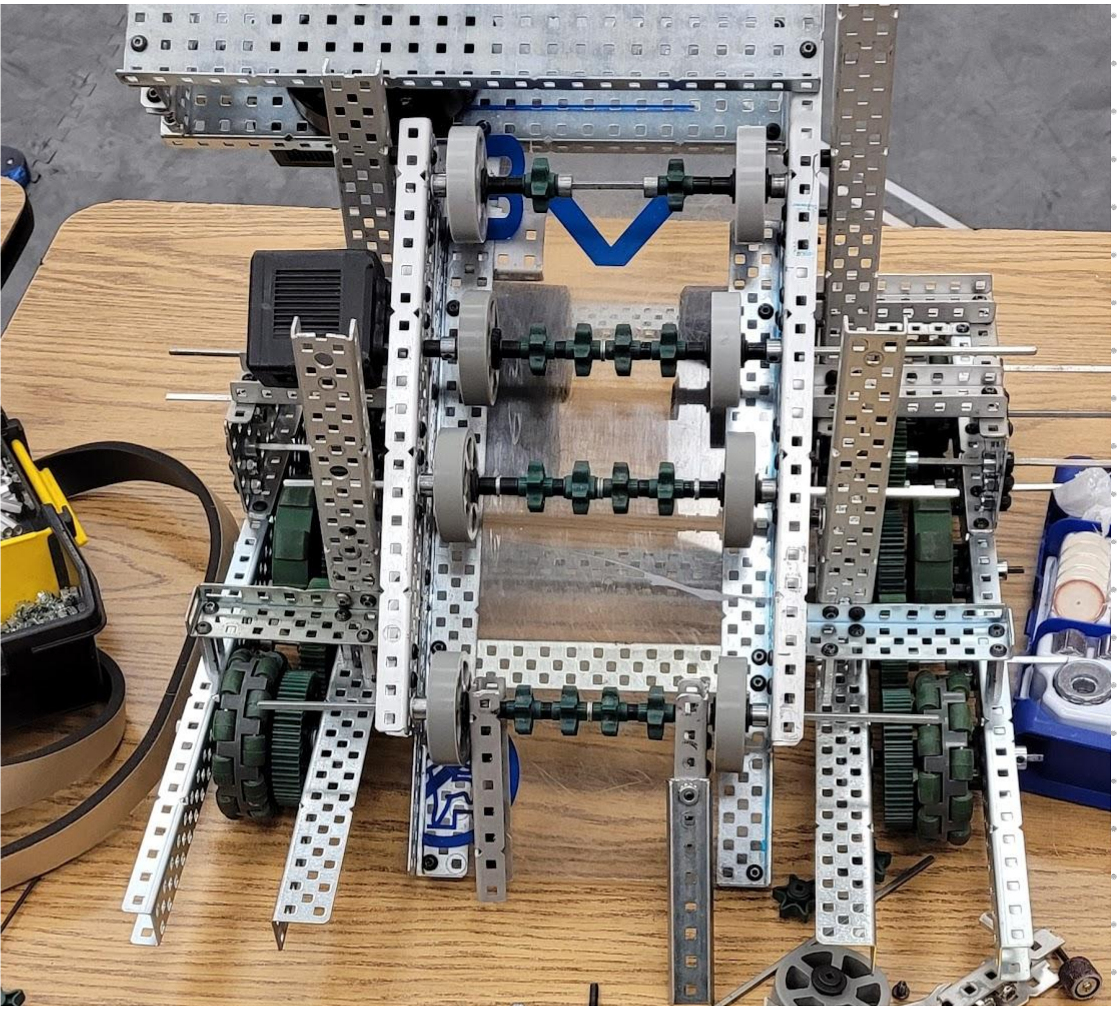
An image of the placement of the flex wheels on the stationary row.



Project Daily Log 34 - Jan 22, weekend after EGF - continued
Name Aster Burrow
Date 1-23-23

On January 23, I worked on the bottom stationary row and the free-moving row of flex wheels, but was unable to finish.

The free-moving row of flex wheels is attached to the bottom row of stationary flex wheels by two 8-hole pieces of c-channel. The c-channel will be attached to each other with a piece of linear rail, as it is very hard to bend. By the end of practice, I was able to get the spacing of the bottom stationary row right so that I could start the next day by finishing the free-moving row. Progress by the end of the day looked like this:



When demonstrating how the intake would work to my teammates, I noticed that the bottom of the intake is slightly too high and cannot easily take disks in. To remedy this, I plan to cut off two holes' worth of polycarbonate on the intake and attach a new curved piece similar to the one used by Kaden and Sam on January 9th. This should help disks to enter the intake smoothly and quickly.

***Note**: There was no practice on Wednesday because our coach was out sick. We will resume work on Monday and take the robot home to make up for lost time.

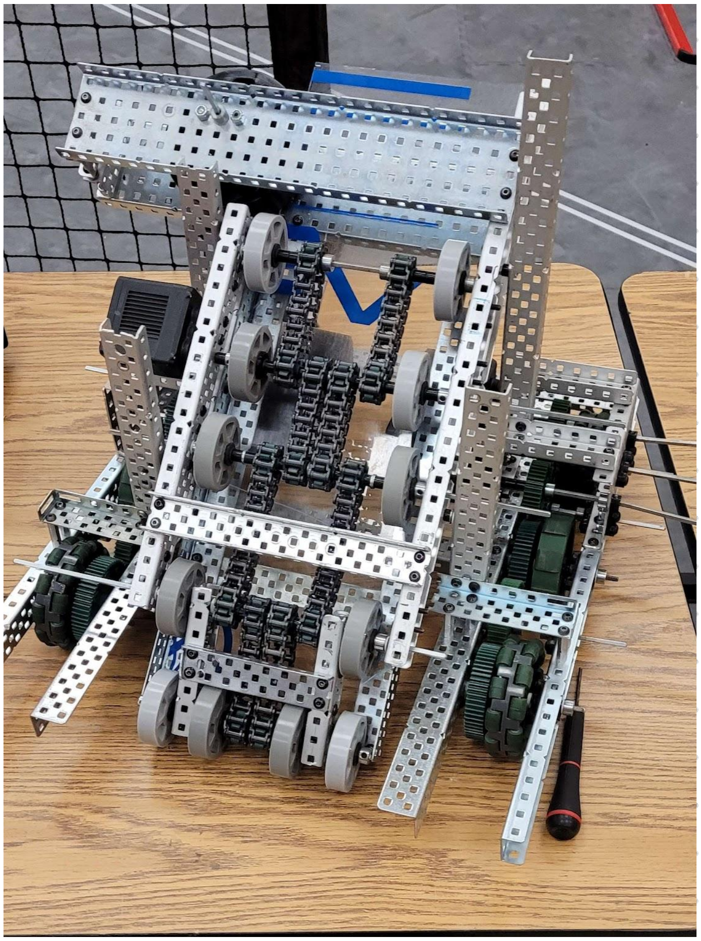
Project Daily Log 35 - Jan. 23

Name Aster Burrow Date 01-23-23

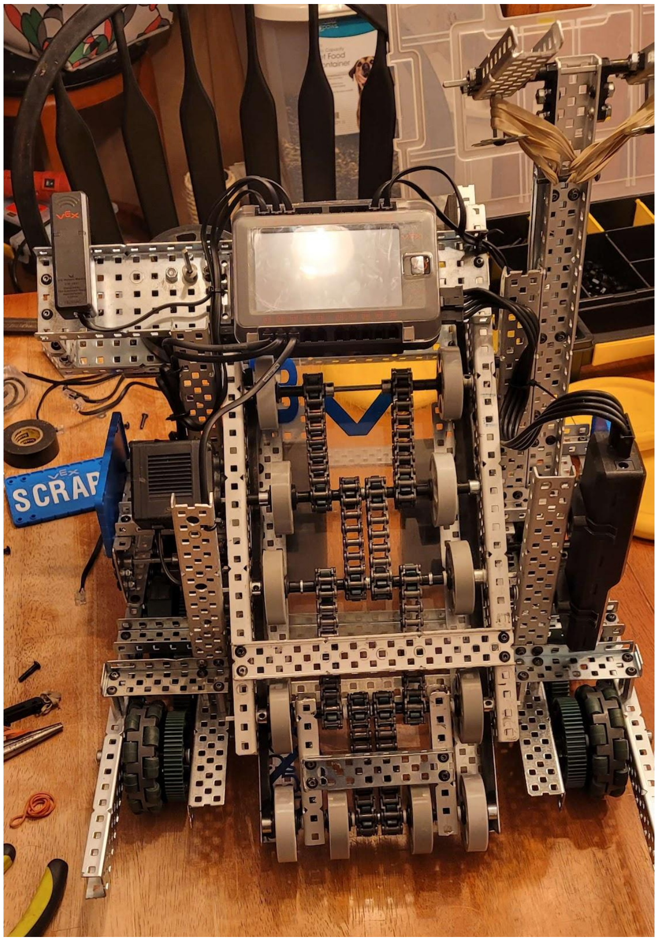
Today our goals are to wire and properly space the flex wheels on the intake as we have been having issues with disks getting stuck halfway through. We also want to cut the base down to fit within size restraints.

We started with the intake we decided to move the bottom row up a hole as the row above it couldn't be moved down due to the supports for the upper arm. I had some minor worries that this would cause issues with the lower pivot point bot it didn't seem to cause any issues however I am concerned that this may cause issues after we lower the polycarbonate on the intake. We also put a piece of foam on each side of the intake to remove some of the wiggle room the disks have in it

before



after



After repairing the intake we set to wiring the robot this didn't take very long due to the fact that most of the wires take the same route to the brain we initially had the brain positioned towards the back of the robot but it stuck out a ways which caused an issue but this was an issue sizing wise we also didn't want to damage it in a roller fight. For these reasons we decided to move the brain to the front of the robot where it would be more protected and inside our size limits.

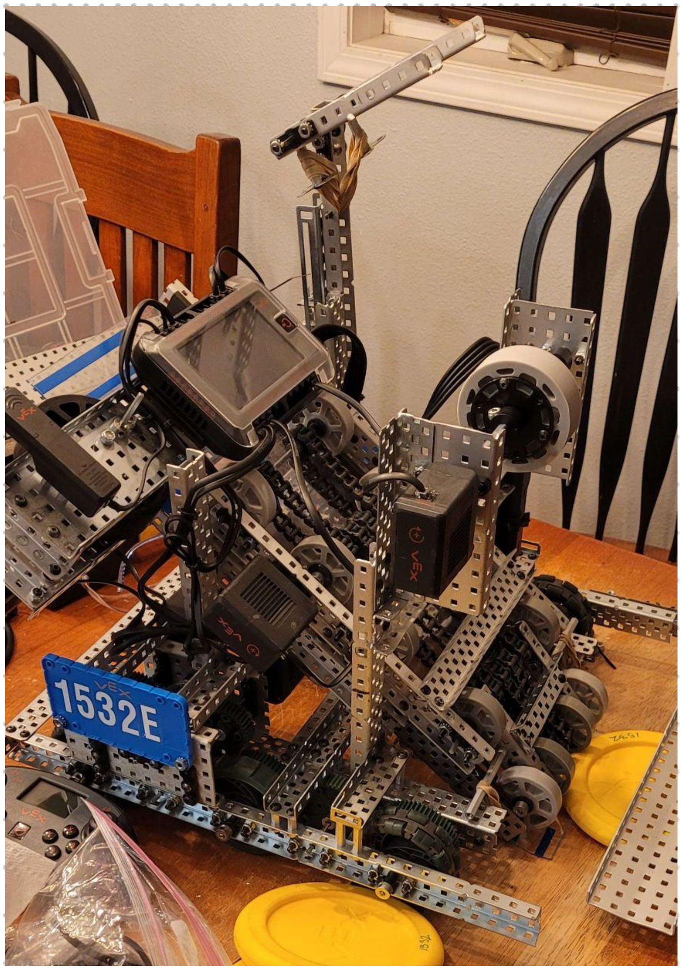
Project Daily Log 36 - Jan. 30

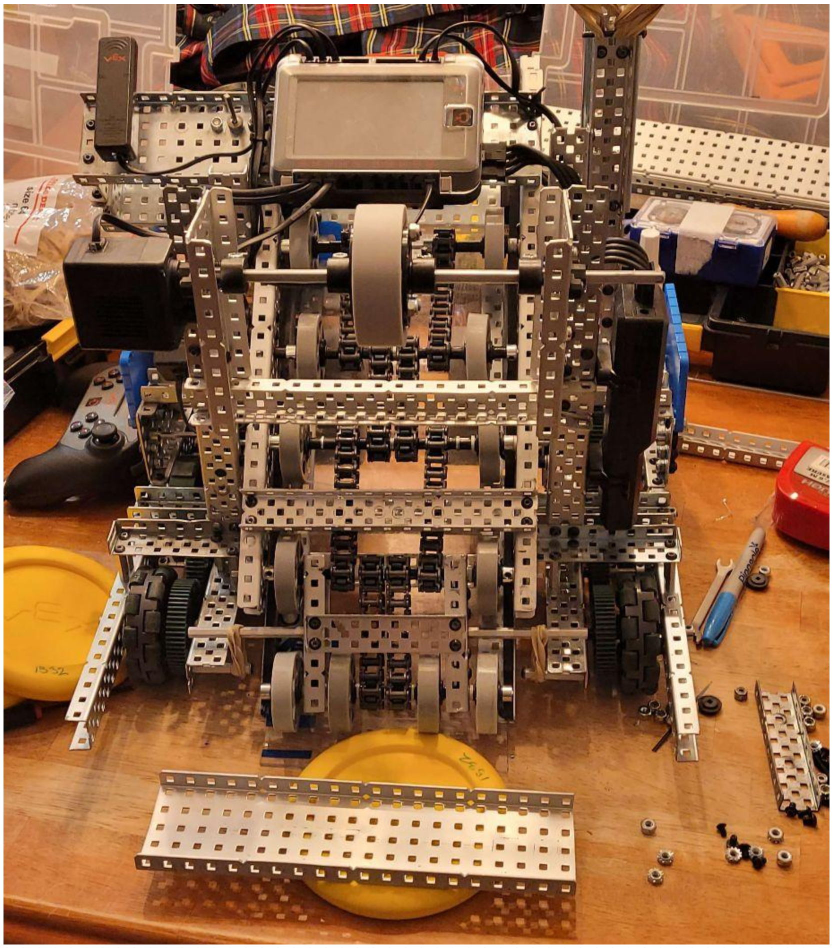
Name Kaden Haugen Date 1/30/23

Today our goals are to code and test the robot, lower the polycarbonate on our intake to better take in disks, ajust the amount of pressure on the diks when they are in contact with the flywheel and install a roller mech.

We started out by uploading and testing the code as we need to be able to run the robot in order to adjust and test everything else and the code had no noticeable issues. After that we decided to test the flywheel and frankly it sucked. We added another piece of foam along the opposing side of the flywheel and that improved our shooting range exponentially. With the flywheel shooting we needed a way to pick up the disks as they are still jamming at the bottom of the intake. We decided to just add a few inches of polycarbonate over top of the stuff that we currently have that just goes slightly lower the leading edge to properly pick up disks now the only thing we need to tackle is the roller mech.

For this we just decided to use the extra motor we have to make it simpler and easier to build. All we did was place 2 pieces of aluminum C channel that came off of the supports for the intake with a singular motor with a 100 RPM gear cartridge in it directly driving a quarter inch shaft with a singular 3 inch low density flex wheel on it.





Project Daily Log 37 - Feb. 1

Name Kaden Haugen

Date 02-01-23

While the outcome of this competition was less than ideal rankings wise it was about what we expected. We placed 29th out of 32 teams in the qualifying rounds if I remember correctly however this wasn't a huge surprise considering the sheer skill level of our opponents. While rankings wise this tournament was a disaster, it had to have been our most productive tournament yet. We made an incredible leap in driving ability as Quinn and I decided to try a 2 controller driving style and while this took an incredible amount of getting used to splitting up the driving definitely helped as I never has to take my hands off the sticks which made us much more efficient on the field. The button maps for the new controllers are on pages W8 and W9.

Along with our massive jump in driving ability we also made several discoveries in terms of what we can improve. The most notable issues were:

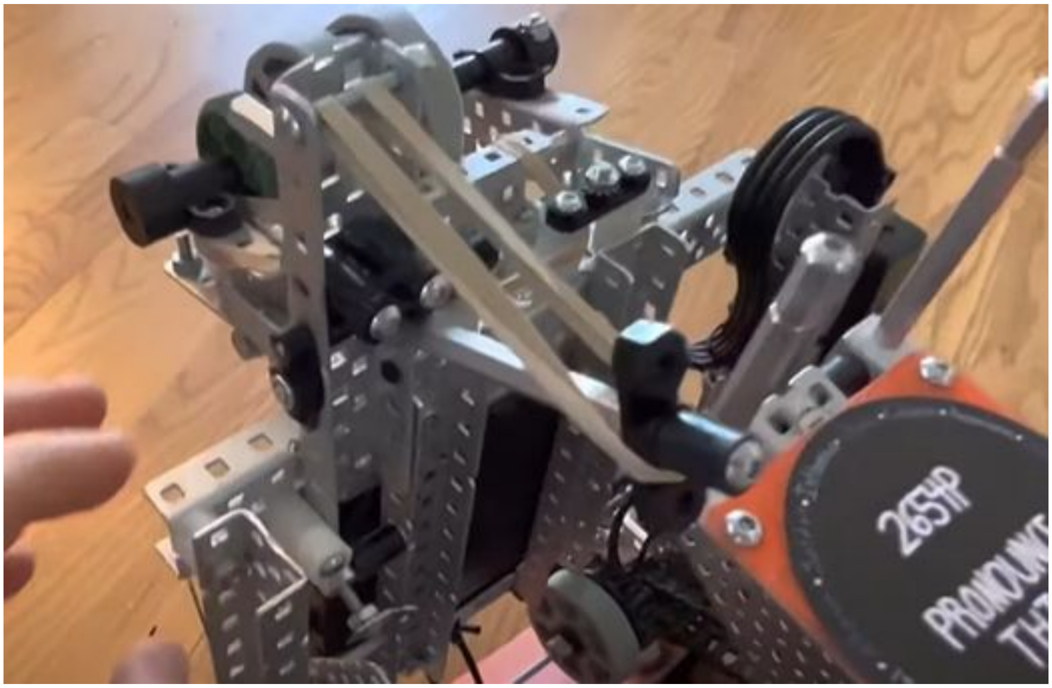
- Our slow drivetrain, the slowness of the robot served as a huge disadvantage as we could not navigate the field fast enough to play proper offence or defence. While the extra torque was useful in roller fights there was no situation where I believe the speed tradeoff would be worth it.
- Our lack of expansion. Having a good expansion gives us valuable points that lost us multiple matches. Those extra 15-20 points can completely change the outcome of the game
- The speed of the intake. Our intake was rather slow with is being directly driven with a green motor cartridge. If we gear is up or swap it to a blue cartridge we will be able to intake and fire much faster
- The weight of our flywheel. With the lighter weight of our flywheel we were forced to wait much longer between shots with the flywheel losing momentum with more weight of the flywheel it will be harder for the motors to start spinning but this also means it will be harder to stop from spinning so it will lose less momentum when we shoot disks. With this we will be able to shoot much faster and have the potential to score much more disks.

On February 6, we re-geared the drivetrain, tested it, and worked on expansion mechanisms.

The gearing of the drivetrain was previously 120 rpm on green motors with a 36 tooth gear driving a 60 tooth gear. This gearing allowed the robot to push others around fairly easily, but it struggled severely with speed. For this reason, we decided to gear the drivetrain to 1:1 with 60 tooth gears for a total rpm of 200.

When testing this gearing, we found that it is significantly faster than the 120 rpm drive base. Although it is a little slow, we decided to keep it for the balance of torque and speed that it achieves.

For expansion devices, Sam has been working on his version of the expansion on 2654P's robot
(found here https://youtube.com/clip/Ugkxoz_PmTJweptn_gPYXL324EM1_Vncjt5l), which is an extremely simple and effective catapult made up of a standoff, a piece of c-channel, a shaft, and a few bearings. He made seven of these to be used in testing and placement on the robot. We're hoping to install these on Wednesday, as we ran out of time.



A screenshot of 2654P's expansion

Kaden is planning on taking the robot home tonight and wants to paint the disk guards.

Project Daily Log 39 - Feb. 6
Name Aster Burrow
Date 02-10-23

On February 8, we worked on attaching the expansion devices Sam made, moved the roller mechanism out further, and tested the robot with its new paint job.

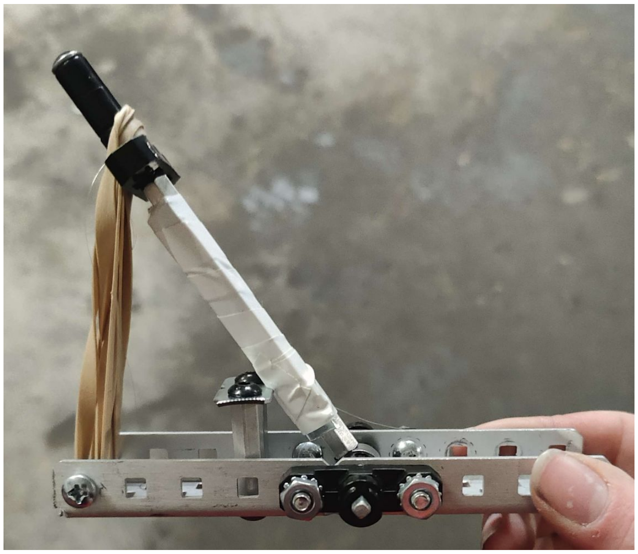
Due to space restrictions, we decided to place the expansion mechanisms on top of the roller mechanism because we had an extra 5 inches of vertical space up there to work with. We ended up mounting 6 of them in a row on a piece of 1x5x1 c-channel at slightly different angles. The center string will be longer than the ends, as we expect to be in the center or corners of the field and want to maximize the length we can get out of the expansion mechanisms.

To fire the expansion devices, we will have two pneumatic single-acting pistons running parallel to the bases of the center catapults that will be attached to a piece of linear rail that will hold down the ends of every catapult and push toward the center of the robot to release.

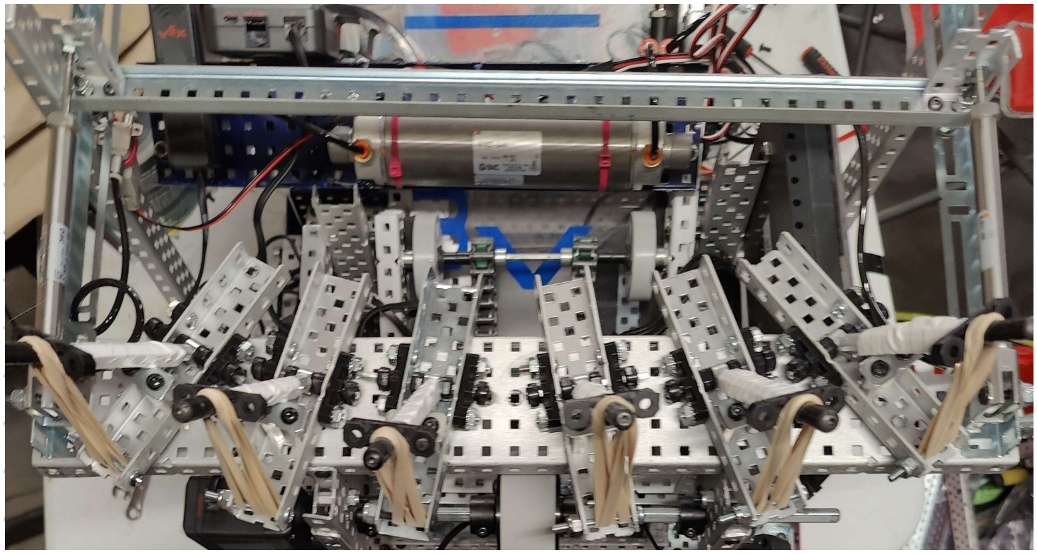
When testing the catapults, we found that adding more than one rubber band bends the standoff severely. To remedy this, we added a piece of cut-up slotted angle to the longer-range catapults to brace them. It seems to work well, but it will be put to the test on Saturday's competition.

A picture of a standoff from a long-range catapult after one shot

A picture of a modified catapult to withstand the force of the rubber bands.



Kaden will be taking the robot home to attach the string storage, test, and finalize the design for Saturday's competition. For now, the full spread of catapults looks like this:



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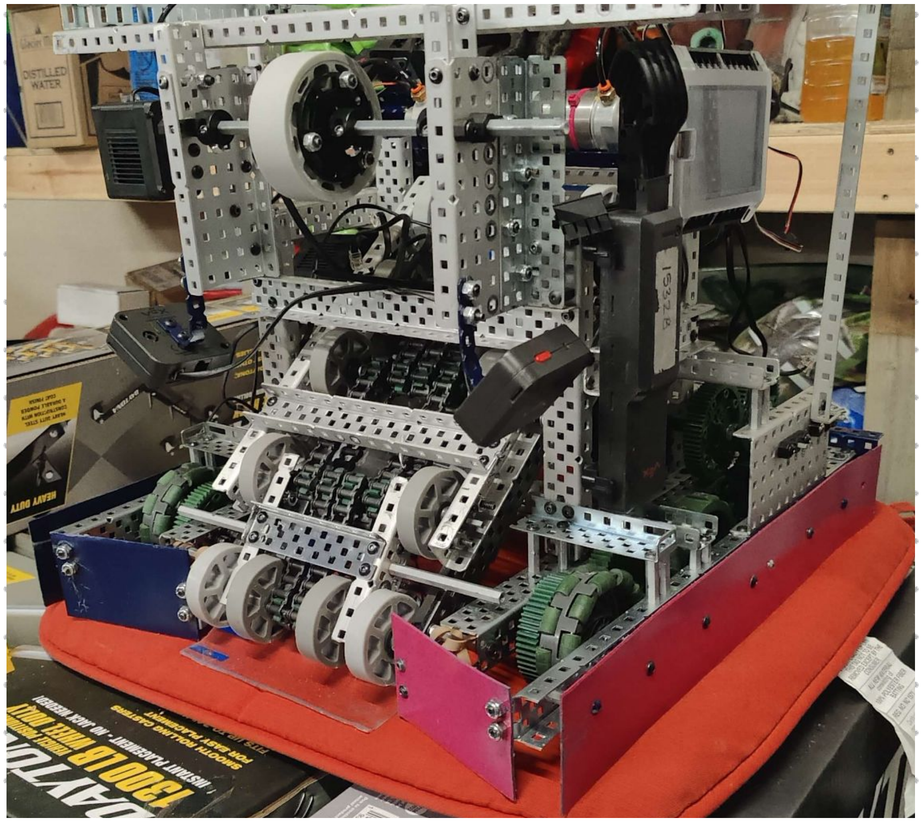
The robot's paint job came out fairly nice-looking. Kaden painted it dark blue for the school colors with pink for our own spin on things. We expected the pink to be brighter, but the color contrasts nicely with the blue. When driving the robot, we found that the paint was slightly tacky and the front panels of the robot were struggling to guide disks into the intake. Kaden is planning to put a clear coat on the panels to fix this.



A picture of the painted robot

At the Rum River competition, we found that our roller mech, which is made to hit the roller when the front panels of the robot hit the field wall, is extremely ineffective when used on fields with bent walls from use. To remedy this problem, we switched the 4 metal washers that were pushing the roller mech out from the bars supporting the flywheel assembly out for short standoffs. We found that this doesn't work as well on a well-maintained field, but it will somewhat work. We plan to do more work on this in the near future to increase the roller mechanism's efficiency.

Side note - we have attached several vision sensors to the robot, but they are currently unused. We're going to work on properly implementing them before State.

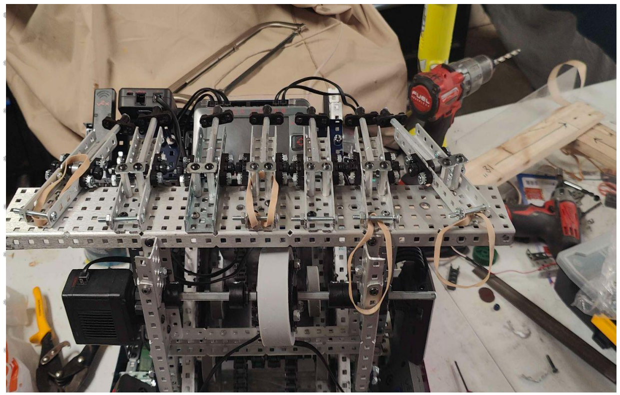
For now, we are as ready as we can be for our home event. We believe we can do better at this competition with the experience and robot we have built and gained.

Project Daily Log 40 - Feb. 8

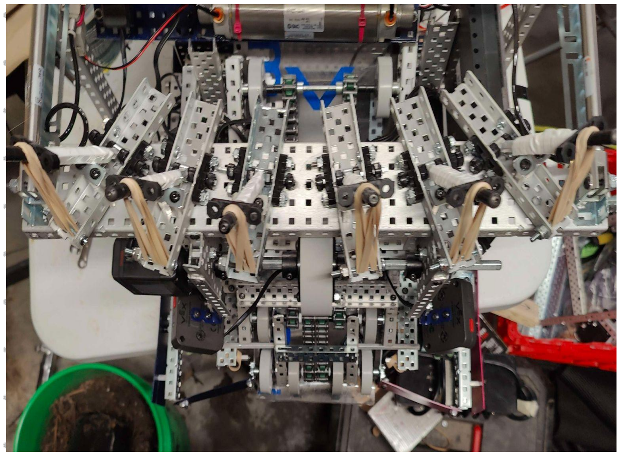
Name Aster Burrow

Date 02-10-23

Today my goal is to find a way to mount and fire the expansions. I am planning to mount them to a piece of 5x25 C channel mounted up above the roller mech. I fear it will be a little tight height wise but I have a inch or two of height to play with. I originally intended to mount all seven of the mousetraps we had assembled but I decided it was best to just mount 6 so I can fit them in at more aggressive angles.

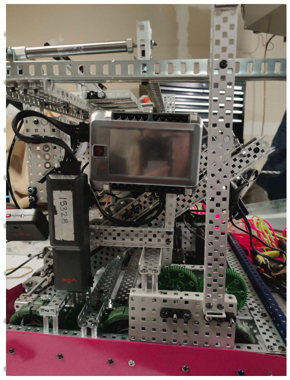


Mounting angles of 7 expansion system



Mounting angles of the 6 expansion system

While working on designs for the firing mechanism I realised that the brain was gonna have to move in order for it to not be blocked. It wouldn't have been an issue as we can start all of our codes from our controller but we were worried that the judges would consider the brain to be too blocked and we wouldn't pass inspection. Due to this we moved the brain to the side of the robot. After moving the brain I had to figure out how to release the expansions. I decided to go with a piece of linear slide rail attached to 2 pieces of slotted angle (one on each side) with a plastic washer on the bottom and top of the screw to help it slide smoother. I chose the slide rail due to its exceptional strength and rigidity along with the fact that it is curved to allow the expansion to release easier.



The brain's new mounting position

How the release is mounted

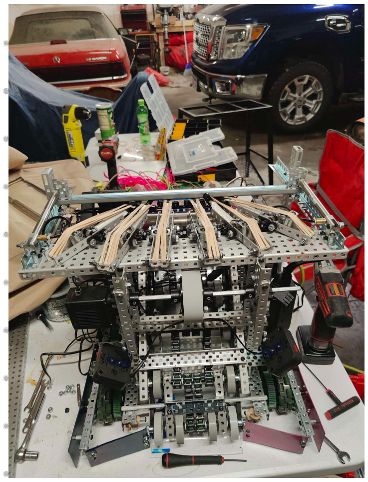
Continued next page

Project Daily Log 41 - Feb. 9-10

Name Kaden Haugen

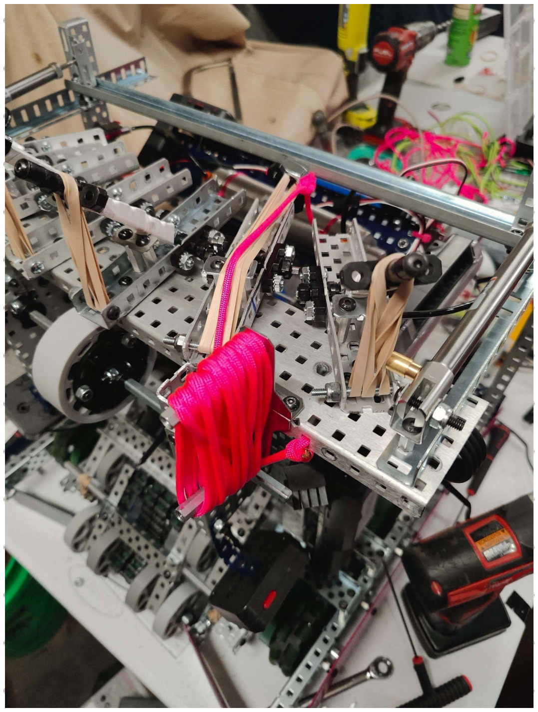
Date 2/12/23

After mounting the release bar we had to figure out a way to move it. I went with 2 single acting pistons on each side of the release bar, mounted farther up on the slotted angle. I connected these by mounting a small piece of chassis rail on each side of the release bar I mounted the moving section of the piston to each of these.



A picture of the expansion while armed

Now that I had a way to actually fire the expansion I had to figure out how to hold the string without getting it caught on other parts of the robot. At first I conceptualised having 2 standoffs mounted on 2 opposing 90 degree gussets but the string would get stuck when I test fired it. After this method failed I decided to just go with a classic mesh pouch. While this doesn't look nearly as good and takes up more space it was getting very late at this point so I just threw a pouch on each of the expansions and called it good.



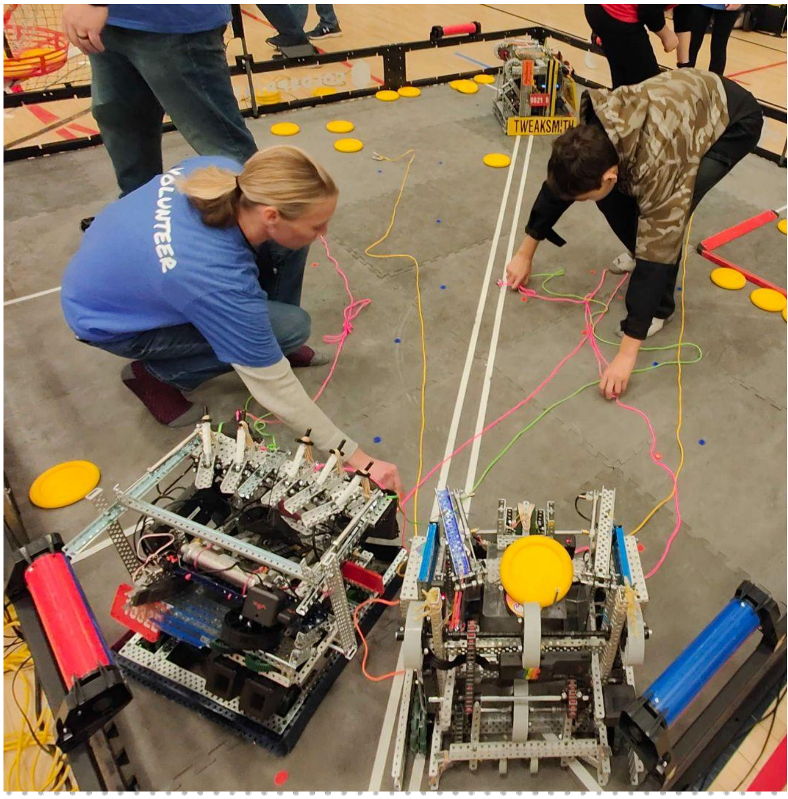
Picture of the failed string holding device, I do not currently have a picture of the mesh pouches.

At the Lumberjack Robotics Competition, we ranked 9th and lost in the semifinals with our alliance partner, 4149G. We won the design award at this event. We spent the majority of our free time working on our expansion, which ended up firing 6 strings in a 90-degree spread from the front of the robot.

Our expansion had two failures: once when the end strings fired into the net and once when one of the nuts flew off and hit our opposing alliance during a match. We dealt with both of these issues to they would not occur again right after each match. For the string in the net, we decided to shorten our end strings by two feet so that they would not get anywhere near the goals when firing from the corner of the field. For the nuts flying off of the string, we melted the knots holding the nuts onto the paracord so that they could not come apart without being deliberately cut.

As our expansion was assembled quickly, its string storage was not particularly ideal for quick reloading. Each string was loaded into individual mesh pockets placed around the robot, and some pockets were smaller than others, making loading in some spots especially difficult. We plan to fix that issue when we have the time to do so, as it is not particularly pressing.

Our setup of rubber bands on the expansion was as follows: 1 rubber band doubled over and one rubber band tied from the set point to the arm of the expansion on the outer four catapults, and 2 rubber bands doubled over on the center two catapults. This setup has too much force and caused the string to bounce back at the robot, so we are going to tune that at the next possible practice to cover the most tiles possible.



An image of our expansion being scored at the event. The strings have visibly bounced back at the robot in the image, causing them to bunch up and cover less tiles.

Continued next page

Project Daily Log 42 - Feb. 11, Lumberjack Robotics Competition

Name Aster Burrow

Date 02-12-23

The length of the strings are 12 ft on the center four and 10 ft on the end two. Two feet was cut off of each of the end strings, leaving them at 8 ft each.

At this competition, our drivers, Kaden and Quinn, became even better at controlling the robot and working as a team. They were able to score 8 disks in one match, which is a huge improvement from the maximum of two at the last competition. We hope to use the little time we have left before State to improve our robot and performance even more.

A picture of us with the Design Award at the competition.

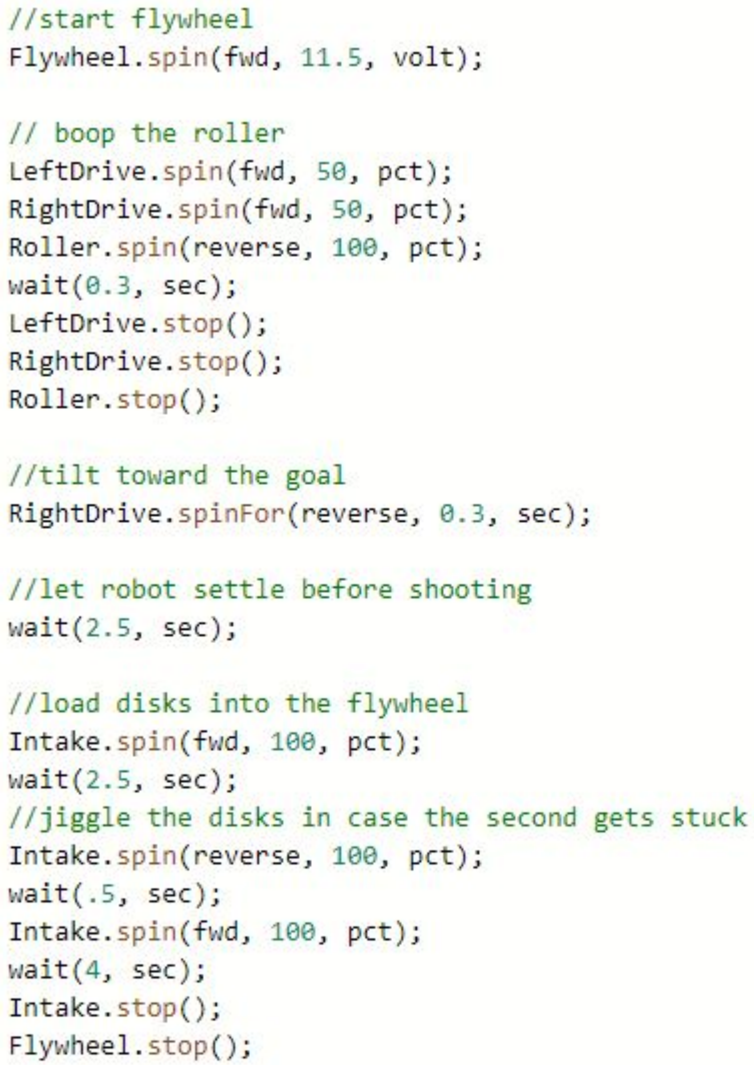
Project Daily Log 42 - Feb. 11, Lumberjack Robotics Competition

Name Aster Burrow Date 02-12-23

On February 13, we worked on a better match autonomous program and lowered the power of the expansion.

Our previous autonomous program turned the roller that can be started in front of and stopped there, earning our team ten points. We decided that with our longer-range flywheel, we should be able to do more. We are currently planning to have two match autonomous programs: one that turns the easy roller and shoots two disks into the high goal, and another that does the same thing on the other side of the field. Both of these programs would earn us at least 10 points with the roller and at most 20 with the two disks added. We're currently working on the easier side of the field so that we have a good program to start the other side off of. As of today, we have the basic pieces of the program together and are working on tweaking it to actually shoot in the goal. By the time I left, it was not tuned properly. We plan to continue that soon.

After I left, my teammates worked on tuning the expansion so that it would not bounce back at the robot. They found that having one rubber band doubled over on each of the four outer string shooters and two rubber bands doubled over on the center two caused it to fire off the smoothest.



A screenshot of the code in progress

```
//start flywheel
Flywheel.spin(fwd, 11.5, volt);

// boop the roller
LeftDrive.spin(fwd, 50, pct);
RightDrive.spin(fwd, 50, pct);
Roller.spin(reverse, 100, pct);
wait(0.3, sec);
LeftDrive.stop();
RightDrive.stop();
Roller.stop();

//tilt toward the goal
RightDrive.spinFor(reverse, 0.3, sec);

//let robot settle before shooting
wait(2.5, sec);

//load disks into the flywheel
Intake.spin(fwd, 100, pct);
wait(2.5, sec);
//jiggle the disks in case the second gets stuck
Intake.spin(reverse, 100, pct);
wait(.5, sec);
Intake.spin(fwd, 100, pct);
wait(4, sec);
Intake.stop();
Flywheel.stop();
```

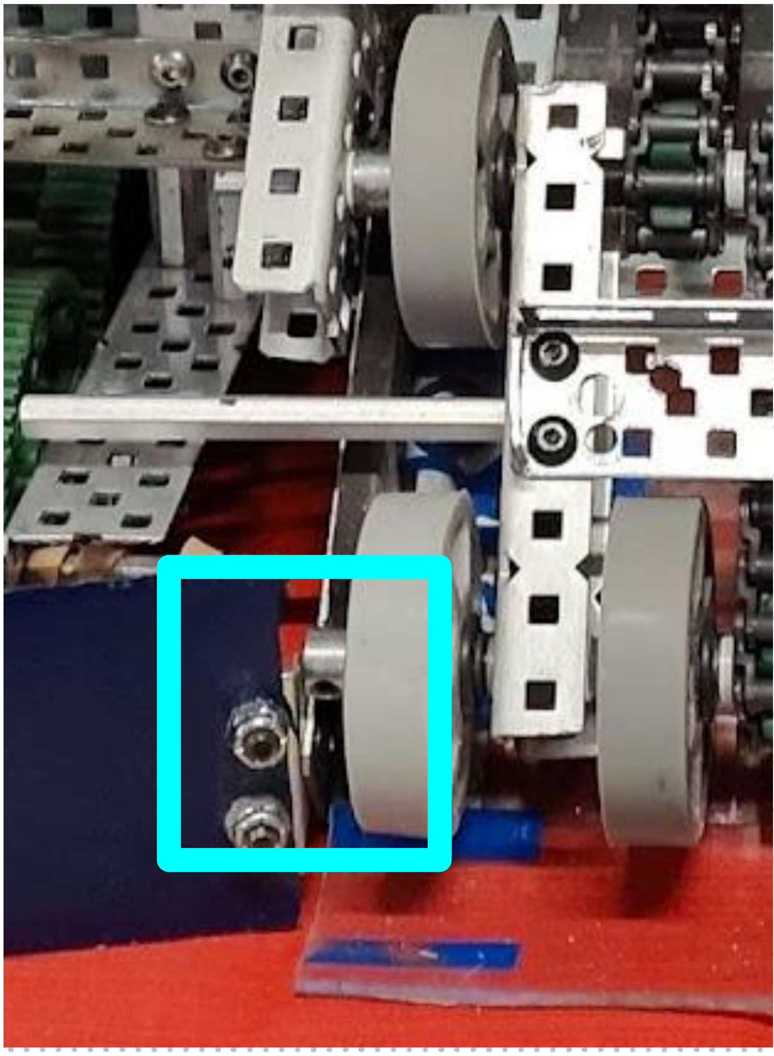
Project Daily Log 43 - Feb. 13

Name Aster Burrow

Date 02-14-23

On February 15, we decided to modify our intake and roller after having issues with jamming and speed.

During autonomous testing at the beginning of practice, we noticed we were having issues with jamming in the intake, as disks would often get stuck near the top during a normal autonomous run. We didn't have any problems with this during the recent competition and couldn't think of any reason why the robot would be behaving in this way, so we decided to check it over. One flex wheel in the top row had lost one of its inserts and the free-moving piece at the bottom of the intake was catching on a piece of metal. Unfortunately, to fix the top row of the intake, we had to take the roller mechanism and the string catapults off of the robot. We spent most of the practice doing that, but managed to fix the top row near the end of our time that day. We plan to pick this back up next Wednesday, as there is no school on Monday for Presidents' Day and the team is a little burnt out from putting so much work into the robot over the past few weeks.



A picture of where the bottom row of flex wheels is catching with a teal box around the area.

We didn't manage to get a picture of the messed-up top row because we were a little distracted by fixing it and didn't realize until after it was back together.

Project Daily Log 44 - Feb. 15

Name Aster Burrow

Date 02-19-23

On February 22, we finished fixing the intake, switched the motor cartridges of the roller and the intake, and began reattaching the roller mechanism and expansion.

After dealing with the pain that was putting the intake back together last week, we decided to take the easy route and bend the piece of metal the intake was rubbing against away from the intake so they couldn't touch. This solved the last easy problem with the intake, as all that remains is an inconsistent jamming issue that we don't have the time to deal with. To remedy that issue in the fastest way possible, we switched the 600 rpm motor in the intake out for a 200 rpm motor for the added torque. The jamming problem happens much less now, but it should be monitored as we move forward.

While the roller mechanism is off of the robot, we decided to switch the 100 rpm motor out for a 200 rpm one for the added speed. The added torque from the red cartridge wasn't necessary and it now runs much faster.

After all of that, we began reattaching the roller mechanism and expansion. The roller was fairly easy to reattach, as it was only four screws and realigning a shaft, but the expansion was proving to be much more difficult, especially because of the string pockets. I plan to take the robot home to work on new string storage and a more compact way to support the expansion, as it currently has a bar hanging dangerously close to our size limits.

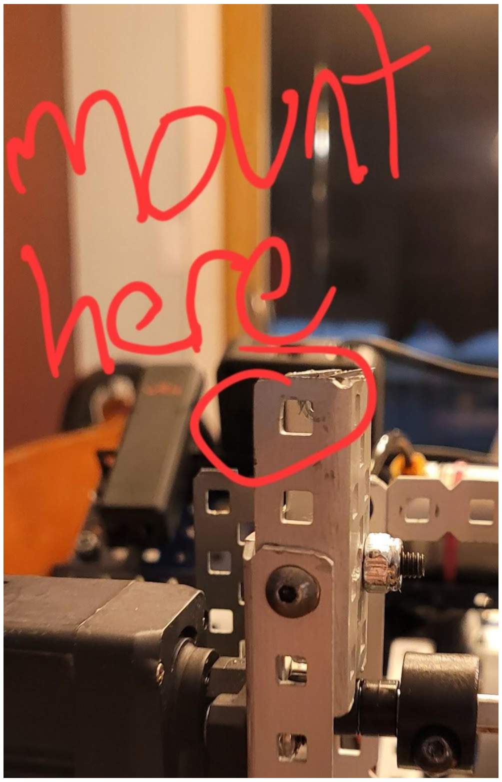
Project Daily Log 45 - Feb. 22

Name Aster Burrow

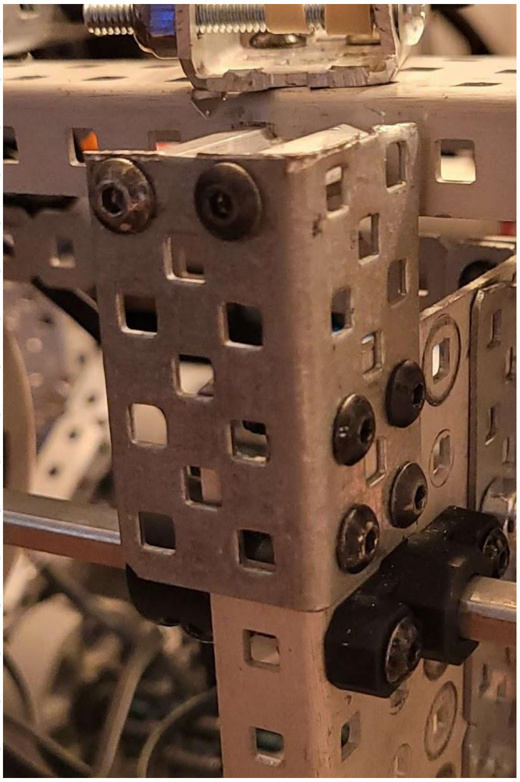
Date 02-25-23

On February 26, I worked on the robot at home. I reattached the expansion, redid the layout for consistency, made the end catapults longer for safety, switched it over to double-acting pistons for their strength, finalized the wiring, decided with our programmer to end our efforts to utilize vision, and attached the new string storage system.

First, I strengthened the mounting for the front of the expansion assembly by switching it from a piece of aluminum c-channel to a piece of steel angle for the extra mounting space for screws. Here is a comparison of before and after:



Before



After

I also added pieces of steel chassis rail in various places on the inside of the frame of the robot to better support the assembly while staying inside of the frame of the robot to prevent damage to it.

In order to make loading the expansion and driving around with it safer, I extended the end arms with one ½” standoff on the end of each one. This was done because the end arms were only held down with about ¼” of the spacers on the end of the arms, while the other arms had ¾” to 1”. With the added length, the arms are held down more securely with ¾” of contact with the bar holding them in place. A picture can be found on the next page.

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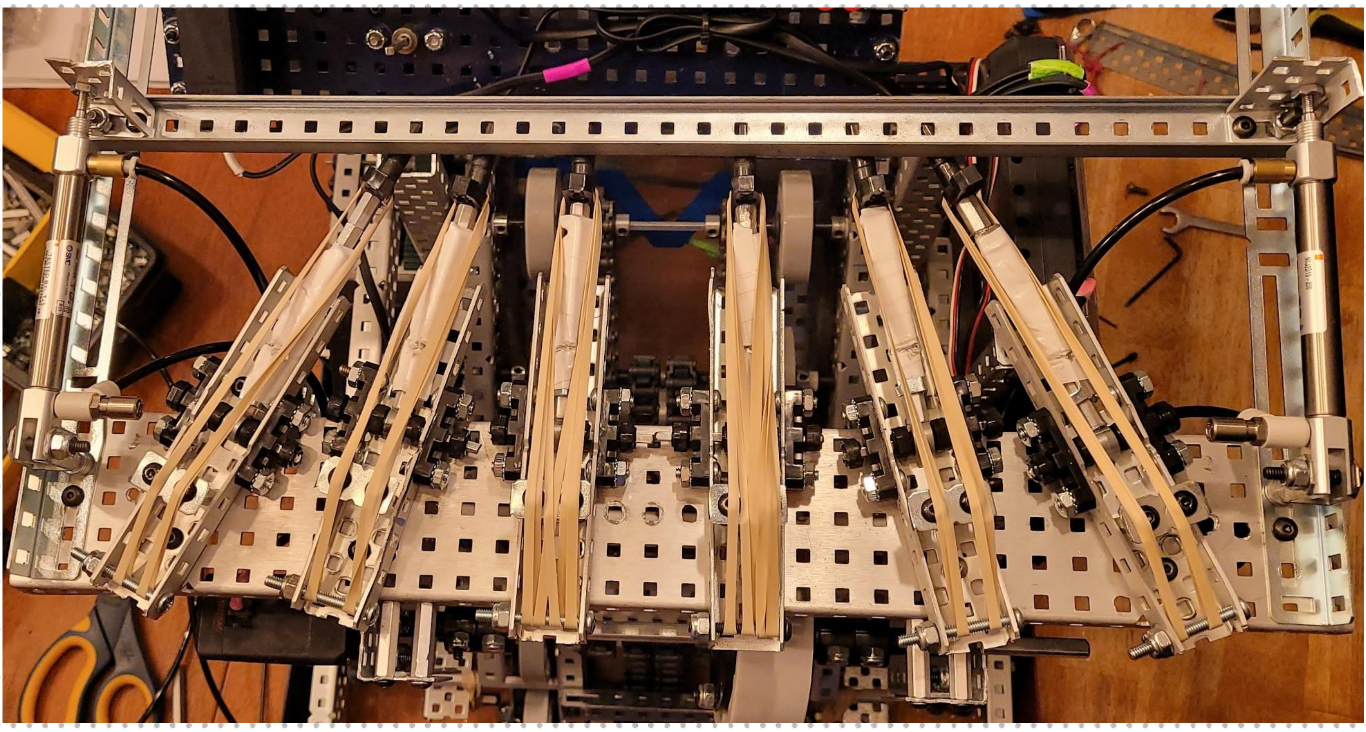
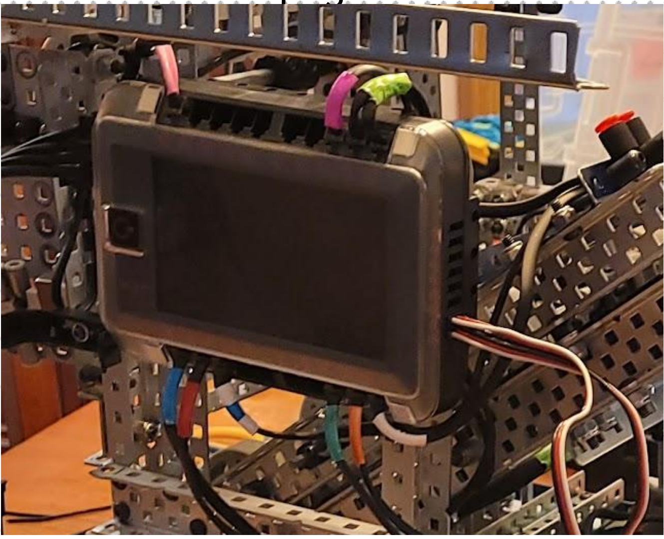


A picture of the loaded expansion assembly. The end arms have an extra ½” standoff attached to each one.

As you can see in the picture, I also switched the expansion release to two double-acting pistons instead of single-acting as they were before. This is for the added force that we’ve found these pistons provide, just in case another robot rams into our expansion tracks and bends them out of shape. We’re hoping that with the extra force, the pistons will push through minor damage to the mechanism and still score points in a match. To mount these pistons with minimal movement of other pieces, I moved the piston mounts two holes back to account for the shorter size of the double-acting pistons.

While working on the expansion assembly, I noticed how disorganized our wiring is and couldn’t leave it alone. All of the wires are now organized and labeled with colors, which can be found listed out on page W12.

A picture of the brain with color labels.



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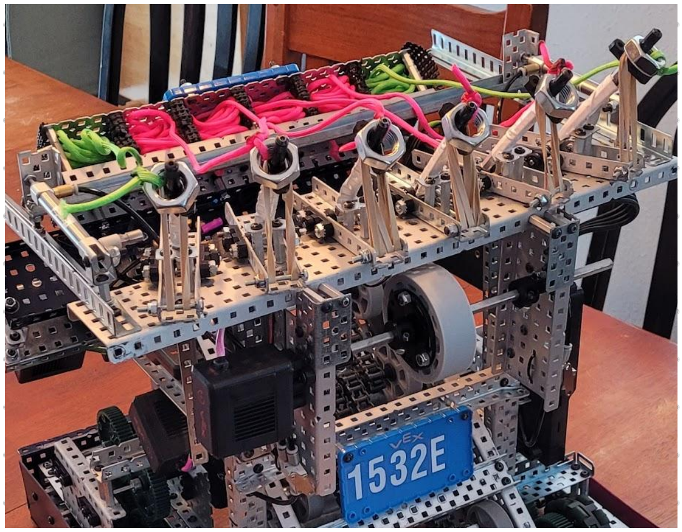
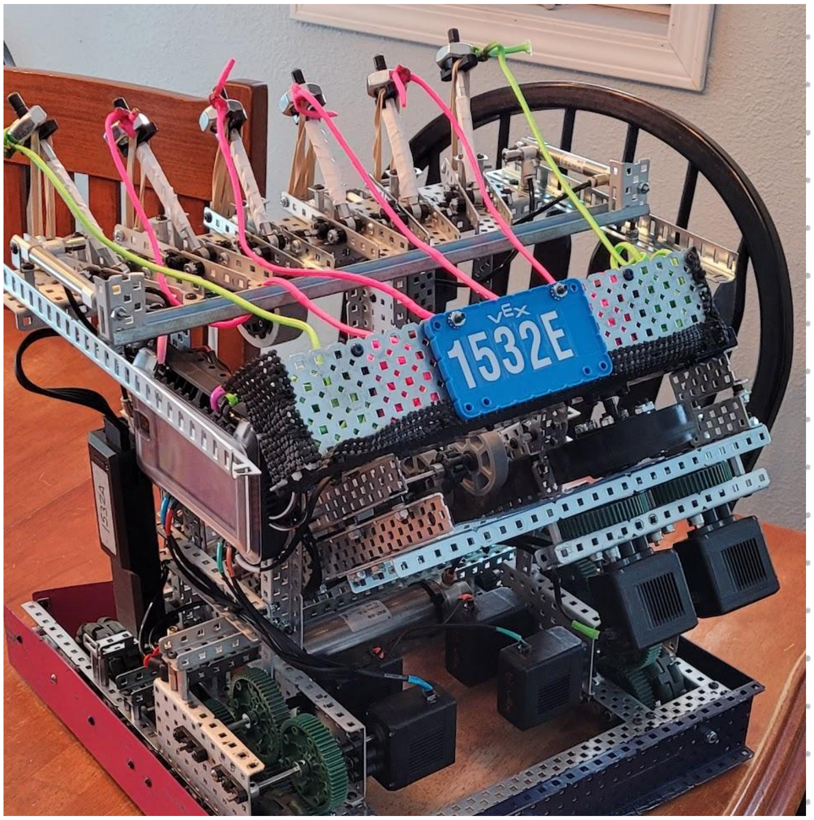
After a long discussion with our programmer, Quinn, we decided to end our efforts to use vision to track the high and low goals. They have been working with vision for the past four years and could not find a way to consistently have the vision tracking work during the little testing time they had. If we had more time to dedicate solely to programming, it may be a possibility, but with the gaps in the goals themselves and the way that the VEX vision sensors track separate blobs of colors as one singular large object, it's incredibly hard to program and impossible with the time we have left. As of today, we decided to remove all of our vision sensors to avoid wasting power and getting distracted by them.

With all of that out of the way, I was finally able to attach the new string storage. It is made up of a flat 5x25 piece of steel and a piece of 1x5x1 25 hole c-channel held apart by 1.5” and .5” standoffs attached to one another with long screws. These standoffs are also used as dividers between 6 sections, which are 3 holes wide each. Grip matting is used as side walls on the storage and is zip-tied on for simplicity. Grip matting is also wrapped around the divider standoffs to create walls between the sections. The storage has been mounted to the upward-facing side of the painted c-channel that the flywheel shaft runs through.

Pictures of the mounting of the string storage.





Project Daily Log 46 - Feb. 26
Name Aster Burrow
Date 02-26-23

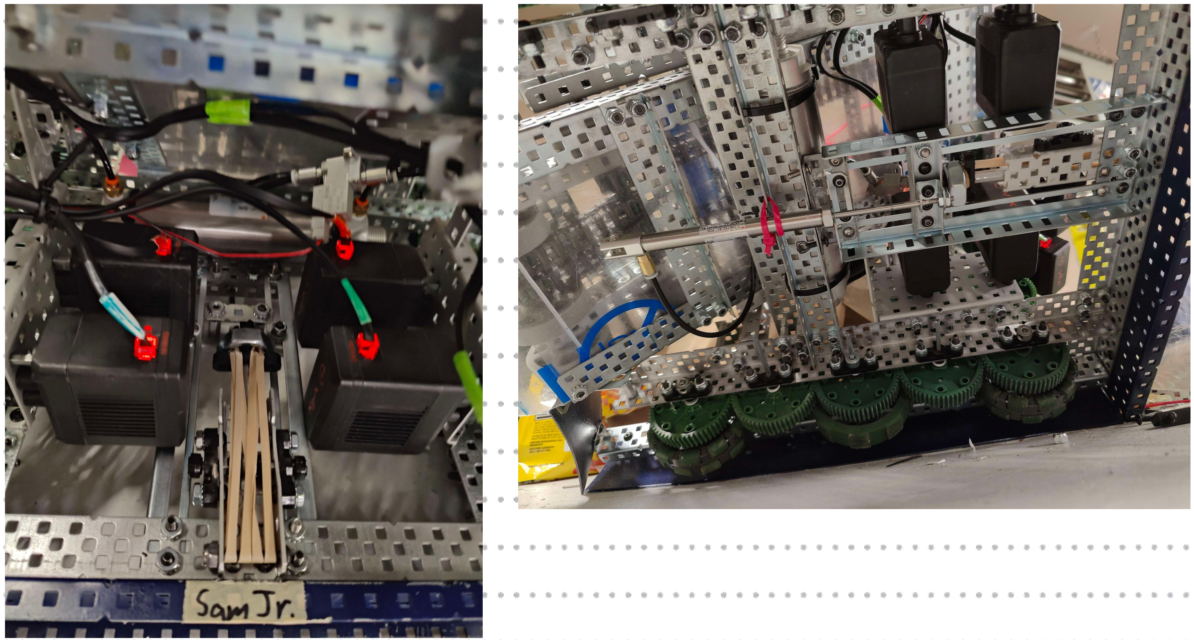
On February 27, we tested the remounted expansion and finished the 20-point autonomous for the easier side of the field.

The expansion needed to be tested and re-tuned after modifying the storage, as the catapults require different amounts of force now to fire. The rubber band layout is now 1 rubber band doubled over on each of the end catapults and 1 rubber band doubled over plus one tied on for the middle four. We found that it's unfortunately impossible to load string by wrapping it around our hands and stuffing it in the compartments as it gets stuck on itself and doesn't fire properly, but we can load the string by starting from the base of the string and pushing it into the compartments. It's slower to load, which may be a problem at State, but it's at the very least faster than our old storage was to load.

While testing the expansion, we found that the catapults are not spread out far enough from each other, causing us to cover less tiles and lose points. Kaden is planning to take the robot home to fix this issue.

Kaden also decided that we need to have an emergency expansion on the back of the robot. It fires exactly like the other expansion mechanisms, but it is only one catapult and uses a single-acting piston to fire. This mechanism has 6 feet of string attached to it and has not been tested, but it should stay below the field wall. Unfortunately, this mechanism is also underneath the robot and can easily be damaged by disks or the low goal. We will discuss this mechanism's integrity when we have the time later.

Pictures of the backup expansion.



After dealing with the expansion, we finished the 20-point autonomous program, and it now consistently scores points. There's a good chance we will have to retune it at State, but it works well for now here. An explanation of this program can be found on page P10.

On March 1, we packed for State and completed the alternate roller autonomous. We already had most of the materials we needed for State, and in fact had too much of most things. We had an excessive amount of aluminum, steel, gears, and chains, and did not need the extra weight to carry to St. Cloud. The only new thing we grabbed was a micro-USB to USB-A cable, as the one we had before was getting worn out. Other than that, we are ready to load tomorrow morning.

During that practice, Quinn programmed an alternate roller match autonomous that shoots two disks into the high goal and turns a roller. This program is similar to the other one, but will compensate better for other teams' programs, as many use the other roller. Besides the spin around to the roller, this program is identical to the one explained on P10.

With all of that taken care of, we are ready to go to State tomorrow. It's been a long journey, but we made it and we can't wait to compete tomorrow! See you then!

A picture of the team at the first competition. We've come a long way since then.

Project Daily Log 48 - Mar. 1

Name Aster Burrow

Date 03-01-23

We entered the competition without very high hopes after seeing what other teams in our area could do at the Rum River Rumble competition we attended earlier in the year. We figured we would rank relatively low and were unsure if we would even be able to qualify. We ended up being pleasantly surprised at the rankings we ended up with.

We had a very even schedule difficulty wise. We ended up with a 6-1 win-loss ratio in the qualifying rounds and getting 10th place. We were having issues with the accuracy of our autonomous for the majority of the competition trying to fix it in every long break we had but we had very little success. Other then that the robot performed very well throughout the competition with no major failures and no overheats which we were very surprised by as this was an issue we have been battling the entire competition season. If we were to make it past state we would have spent much more time working on our autonomous programs to eliminate any of the issues we were having. We also would have liked to make the drivetrain a little faster due to the fact that we were having a hard time getting across the field in time to defend the high goal because our drivetrain was geared 1:1 unlike many teams 1:1.75 ratios. Another thing we would have liked to change is the weight of the flywheel as it's light weight caused it to lose a lot of momentum every time we shot a disk which meant we had to wait longer before we could shoot the next disk. We wanted to make it heavier so it wouldn't lose so much momentum however we were also worried about the extra strain on the motors.

There was nothing special about the elimination rounds. We had Sam talking to potential alliance partners almost the entire second day. But we still had a hard time finding a partner due to the incredibly mediocre our robot was. We had intended to alliance with our sister team 1532F for most of the day but they were chosen by another team just before the announcer got to us which had offset our plans a little bit but we had learned at previous competitions to have at least 2 or 3 backup choices so it wasn't too big of a deal. We ended up aliencing with team 739B which had a linear flywheel robot which was a better shooter than us so we had them do the majority of the shooting while we focused on defence. This strategy worked pretty well for us and we made it to the quarter finals. We ended with a pretty difficult match and ended up being eliminated. While we were a little disappointed overall we were very proud of our performance as a team. We didn't end up winning any awards so sadly this is the end of our robotics season. Looking back at where we started it is amazing how far we have come as people and as a team.

Project 2022/2023 State Recap

Name Kaden Haugen Date 03-05-23

Last weekend, we discovered we made it to Worlds via the waiting list! Which is fantastic and an incredible honor to me and my team. We emptied all of our boxes after State so today we need to refill them. We gifted our extensive hardware boxes to our other Worlds team, 1532A, who found out they were going right after State, so we have to completely start from scratch. I brought in a husky 2-tier toolbox for us to fill.

The toolbox before filling it

We spent the entire day working on filling the toolbox, however, we were unable to finish. We divided our forces so that Sam filled the our electronics box where we keep our main controllers along with 2 spares, our batteries, chargers, 2 extra brains with pre-uploaded codes, license plates, safety glasses, loctite, and various tools that couldn't be fit in the 2-tier box. While Sam worked on that, Aster filled the 2-tier hardware box I had mentioned earlier which contains so many hardware inserts and electronics that it would take an entire page to list. While the other two filled their respective boxes, I filled our main materials box which contains all of our spare metal, any large tools, spare rubber bands of both legal sizes, and anything else that is too large to fit in the other two boxes. While we spent the entire day refilling the boxes Aster wasn't quite able to finish filling the hardware box today so we will have to continue filling that tomorrow.

Today after practice, Aster decided to work on a team logo to place on shirts we wish to get printed before worlds. The entire team spent quite a bit of time discussing what we should use as a logo in the team Discord server and eventually decided we wanted a cartoon style monkey wearing sunglasses with a space helmet that matches the colors of our robot's side guards. Aster set to work and came up with several concepts, which we spent quite a bit of time discussing what we did and didn't like about each one and what should be changed and what to keep.

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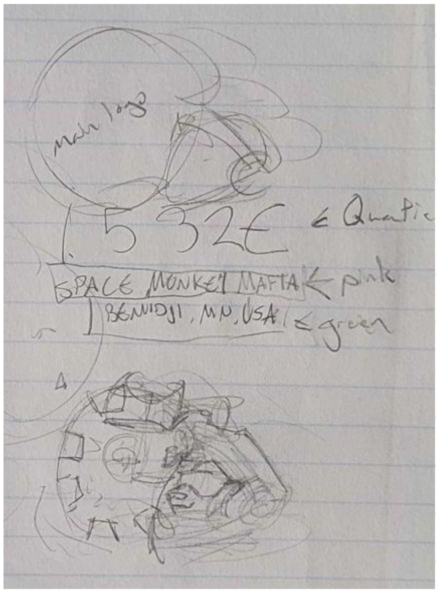
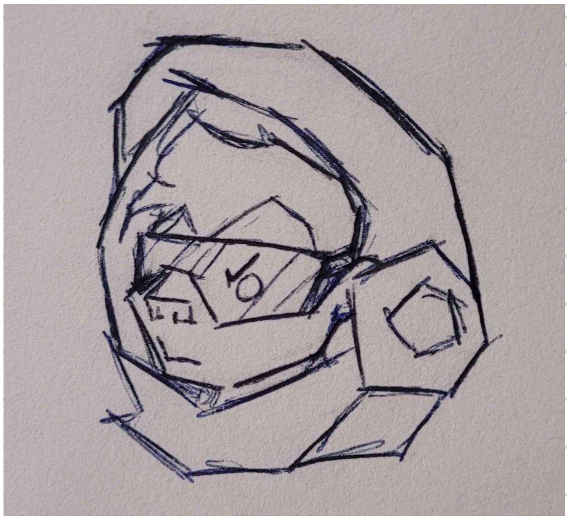
Project Daily Log 51 - Mar. 27

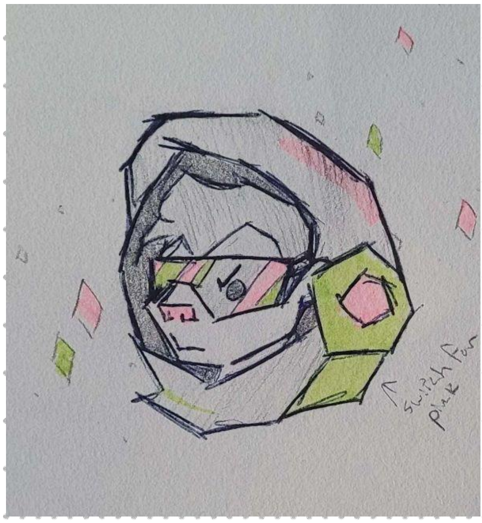
Name Kaden Haugen Date 03-27-23

After extensive discussion and minor modifications we came up with these design concepts.



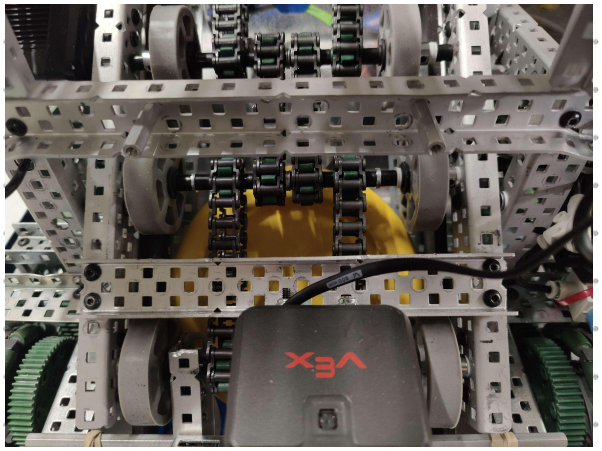


We were very pleased with these designs and liked the idea of having our program logo in the background of the main logo. We also thought that it could use some color so in a impressive urge of motivation Aster threw this together.



We were all very happy with these colors but it was getting late and Aster had homework to do and we obviously can't keep him from that so we decided to call it a day and spend more time on it tomorrow.

Today, our goals are to finish filling the hardware box and fix the issues we have been having with our intake. Aster decided to go into our materials room and finish filling our materials box so I decided to tackle the issues we have been having with our intake. At our last 2 competitions, we had issues with disks sticking halfway up the intake. We are currently unsure of the cause of the issue, but we believe that this may be caused by the odd spacing between the flex wheels on one of the middle flex wheel rows. They are spaced farther apart than the rest of the wheels and have a slightly wider gap between the rows above and below them due to the mounts for the main frame of the intake being in the way. I am hoping that if I bring them slightly closer together they will get a better grip on the disks and no longer jam.

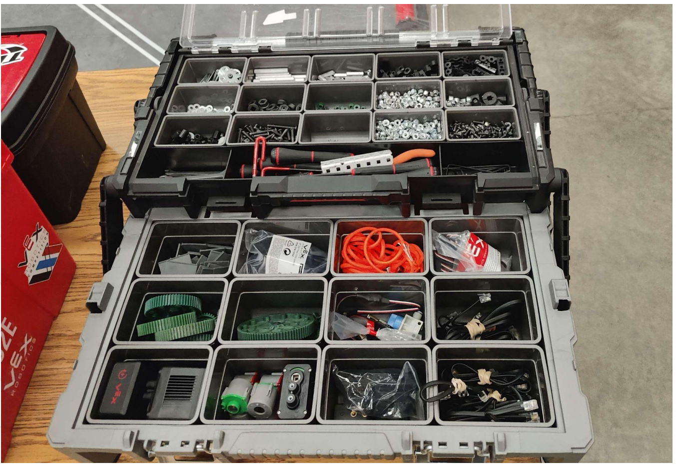


In this image, you can see the slightly wider spacing between the flex wheels on the center row. You can also see that they cannot quite reach the disk. I believe that if the wheels are closer together they will be able to properly reach the disk which would cause the intake to function much better.

I pulled that section of the intake apart, which was very difficult due to the tight space caused by all of the braces supporting the intake. After a little bit of struggling, I moved the flex wheels inward with one large plastic spacer on each side. After this, I visually inspected the chain and sprockets for any visual wear and replaced any worn links to prevent any future failures. When I was finished with this, I put the chains back on and tested it. The intake performed much better than before and no longer stuck in the middle.

While I worked on fixing the intake, Aster was nearly done filling the hardware box. We filled it with everything we thought we could possibly need for any potential robot failures or any modifications we decide to make outside of school meeting hours.

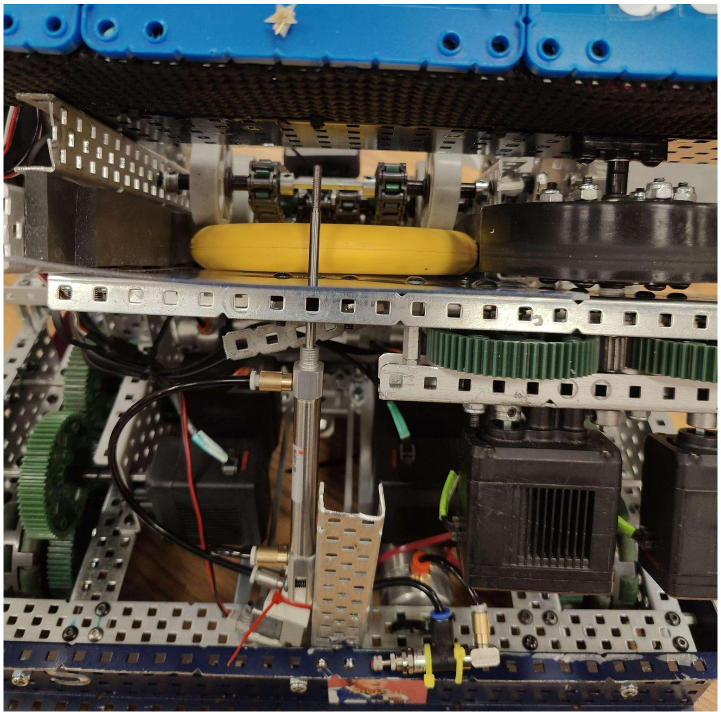
The completed box.



Continued next page

After Aster finished with that, he went to work on the logo, and I received an idea from one of our sister teams, 1532F, to use a piston just before our flywheel to stop the disks from being pushed out of the robot. I thought this was a very useful idea and discussed doing this with my other teammates. They agreed that this was a very interesting concept that could majorly help us while intaking and holding disks. This was the biggest flaw with our robot at State, as it was very difficult to intake more than 2 disks. When the intake starts to get full, it pushes disks out of the back of the robot instead of storing them, so this could massively improve our efficiency on the field.

All we had to do was drill a hole in the bottom of the polycarbonate intake guide for the piston to go through and 2 more to hold a quarter inch bearing that is being used to keep the piston in line with the hole even when it is retracted to shoot disks. After that all I had to do was add a piece of C channel to support the piston and we were able to test it. The test went perfectly other than some coding issues we had but no mechanical issues. It does it’s job just as intended. While its up the disks can’t get into the flywheel area which makes it much easier to properly fill the intake.



Aster began digitizing our logo by drawing over the outline in photoshop . The helmet and monkey outline is below.

Project Daily Log 52 - continued

Name Kaden Haugen

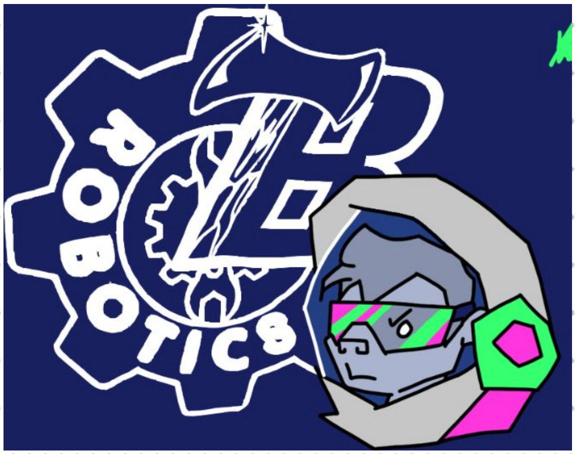
Date 3/28/23

Today, our goals are to add some more weight to our flywheel to reduce the amount of momentum it loses after shooting disks and to continue to digitize our logo.

I begun by removing the shaft that holds the flywheel and getting spacers absolutely everywhere while pulling out the flywheel shaft. After removing it, the team discussed what we should change in order to get it heavy enough to retain momentum and fit in our tight flywheel area. Simply adding an 84-tooth gear full of screws to the top wasn't an option due to space. I originally considered putting pieces of 1x1 steel on opposing sides of the flywheel, but decided that this would be too hard to properly balance due to inaccurate cuts in the metal and could be dangerous with the high speed the flywheel spins at. After some consideration, I decided to put a long screw, a nyloc nut, and 6 metal washers in each screw hole on the flywheel wheel hub. I was unsure if this would be heavy enough, but figured that it would at least be better than it was originally. After doing this, I had to put the flywheel back on the robot which was quite a chore. I had to remove the motor mounting plate, but eventually got it back together. I later regretted not replacing the motors with brand new ones while we had it apart to help prevent any failures at Worlds, but decided it wasn't worth my time to pull it back apart.

Meanwhile, Aster was working on digitizing the logo. He took a rudimentary version of the Bemidji VEX logo and put the monkey next to it, coloring the monkey in the process. An image of the progress can be found to the right.

This arrangement is meant to look similar to 1532A's shirts, the design for which can be found to the right.



Project Daily Log 53 - Mar. 29

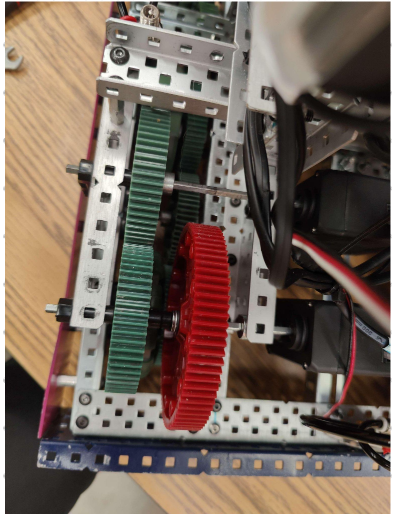
Name Kaden Haugen and Aster Burrow

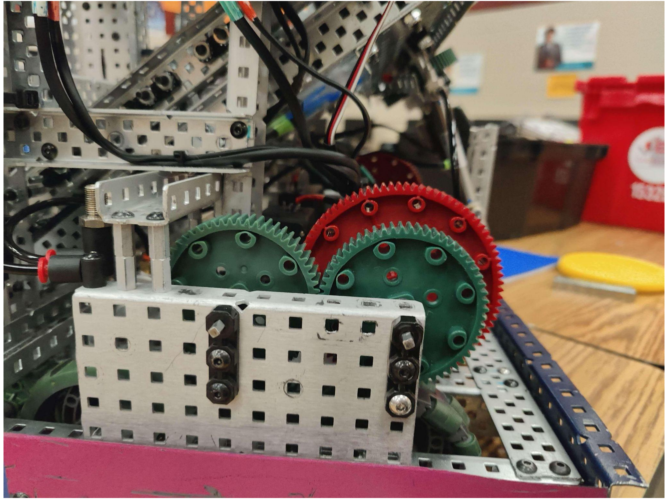
Date 03-29-23

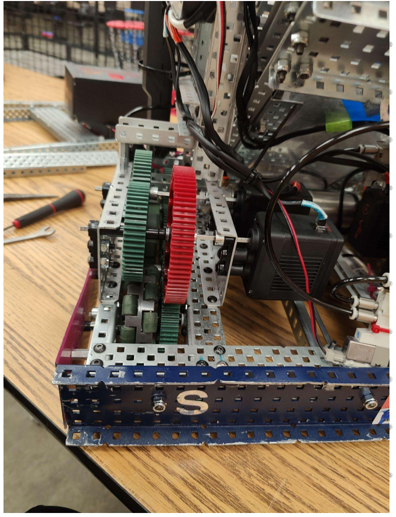
Today, our goal is to regear our drivetrain to not be so obnoxiously slow and work on the team logo.

At our previous competitions, we were having issues with our drivetrain being too slow to effectively navigate the field. While the torque was useful for playing defense and roller fights, all that torque is useless if we can’t get to the proper side of the field to use it.

We spent quite a bit of time discussing what gear ratio would be best for the robot and what gears to use for quite a while both in practice and virtually. After discussing we decided on 280 RPM using 84 tooth gears connected to the existing 60 tooth gears on the drivetrain. We decided that this would be best due to the fact that we wouldn’t need to take anything apart which would greatly speed up the conversion process. We started by figuring out what gears would need to go where before taking anything apart. We decided that in order to make this fit properly we should use a compound gearbox to tie the 2 motors together with 2 60 tooth gears and get the power to the wheels with an 84 tooth gear on the same shaft as one of the 60 tooth gears that connects to the drive wheels. After figuring out how we would do it we started the tear down process which is always the easy part. After removing parts that needed to be switched I moved each of the motors up 1 hole to accommodate the larger 84 tooth gears. While I had the motors off I also swapped them for brand new ones we had come in after ensuring that they weren't rev10. I did this to help prevent failures at world's as this is a complex system that would be inconvenient to replace a motor on between matches. After I did that I simply had to assemble it as explained before which went relatively smoothly other than some funky spacing.



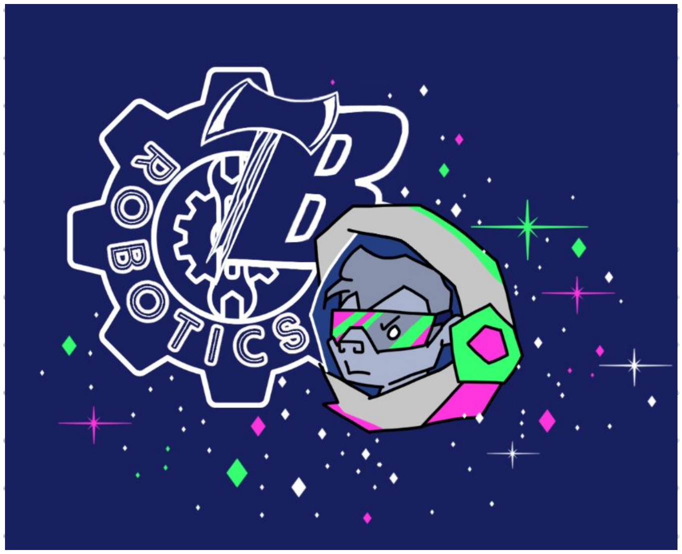




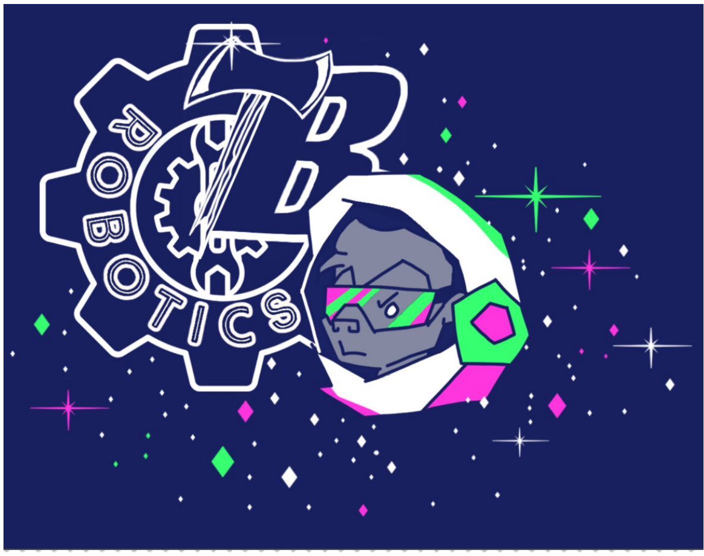
Here is a proper picture of the gearing system we used as it is difficult to explain with just words. The 2 60 tooth gears shown in picture 2 is what connects the 2 motors together and the red 84 tooth gear is on the same shaft as the 60 tooth on the back side of the robot which connects to another 60 tooth gear that ties all of the wheels together.

Continued next page

On Thursday, I put all of my time into the logo. I was able to upgrade our Bemidji VEX logo from the copy from a shirt that it was before to a fully rendered white version for simplicity and screenprinting.



Then, I combined the two logos, added stars to it, and added shiny bits to the helmet to make the most of the pink and green.



Next, I changed the color of the helmet to white, made the monkey all one color, and removed black lines to save costs during screenprinting.

Finally, I added the text to the logo with our team number, name, and hometown. I wasn't able to center the text, as I ran out of time.

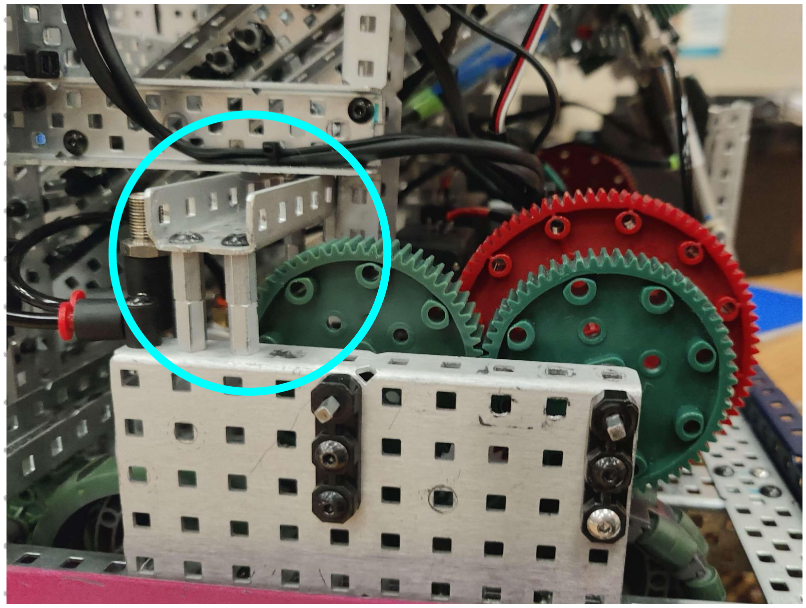
Project Daily Log 54 - Mar. 30 - continued

Name Aster Burrow

Date 03-30-23

On April 3rd, we finished putting the robot together after the drivetrain regearing, tightened various screws on the robot, tested the flywheel after its weight change, worked on a promotional robot for our team, and finalized the team logo.

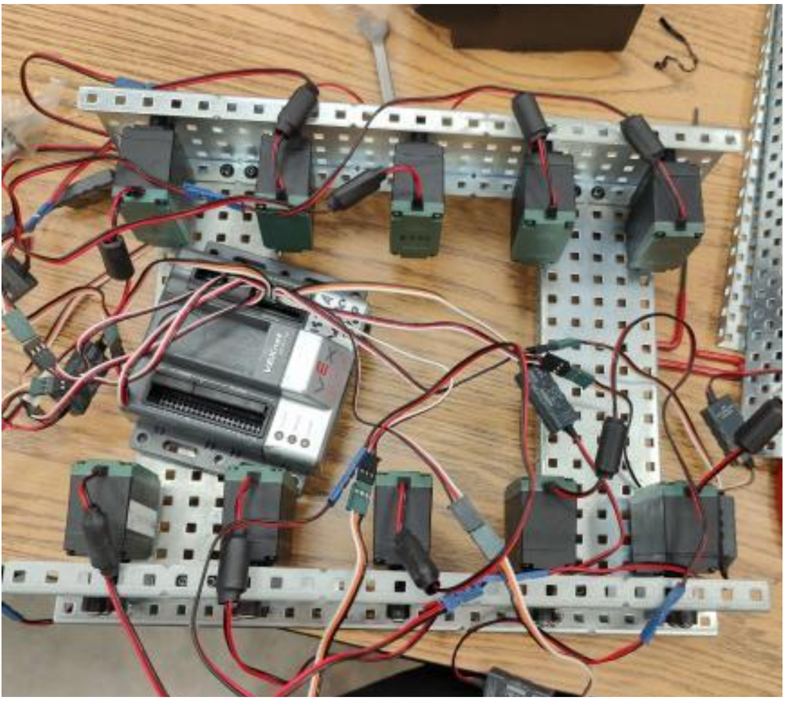
All that was left to do to finish putting together the robot was replacing one support that had been removed to make space for the new 84t gears on the drivetrain. This support is integral to the structure of the drive base, as it keeps the distance between the outer plate and the motor plate on the gearboxes of the drivetrain. The support can be seen here, circled in light blue:



Next, we tightened various screws on the robot, especially focusing on the hard-to-reach ones and replacing any normal nuts left over from prototyping with nyloc nuts. We did not have time to finish, so this will be a work-in-progress over the next couple of days.

We also decided to test the flywheel after its weight changed, as Kaden had noticed slight resistance from the shaft when initially running it. The issue is not present now, and was likely caused by loose structural support screws.

While everything else was happening, Sam worked on building a small robot with Cortex parts we had on hand to carry around candy and a flag to promote ourselves to other teams. It currently consists of a drive base without wheels that needs to be geared, but it is considered a side project that will get pushed aside if we need to. A picture can be found to the right:



Continued next page

We also finalized our team logo and got it ready to be screenprinted on Monday. The final shirt design looks like this:

Back of shirt

Front of shirt

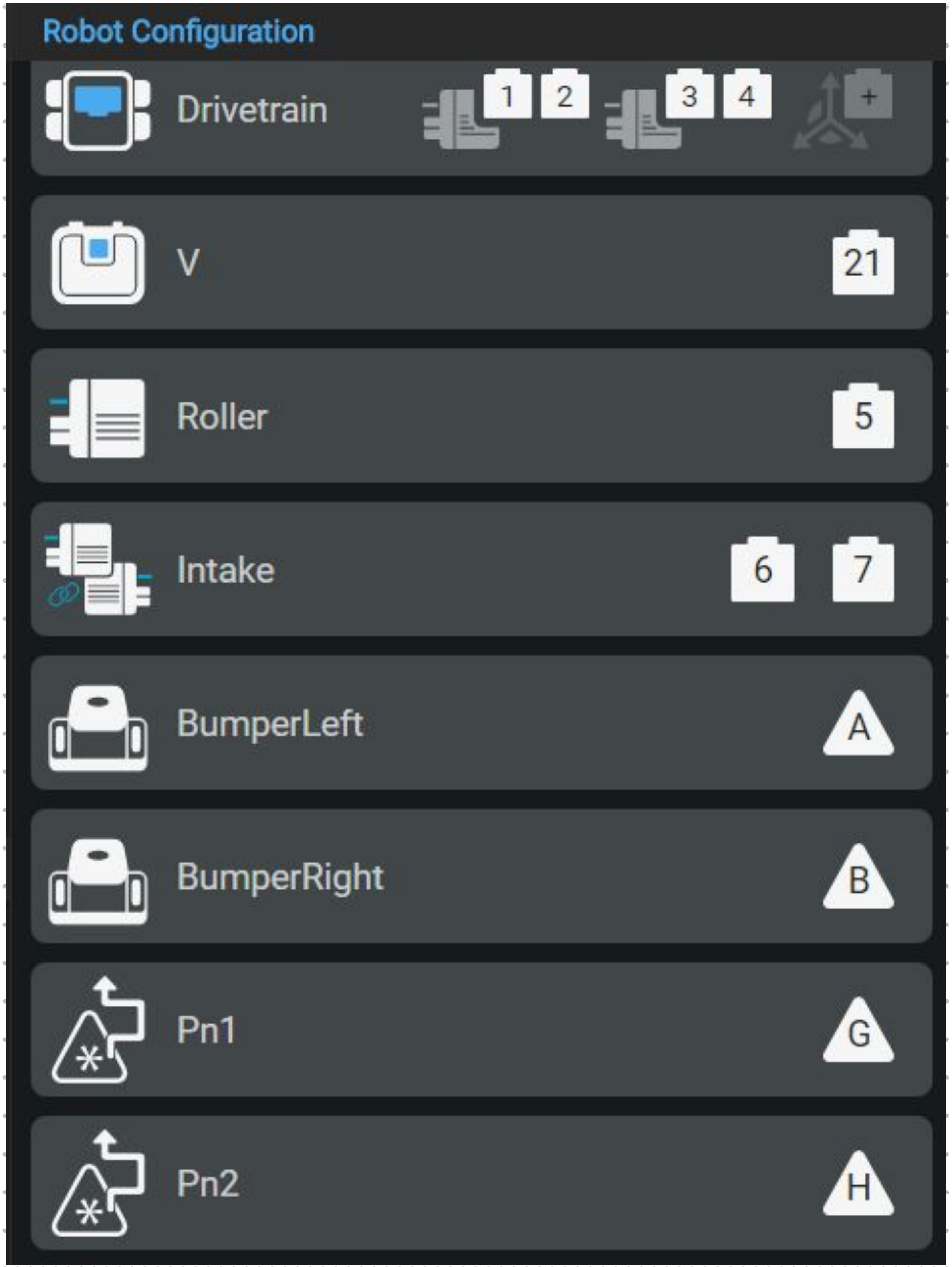
We decided to put the logo on the back because teams are more likely to see us from the back when we're on the field. The logo will likely be put on other things like stickers, if we have the time and money.

Note: Due to blizzard conditions, we were unable to have robotics practice on Tuesday, Apr. 4 and Wednesday, Apr. 5.

Programming

Section P

As of September 22
This configuration serves only as a placeholder for what we'd actually use, we did not know exactly what motors we're using and what they'll be used for.



Robot Configuration

Drivetrain	1 2 3 4 +
V	21
Roller	5
Intake	6 7
BumperLeft	A
BumperRight	B
Pn1	G
Pn2	H

Project Robot Configuration 1

Name Quinn Burrow

Date 09-19-22

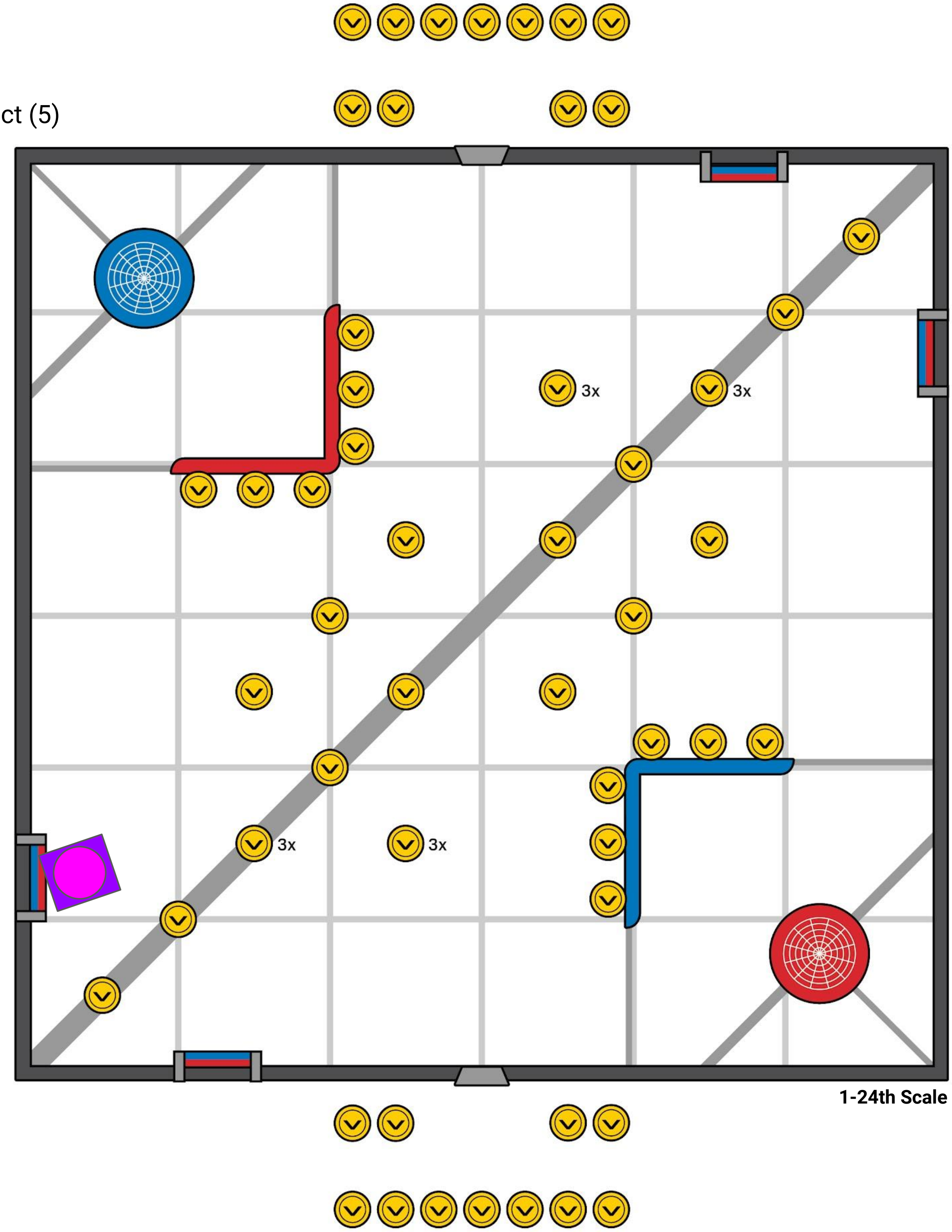
↓ - Shoot (1)

🟪 - Robot Start

↓↓ - Movement (2, 4)

● - Roll (3)

↓ - Collect (5)



Project Autonomous 1 Roller Bottom

Name Quinn Burrow

Date 09-19-22

Page P2

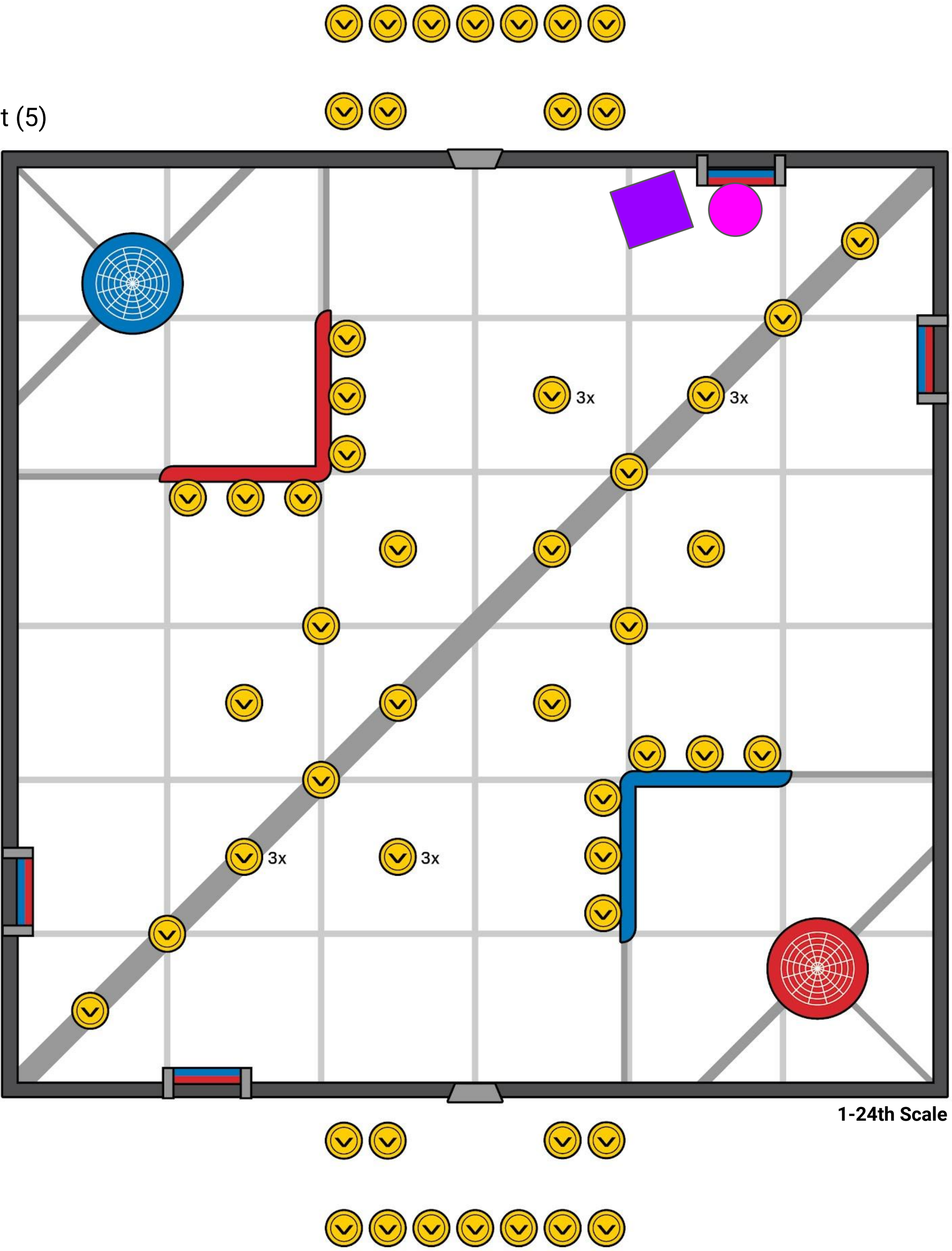
↓ - Shoot (1)

🟪 - Robot Start

↓ - Movement (2, 4)

● - Roll (3)

↓ - Collect (5)



Project Autonomous 1 Roller Top

Name Quinn Burrow

Date 09-19-22

Page P3

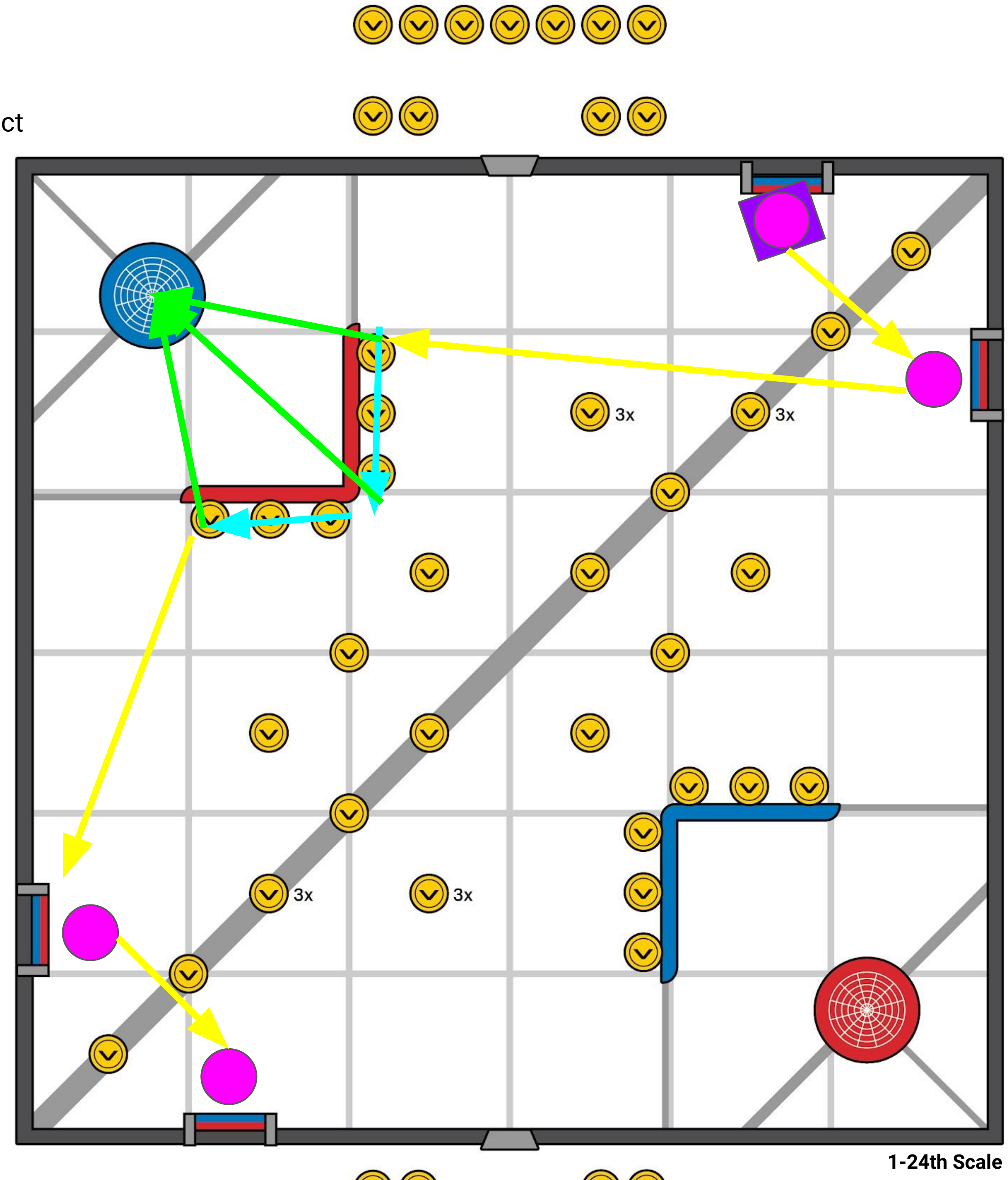
↓ - Shoot

🟪 - Robot Start

↓ - Movement

● - Roll

↓ - Collect

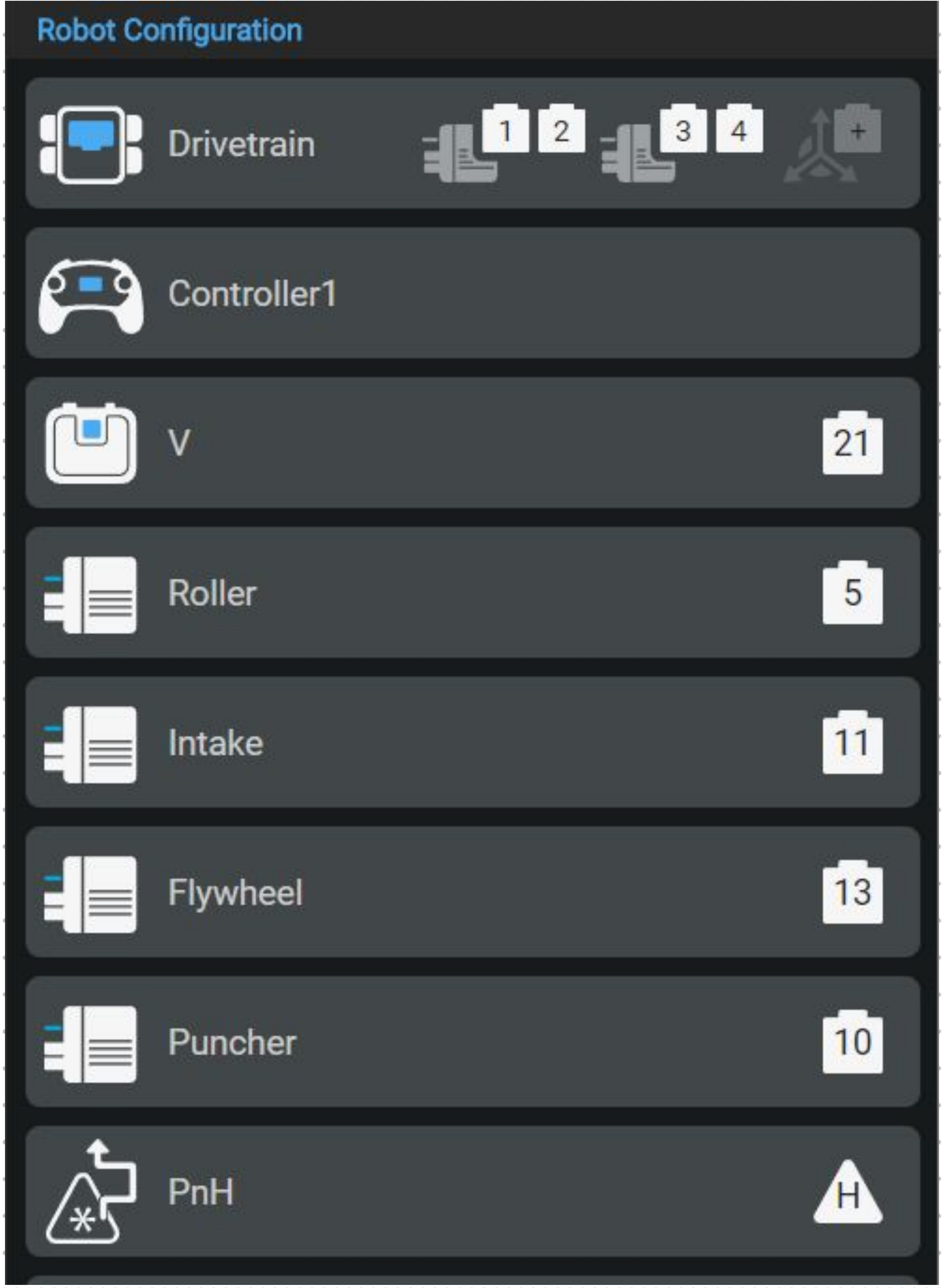


Repeat what was done on red side

Project Skills 1, Blue Goal Only

Name Quinn Burrow Date 09-19-22 Page P4

As of November 16



Robot Configuration

Drivetrain	1 2 3 4
Controller1	
V	21
Roller	5
Intake	11
Flywheel	13
Puncher	10
PnH	H

Project Robot Configuration 2

Name Quinn Burrow Date 11-16-22

This code starts the robot on the side of the field with the harder to reach roller for match autonomous', as the robot cannot start in front of it. This program starts the robot on the edge of the starting position area with the robot touching the field perimeter and facing into the field. It moves in a rectangle and hits the roller, fully changing its color.

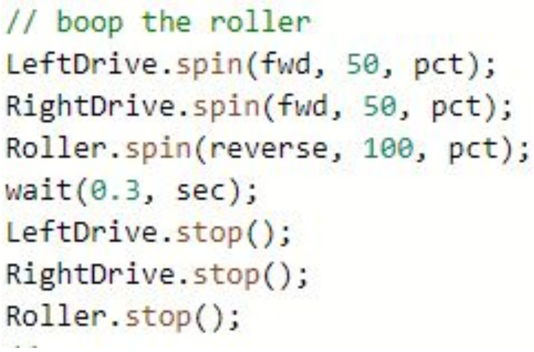
```
void autonomous(void) {
  leftDrive.setVelocity(100, pct); // velocity to 100
  rightDrive.setVelocity(100, pct); //on intake, drive
  intake.setVelocity(100, pct);

  rightDrive.spin(forward); // drive forward from start
  leftDrive.spin(forward);
  task::sleep(200);
  rightDrive.stop();
  leftDrive.stop();

  leftDrive.spin(forward); // spin parallel to roller
  rightDrive.spin(reverse);
  task::sleep(350);
  rightDrive.stop();
  leftDrive.stop();
  task::sleep(100);

  rightDrive.spin(forward); // drive parallel to roller
  leftDrive.spin(forward);
  task::sleep(350);
  rightDrive.stop();
  leftDrive.stop();

  leftDrive.spin(forward); // spin toward roller
  rightDrive.spin(reverse);
  task::sleep(350);
  rightDrive.stop();
  leftDrive.stop();
  task::sleep(100);

  rightDrive.spin(forward); //drive toward roller
  leftDrive.spin(forward);
  task::sleep(470);
  rightDrive.stop();
  leftDrive.stop();

  rightDrive.spin(forward); // drive onto roller and spin
  leftDrive.spin(forward);
  intake.spin(reverse);
  task::sleep(400);
  rightDrive.stop();
  leftDrive.stop();
  intake.stop();
```

Project Alternate Roller Auton - Match

Name Aster Burrow

Date 12-05-22

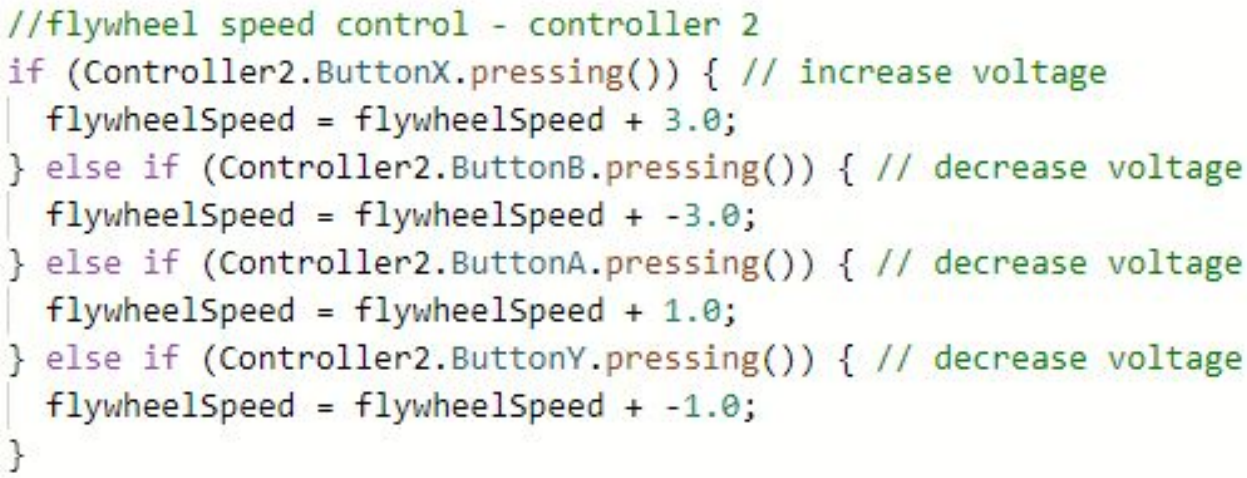
During the autonomous period, as of right now we only have one code. It runs into the roller that robots can start in front of and spins it to the alliance color.



```
// boop the roller
LeftDrive.spin(fwd, 50, pct);
RightDrive.spin(fwd, 50, pct);
Roller.spin(reverse, 100, pct);
wait(0.3, sec);
LeftDrive.stop();
RightDrive.stop();
Roller.stop();
```

This code is meant to run with two controllers so that the controls are more manageable and the robot can always be driven (fingers don’t have to be taken off of joysticks to press other buttons). Kaden usually runs controller 1 and Quinn usually runs controller 2, but we plan to have everyone practice with all controller for familiarity and emergency substitution for the drive team. The controls for each controller can be found on pages W8 and W9.

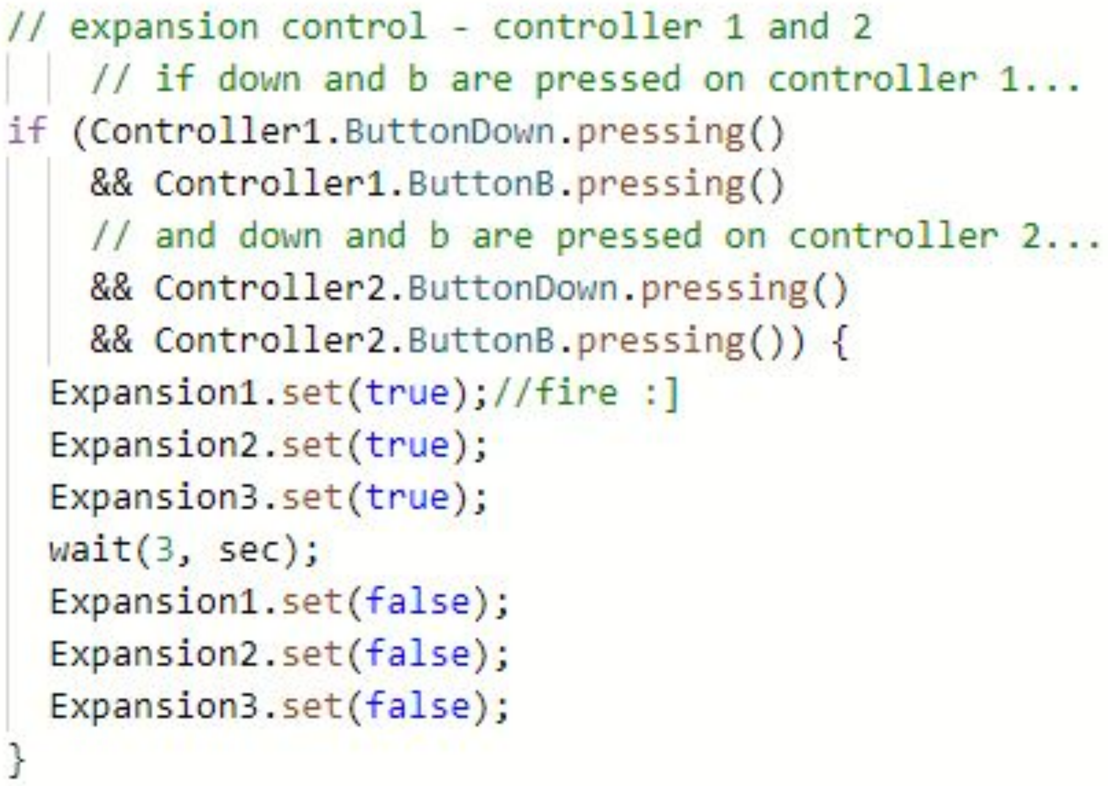
We use different types of values for controlling different parts of the robot. Most of the robot functions off of percentages. The intake and roller are set to run at 100% power, while the drivetrain percentage is controlled by the position of the joysticks. The flywheel, however, runs off of voltage. We decided to do this because we were encountering issues with the motors’ built-in PID loop in which the speed would waver around the correct value but never even out. In V5 motors, when they are controlled via voltage, they do not use the problematic PID loop. We decided to run our flywheel at a base speed of 9.1 volts, which is approximately 430 rpm on the motors. This voltage can be changed on the fly when buttons X, B, A, or Y are held down on controller 2 when the flywheel is running.



```
//flywheel speed control - controller 2
if (Controller2.ButtonX.pressing()) { // increase voltage
  flywheelSpeed = flywheelSpeed + 3.0;
} else if (Controller2.ButtonB.pressing()) { // decrease voltage
  flywheelSpeed = flywheelSpeed + -3.0;
} else if (Controller2.ButtonA.pressing()) { // decrease voltage
  flywheelSpeed = flywheelSpeed + 1.0;
} else if (Controller2.ButtonY.pressing()) { // decrease voltage
  flywheelSpeed = flywheelSpeed + -1.0;
}
```

Continued next page

To make our expansion as safe as possible, we decided to only allow it to fire when buttons B and Down are pressed on both controllers so that our drivers must agree on when the expansion can fire.



```
// expansion control - controller 1 and 2
    // if down and b are pressed on controller 1...
if (Controller1.ButtonDown.pressing()
    && Controller1.ButtonB.pressing()
    // and down and b are pressed on controller 2...
    && Controller2.ButtonDown.pressing()
    && Controller2.ButtonB.pressing()) {
  Expansion1.set(true);//fire :]
  Expansion2.set(true);
  Expansion3.set(true);
  wait(3, sec);
  Expansion1.set(false);
  Expansion2.set(false);
  Expansion3.set(false);
}
```

As of February 22

Robot Configuration

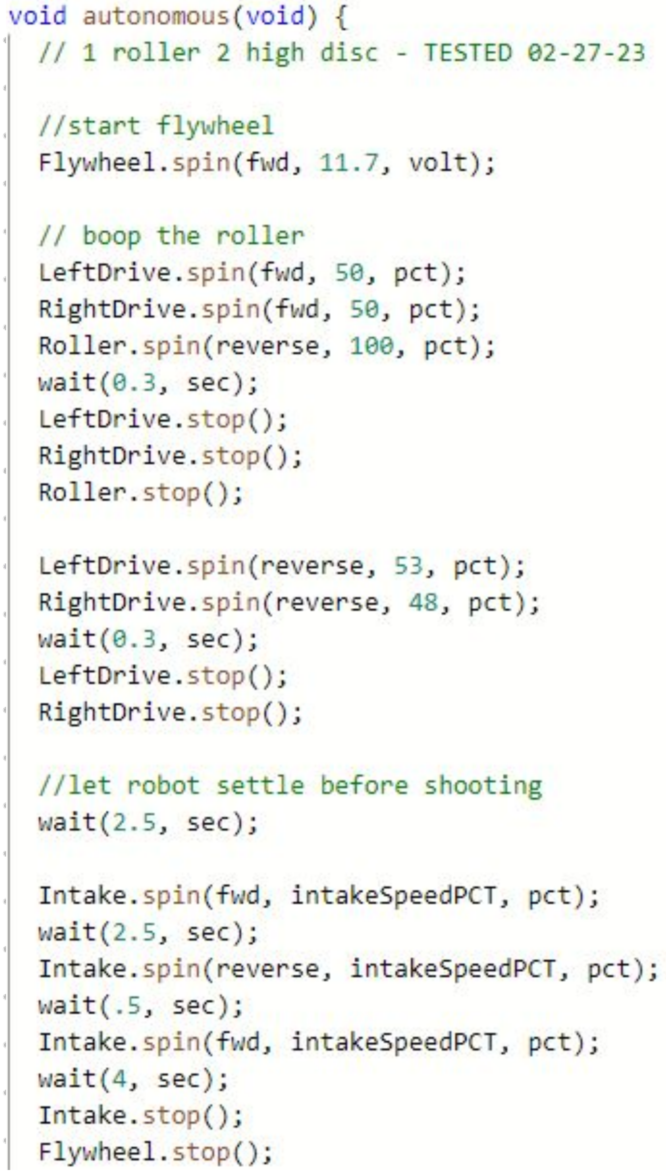
Controller1	
LeftDrive	9 10
RightDrive	2 3
Flywheel	11 12
Intake	13
Roller	20
Controller2	
Expansion1	A
Expansion2	B
Expansion3	C

Project Robot Configuration 3

Name Quinn Burrow

Date 02-22-23

In this program, we wanted to autonomously turn a roller to our alliance color and fire two disks into the high goal within the 15-second match autonomous period. In the past, we turned the roller during the autonomous period with no other action taken because we did not have the time to dedicate to the program. With the work done on February 13 and today, we have put this program together:



```
void autonomous(void) {
  // 1 roller 2 high disc - TESTED 02-27-23

  //start flywheel
  Flywheel.spin(fwd, 11.7, volt);

  // boop the roller
  LeftDrive.spin(fwd, 50, pct);
  RightDrive.spin(fwd, 50, pct);
  Roller.spin(reverse, 100, pct);
  wait(0.3, sec);
  LeftDrive.stop();
  RightDrive.stop();
  Roller.stop();

  LeftDrive.spin(reverse, 53, pct);
  RightDrive.spin(reverse, 48, pct);
  wait(0.3, sec);
  LeftDrive.stop();
  RightDrive.stop();

  //let robot settle before shooting
  wait(2.5, sec);

  Intake.spin(fwd, intakeSpeedPCT, pct);
  wait(2.5, sec);
  Intake.spin(reverse, intakeSpeedPCT, pct);
  wait(.5, sec);
  Intake.spin(fwd, intakeSpeedPCT, pct);
  wait(4, sec);
  Intake.stop();
  Flywheel.stop();
```

This program revs up the flywheel during the entire period, hits the roller, and backs up a little bit to shoot the two preloaded disks into the high goal. The intake reverses for a short period to attempt to dislodge the second disk if it is stuck, as it has been fairly unpredictable in testing. Previously, we didn’t back up from the roller to shoot, but for a reason we could not figure out the intake would not run autonomously when in contact with the field wall. We tested the intake using match controls and manually while in contact with the field with no issues, but it simply would not run when contacting the field wall. It now works perfectly fine and has been tested five consecutive times without failing.

Project An Explanation of the 1 Roller 2 Disc Match Autonomous

Name Aster Burrow & Quinn Burrow Date 02-27-23

Engineering

Section E

On September 19, we discussed ideas for the roller, as each of the 4 rollers could provide our team with 10 points respectively. Our initial idea was to use wheels pressed against the roller to control its position, but the roller proved to be too difficult to move in this way. Quinn then noticed the gear teeth present on each side of the colored parts of the roller that could be used to turn it. The first prototype for this idea involves 2 84-tooth gears positioned to fit around the colored section of the roller. The motor has a green cartridge, and the gearing is a 12-tooth drive gear to the 84-tooth gears for more torque. It is geared in this way because of the resistance the roller provides when it is turned.

We also discussed having a vision sensor positioned above the roller to detect the current color and provide information to the robot on how to change it along with two limit switches that would be set off when the robot hits the field wall and is correctly positioned to run the roller spinner. These sensors combined would allow the robot to autonomously run the roller spinner when a button is held.

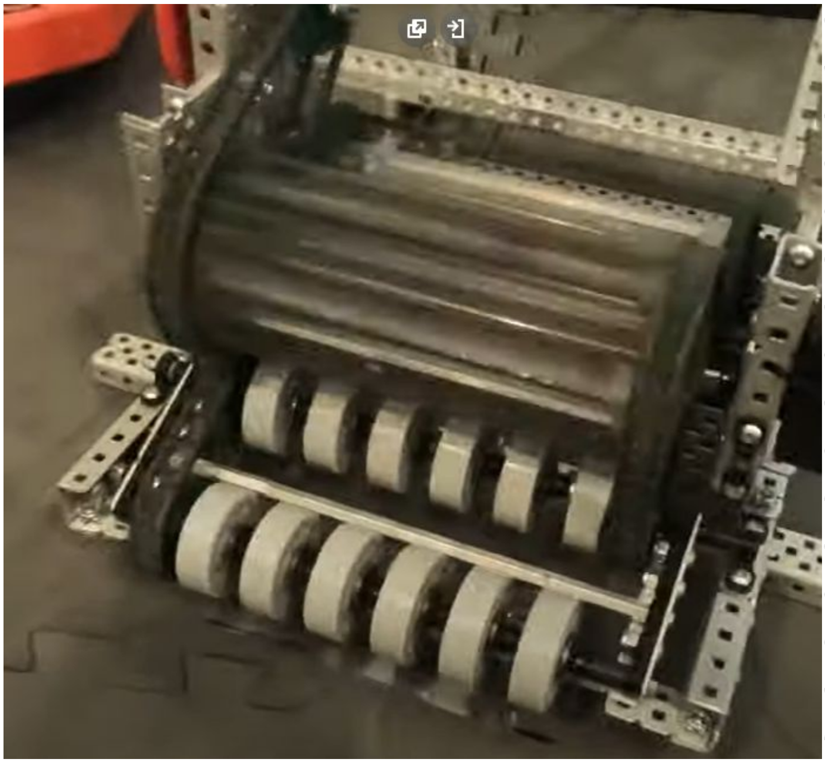
We did not address the issue of lining up the mechanism efficiently in a match. We are going to save that for later, when the mechanism can be attached to the robot and tested.

An image of a roller and a prototype for turning it. The prototype looks as it is described above.

On September 21, we discussed potential shooter designs for the robot. We are currently considering a flywheel and a catapult design. The catapult is potentially more accurate, but is harder to vary in launching distances, while the flywheel can be slowed or sped up for different distances. A basic design for the flywheel and the catapult is shown in the sketch below.

We also discussed intakes for the robot. To accommodate for the intake, the drivetrain will have an open front. In it, there will be two rows of flex wheels, with one below the disks and one above to take them in. From there, the disks will be moved on a belt to the shooting mechanism. This would be controlled by one motor.

Another possible intake design would mirror the one shown in this video https://youtu.be/T0Jbtfh57Cg and be repurposed for our use.



A screenshot of the linked video.
It shows one possible intake design.

Project Possible Shooter and Intake Designs
Name Aster Burrow
Date 09-24-22

The design that we agreed to move forward with on the drivetrain is a 2-motor omni-wheel drivetrain. We have chosen it because its use of 2 motors compared to the 4 that a mecanum or x-drive base would use allows us more freedom in the components of the superstructure of the robot. The drivetrain features an open front to allow for a disk intake and enclosed wheels for their protection. The wheels are positioned higher on the chassis so there is less space between the chassis and the floor. This lowers the possibility of disks getting caught under the robot. The drivetrain is sketched below.

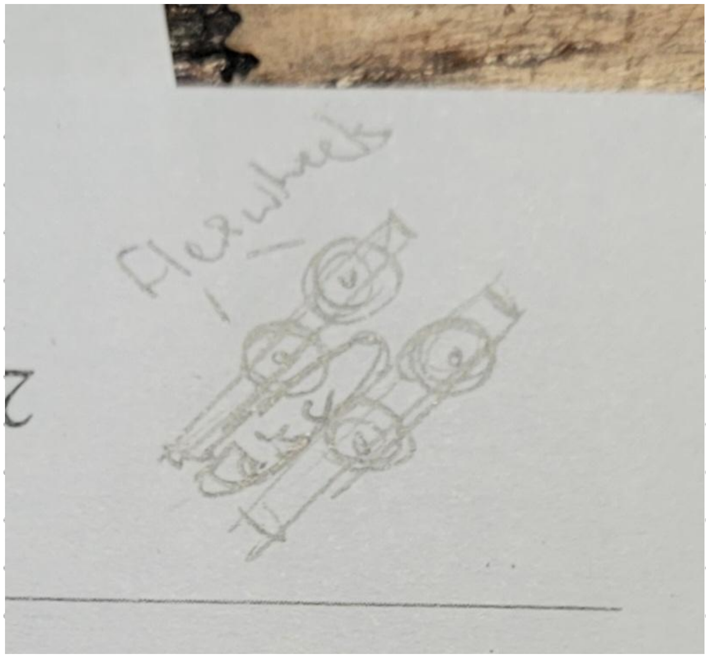
Another design we are considering for the chassis is an x-drive base. This would allow us greater speed and maneuverability, which is beneficial for shooting in this game as well as avoiding defense. This base does take up more space with the wheels and offers less torque than a straight-wheeled base, but these factors could be accounted for in the design. Ultimately, we have decided to pursue it as a side project, as none of our team members have used it before and would need to learn more about it to go forward with implementing it.

09-24-22

An expansion of the drivetrain discussion - we are currently considering 4 motors. We decided on a number too early, and need to wait to see what we have to work with once the design is finalised. We are sure of having a 4-wheel omni base, but are unsure of the wheel size. We are currently leaning towards smaller wheels so that there is less of a gap between the chassis and the floor. More discussion will occur at the next practice.

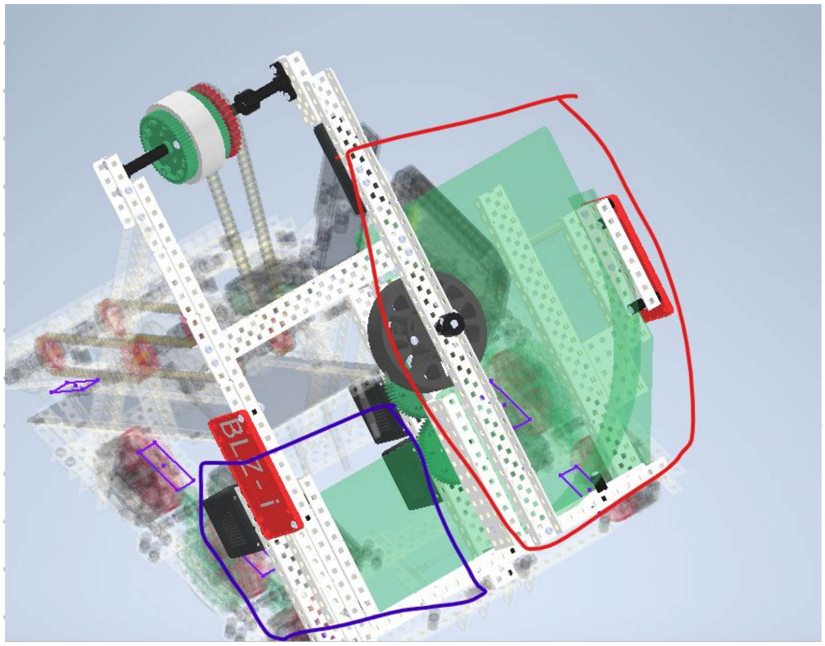
09-27-22

After witnessing the longer range and variability in shot lengths that a flywheel provides, we have decided to move forward in designing one. Initially, we designed a flywheel that would take disks directly from the intake and shoot them with two rows of flex wheels geared for high speeds.



A picture of the original flywheel design sketched on paper.

After researching other flywheel designs, we discovered BLZ-i's flywheel design, which consists of an indexer to push the discs into the flywheel and a large flex wheel with an arc made of polycarbonate to guide the disks out of the flywheel. We have decided that this design is much simpler and easier to use, as disks are not immediately pushed into the flywheel when they get through the intake. For these reasons, we have decided to create our flywheel system similarly to BLZ-i's flywheel.



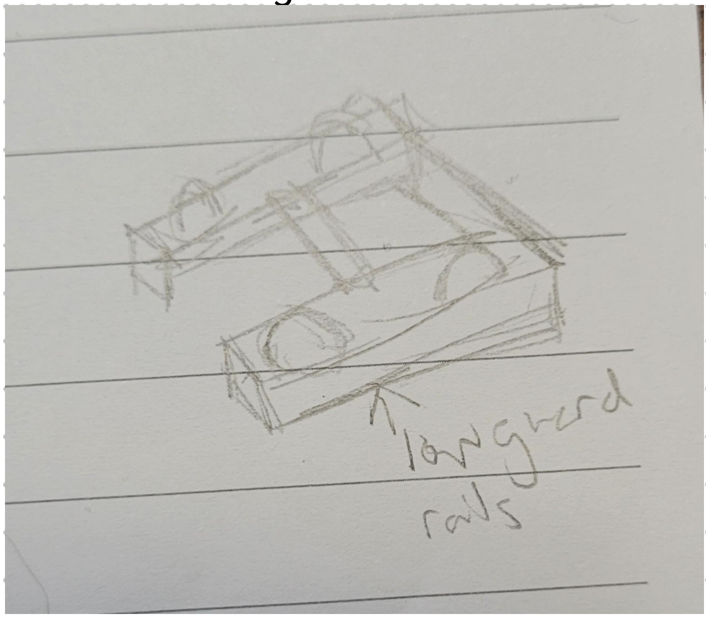
An image of BLZ-i's indexer and flywheel the flywheel is boxed in red and the indexer is boxed in blue.

Project Shooter Discussion

Name Aster Burrow

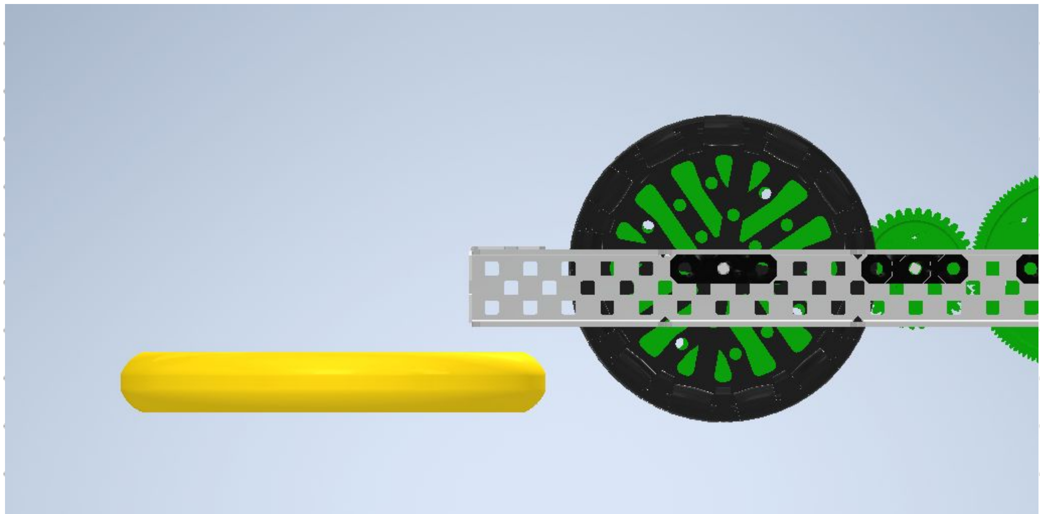
Date 09-27-22

In the initial designing of our drivetrain, we recognised the need to protect the robot from becoming stuck on disks during matches. Initially, we considered having guard rails on the outsides of the robot raised about a half inch off the ground so that no disks could get under it.



A sketch of a 4-wheel drivetrain with low guardrails around the outside faces of the chassis

During the planning of the drivetrain on Sept. 21, we decided to place the wheel drive shafts higher up on the chassis in an attempt to remedy this issue, as adding guard rails would add extra weight and use material that is in high demand.



An image of the drivetrain CAD model set next to a disk. There is a clear space between the chassis and the top face of the disk, making moving the wheels an unviable solution for disks getting caught under the robot.

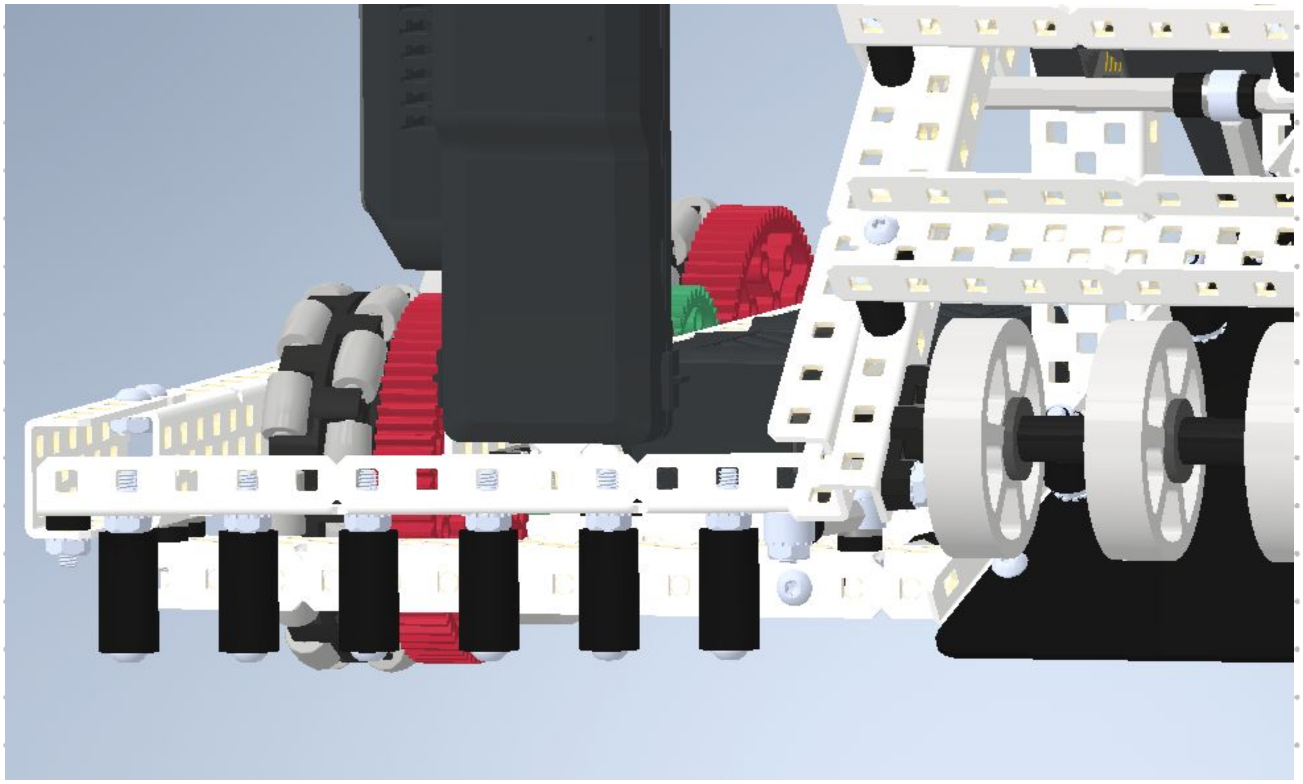
(continued next page)

Project Wheel Guards

Name Aster Burrow

Date 09-27-22

Our final solution to the issue originate from looking at the CAD model of BLZ-i. The robot utilizes a row of bolts with free-moving long spacers angled towards the intake to more easily direct disks toward it. We figured out that these spacer rollers could be used to accomplish the opposite and direct disks away from the robot as well. We plan to position them at regular intervals around the robot to push disks away from the wheels and underside of the robot to protect it from failures and penalties.



A picture of the front of BLZ-i. In it, six bolts are positioned upside-down with spacers on the screw. These spacers are low enough to interact with disks and guide them into the intake of the robot.

Project Wheel Guards - Cont.

Name Aster Burrow

Date 09-27-22

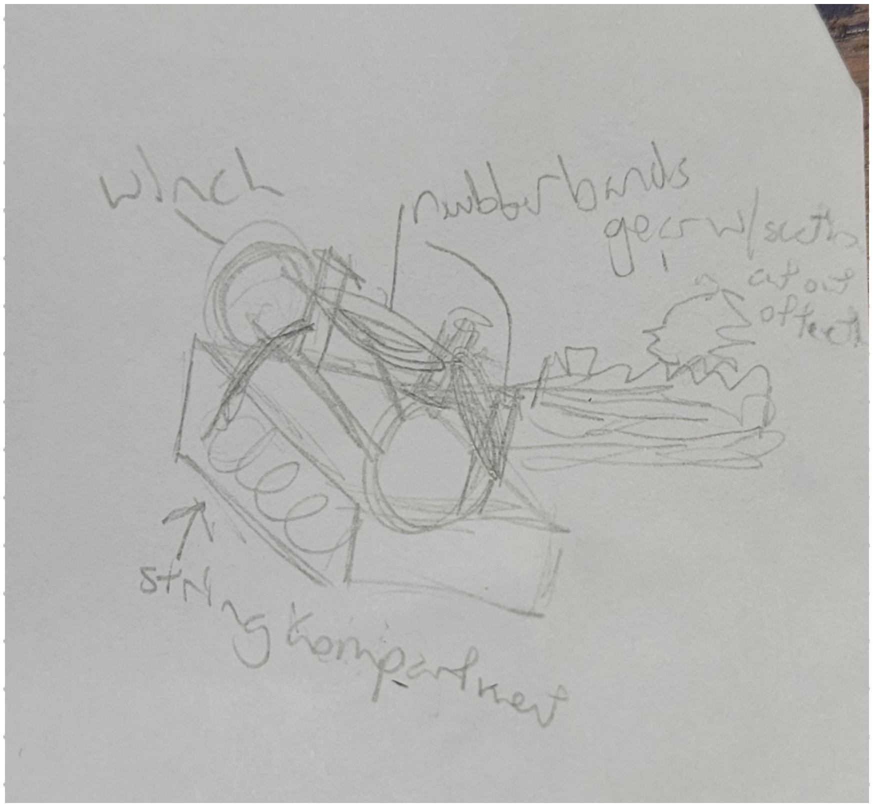
In the endgame for Spin Up, teams can cover as many tiles as possible for points. They must be in contact with the tiles and the extension mechanisms must be attached to the robot. There are no penalties for accidental damage, trapping, contact, or anything along those lines. The only off-limits area is the 4 low goal tiles under the nets, as they will not score points and touching the net will cause disqualification. This is paraphrased from the Game Manual, sections G12d, G15, SG3, and SG4.

Based on these restrictions, we have generated four ideas on how to expand during the endgame:

- String cannons that shoot out to cover as many tiles as possible
- Bars that pop off of the sides of the robot and hit the tiles
- Spring-loaded bars attached to the robot with string, such as in this video (1)
- Scissor lifts with string hanging to the ground to cover tiles and close off a corner with rollers in it

Based on effectiveness and functionality, we have chosen to implement the string cannons and the scissor lifts, as we could cover tiles in four directions and close off two rollers in the endgame.

The string cannons will use puncher mechanisms on winches attached to the robot by long pieces of string to cover tiles.



An image of a potential string shooter design.

Project Endgame Expansion Ideas

Name Aster Burrow Date 09-27-22

On September 28, we decided that the robot should have:

- For the drivetrain:
    - 4 motors on the drivetrain for more torque with 4 3.25” omni wheels to keep the robot closer to the ground
    - Spacer rollers on the sides and back of the robot to deflect disks, inspired by BLZ-i’s passive intake system
- For the shooter assembly:
    - An offset intake to allow for a 90° flywheel, which will shoot further as the disk has more contact with the flywheel. Chosen due to the increased period of contact between the disk and flywheel.
    - A roller mechanism powered by the intake motor to reduce motor usage. It will use a 3” flex wheel to move the roller
        - A vision sensor to detect the color of rollers and automatically operate them. For safety, two limit switches must activate and hit the field wall before the roller mechanism will run.
    - A 4” flex wheel on the flywheel
    - A ratchet mechanism, similar to the one shown here(1). It was chosen to reduce the stress on the flywheel motor.
    - An indexer for disks entering the flywheel powered by one pneumatic piston to reduce motor usage
- For the endgame:
    - Two string cannons powered by one motor. They will be puncher mechanisms and will use VEX winches as counterweights for the string.
    - Two ‘arms’ made of scissor lifts that extend off the sides of the robot to secure a corner with rollers. String segments will hang from the ‘arms’ at regular intervals to contact as many tiles as possible.

The robot will have 4 motors on the drivetrain, 1 on the intake/roller, 1 on the flywheel, 1 for the scissor lifts, and 1 for the string cannons, amounting to 8 motors total. There will also be one pneumatic piston and 1 air tank for the indexer.

1 - https://www.youtube.com/watch?v=BceXqqF3ONA

Project Finalized Design Plans

Name Aster Burrow Date 10-07-22

On January 13, we made the decision to redesign the robot after encountering issues with the orbital flywheel.
Our list of issues was:

- Not accurate disks stuck in robot
- Indexer kept jamming and all solutions failed to completely fix the problem
- Intake was messed up and could not run without being oversized
- Uncomfortably close to the sizing limits

For these reasons, we wanted to rebuild a robot that would have:

- More accurate shooting
- Faster shooting
- Smaller robot
- More pushing power in the drivetrain

After looking at robots from competitions we've been to so far and researching teams such as 99766E and 606X, who had released explanation videos here https://youtu.be/x1WVzqx8Ino and here https://youtu.be/2ZWuM_IV_zU respectively, we decided to build a catapult with a 6 motor drivetrain. This robot will be built to quickly shoot three disks at a time, cross the field as quickly as possible to shoot and manipulate rollers, and push other robots around when fighting over rollers. We have one week before our next competition, so the work will be left to Kaden to make more specific design decisions at this time. I will attempt to supply him with whatever programs and field dimensions from the CAD model he needs.

After the resounding failure of the catapult, we decided to take some time to reassess the capabilities of the robot, how it could improve, and whether it would be worth it to rebuild. We ultimately decided that although the catapult had potential, there were many glaring issues that would have forced us to rebuild the entire robot anyway. These issues were:

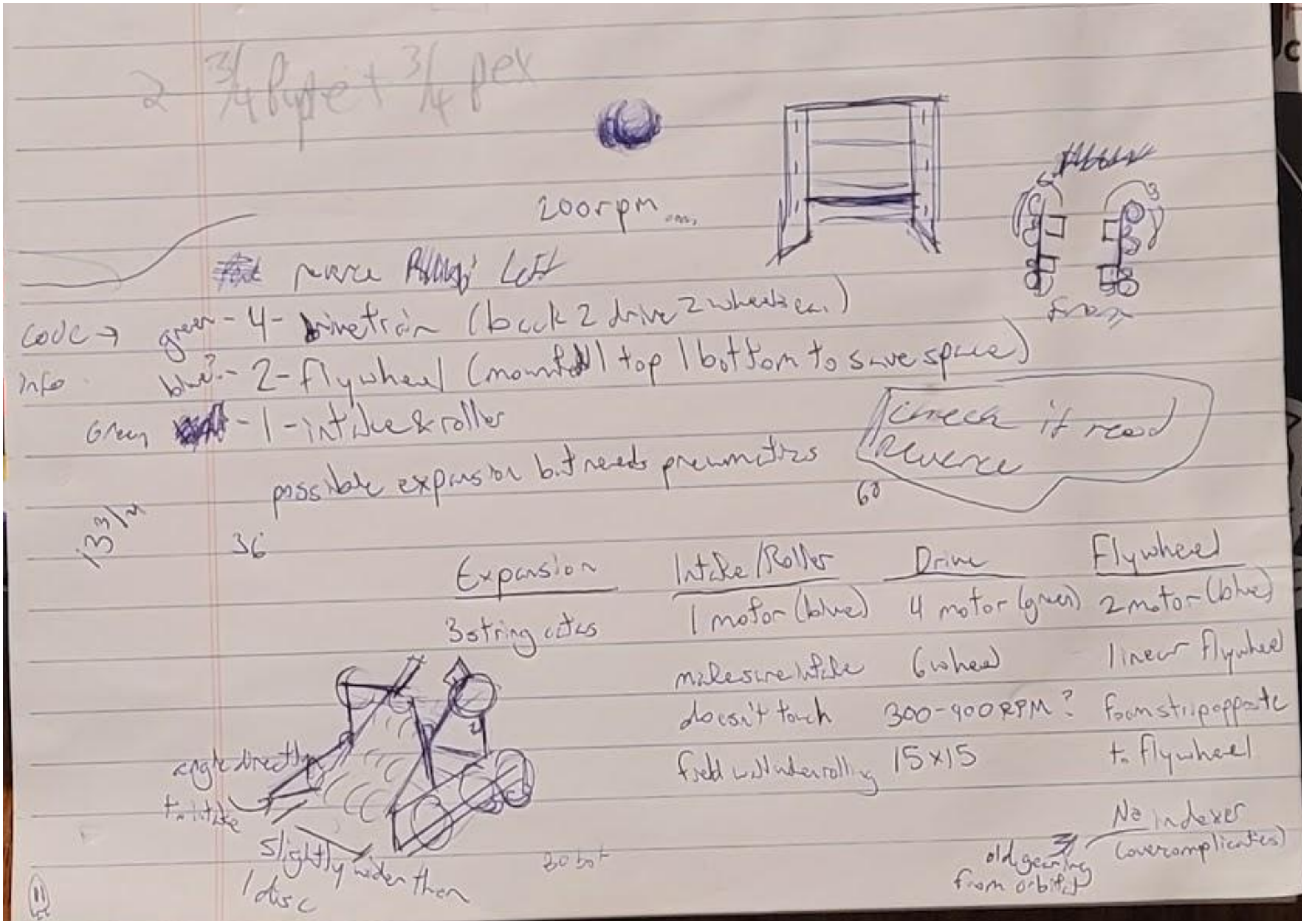
- A severely misaligned drivetrain that continuously snapped every chain on the motor boxes when driving
- Snapped teeth on the catapult slip gears caused by rushed assembly and excessive force
- Little to no space to add pieces to automate reloading the catapult with a limit switch
- Frame that couldn't handle the release of the catapult (it practically shook itself loose)
- Poor intake placement that required a steeper angle to work properly that could not easily be fixed
- Far too light to utilize its advantage in torque with the 6 motor drive base

These issues would have required a full rebuild to fix, and quite honestly I was sick of looking at the thing, so I began to come up with a new and simpler design that could not fail easily. It is based on the successes of other robots at the competition, the past success that our sister team, 1532F, found with a similar design, and a discussion with my coach, who was able to offer a more neutral perspective on the design process. This design would have:

- 4 motor 6 wheel drive to save motors and have more contact with the field in case we run over a disk
  - Gearing of the drivetrain is undecided so far, but lower speed may be beneficial with our driver's more violent driving style
  - Omni wheels on the ends and normal wheels in the center for easier turning and to keep the robot from being pushed at the sides
- A simple linear flywheel with no indexer to keep mechanisms simple and reduce the time needed in building and troubleshooting
  - Two flywheel motors with blue cartridges geared to 3000 rpm like the previous flywheel
  - One intake motor with a green cartridge directly run at 200 rpm
- 3 expansion mechanisms on the sides and back of the robot with 2-3 arms off of each of them
  - String catapults operated by pneumatics. Design is undecided but must be compact

An initial design sketch can be found on the **next page**.

This is the initial design and sketch for the robot.



2 3/4 [illegible] + 3/4 pex

200rpm

~~[illegible]~~ reverse [illegible] Left

code → green - 4 - drivetrain (back 2 drive 2 wheels ea.)

info blue? - 2 - flywheel (mounted top / bottom to save space)

Green ~~[illegible]~~ - 1 - intake & roller

possible expansion but needs pneumatics

check if need reverse

60

13 3/4

36

Expansion	Intake/Roller	Drive	Flywheel
3 string cutters	1 motor (blue)	4 motor (green)	2 motor (blue)
	make sure intake	6 wheel	linear flywheel
	doesn't touch	300-400 RPM?	foam strip opposite
	field wall when rolling	15x15	to flywheel

No indexer (overcomplicates)

3:1 old gearing from orbital

Project Design Plans - Redesign 2, Linear Flywheel

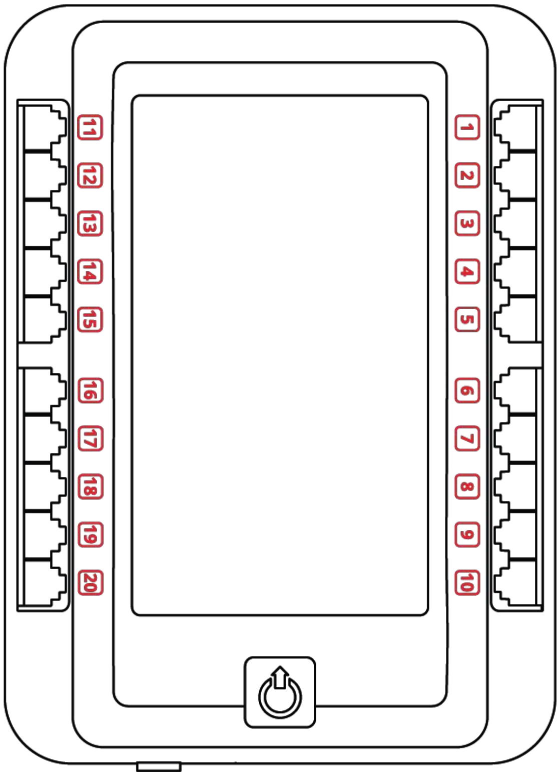
Name Aster Burrow

Date 01-23-23

Wiring

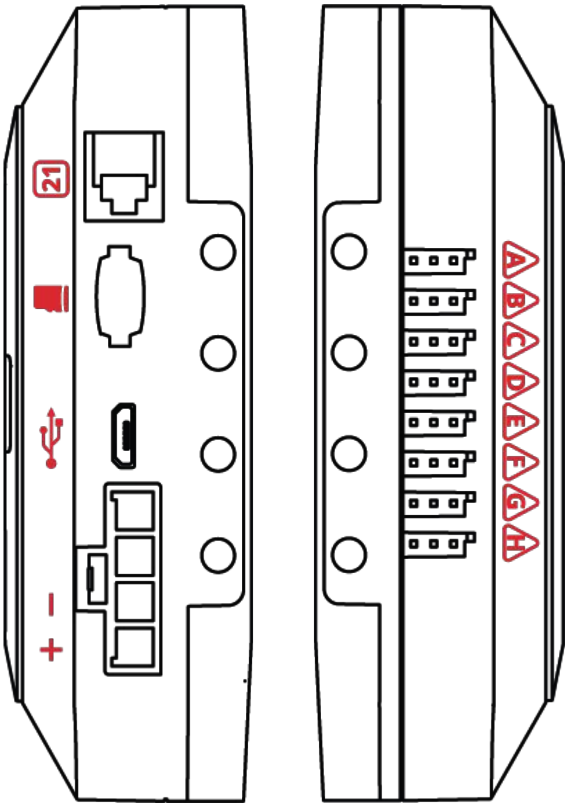
Section W

Shooter- 11
12
13
14
15
16
17
18
19
20



1 -Left Front Drive
2 -Left Back Drive
3 -Right Front Drive
4 -Right Back Drive
5 -Roller
6 -Intake
7 -
8
9
10

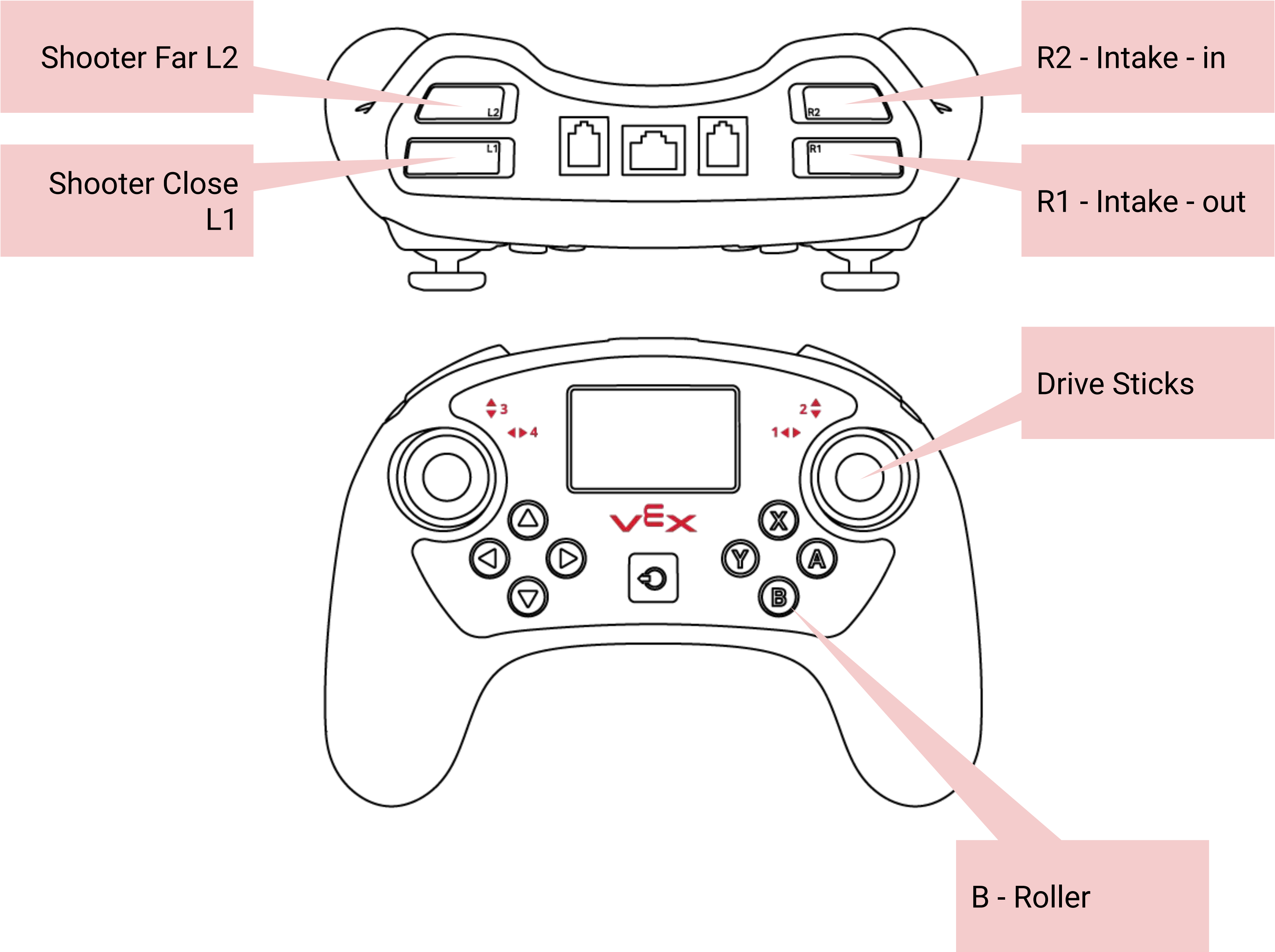
Vision Sensor- 21



A -Left Bumper
B -Right Bumper
C
D
E
F
G
H

Project Brain Wiring Version 1

Name Quinn B. Date 09-24-22 Page W1



Shooter Far L2

Shooter Close L1

R2 - Intake - in

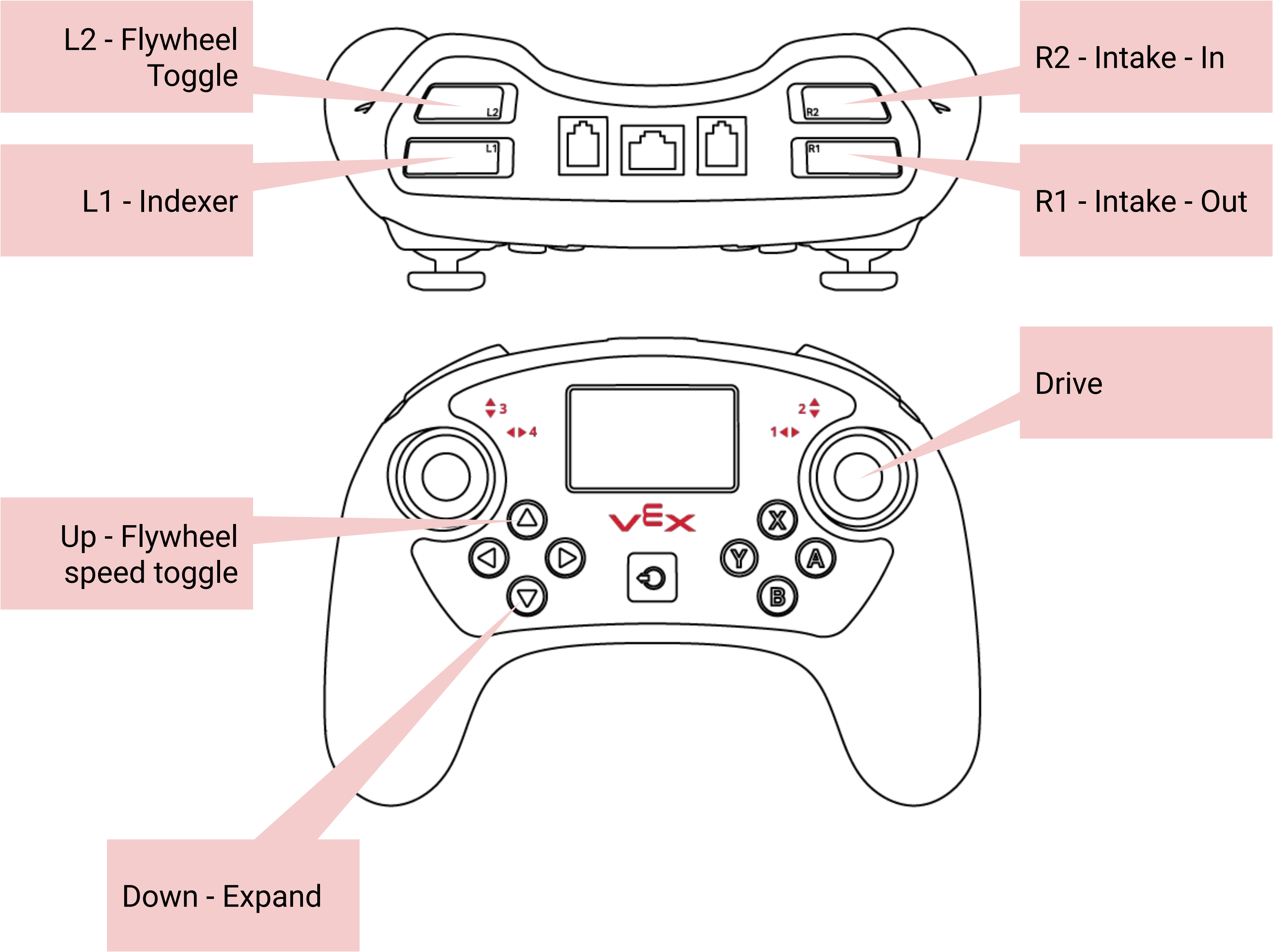
R1 - Intake - out

Drive Sticks

B - Roller

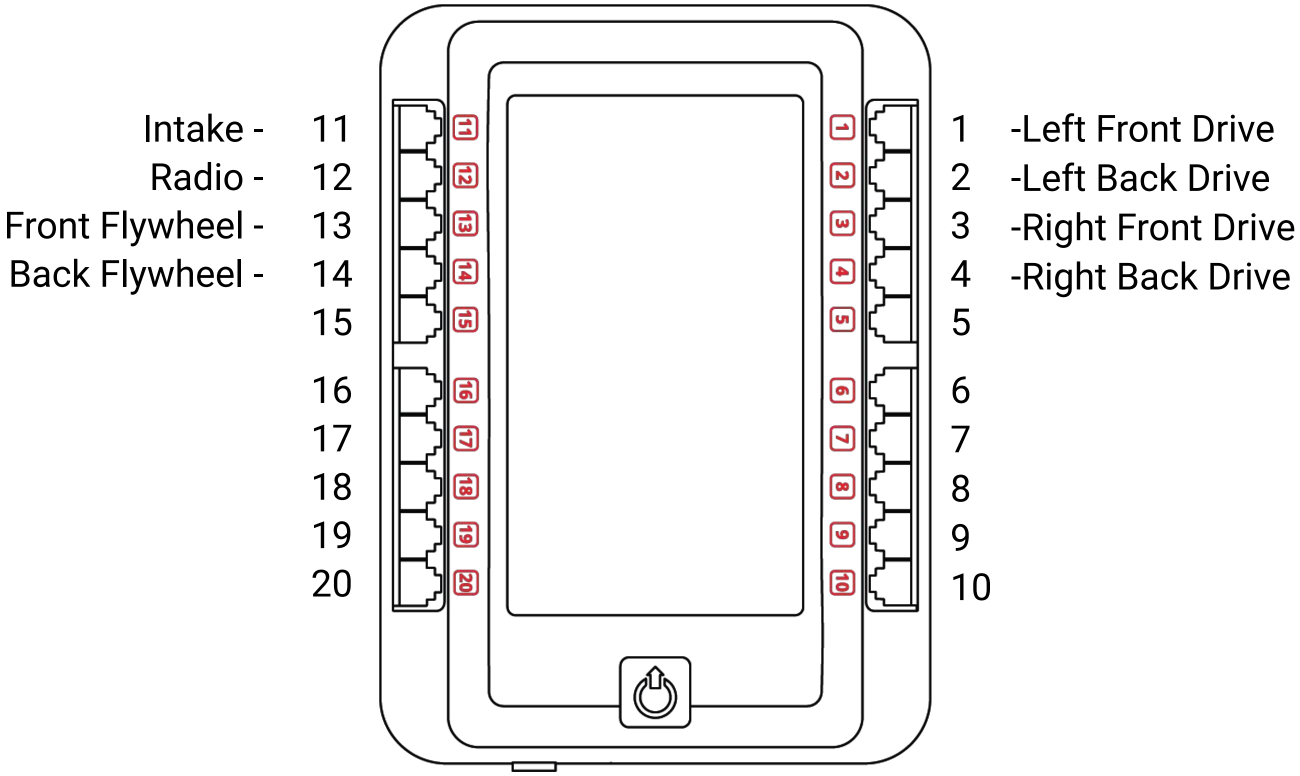
Project Controller Configuration Version 1

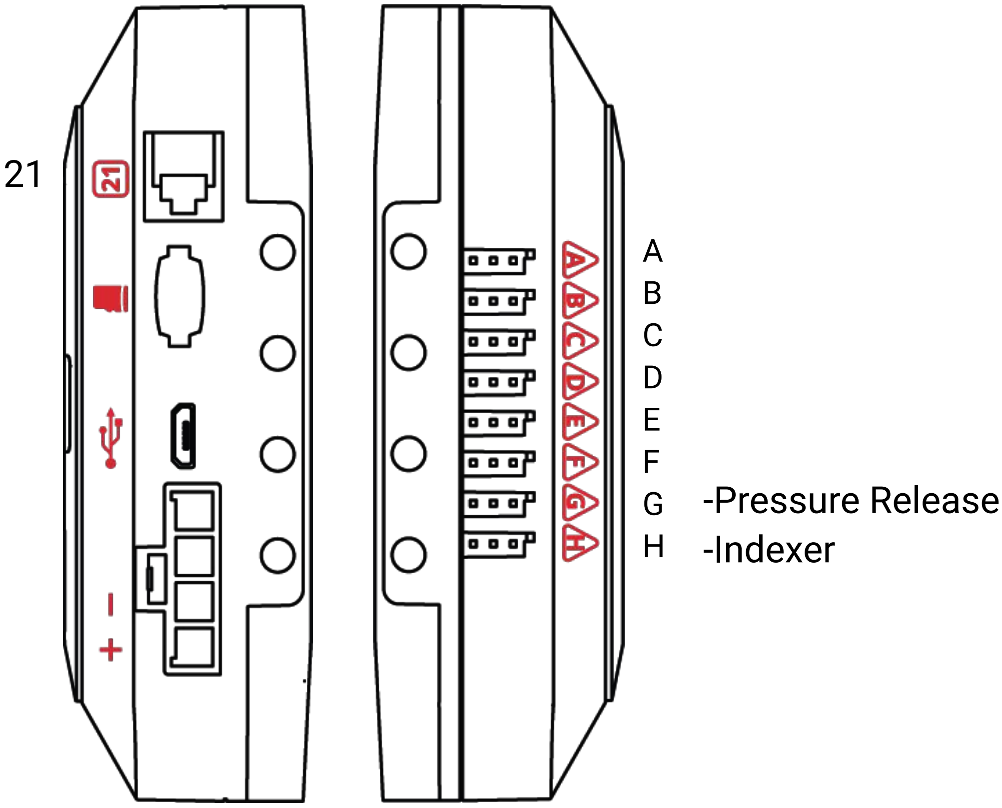
Name Quinn Burrow Date 9-24-22



Project Controller Configuration Version 2

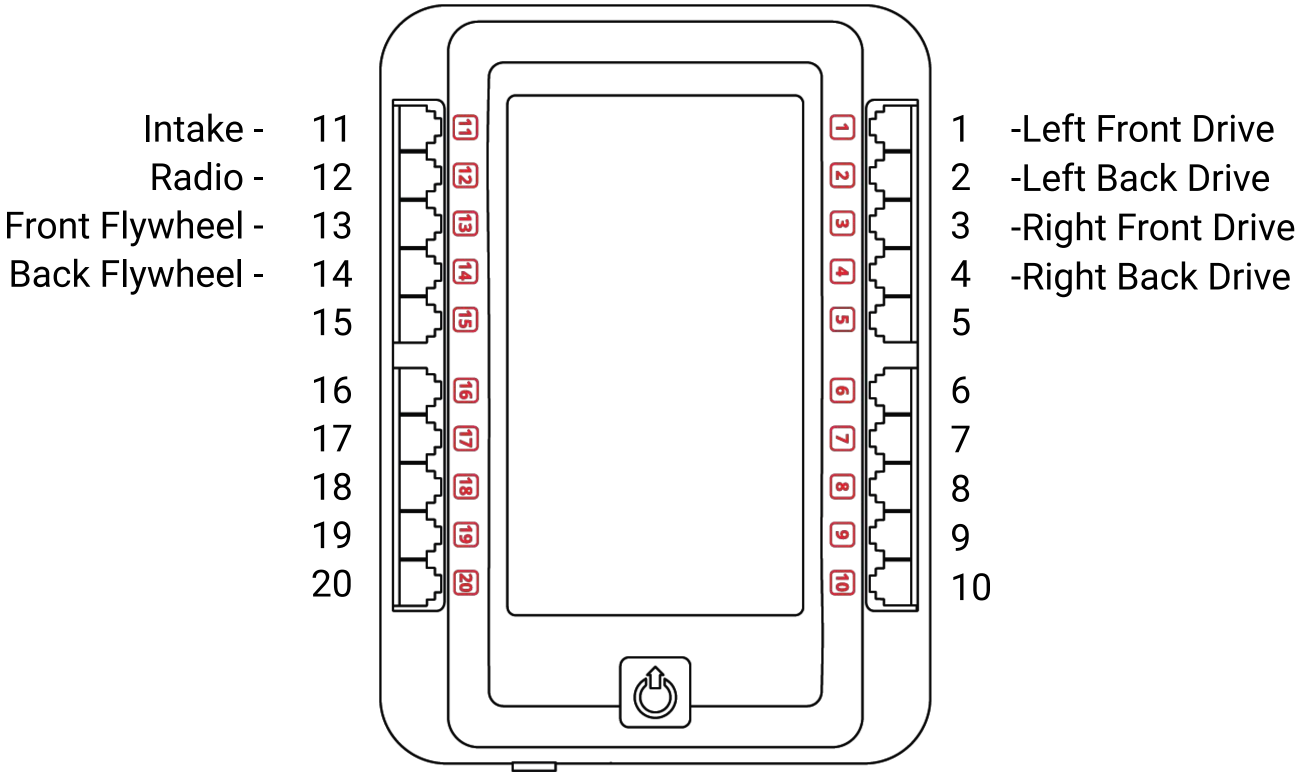
Name Kaden Haugen Date 11-17-22 Page W3

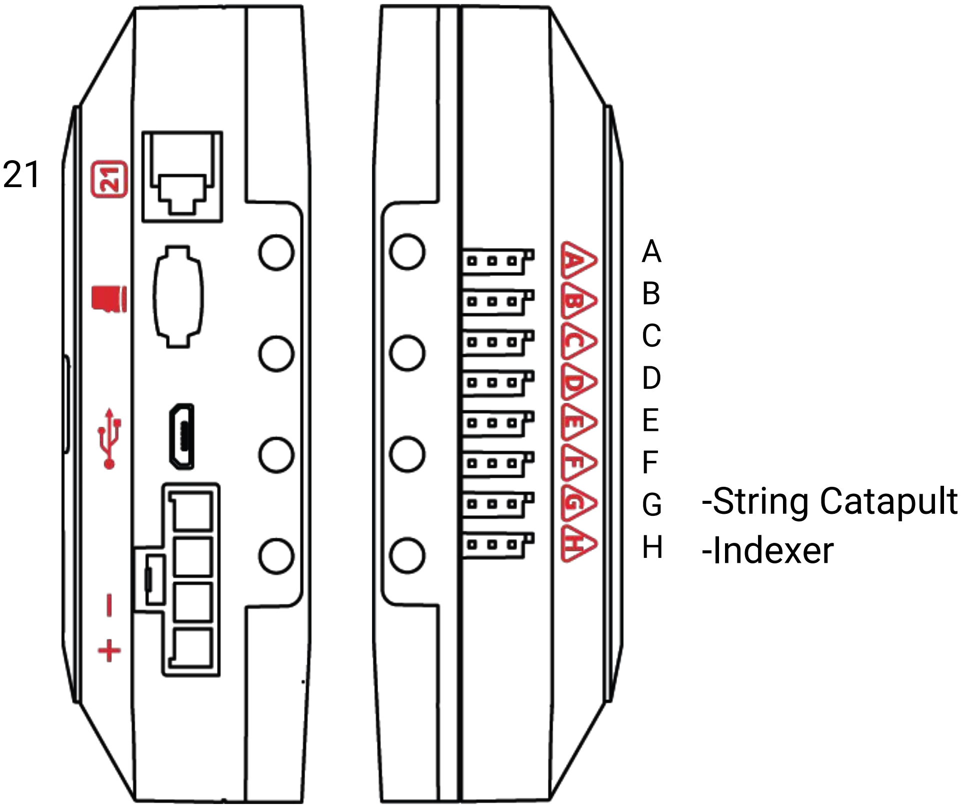




Project Brain Wiring Version 2

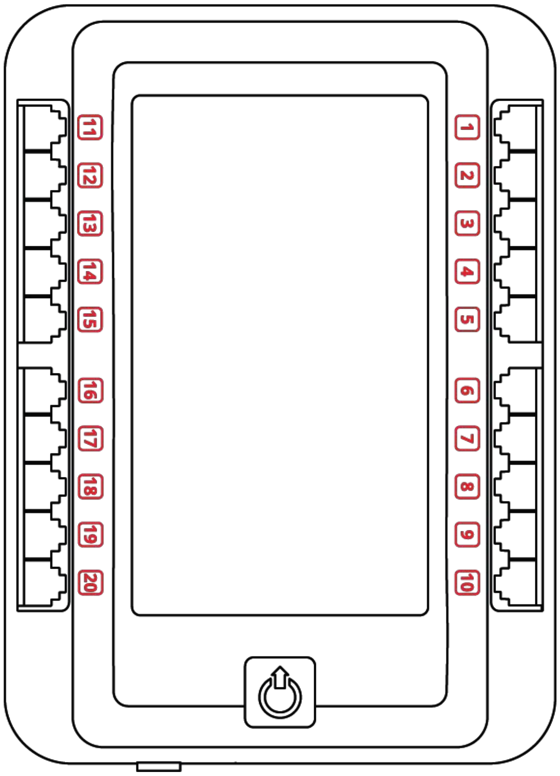
Name Aster Burrow Date 11-17-22



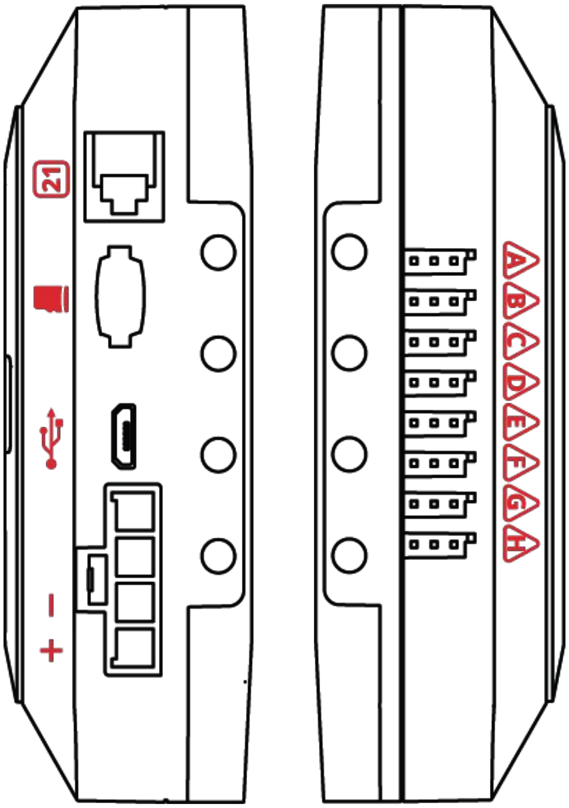


Project Brain Wiring Version 3

Name Aster Burrow Date 12-02-22 Page W5



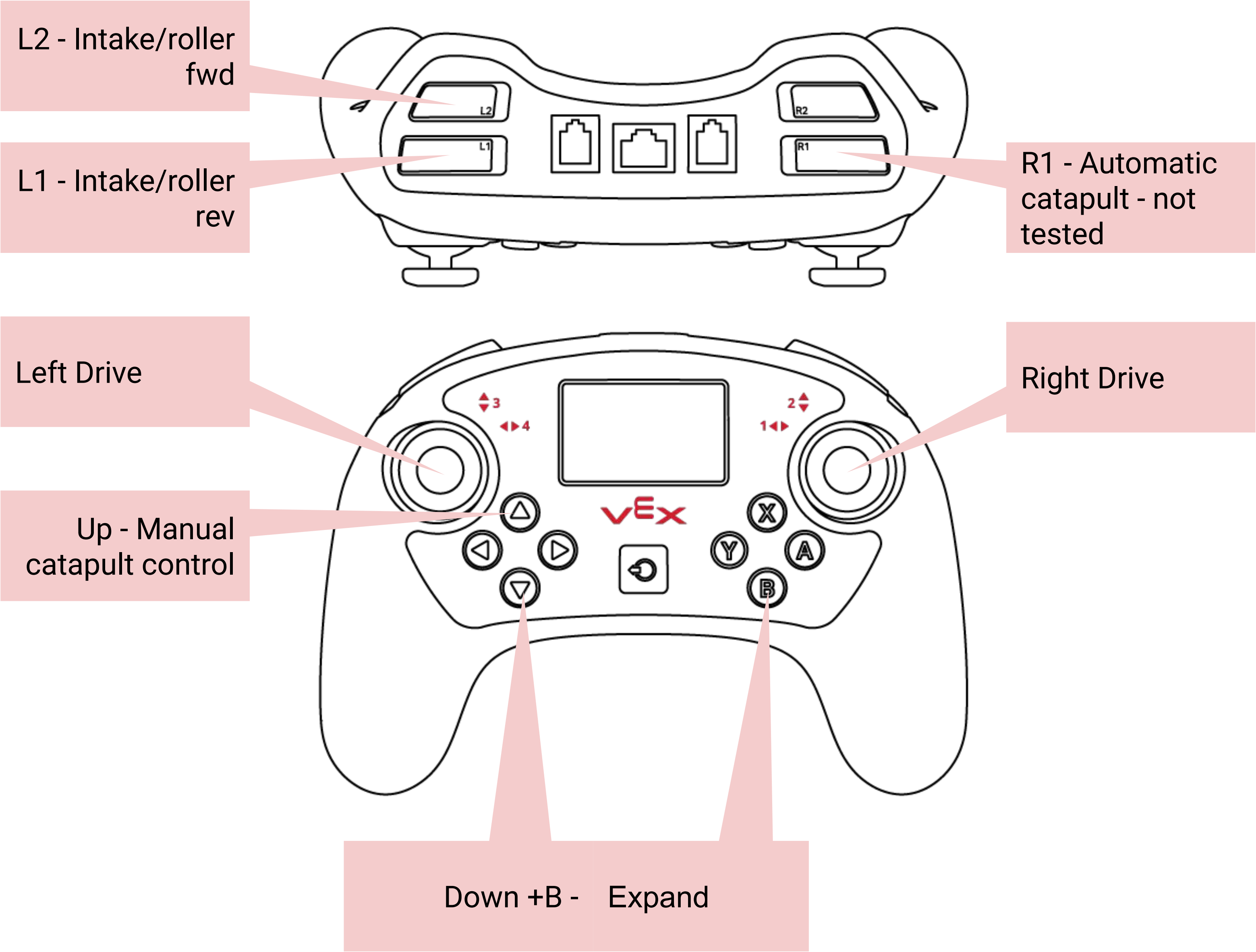
radio	11	1	leftFrontDrive
	12	2	leftMidDrive
	13	3	leftRearDrive
	14	4	rightFrontDrive
	15	5	rightMidDrive
	16	6	rightRearDrive
	17	7	catapult
	18	8	intake
	19	9	
	20	10	



21

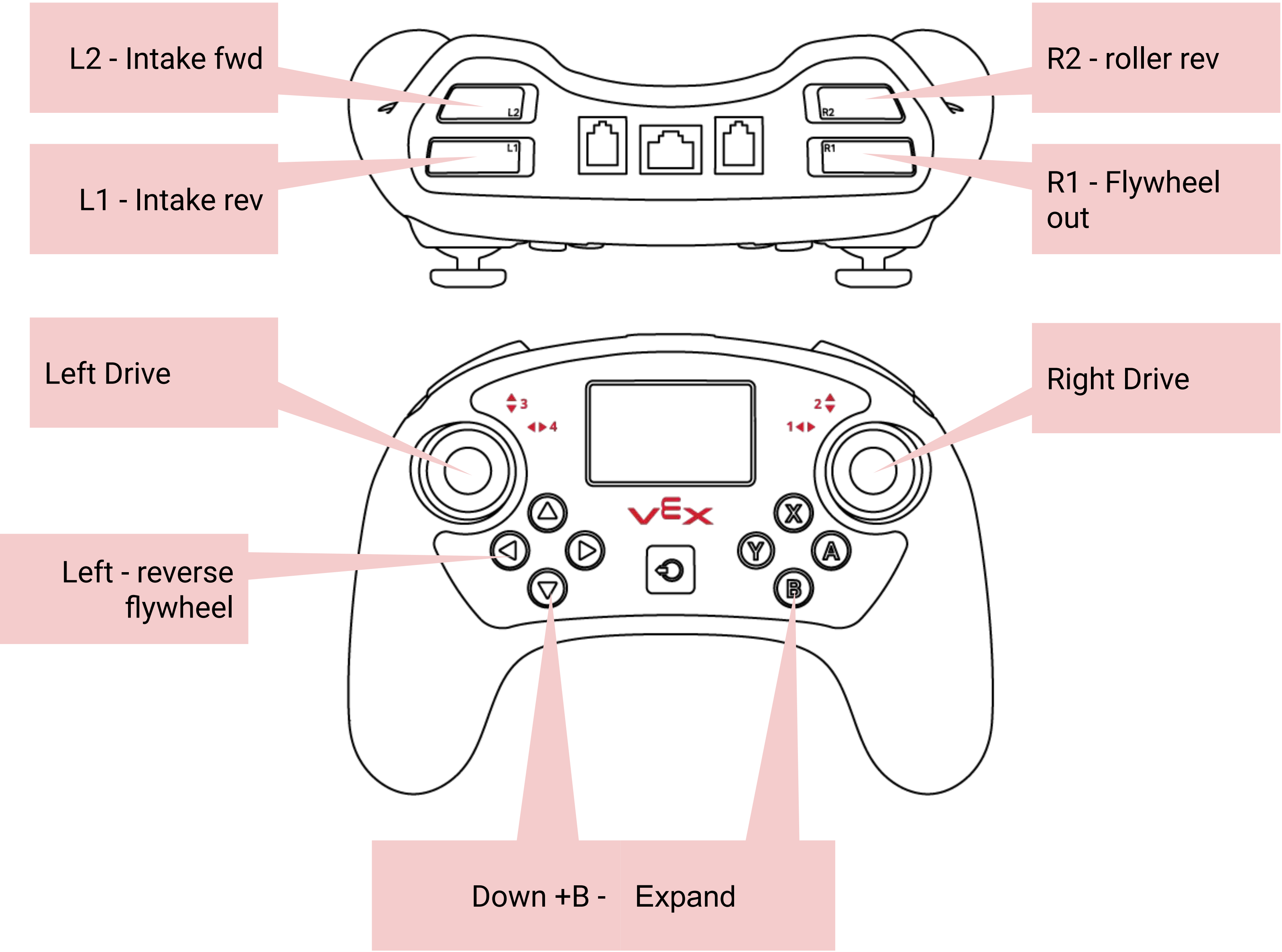
A	cataSwitch (not on yet)
B	stringCata (not on yet)
C	
D	
E	
F	
G	
H	

Project Brain Wiring Version 4 - Catapult Wiring
Name Aster Burrow Date 01-16-23 Page W6



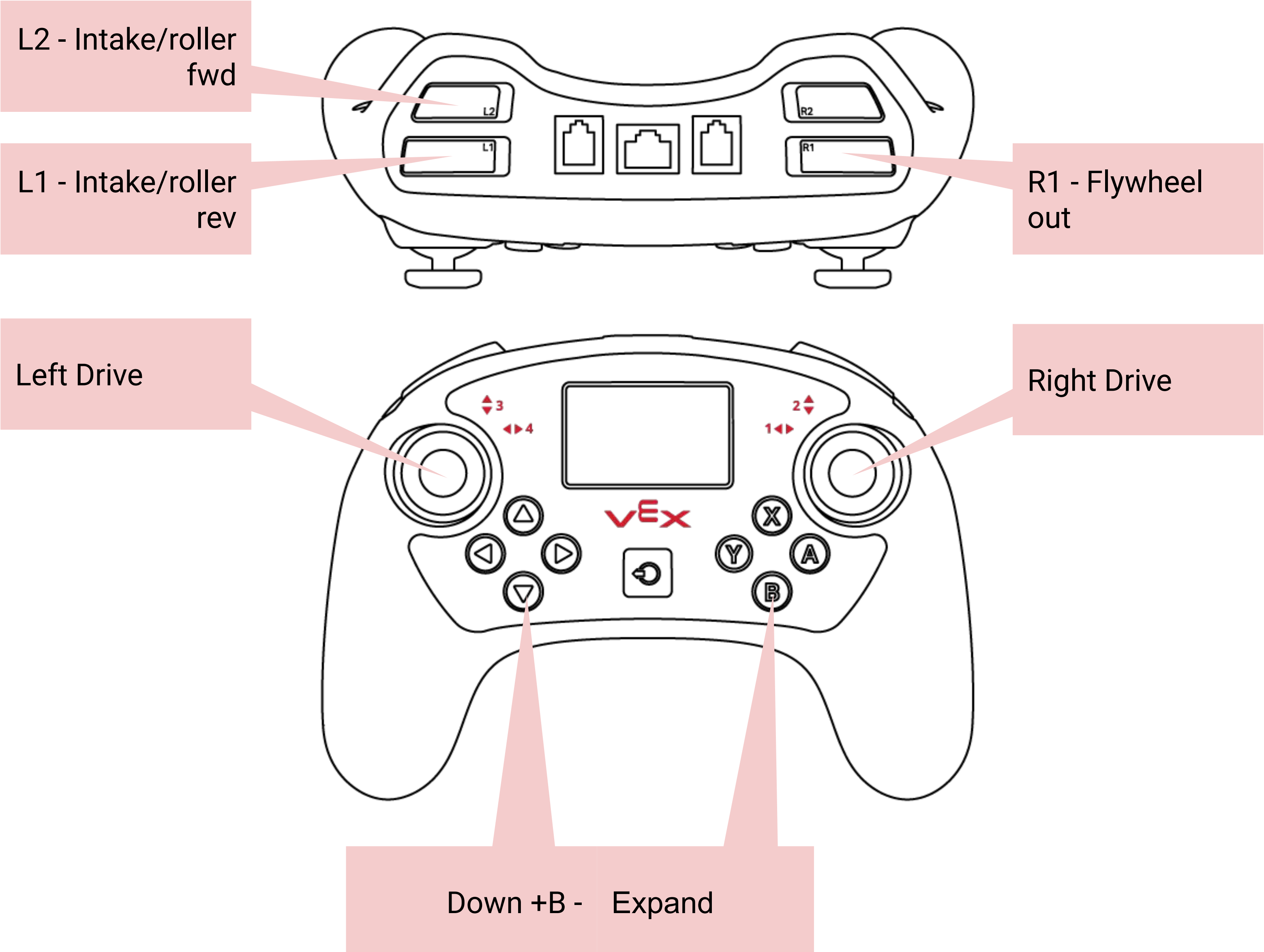
Project Controller Configuration Version 3 - Catapult

Name Aster Burrow Date 01-16-23



Project Controller Configuration Version 3 - Linear Flywheel

Name Aster Burrow Date 01-30-23

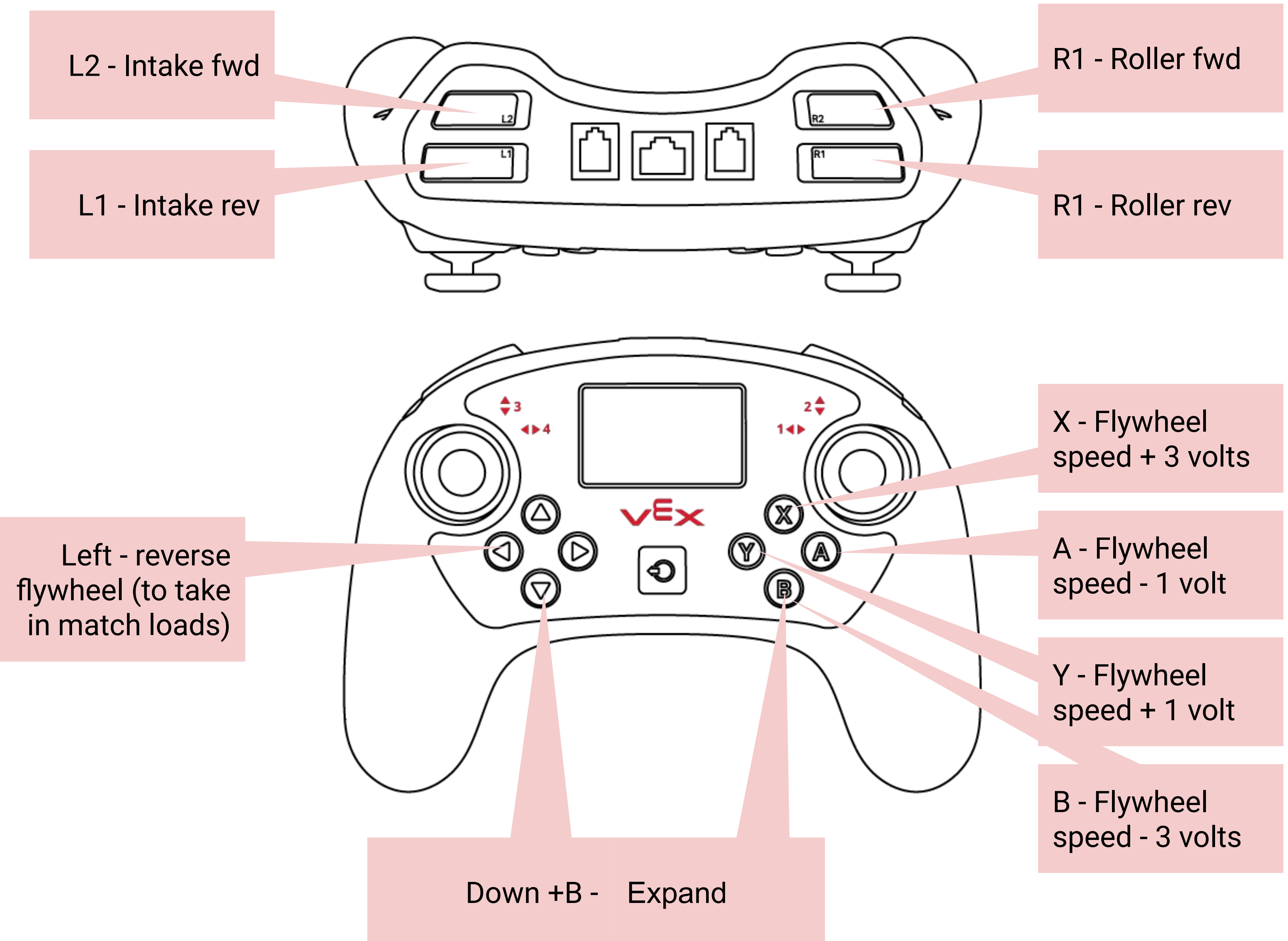


NOTES:

1. This code uses two controllers - this is controller 1
2. For the expansion control, down and B must be pressed at the same time on both controllers

Project Controller Configuration Version 4 - Linear Flywheel Cont. 1

Name Aster Burrow Date 02-04-23

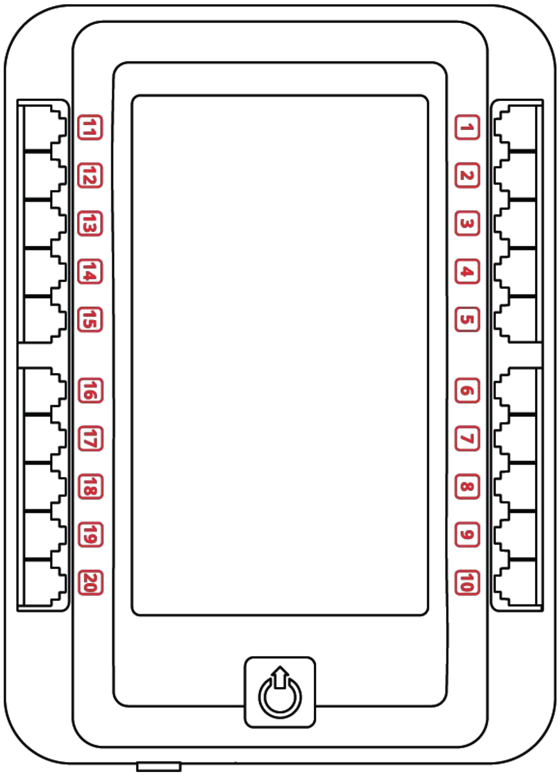


NOTES:

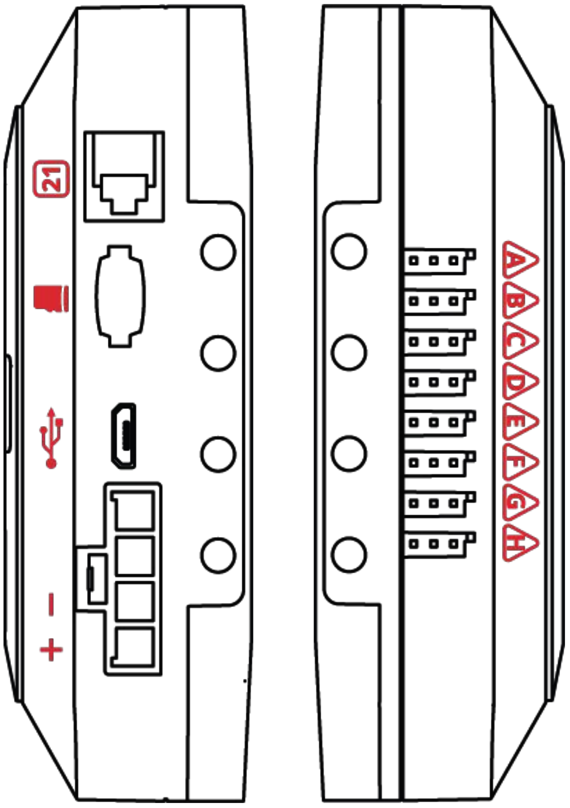
1. This code uses two controllers - this is controller 2
2. For the expansion control, down and B must be pressed at the same time on both controllers

Project Controller Configuration Version 4 - Linear Flywheel Cont. 2

Name Aster Burrow Date 02-04-23



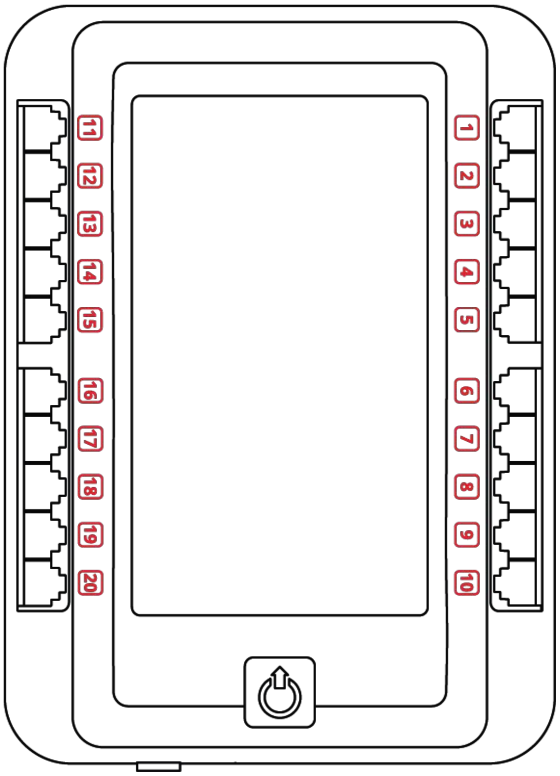
blue motor - Flywheel	11	1	Radio
blue motor - Flywheel	12	2	RightDrive - green motor
blue motor - Intake	13	3	RightDrive - green motor
	14	4	
	15	5	
	16	6	
vision - GroundView	17	7	
vision - CloseUp	18	8	FarView - vision
	19	9	LeftDrive - green motor
red motor - Roller	20	10	LeftDrive - green motor



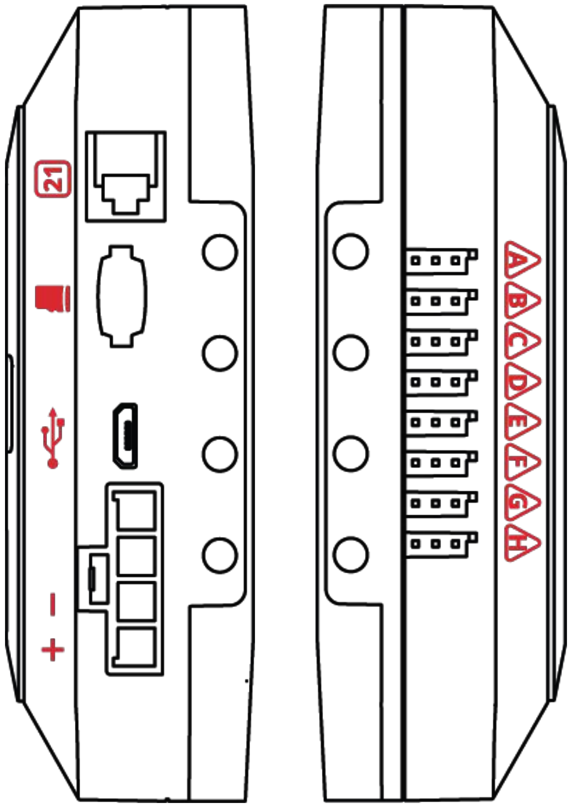
21	
A	Expansion1 - solenoid
B	Expansion2 - solenoid
C	Expansion3 - solenoid
D	
E	
F	
G	
H	

Project Brain Wiring Version 5 - Linear Flywheel Wiring

Name Aster Burrow Date 02-10-23 Page W11



🟩	blue motor - Flywheel	11	1	Radio	☐
🟩	blue motor - Flywheel	12	2	RightDrive - green motor	🟧
🟪	green motor - Intake	13	3	RightDrive - green motor	🟩
		14	4		
		15	5		
		16	6		
		17	7		
		18	8		
		19	9	LeftDrive - green motor	🟥
🟪	green motor - Roller	20	10	LeftDrive - green motor	🟦



21

A	Expansion1 - solenoid
B	Expansion2 - solenoid
C	Expansion3 - solenoid
D	
E	
F	
G	
H	

NOTE - this version adds the colors the wires are marked with on the robot to the diagram.

Project Brain Wiring Version 6 - Linear Flywheel Wiring ver. 2
Name Aster Burrow
Date 02-26-23
Page W12

References and Templates

Section R

Full Scale

Project Full Scale Grid

Name

Date

Page R1

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33

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35

Half Scale

Project Half Scale Grid

Name

Date

Page R2

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35

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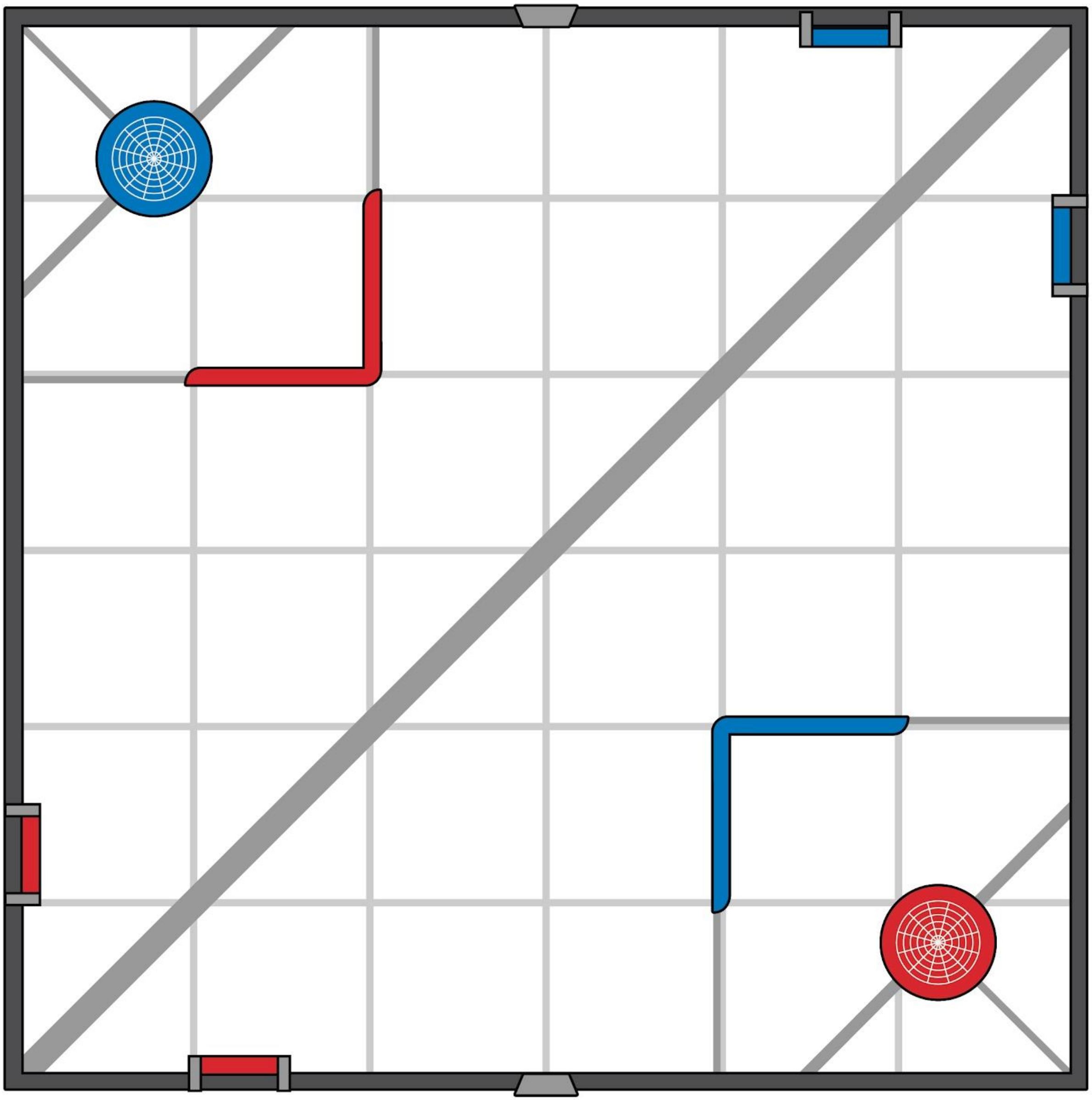
Third Scale

Project ⅓ Scale Grid

Name

Date

Page R3

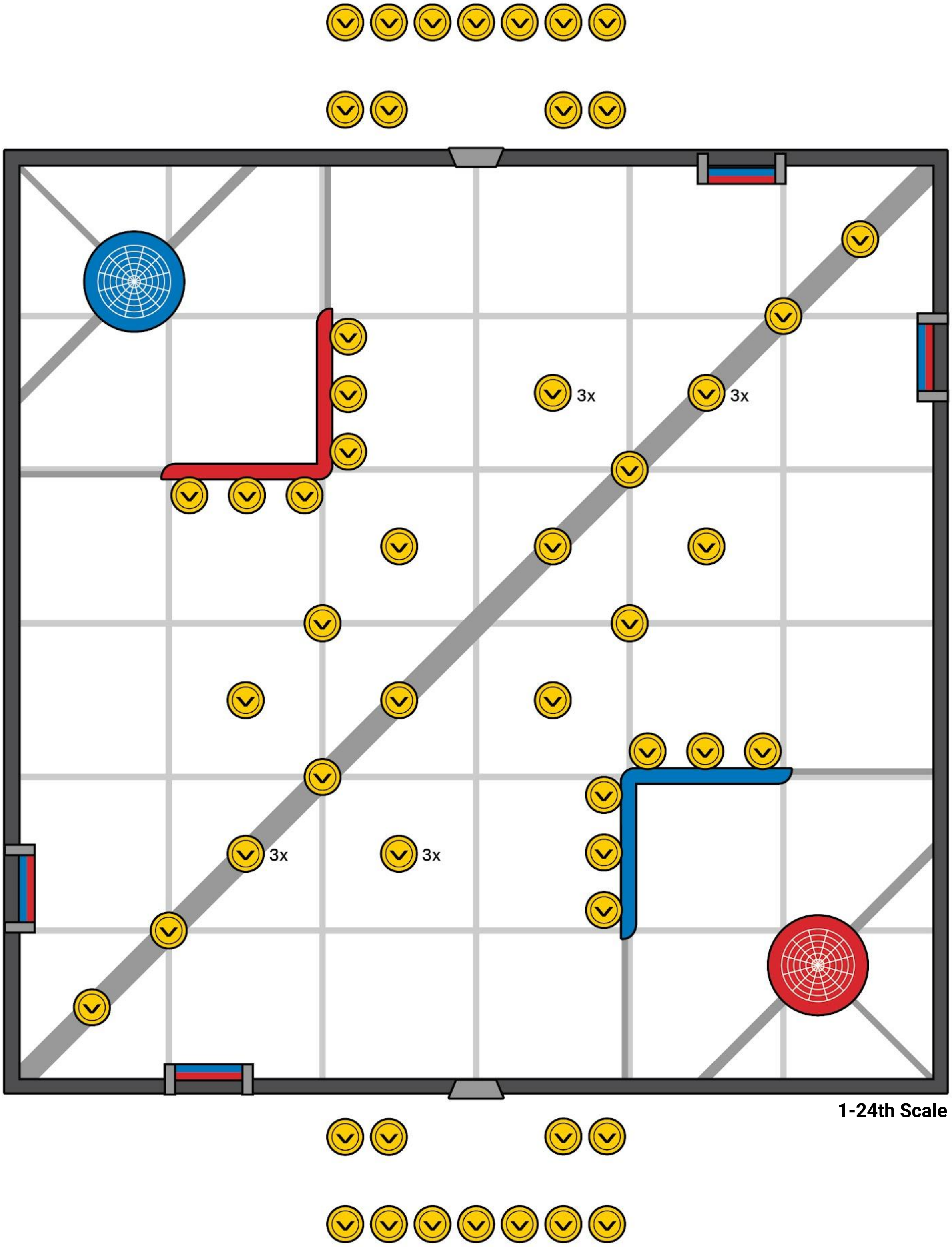

1-24th Scale

Project Empty FIeld Diagram

Name

Date

Page R4



1-24th Scale

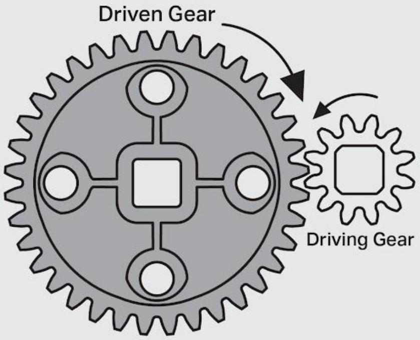
Project Field Diagram With Disk Layout

Name

Date

Gear Formulas

$$\textbf{Gear Ratio} = \frac{\text{\# of Driven Gear Teeth (Output)}}{\text{\# of Driving Gear Teeth (Input)}}$$



Power Transfer is a 1:1 gear ratio where the driving and driven gear have the **same number** of teeth.

Increasing Torque (lowering speed) is a gear ratio where the driving gear has **fewer teeth** than the driven gear.

Increasing Speed (lowering torque) is a gear ratio where the driving gear has **more teeth** than the driven gear.

Compound Gear Ratio = (Gear Ratio 1) × (Gear Ratio 2) × (...)

Motion Formulas

$$\textbf{Average Speed} = \frac{\text{Total Distance}}{\text{Total Time}}$$

Distance is from the **axis of rotation**

$$\textbf{Rotational Speed} = \frac{\text{\# of Turns}}{\text{Time}} = \frac{\text{Degrees}}{\text{Time}}$$

Circumference = π × Diameter

Power = Force × Velocity

π ≈ 3.14

Torque = Force × Distance

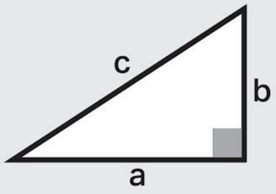
Force = Mass × Acceleration

Mathematical Formulas

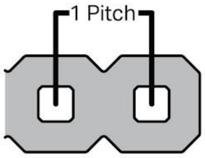
Complimentary angles are angles that sum to 90°

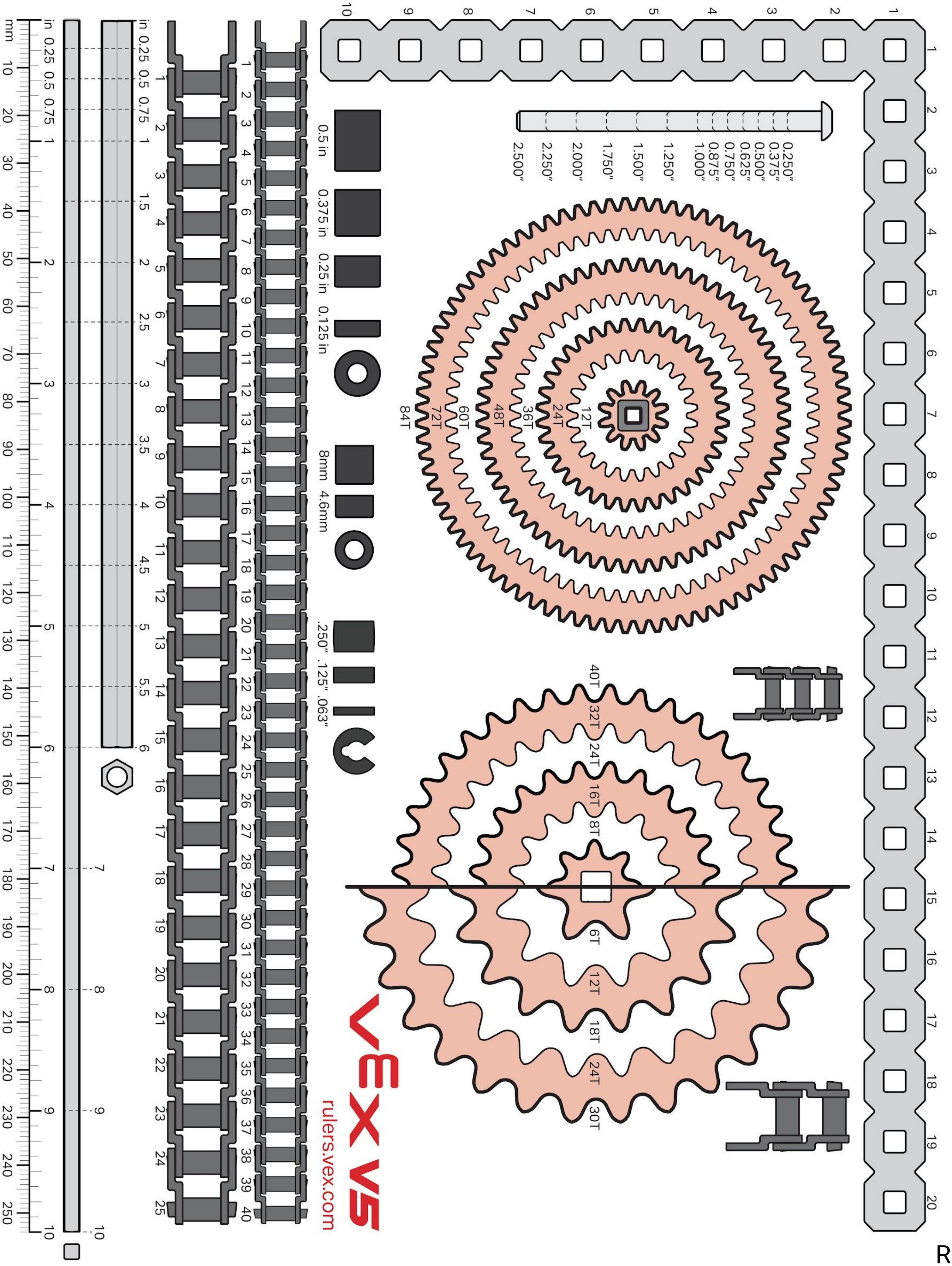
Supplementary angles are angles that sum to 180°

Pythagorean Theorem: $c^2 = a^2 + b^2$



1 Pitch = 0.5 in =12.7 mm





0.250"
0.375"
0.500"
0.625"
0.750"
0.875"
1.000"
1.250"
1.500"
1.750"
2.000"
2.250"
2.500"
12T
24T
36T
48T
60T
72T
84T
8T
16T
24T
32T
40T
6T
12T
18T
24T
30T
0.5 in
0.375 in
0.25 in
0.125 in
8mm
4.6mm
.250"
.125"
.063"
in
mm
VEX V5
rulers.vex.com

R7