Engineering Notebook

221Z

Team Number

Photonics

Team Name

Westwood Community High School

School

9/2/2023	1/18/2024	1 of 1
Start Date	End Date	Book #

V2.1 Date 6.12.2

VEX ROBOTICS

REC FOUNDATION

Shivank

Our First Practice

Meeting The Team

We are a team from Westwood community High School in Fort McMurray Alberta. Our team has years of combined expierence where we work together to achive the best robot we can while also gaining some hands on skills. A fun fact about our team is that we are one of the most northern teams in the world. We are exicted to apply our skills to the new game of Vex Over Under.

Shivam Khatri

Shivam Khatri thats me!

- Grade - 11
- Second year of VEX Robotics
- Role - Lead notebook, and main driver
- Strengths - Organized, Analytical, Hard worker.

Shahmeer Awan

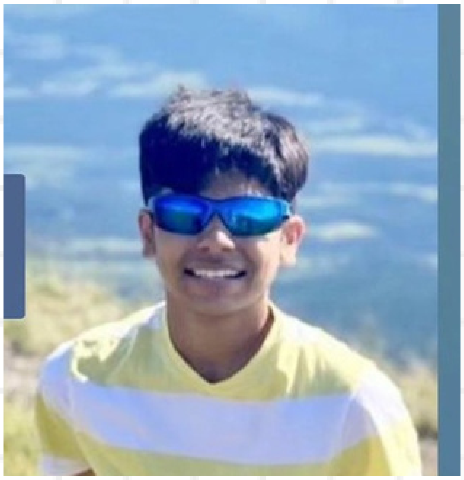
- Grade - 12
- Third year of VEX Robotics
- Role - Lead engineer, secondary designer
- Strengths - Leadership, Empathy, work ethic

Shayan Awan

- Grade - 10
- Second year of VEX Robotics
- Role - Lead programmer, secondary notebook.
- Strengths - Teamwork, communication,problem solving

Vineet Parikh

- Grade - 11
- Second year of VEX Robotics
- Role - Lead designer, secondary builder,and secondary programmer.
- Strengths - Time management, Creativity, Adaptable



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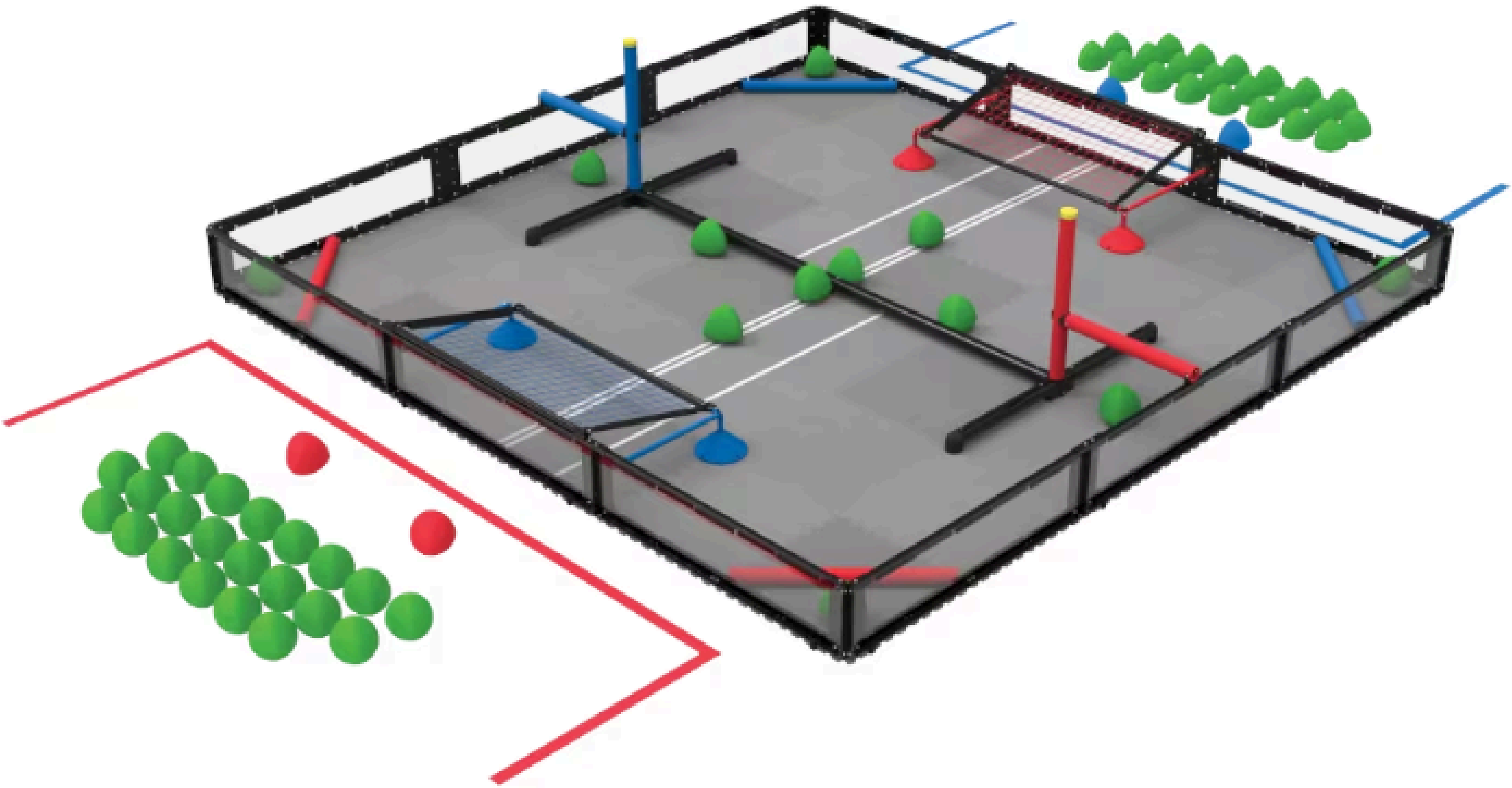
Identifying the Game Objective

Vex Over Under



Field Elements

This years main field element is the “triball” a cone shaped ball known as a Reuleaux triangle.

- Maximum of 60 triballs on the feild at one time.
- 12 triballs start on the field at the beginning of the game.
- 4 triballs for match loads.(2 blue)(2 red)

- The weight of the ball ranges from 103-138g.
- The height of the ball is 6.18" inches.

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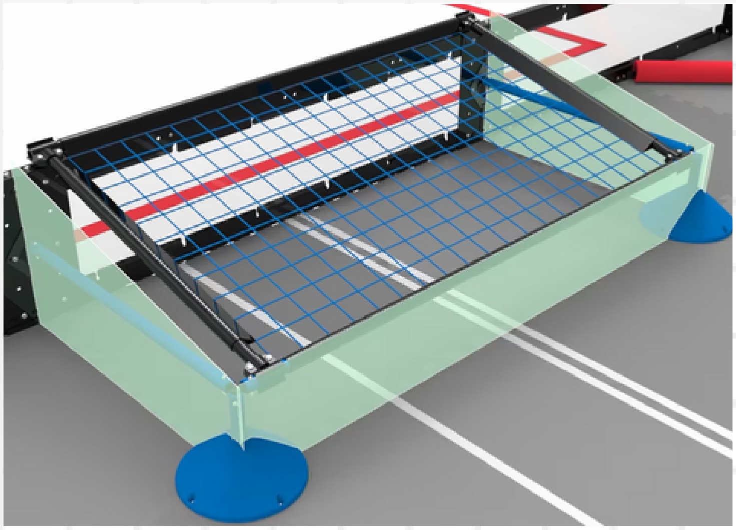
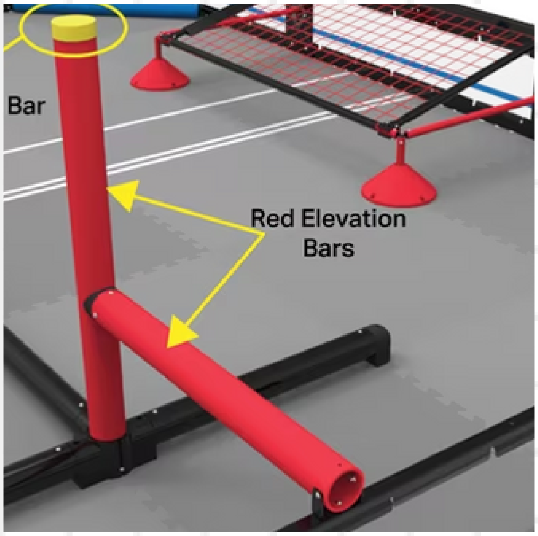


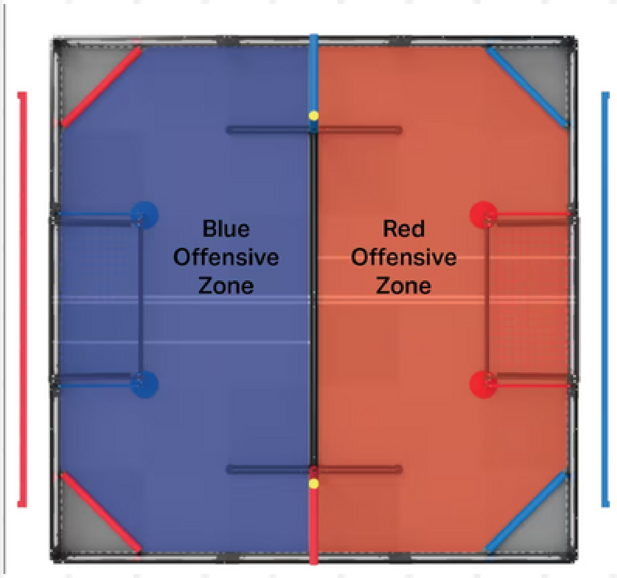
Most of the points will come from scoring the triballs into the net shown to the left.

- 2 goals(1 per alliance)
- 5.78" from thier lowest point.
- 19.20" wide from the side.
- 39.40" wide from the front.

This is what is part of what is considered the “endgame”. Players main objective is to hang on at the end of the game.

- The height of the horizontal elevation bar is 14.01 inches
- The height of the vertical elevation





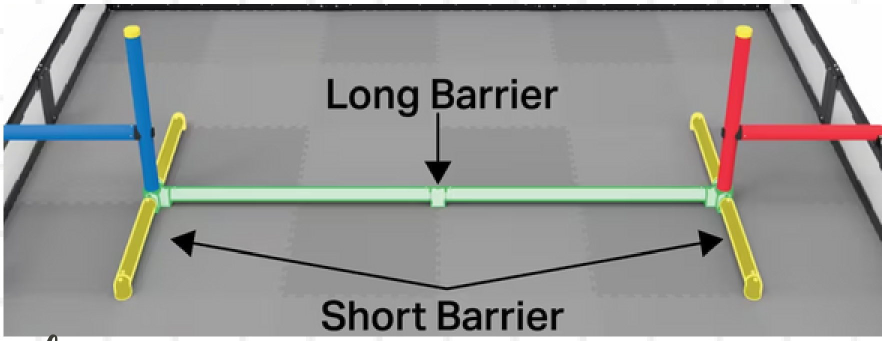
There are two offensive zones.

- One for each alliance

Any green triballs in a alliance zone is considered points for the alliance who’s zone it is.

- Green triball in the red offensive zone is points for the red alliance.

Alliance zones are seperated by a long and a short barrier.



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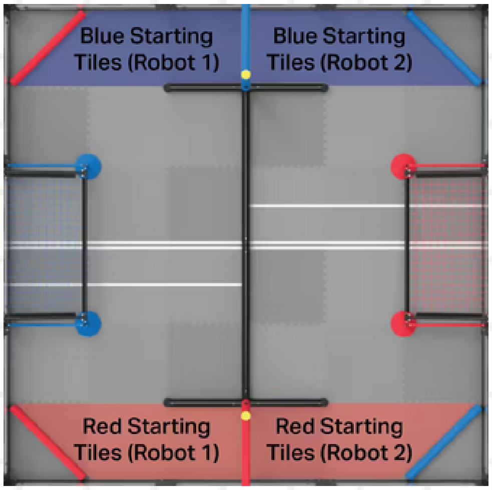
Point Scoring

Each triball scored in the net is 5 points.
Each triball scored in the offensive zone is 2 points.
Triballs can be removed from the net if both robots are on one side of the barrier also called "double zoning."
At the end of the Match, the Robot that has climbed the:

- Highest -20 points
- Second-Highest - 15 points
- Third-Highest - 10 points
- Fourth-Highest - 5 points

Any Robots that share an Elevation Tier are awarded the same number of points based on their comparative height to the other Robots in the Match
The alliance with the most autonomous points recives 8 points.

The Match



Robot alliances start on opposite sides of the field as shown in the photo to the right.
There is a 15 second autonomous period that is controlled completly by a code.
After that there is a 1 minute 45 second driver control period where drivers aim to get the most ammount of points as they can.

Violations

Disqualification – A penalty applied to a team for a rule violation
Entanglement - A Robot is grabbed, hooked, or attached to an opposing Robot or a Field Element.
Trapping - Limiting the movement of an opponent Robot to a small or confined area of the field.
Pinning - Preventing the movement of an opponent Robot through contact.

Lifting - Controlling an opponent's movements by raising or tilting the opponent's Robot off of the foam tiles.
Match Affecting – A Violation which changes the winning and losing Alliance in the Match.
Minor Violation – A Violation which does not result in a Disqualification.

- Accidental, momentary, or otherwise non match affecting violations.

Major Violation – A Violation which results in a Disqualification.

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Our Game Plan

We were very exicted when the new game came out so we started to think about the strategies that we would use and how we would build our robot around those stratgies. Our first strategy was to create a fully offensive robot which picks up the triballs and places them into the net. So we weighed out our pros and cons.

Pros	Cons
• A lot of points scored. • Smaller and faster robot	• Relys on our teammate for extra triballs • Easily countererd.

Vineet then said the idea of making our robot compeletley defensive. Everyone thought that this was more of a risky strategy but we still weighed out the pros and cons.

Pros	Cons
• Easier to give our teammate triballs • Can prevent the other team from scoring points.	• Relys on our teammate to score goals. • Wouldn't be able to score many points.

We then combined our two older ideas to make a new one. Half defensive half offensive where we decide which way to go based on our teammates skills. We would do this by haivng an intake and a catapult that would be dedicated just for matchloads.

Pros	Cons
• We can never be useless • Can score goals with both a catapult and intake/outake.	• Harder to build

We decided to go with our last idea of being half offenisve and half defensive based on our teammate.

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Brain Storming

Our First Base

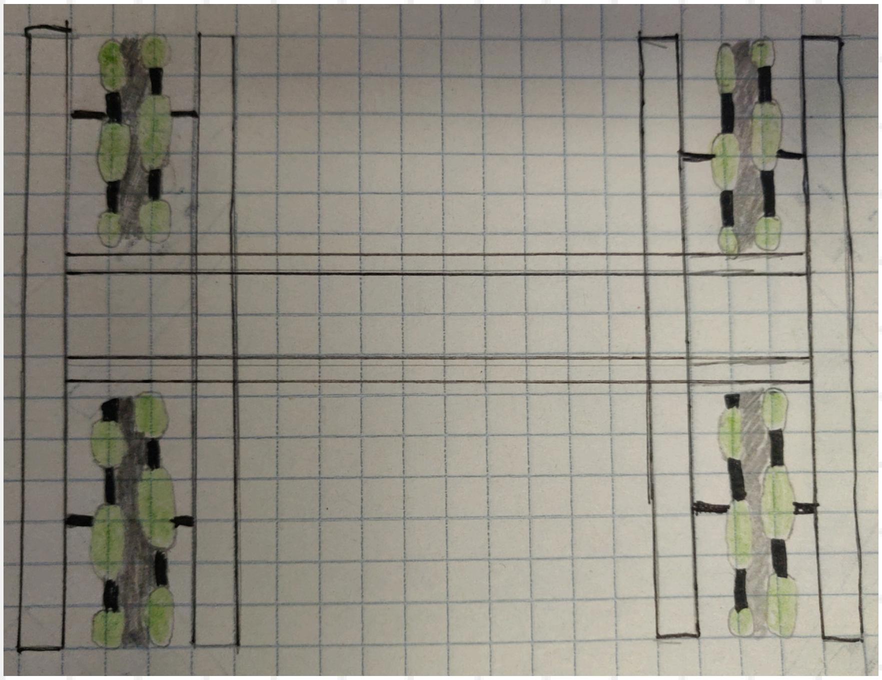
Base

Our goal when making the base was to make something that could traverse the field quickly while also having a lot of power to do things such as climb over the center pipe and push triballs under the net. For this we need a balance of torque and speed without compromising a compact design.

Prototypes

Standard OmniWheel Base

Our first idea to make a 4 wheel base with 4 omni-wheels in all 4 corners. This would be connected using four motors connected to all four wheels. This is the most common type of base.



Pros	Cons
• Easier to build • Takes up less space	• Low traction • It can only move in two different directions • No gear ratio

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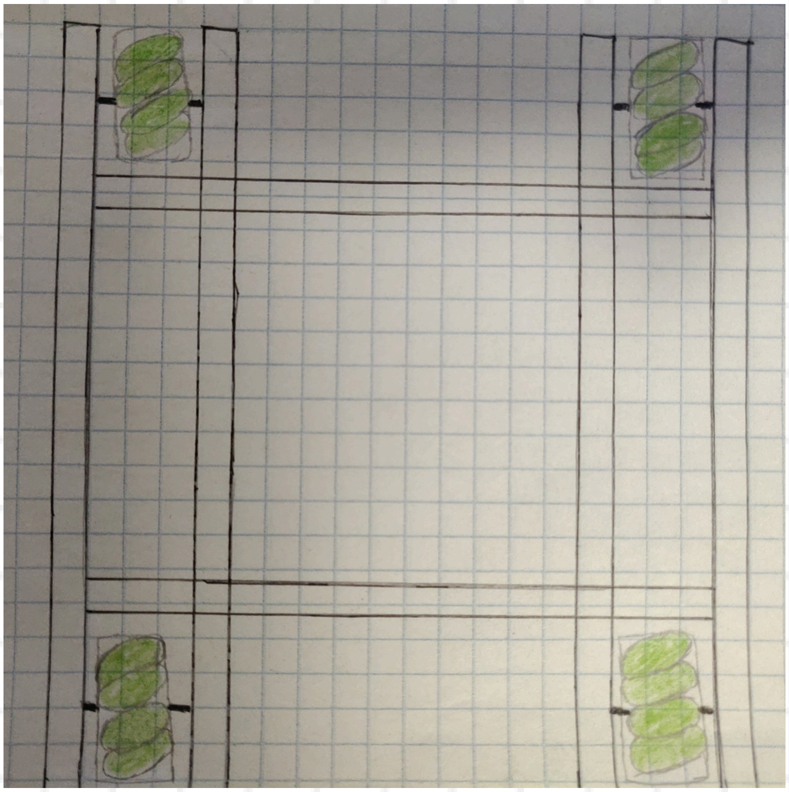
Standard Mecanum Base

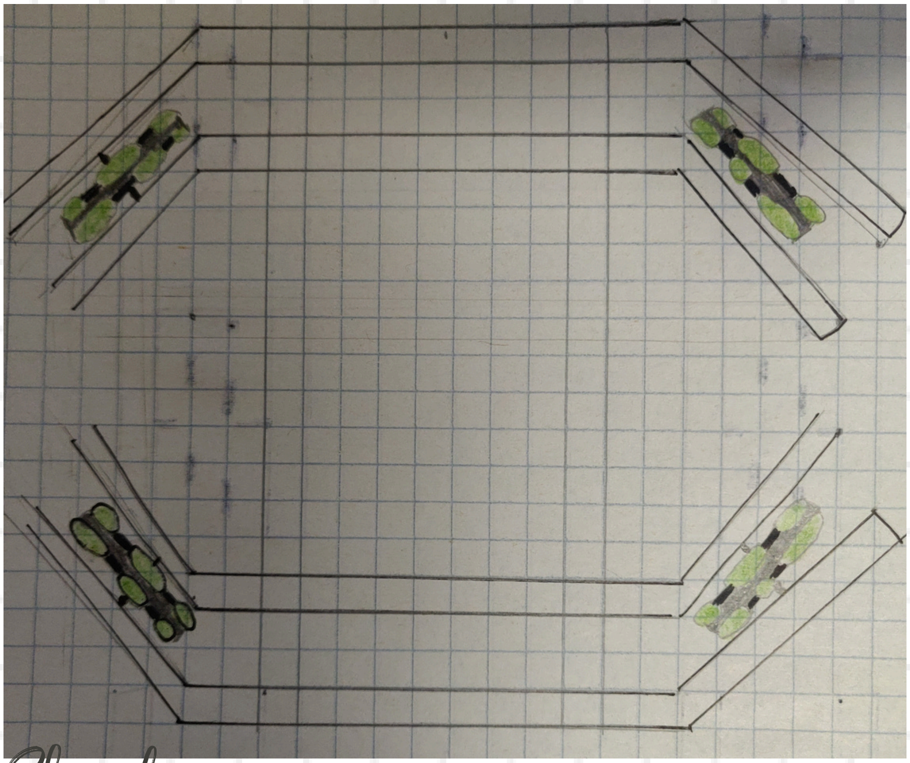
Our next idea was like our previous idea but modified. This was that instead of omniwheels we would have mecanum wheels. This would allow us to move sideways.



Pros	Cons
• Movement in all four directions • Simple • Easy to build	• Low traction • Slow • No gear ratio

Holonomic/X-Drive

I then had the idea of using a xdrive. This is a drive with omniwheels set up in a hexagonal pattern. Each wheel is oriented 45 degrees from the regualr tank-drive.



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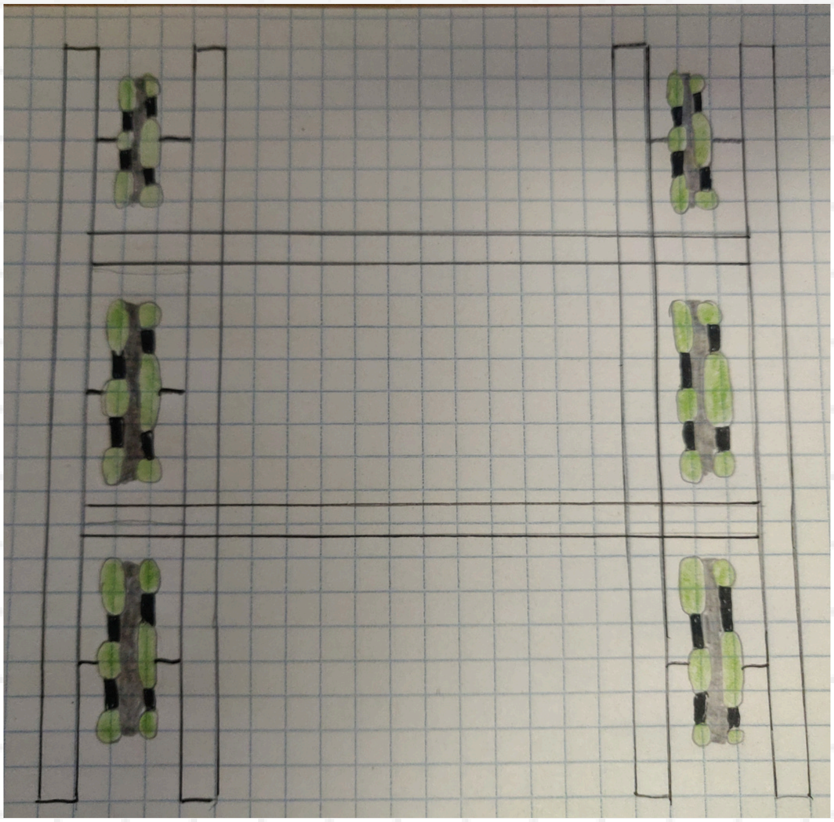
Pros	Cons
• Fast • Moves in all directions • More traction	• Complex • Hard to program • Takes up a lot more space

6 Omniwheel Drive

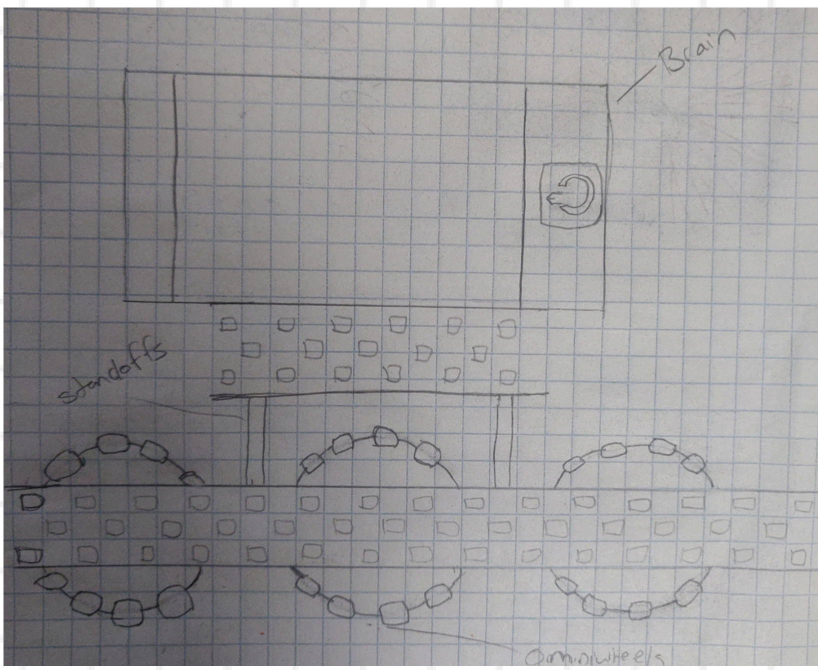
Another idea that we had was to have the standard omniwheel base but with a little twist. This would be that in the center between the two wheels we would have another one on each side. The motors would go on the 4 outer wheels.



Pros	Cons
• Fast • A lot of power due to gear ratio • Does not take up too much space	• Complex • Little traction

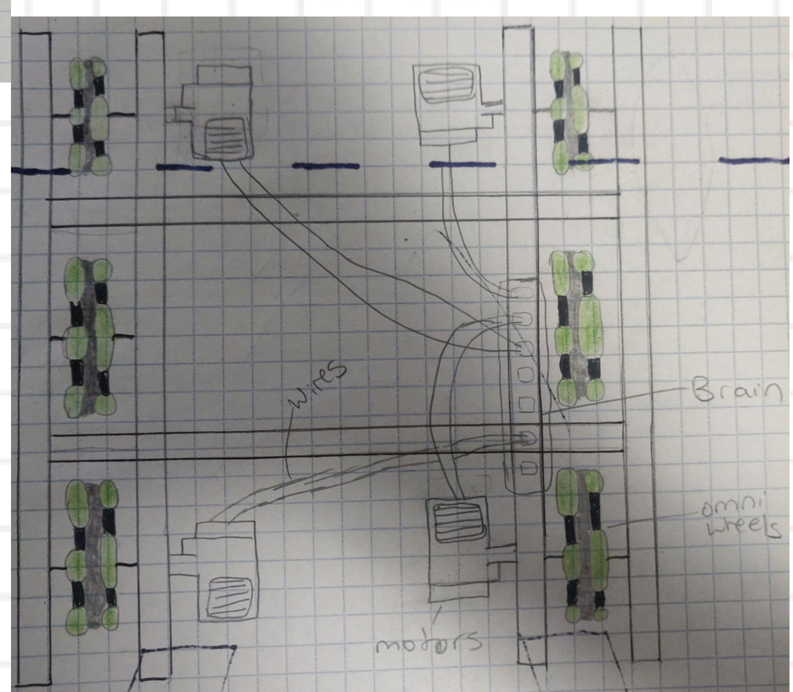
Our First Base

After looking at our options along with looking at the game more indepth. We realized that we needed something that was simple and accessible so we could change the design if we encountered any problems. We also did not mind anything that would be complex and hard to build as we had enough time for us to finsh everything and have a lot of breathing room. This made our option very clear. We decided to go with the 6 wheel omniwheel drive. In this design we would have 4 motors connected to the four outer wheels. We also decided that we would have a C-Channel connected by standoffs to the inside top of the base on the right side where the brain would sit. This is how it looked:



Side View

Top View



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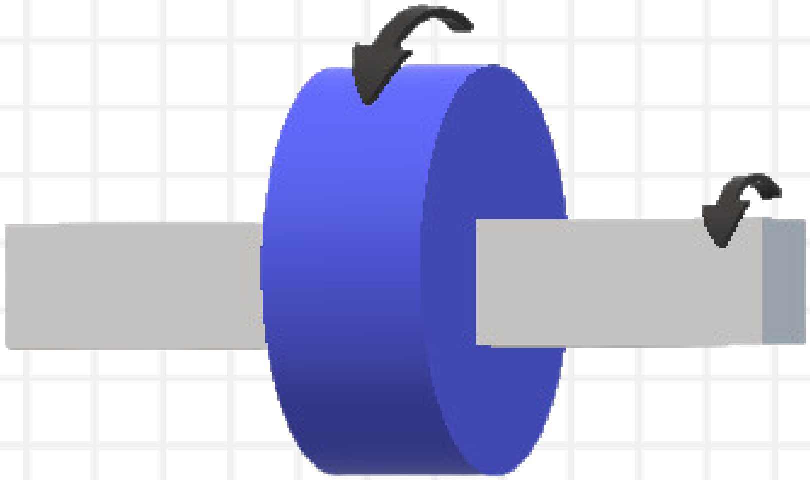
There are two major ways to connect the wheels to the base. These are screwjoints and by axel. There are benefits to each so us as a team weighed these pros and cons out.

Axel

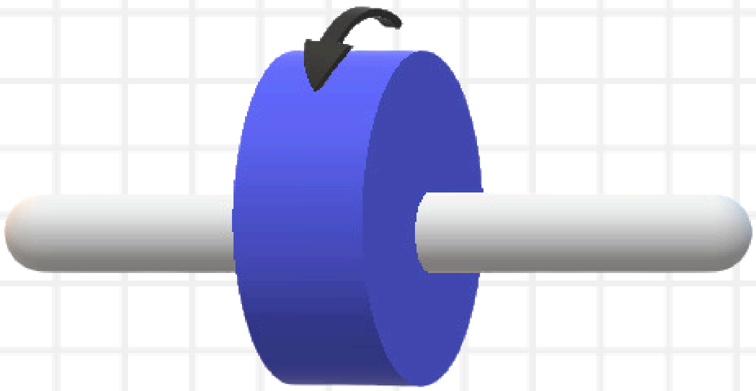
This is the most basic and most common way of attaching the wheels to the base. This is where there are 4 bearing flats total, 2 on each c-channel. Through the center of these there is an axel connected to a wheel with a sqaure axel fitting. Ofcourse inbetween them there are spacer, shaftcollars, washers, and more.



Pros	Cons
• Easy to build • Reliable	• High friction • Hard to configure the design

Screw Joints

This is another way to build the base. Instead of the wheel spinning by an axel it spins by gears. The wheel spins freely on a screw and screw spins by a gear which is connected to a second gear. This second gear has an axel connected to a motor which makes it spin.



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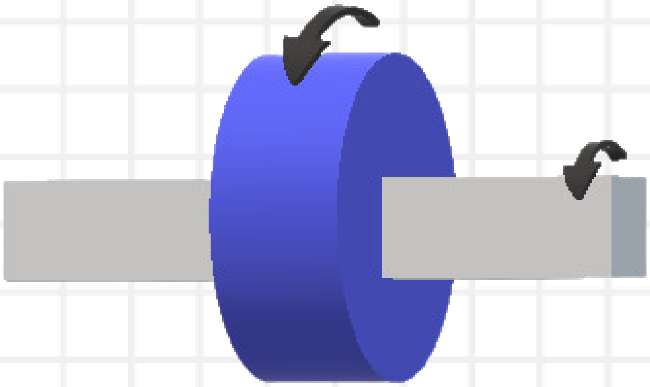
Pros	Cons
• Low Friction • Reliable	• Harder to build than using an axel • Can't attach directly to the motor

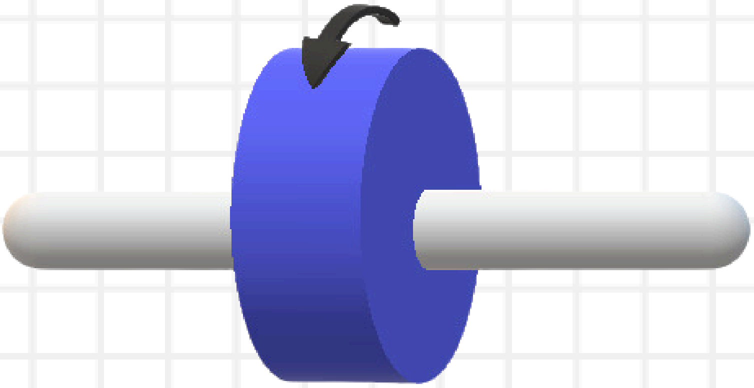
For our wheels we decided to use screw joints as this is one of the major parts that are moving. This would give us less friction which allows us to make our motor spin faster without it overheating. We also decided to use axel to connect the second gear to the motor. This was one of the most reliable ways that we could get power to our wheels. We used a 1 to 1 gear ratio for the wheels. This gave us extra power and gave us sufficent speed to traverse the field an a short amount of time. Our extra power also gave us the ability to better push robots if we ever need to.

More Information on Screw Joints

Screw joints are a little bit confusing on how they work. When you are using an axel to pwoer the base. The wheels are fixated to the axel. For screw joints the wheel is rather spinning on top of the screw rather than spinning with the screw. This reduces friction as there are less moving parts. This less friction also gives us more benefits than just that. First off, we can run a consistent 200 rpm with close to no drops in rpm which means we are using less wattage. It also allows us to run the motor for longer and maybe even faster which gives us the ability to play back to back games with close to no issues.

Comparison below:





To connect the two sides of our we used a couple different methods. Our first method was to use standoffs to connect the two sides. We used 4 standoffs total. Ofcourse those have smaller standoffs connected by headless screws because we could not find any standoffs that size. Another method that we used was to put a c-channel at the back. This c-channel provided us with structural support while also giving us a place to attach our catapult onto which we will talk about later.

After looking at the pros and cons we decided to go with screw joints on our first base. There were many benefits from this such as simplicity, accessibility, fast.

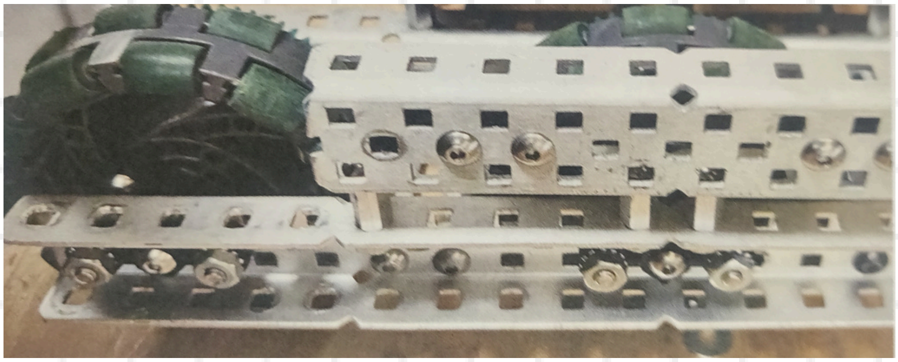
Simplicity - This design was very clean as screwjoints dont take up a lot of space which benefited us a lot. The first benefit was that, due to the simplicity of them it decred weighted and allowed us to make easy modifications whenever we wanted. This weight reduction also meant that we could place other mechanisms without having the worry of the robot being too heavy and slow.

Accessibiility - This design also allows us to access the internal parts of the robot without it being a big hassle. Even the harder to reach parts would be easy becasue we would just need to take apart the screwjoint which is possible as they are simple to build and take apart.

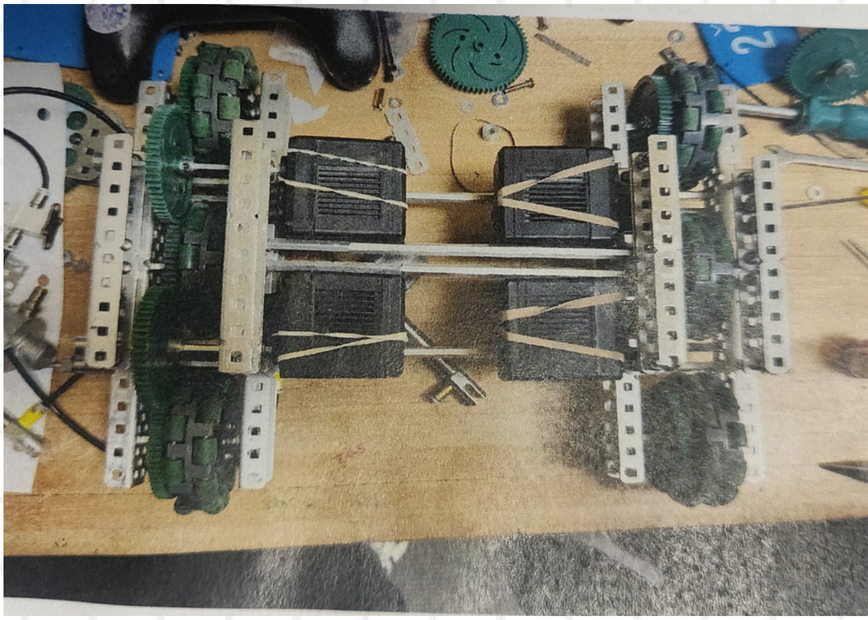
Fast - This design is supposedly fast as the screwjoints reduce friction. Another thing that helps with the speed is the light weight design. This gives us a lot more speed which is crucial for this game.

Images of our base below:
Note - The images below do not have the brain connected nor do they have the c-channel connected.

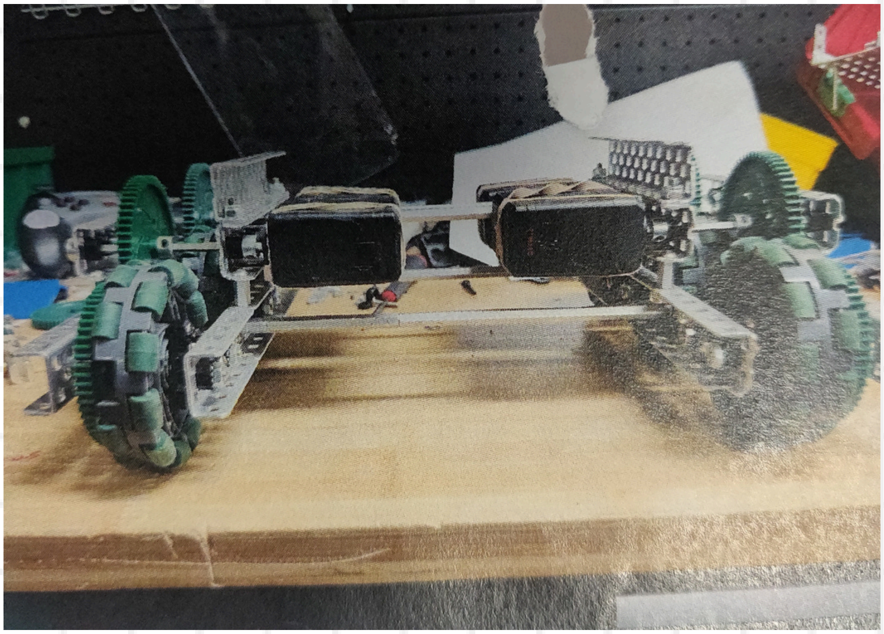
Side View



TOP VIEW



Front/back View



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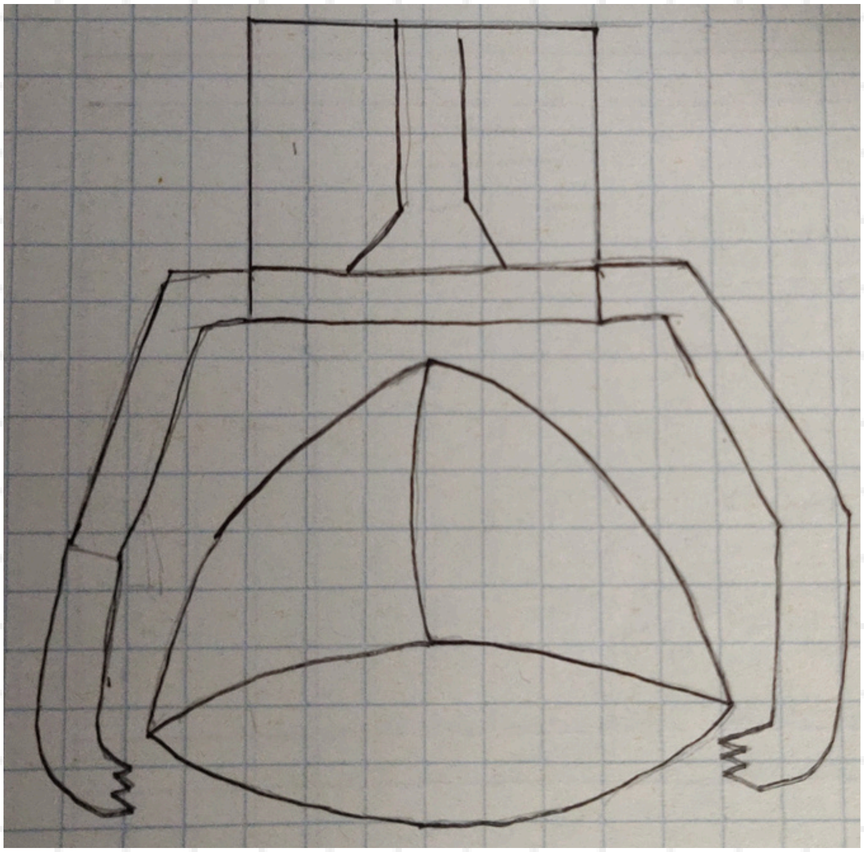
Brainstorming

Our First Intake/Outake Ideas

After looking at the game we realized that we needed something that can pick up the triballs and drop them off in or close to the net for us to push it in and secure 5 points. This meant that we needed something that gave us grip to hold the ball, had speed so we can pick up and place triballs fast, and be the right height so it doens't hit the top of the net. Since an intake can be anything we had a lot of ideas which were

Claw

The trailer had many robots with a claw and that was our first idea. It would be a claw with 2 motors, one to control up and down movement, and one to control opening and closing. Most of us did not like this idea but we still weighed out the pros and cons.



Pros	Cons
• Easy to build	• Slow • Unreliable • Requires a lot of precision

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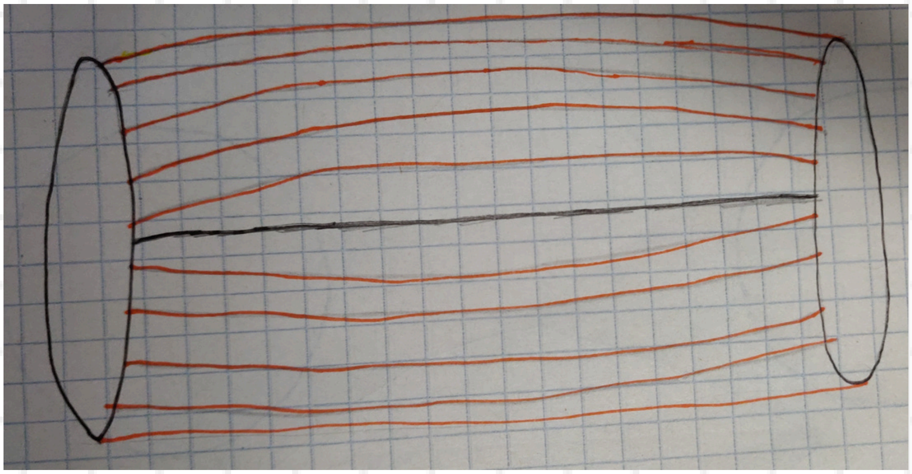
RubberBand Spinning intake

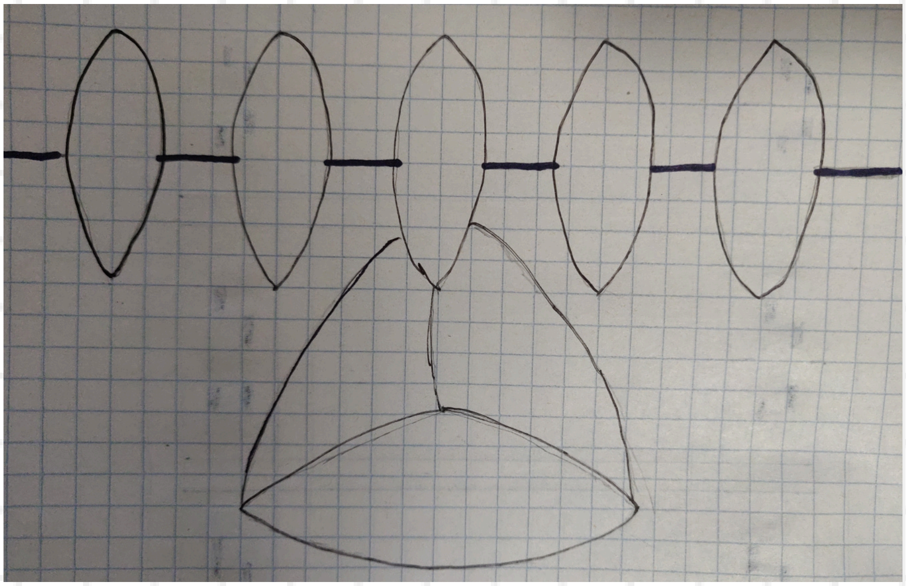
This was our next idea where we would have 2 gears spread apart with rubberbands connecting them and as those two gears spun the rubberbands would pick up the triballs and vice versa for dropping them. Many of us thought this might be a good idea.



Pros	Cons
• Fast • Easy to build	• Unreliable as rubberbands could snap

Floating Flexwheel Intake

Another idea we had was to make a floating intake made compoletly out of small flexwheels. As the triball went under flexwheels they would lift up to make space. Once the triball is in the flexwheels would drop down to secure the triballs.



Pros	Cons
• Fast • Takes up little space	• Harder to perfect the height

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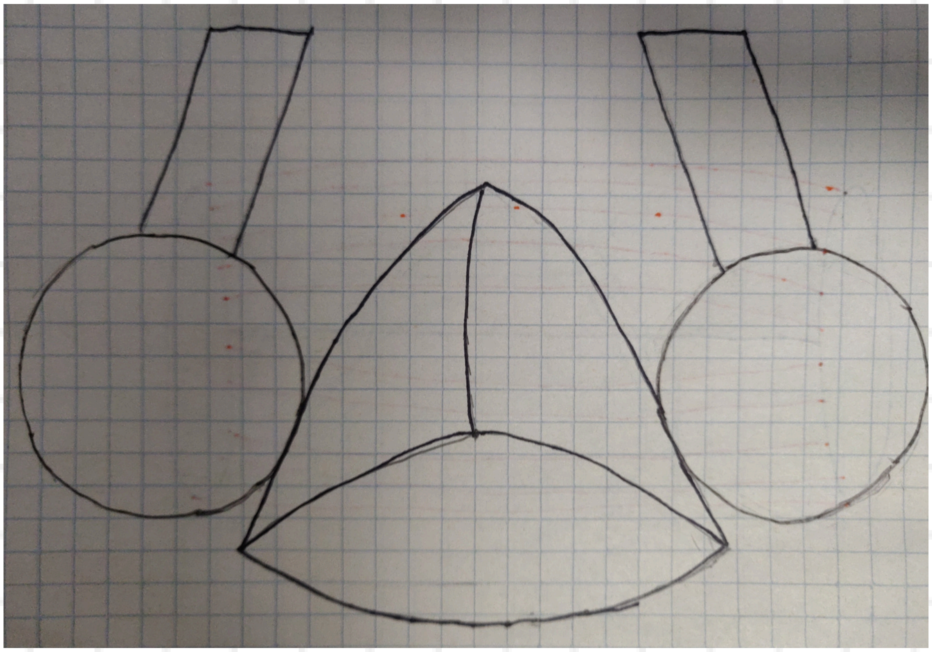
Horizontally Floating Flexwheel Intake



Our next idea was to make an intake with 2 big flexhweels that were connected to two seperate motors. As the triball went inbetween the flexwheels, they would open up horizontally allowing the triball to go in. Once it was in they would close back up with rubberbands securing the triball in place. It would be vice versa for outaking the ball.

Pros	Cons
• Fast • Easy to make • Can fit under the net to place and take out triballs.	• Takes up a lot of space

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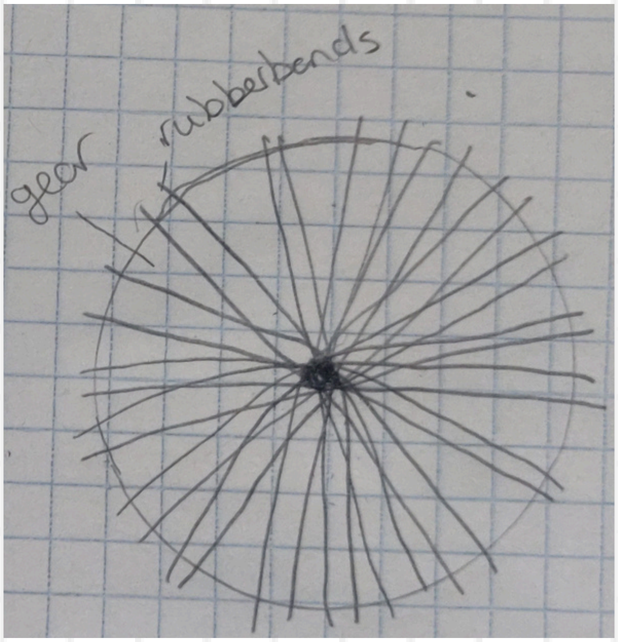
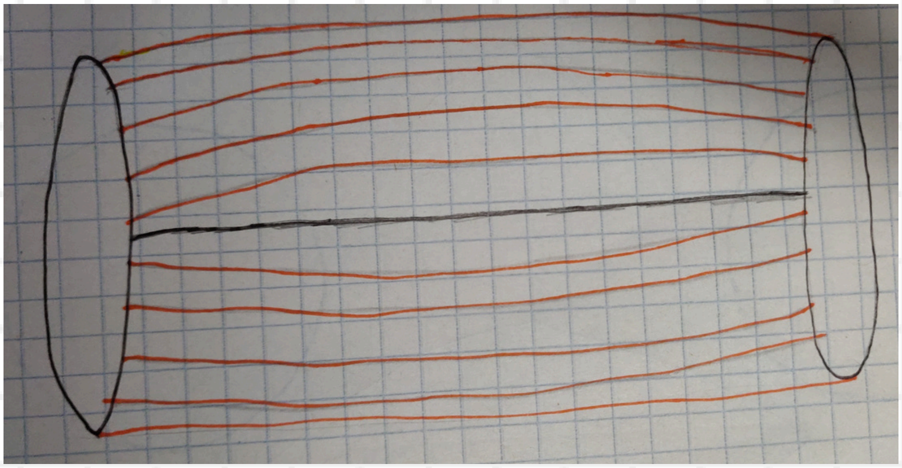
Our First Intake

Our first intake was very beneficial to us as we figured out what woudn't work, what would be hard to work with, and what would be easy to work with. Our first design was the spinning rubberband intake as we thought that this would be an easy design. Even though we were right we still changed it. Here's why. So for our first idea we went with a gear on two sides connected by an axel with rubberbands around the gear connected to the axel. Our first design looked like this:

SIDE VIEW



TOP VIEW



Pros	Cons
• Easy to make	• Hard to replace broken rubberbands • Very messy • Unpleasant to look at. • The rubberbands had to extend a lot more as they are connected from middle of the gear to the middle of the other gear.

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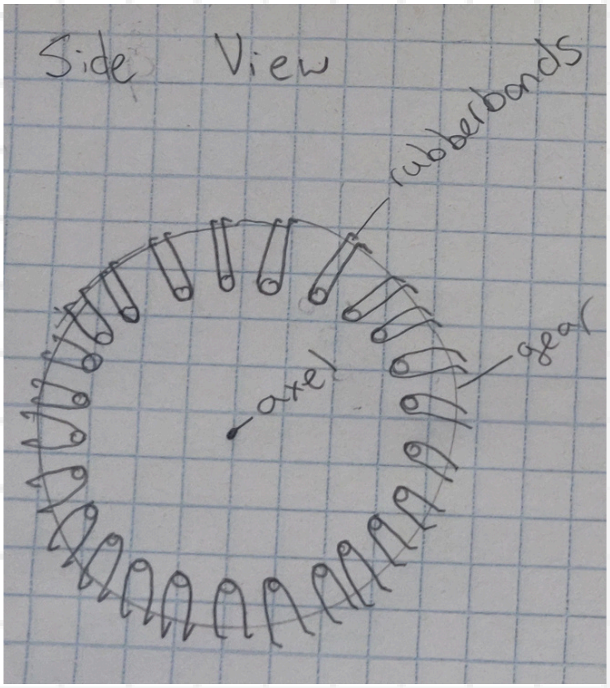
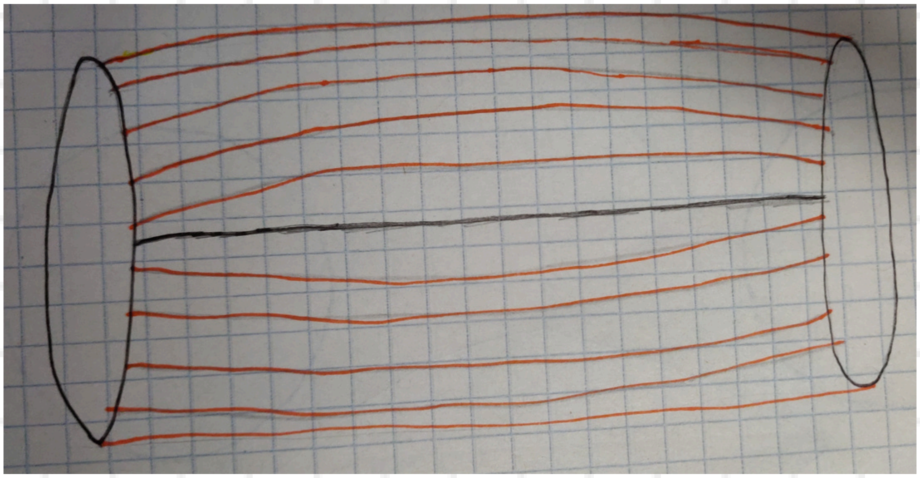
Our Semi Second Intake

We decided to change that intake from all of the rubberbands connected to the axel to having screws in the holes of the gears and connecting the rubberbands to those. This worked out a lot better for us and the design looked like this.

Side View



Top View



Pros	Cons
• Less stress on the rubberbands as they are going from outside of the gear to outside of the other gear. • Clean and organized • Pleseant to look at • Easy to replace rubberbands	• Hard to make

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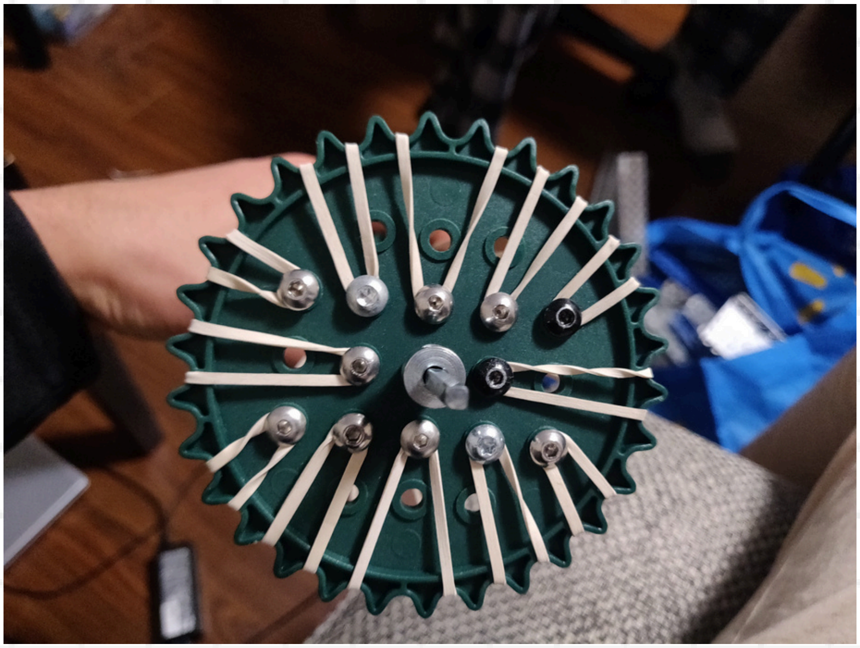
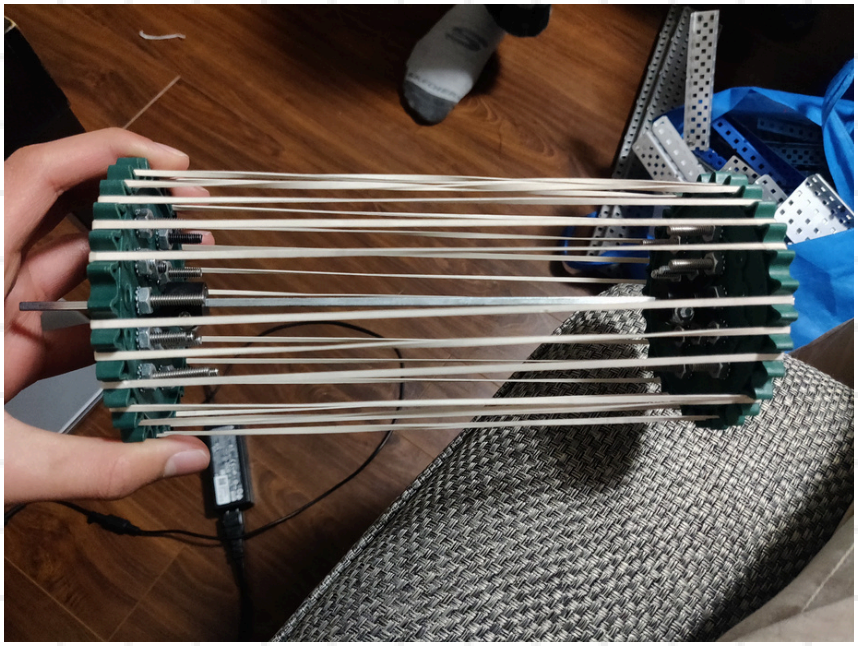
After we built this second intake we had to tweak a couple things so it differed from the design. Rather than having alot of screws with one rubberband connecting to each we less rubberbands overall but had stronger and larger ones with the screws in a line. This looked a lot cleaner and pleasent aswell. The less rubberrbands also worked better as we had more space in between rubberbands for teh triball to get stuck in.

Side View



Top View



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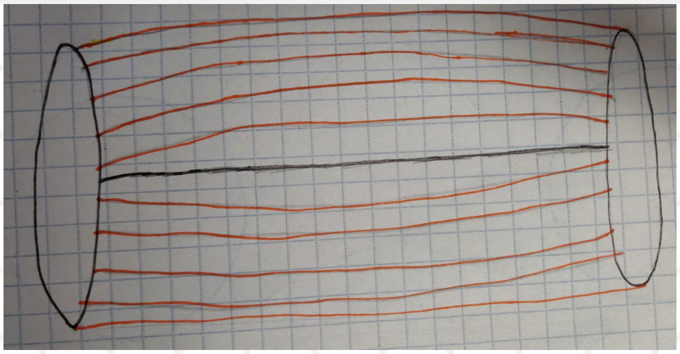
Brainstorming

Our First Launcher Ideas

Once we heard that there was only 12 triballs on the field with 24 match loads outside the field we realized we needed something to use those matchloads. Using our intake would be very slow as it would take atleast one second to get from the matchload zone to the center to drop it off, and one more second to come back. We knew that we needed something that could unload all of the triballs fast. Something like a catapult, or puncher, or flywheel design. We then started brainstorming ideas and what we came up with was a very big range.

Double Spinning Rubberband LAUNCHER

Since our first design of our spinning rubberband intake worked well, we thought that we might use the same concept for the launcher. This idea would have two spinning rubberband "intakes", one on top and one on the bottom. When the triball is placed it would just launch it.



Pros	Cons
• Fast • Easy to build	• Unreliable • Takes up a lot of space • Hard to place triballs into

25/9/2023

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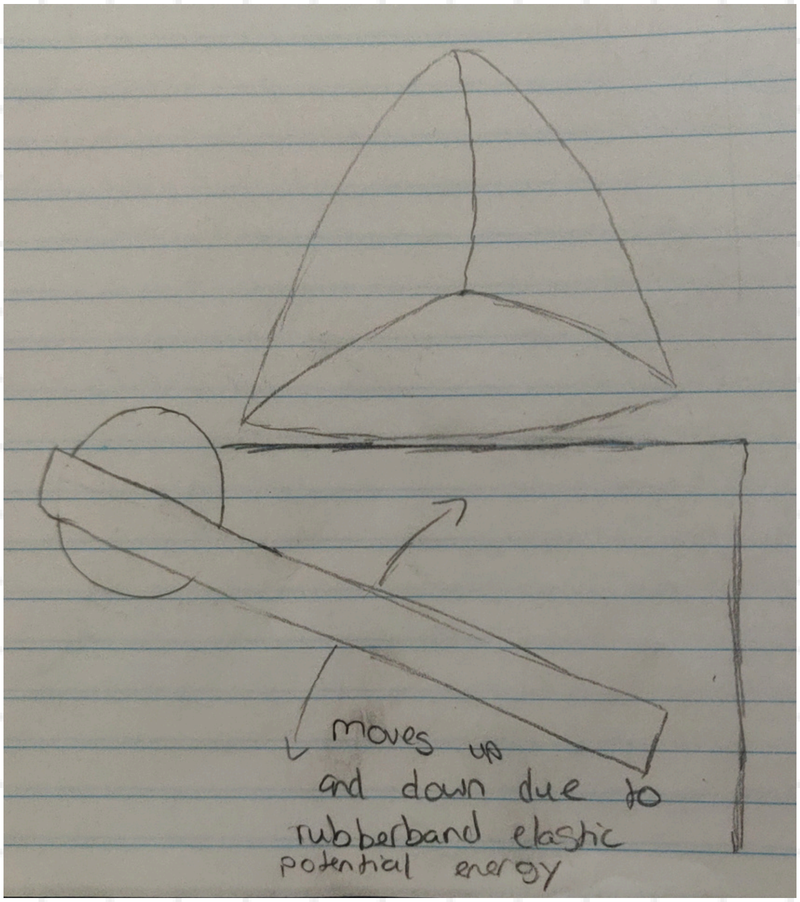
Puncher type catapult

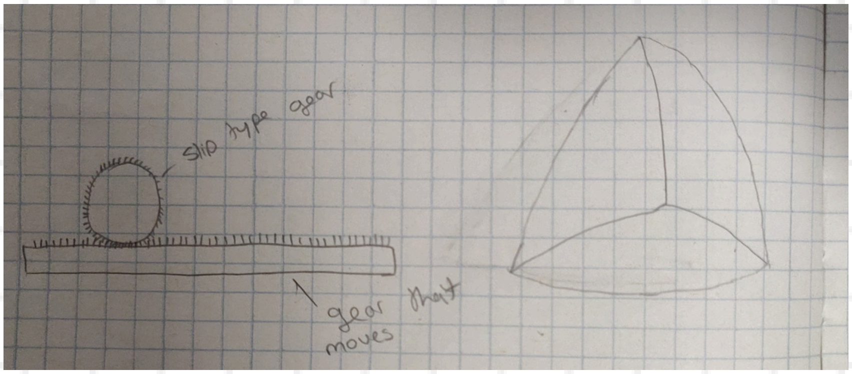
Our next idea was that we would do a puncher type catapult. This idea is bascially an elevated platform where the triball is placed. Underneath the platform is where the magic happens. There is a cutout in the platform that lets this puncher spinning in a circular motion like a catapult. This puncher punches the triball at a certain angle so it is launched. It is like a puncher and a catapult combined.



Pros	Cons
• Reliable • Fast	• Takes up a lot of space • Hard to build • Hard to place triballs

A puncher

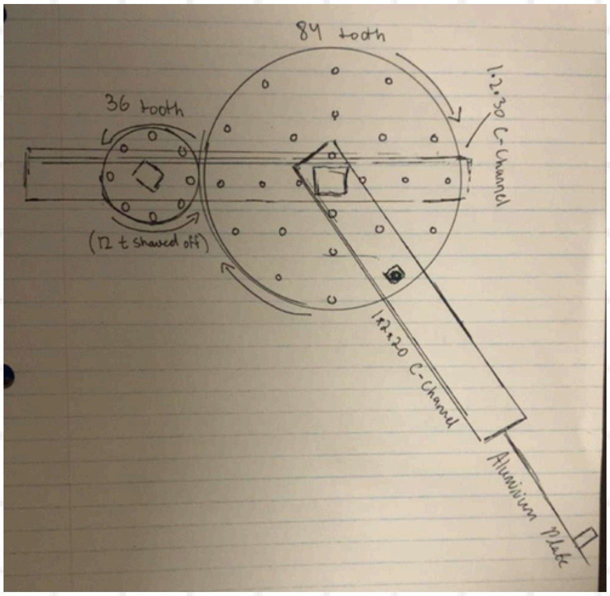
From the last idea we had teh new idea of a puncher. This was basically a horizontal arm on a slip gear powered by a motor that would punch the triball sending it very far.



Pros	Cons
• Does not take up that much space • Easy to place triballs • Fast	• Hard to perfect • Unreliable • Launches in all directions

Catapult

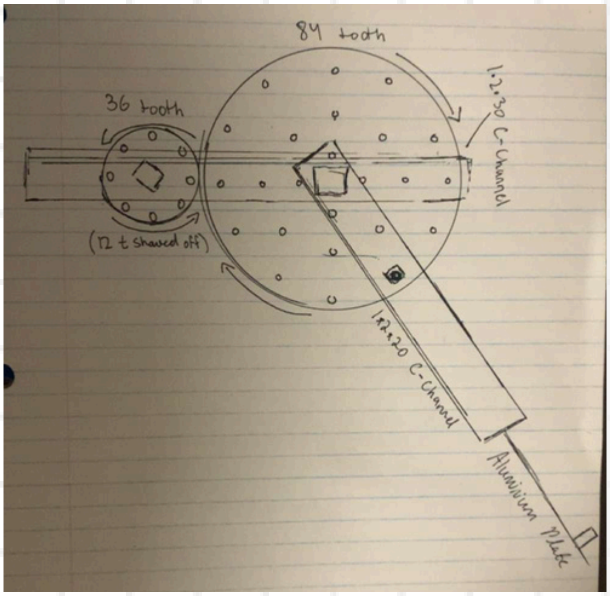
Another idea emerged from Shayans puncher type catapult. I(Shivam) realized that we can just build a catapult. This would be a slip gear powered by a motor which would spin. The catapult itself would be brought down by rubberbands.



Pros	Cons
• Easy to place triballs • Fast	• Unreliabe due to rubberbands snapping • Hard to build

Catapult with a Ratchet

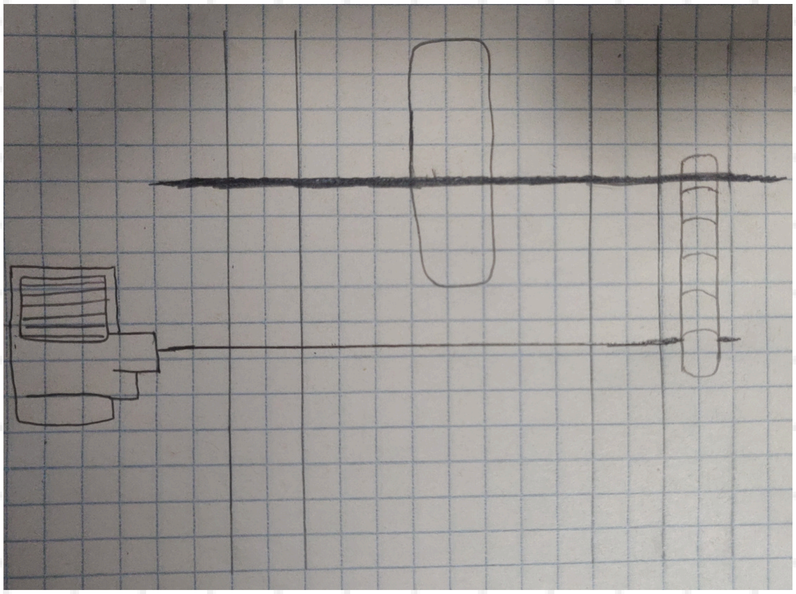
Another idea emerged from Shayans puncher type catapult. Shahmeer realized that we can just build a catapult. This would be a slip gear powered by a motor which would spin. The catapult itself would be brought down by rubberbands.



Pros	Cons
• Easy to place triballs • Fast	• Unreliabe due to rubberbands snapping • Hard to build

Vertical Flexwheel spinning Launcher

This was Shahmeers idea which came from our double flexwheel intake/outake. This is bascially two flexwheels beside each other run by two seperate blue motors which make the flywheels spin very fast. This makes the triball lauch across the barrier and onto our offensive side.



Pros	Cons
• Easy to build • Faster than any other idea	• Unreliable shot • Hard to place triballs onto

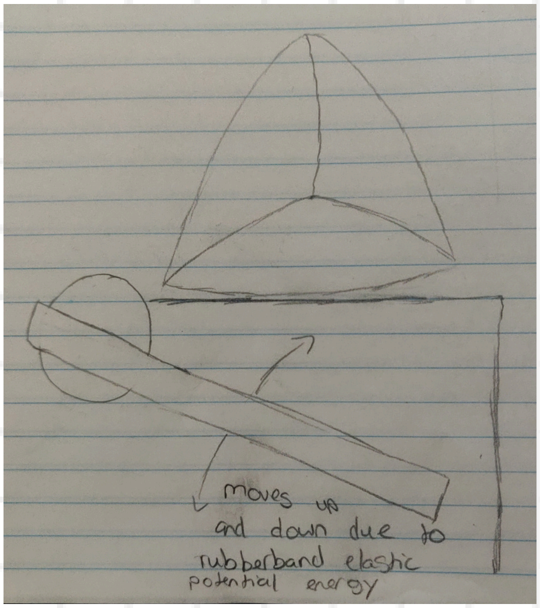
8/10/2023

Shivank

Our First Catapult

In our first catapult we wanted something that would be able to throw the matchloads quickly and effectively to the other side. We also wanted something that would be able to throw it over the barrier but not just straight at it. What we wanted was something that would be able to shoot it at a specific angle. This angle would be big enough to throw it over other robots but small enough so that it doesnt fly extremely high.

We decided to go with the puncher type catapult. This is where there is a platform where the triball is placed. This platform has a cutout where a flexwheel on a c-channel rotates and punches the triball making it launch.



Problems

One of the biggest issues that we encountered was the angle. Chaning the angle was very hard in this design as we would need to change the placement of the spinning portion and even manipluate the slip gear. If we had too low of an angle our triball would be easily countered by opposing robots. If the angle was too high this would hurt how far the triball went. We built a lot of the catapult but after encountering a lot of angle problems we decided to scrap the idea and move onto a different idea.

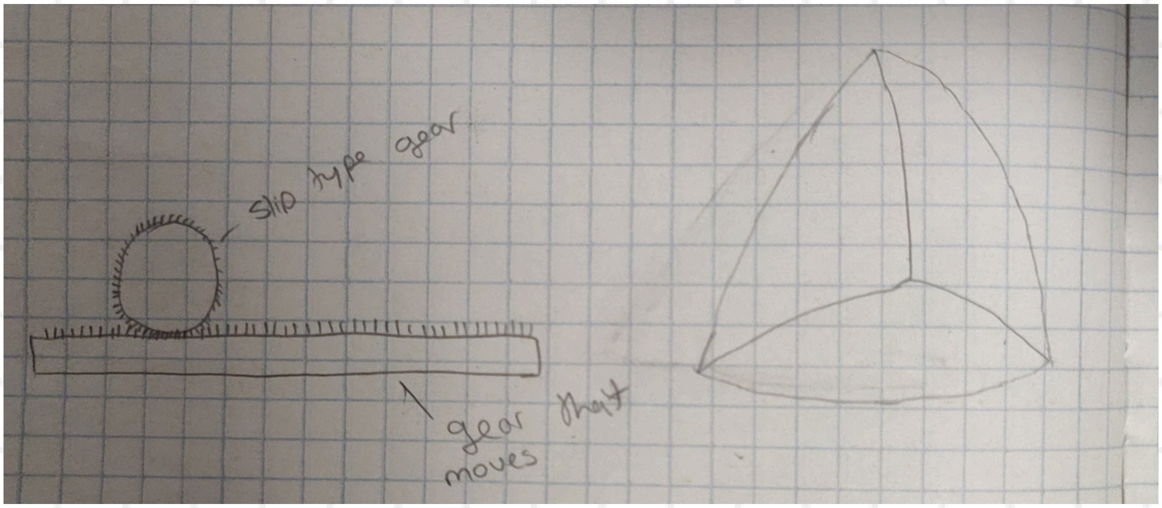
8/10/2023

Shivank

Our Second Catapult

After our first failure for a catapult we were all motivated to come up with a new, and reliable idea. This idea came from last years spin up game. For our last year robots we needed something that was able to push the discs into our shooting mechanism. This was refered to as an indexer. An indexer basically pushed the object into the shooting system. In our case we decided to make a powerful enough indexer that would be able to push the triballs onto the other side.

This design would basically use a small gear connected to a rack gear basically turning into a slip gear. The rack gear would be the gear that is moving. This movement would be the thing used to launch the triballs.



Problems

We encountered a couple problems with this idea. The first one was that it took up a lot of space. This was because to successfully pull off this idea we needed something that was elevated so the slip rack gear would have enough space to be placed without interfering with the intake. We also needed extra space for the actual triball to sit.

We got this put on but we faced another problem. It was the angle again. The problem this time was that the puncher shoots the triball straight. This means that if we don't keep the whole puncher at an angle then the triballs will very easily hit the other robots.

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Shivank

This meant that we had to angle the puncher. Desipite it already taking up a lot of space this angle made it take up a lot more space. This is because before we had it sitting above the intake but now since we need to angle it we couldn't angle it. We then had to move the whole puncher back which unfortunately made it stick out.

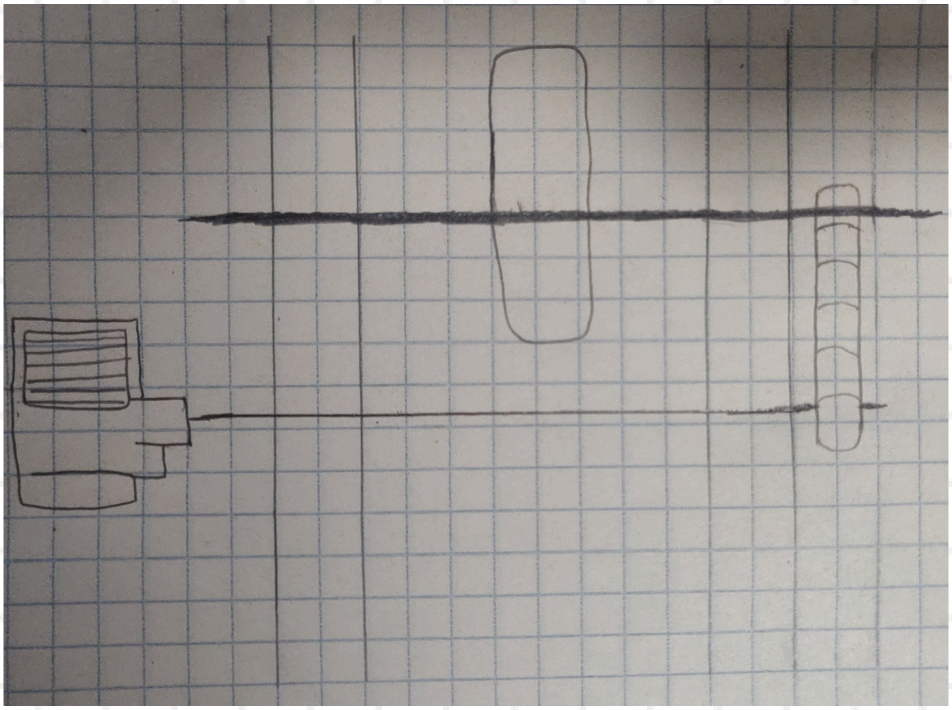
Since it was sticking out other robots could easily get caught on it disabling us or even getting us ejected. Another thing it could do was break if the other robots hit it strong enough and multiple times. This sticking out was a big stresser for us. We decided to not do this idea in the end and switch the idea again.

8/10/2023

Shivank

Our Third Catapult

After two issues with angle we were very frustrated and just wanted something that wouldn't require a specific angle. We thought of using flex wheels but not the normal way. Rather than having two flex wheels placed far apart spinning in opposite direction where the triball goes through it and gets launched. We decided to have one vertically placed flexwheel where the triballs is just placed on top and gets launched. This seemed to work well when we were testing it so we were all very happy.



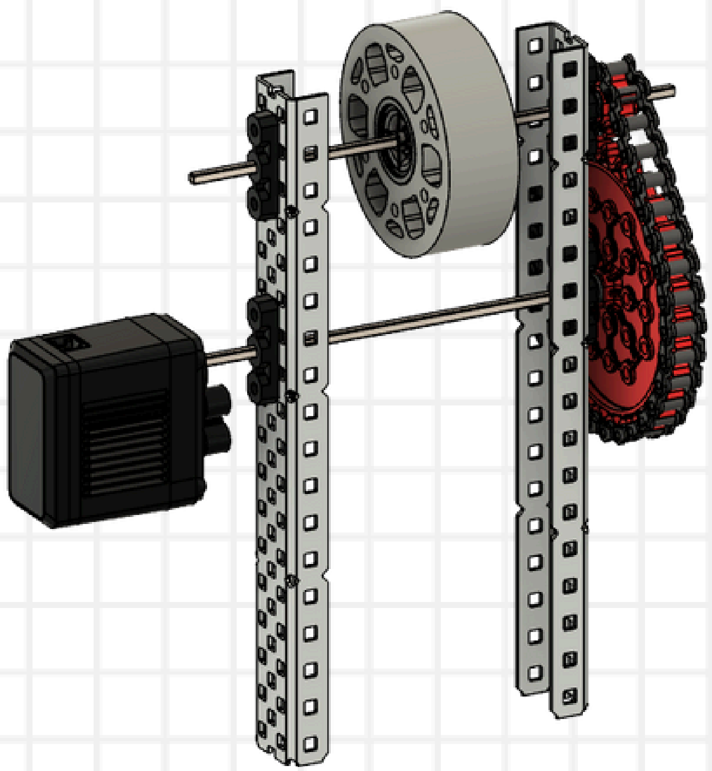
Problems

Once we connected this to the base thats when we ran into some problems. Our first problem was that it was not powerful enough. This meant that the triballs would not go over the central barrier. Even though this was an easy fix it created more problems going on.
The first problem that it created was that since it was already on a blue motor we had to change the gear ratio. We had to make the gear ratio bigger which meant more load on the motor. The load made it very inconsistent with a lot of friction so that the motor would speed up and slow down often. This was not good.
17/10/2023

Shivank

The next problem came with actaully placing the triballs on the flex wheel. If we did not have the correct angle then the triball would not go over the barrier. Often times the triball would just fall in front of the robot becuase we have to load it in a rush to make it as fast as possible.
This made the design very inconsistent and unreliable because first of the motor would speed up and slow down due to extra load becuase of the bigger gear ratio. Another reason for unreliability was that it was hard to place the triballs on the flexwheel. We tested it a total of four times and on average less than half of the triballs went over and about twenty percent of the triballs fell right in front of our robot. It looked like this:

CAD File



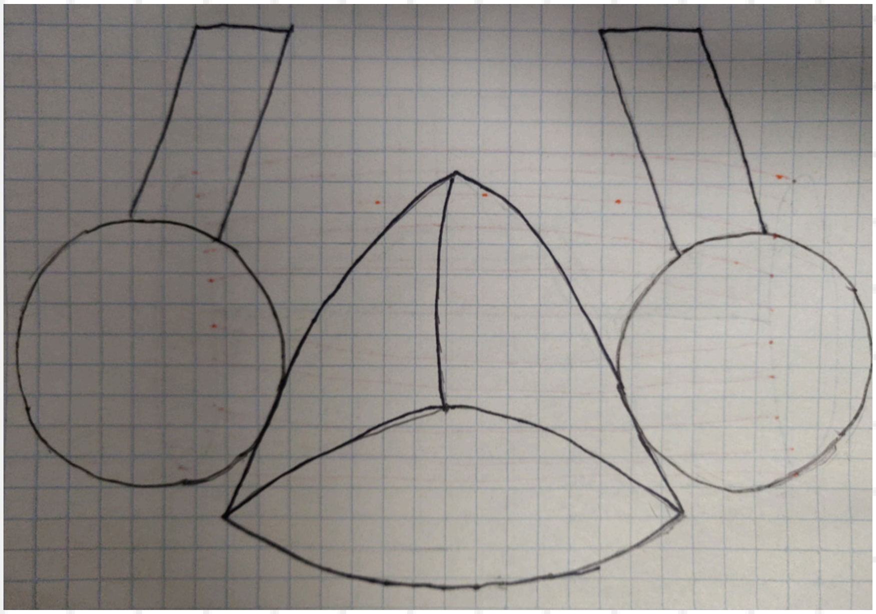
There were 2 18 long c-channels with a a flexwheel connected to the top. Both c-channels have bearing flats on both sides to reduce friction from the axel going through them. On the outside of the c-channel there was a 6 tooth gear connected by chain to a 30 tooth gear. This gave us a lot speed but due to bad design and a rushed build it slowed down a lot. Also when the triballs are placed on the low amount of torqure slowed down the flywheel a lot which caused the flywheel to fall short.

18/10/2023

Shivank

Our Second Intake

When we tested our first intake we had a big issue. The last rubberband intake would not move up which means that the triballs could get intaked but it would be very hard for them to be outaked. This was because the rubberband inake was at perfect height that it would interfere with the upper bar. This was a problem as if we outaked the triball before the net then it would take us a lot of time to drive back and push it into the net. We had to rebuild this. We decided to go with the horizontally floating flexwheel intake. This intake would be low enough so that we did not have to worry about it interfering with the bars of the net.



Problems

We had our intake sticking out a bit so we were able to take triballs out of the matchload zone. This would make us not totally useless if our teamamte does not have a catapult as right now our catapult is in progress. We decided to use 2, 3 wide c-channels for the arms to hold the flexwheels. Then we used 2, 3 inch, flex wheels as the actaul intake. Just like our base design we used screw joints to reduce friction but slightly modified it to be able to fit it onto our flex wheels. Using this screw joint method we were able to reduce the load of the motor which also reduced the chance of the motor overheating.

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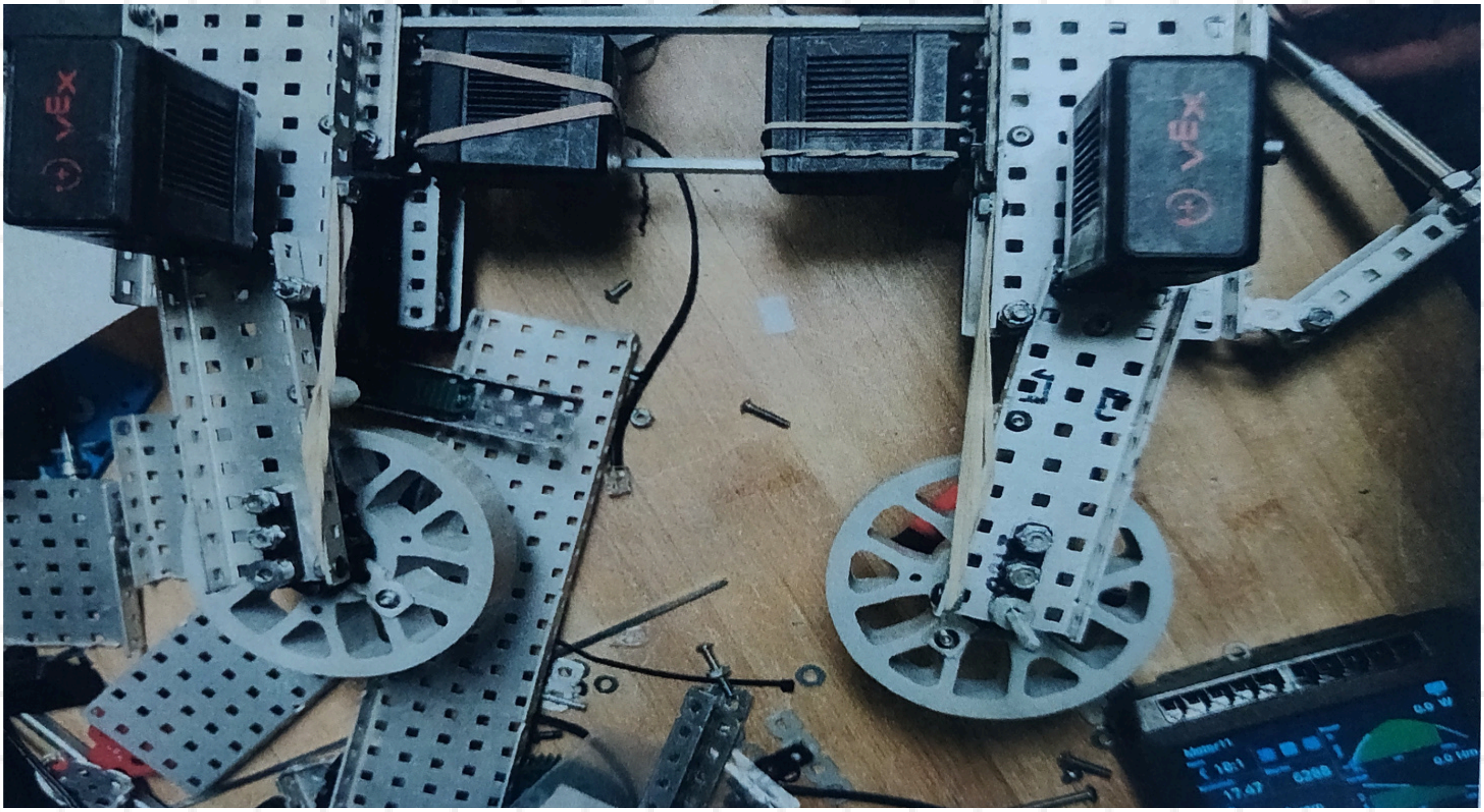
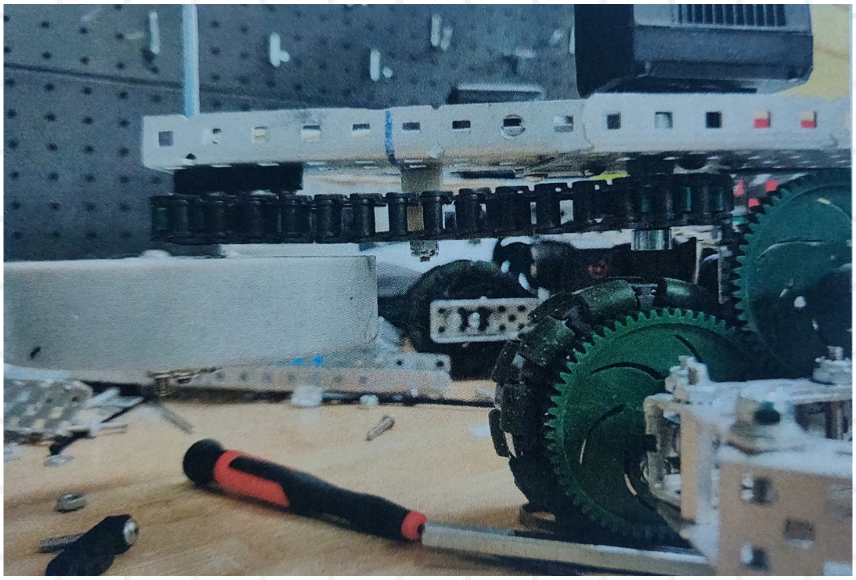
It provided us 200 rpm with a 10 rpm tolerance at its max. Our wattage was also only 0.0 to 0.3 which is really low espically when using gears and chains. We used a motor that is connecterd to a higher gear connected by chain to a smaller gear which is connected to the flexwheel. This gear ratio creates a faster spin on the intake which is good for us as we need speed not grip as the flex wheel already has grip. This design kept the intake nice and compact because it was able to expand.

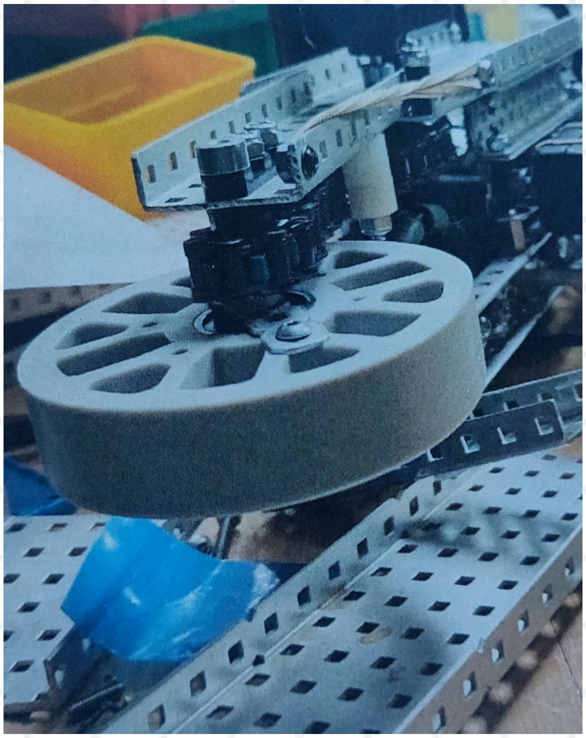


Our first problem was that once the flex wheel expanded horizontally they would not come back which is obvious. We solved this issue by putting rubberbands ocnnected to a screw on the side of the c-channel. The next issue came with chain tension. If the tension was too loose the intake would not function properly. If the intake was too tight then the chain would skip links which causes the intake to malfunction. To combat this we left the chain loose but put a 2 spacers, a screw, and a nut, which worked very well. Images below.

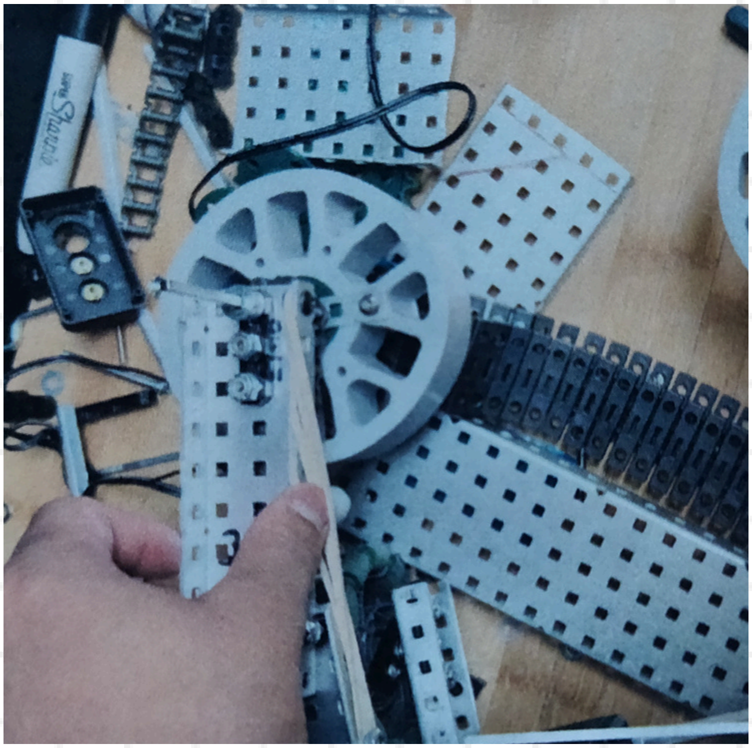
20/10/2023

Shivank

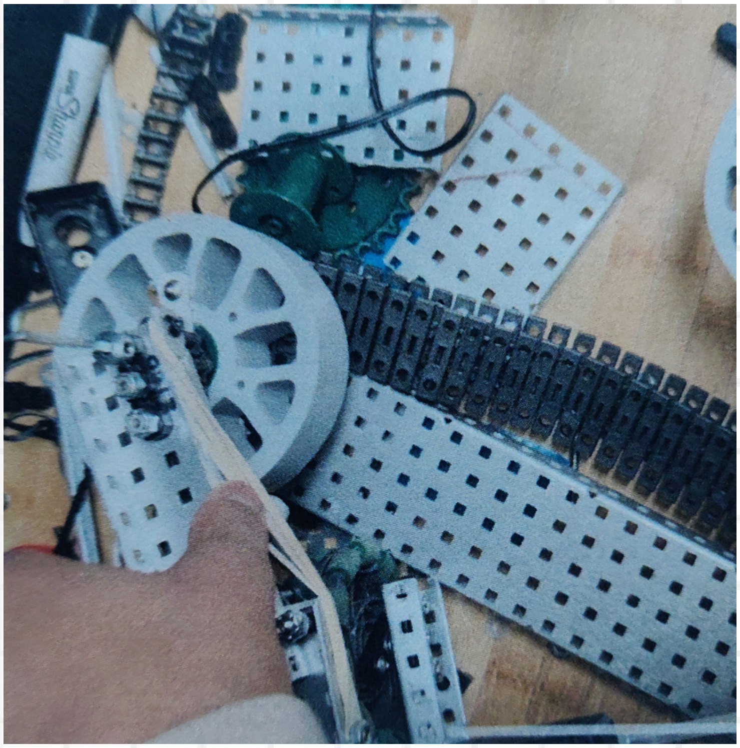




Before Expansion



After Expansion

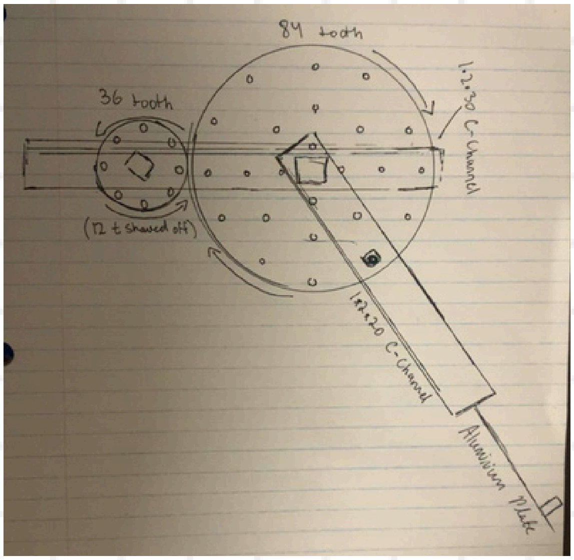


20/10/2023

Shivank

Our Fourth Catapult

This was our final catapult before our first tournament. Fun fact, this was the most northern most tournament in the whole world. Our team has always liked the classiscs. Around 400 BCE the catapult was invented. We decided to rebuild this idea but in 2023. Our last and final idea was the catapult. There were many benefits by doing this rather than doing the other ideas. First off we did not need to worry about angle in this becuase it can be easily manipulated by shaving off a couple gears on the slip gear. The next thing is for this we don't too much speed we just needed to use elastic potential energy which we got from rubberbands. This was a great idea and it has been used for thousands of years so we knew it should work.



The catapult had a total of 2 gears. One slip gear and one 84 tooth gear. The slip gear is 36 teeth with 10 shaved teeth but it was very slow so we had to shave a couple more and change it to 14 slip gear shaved. This design worked well but it still had some minor flaws. We were very close to the tournament so we decided not to change the design because it did still get it over the middle bar and while doing it at a decent speed. The speed was still low at about 1 shot per second which is not bad but it would still give us good placement during the upcoming tournament.

20/10/2023

Shivank

Speed Calculations

Speed of Catapult = RPM of Catapult X Ratio of Slip Gear

Ratio of Slip Gear = Total teeth / (Total teeth - Shaved Teeth)

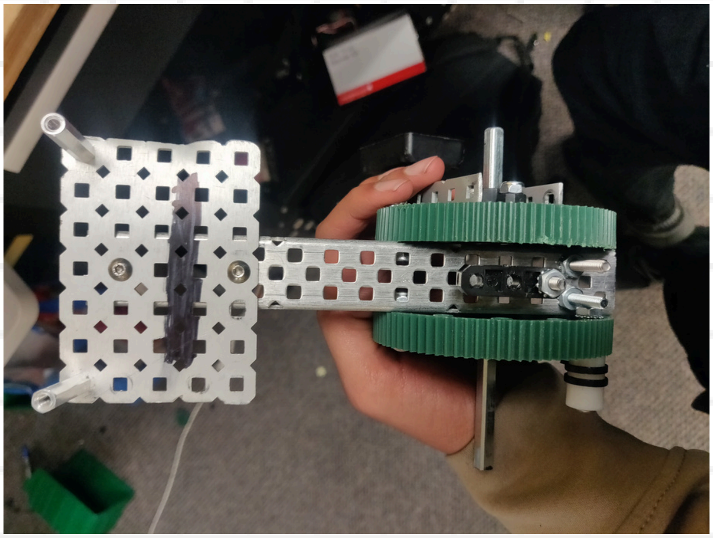
RPM = 200

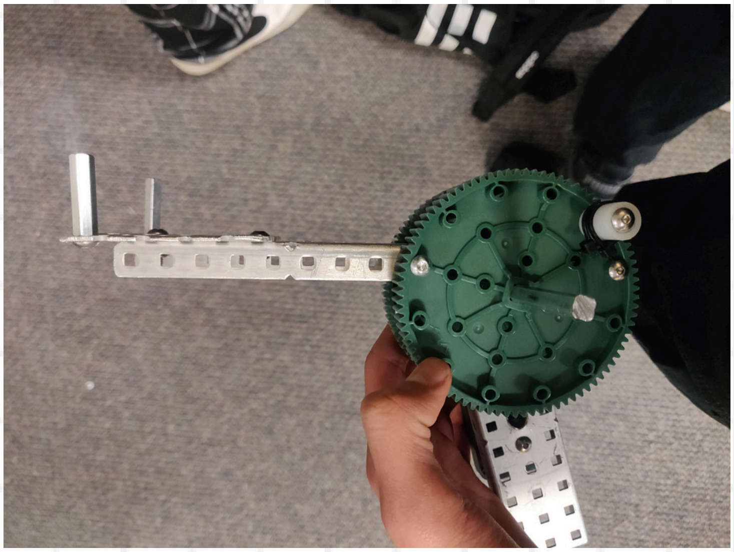
Total Teeth = 36

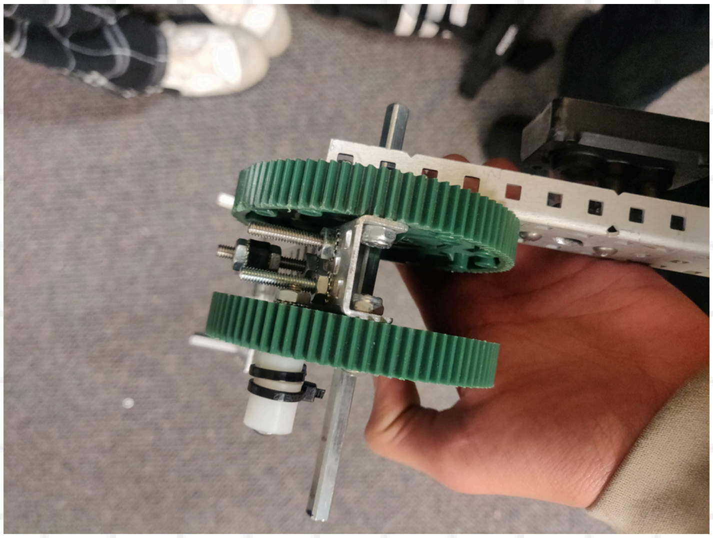
Shaved Teeth = 14

- 200x(36/(36-14))
- 200x(1.63636363636)
- 327.2727272727

= 327 shots per minute







This speed wasway too high for us to place the triballs onto catapult as there were 5.5 shots per second. This makes it nearly impossible to place the matchloads onto the catapult. We then lowered down the speed of the motor to 20 percent which is 40 rpm. This speed gave us enough time to load the matchloads while also being fast enough for us to get all of the triballs out.

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Shivank

Speed of Catapult = RPM of Catapult X Ratio of Slip Gear

Ratio of Slip Gear = Total teeth / (Total teeth - Shaved Teeth)

RPM = 40

Total Teeth = 36

Shaved Teeth = 14

- 40x(36/(36-14))
- 40x(1.63636363636)
- 65.4545454

=65 shots per minute

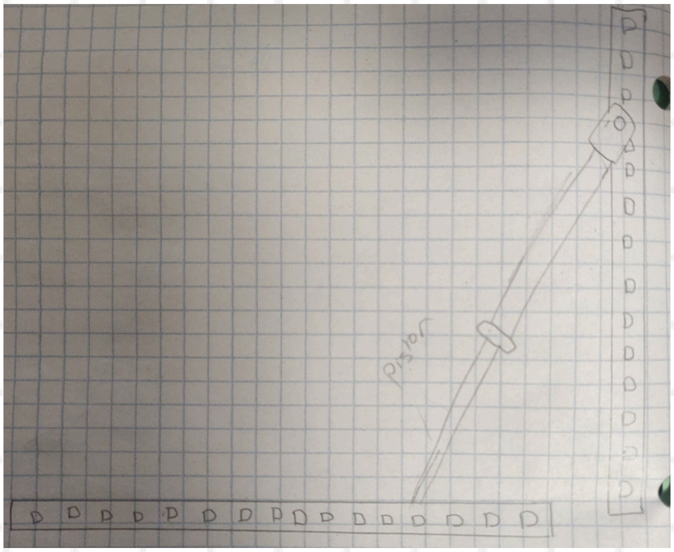
Brainstorming

Wings

When we first sawa the game we realized that just our robot would not be big enough to push many triballs in the net all at once. The maximum distance the robot can horizontally extend during the match is 36 inches total. We decided that we would build something that would extend to around 36 inches. The part that actually extends is a c-channel that gets extended by a piston.

Vertical Wings

Our first idea was to create a c-channel that sits vertically on the side of the robot. This c-channel would be connected to a piston sitting on a diagonal axis. When the piston extends the c-channel gets pushed down while keeping it under 36 inches.



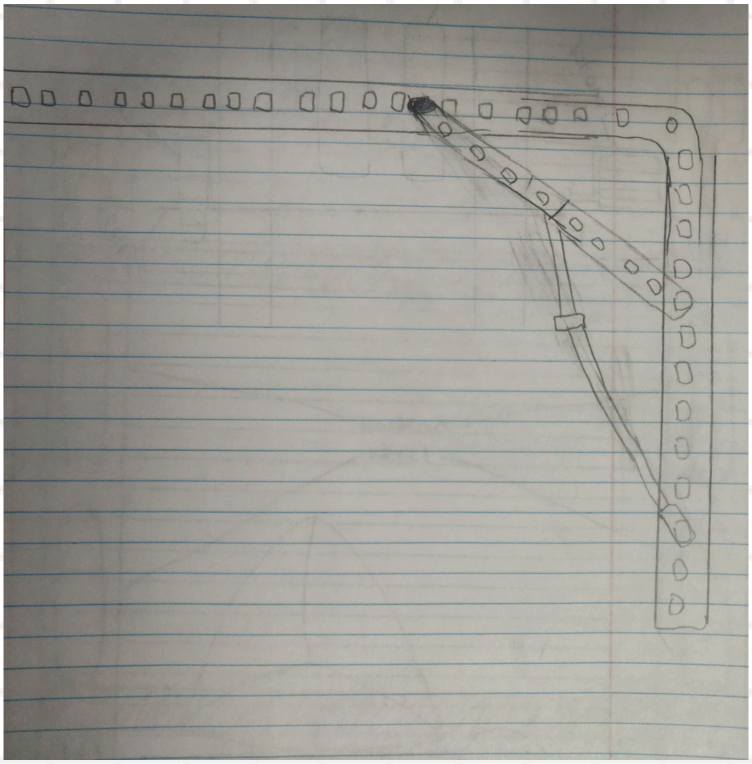
Pros	Cons
• Cannot be pushed back • Does not take up much horizontal place	• Easy to break the piston if something hard is hit. • Takes up a lot of vertical space

29/10/2023

Shivank

Horizontally locking Wings

We realized that even though the vertical wings would easily be able to break they wouldn’t be pushed back if something is pushed agasin’t it. This next idea would be the same but rather than the wings being vertical they would be horizontal. Basically there would be two one wide c-channels that would extend to be straight which would lock the wings making them not move back.



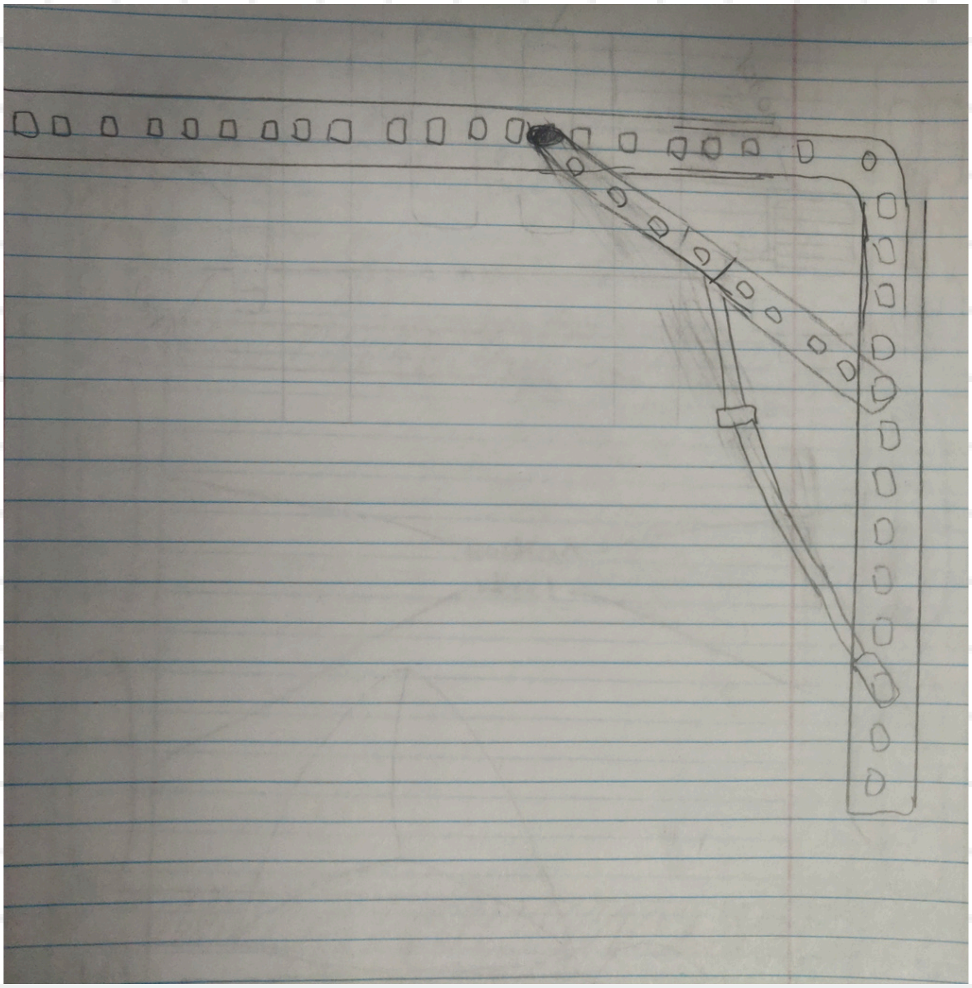
Pros	Cons
• Reliable • Locks • Strong	• Hard to build • Piston might not extend due to angle

30/10/2023

Shivank

Our First Wing

When we first made our wings we wanted something that would be strong and realible. We had two options but since we wanted something that wouldn't break our vertical wings would not work as they could break easily. We built our wings with a piston and 2 four long 1 wide metal peices. It was built like this:



When we put this idea together it looked promising and it even worked when we extended the piston by hand. But our problem came when we connected the piston to the air tank. When we did this, the piston wouldn't extend. This is because the angle was too low. We had to rebuild. We had to start brainstorming again because we did not want to do the vertical wings as they could easily break making them useless.

30/10/2023

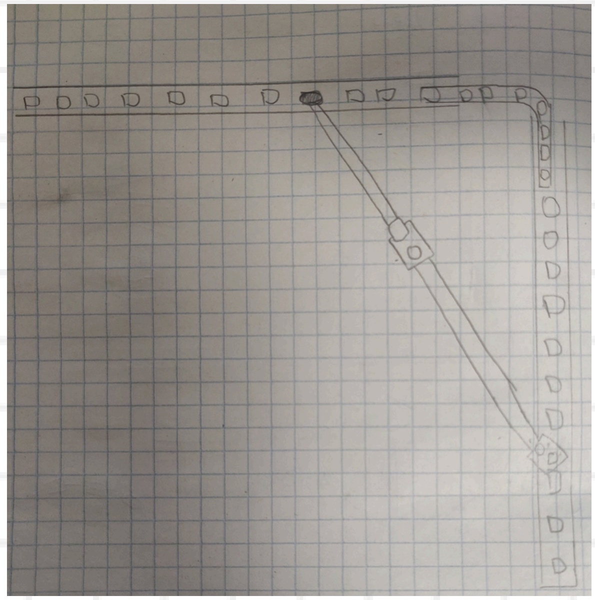
Shivank

Second Brainstorming Session

Wings

Direct Non Locking Wings

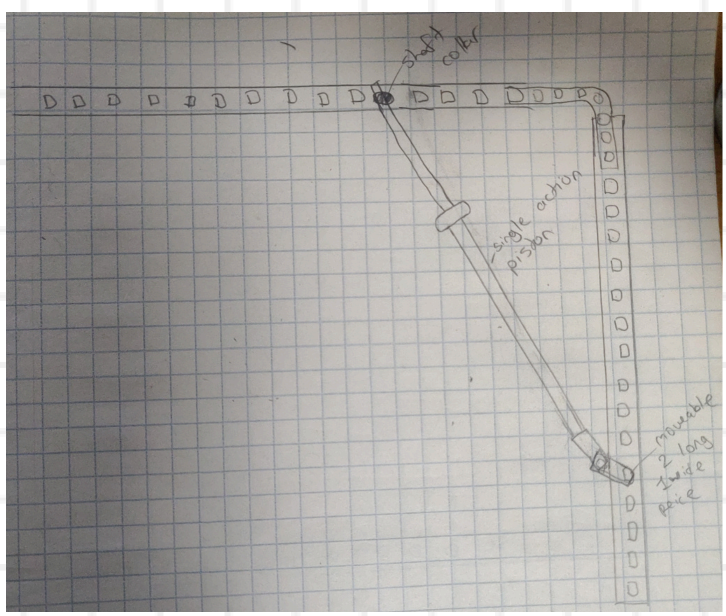
Our next idea came after our first failed idea. This was rather than having 2 one wide c-channels we would not make it locking and connected the piston via shaft collar to the c-channel itself. This would allow us to overcome the problem of angle while also giving us the ability to push wings



Pros	Cons
• Cannot be pushed back • Does not take up much horizontal place	• Easy to break the piston if something hard is hit. • Takes up a lot of vertical space

Direct Wings With Single Action Piston

Our last idea would be using a double action piston but this idea is using a single action because then we woudln't have to rely on rubberbands to retract the piston. This would be helpful because then the piston would make it stronger becuase the rubberbands wouldn't be pulling back on the piston.

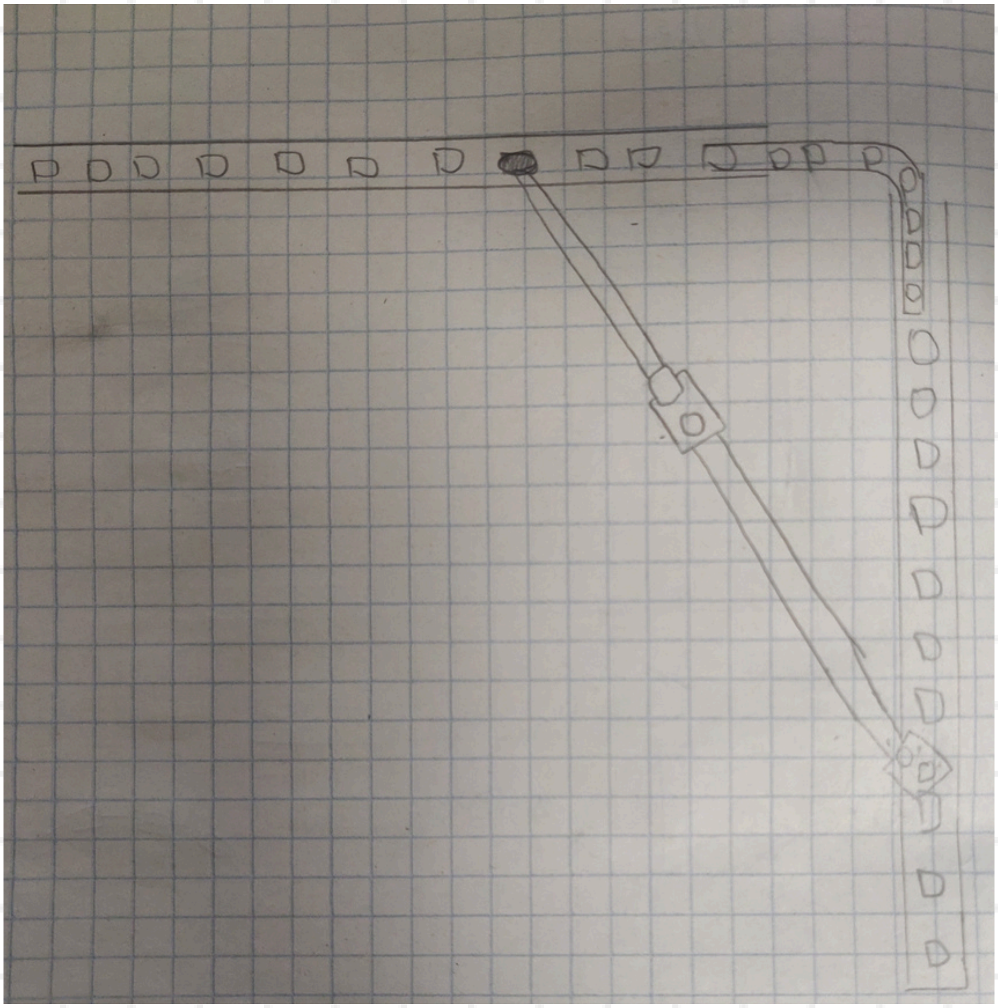


4/11/2023

Shivank

Our Second Wing

Since our last design work due to angle we decided to make direct wings. This is where there is a c-channel connected directly to a piston rather than 2 one long c-channels. This method works well because the c-channel that expands is sticking out by 3 holes which makes the angle sufficent enough to expand.



Since our last design work due to angle we decided to make direct wings. This is where there is a c-channel connected directly to a piston rather than 2 one long c-channels. This method works well because the c-channel that expands is sticking out by 3 holes which makes the angle sufficent enough to expand.

4/11/2023

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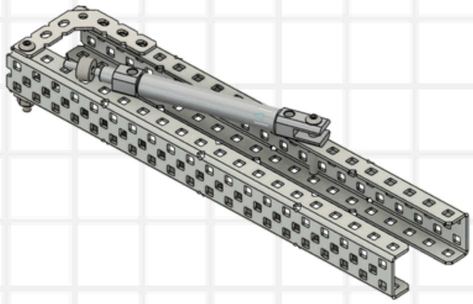
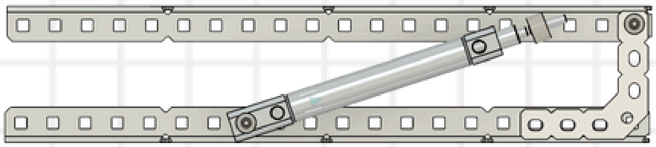
CAD Files

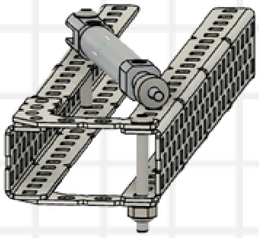
Top Angled View of Wing



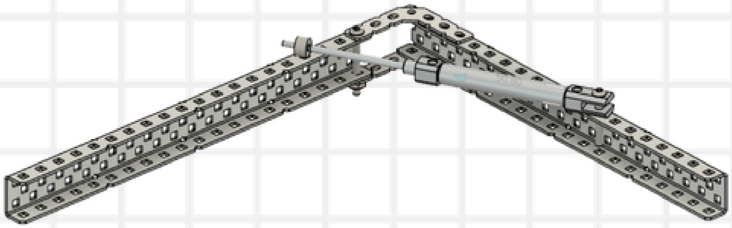
Top View of Wings



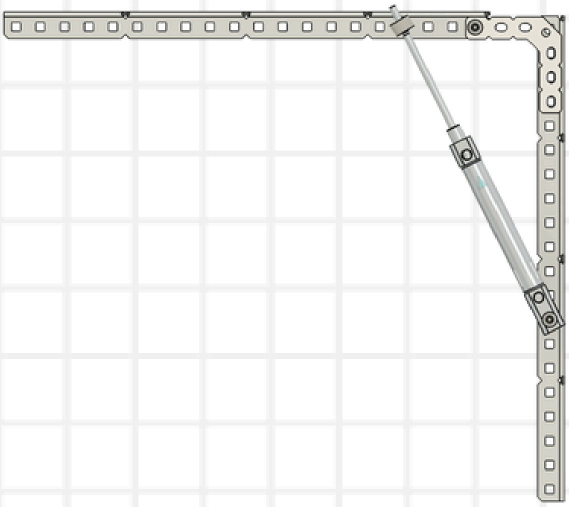
Front View of Wings



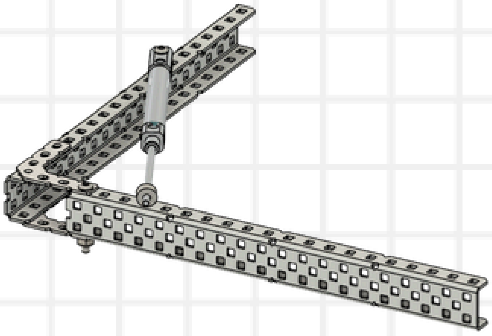
Top ANgled View of Extended Wings



Top View of Extended Wings



Front View of Extended Wings



9/11/2023

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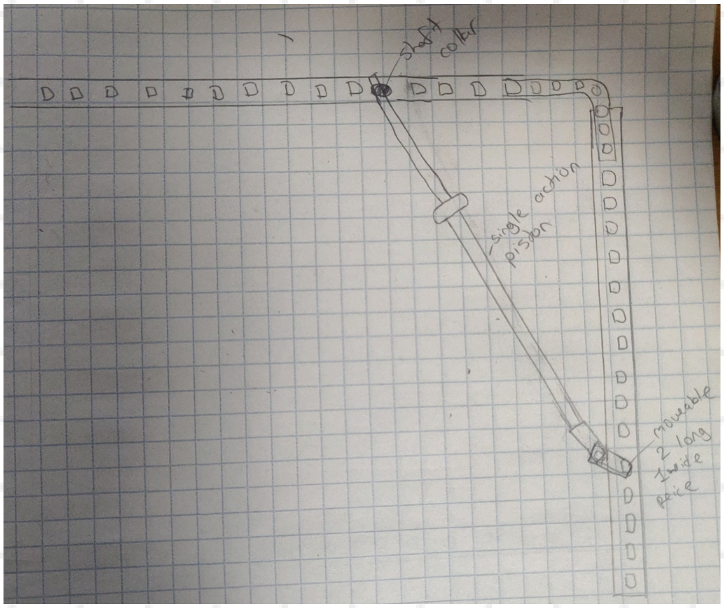
Our Third Wing

Our last design was great. It was strong, compact, and had little to no issues while being extremely reliable. Even though it was good we still did not want to work with rubberbands as they are usually hard to work with and the decrease the efficiency and power of the wing as they are going against the piston itself. This makes the piston weaker which is not good when we are pushing many triballs at once.



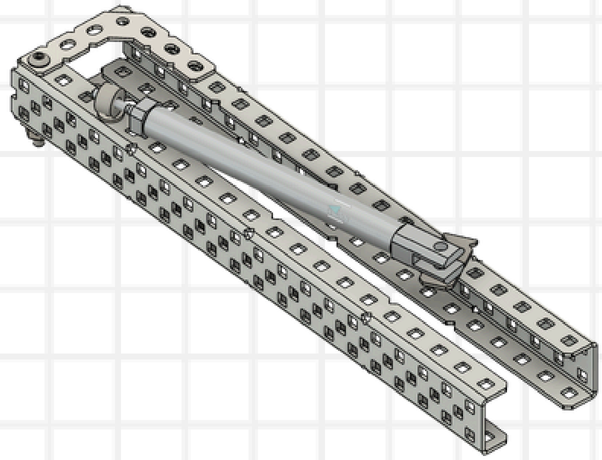
This new design was similar to the old one. It had 2 c-channels connected by an L piece gusset. On the non moving c-channel there is a piston. On the old design the piston was directly connected to the c-channel. On this design we had a flat metal bar that was 2 long and one wide connected to the c-channel. We decided to use a single action piston rather than a double action. Since the body of the single action is bigger we decided to connect the piston to the flat piece. The flat piece was free moving while the piston is still free moving but a lot tighter so it can only move a little bit. This design worked a lot better as the single action piston was much stronger and since we did not have to rely on rubberbands it gave us more strength. For the tournament we were very happy with the design and knew it would come in very handy.

10/11/2023

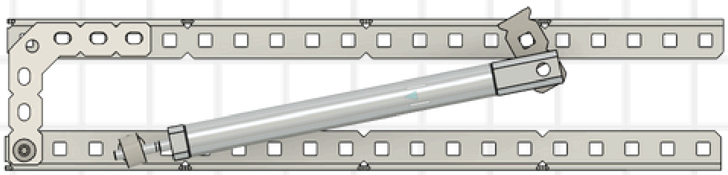
Shivank

CAD Files

Top Angled View of Wing

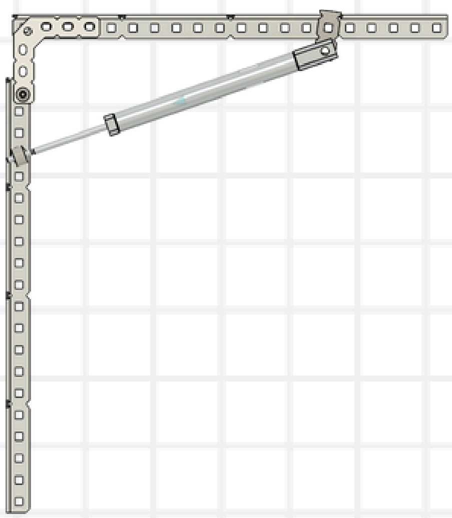


Top View of Wings

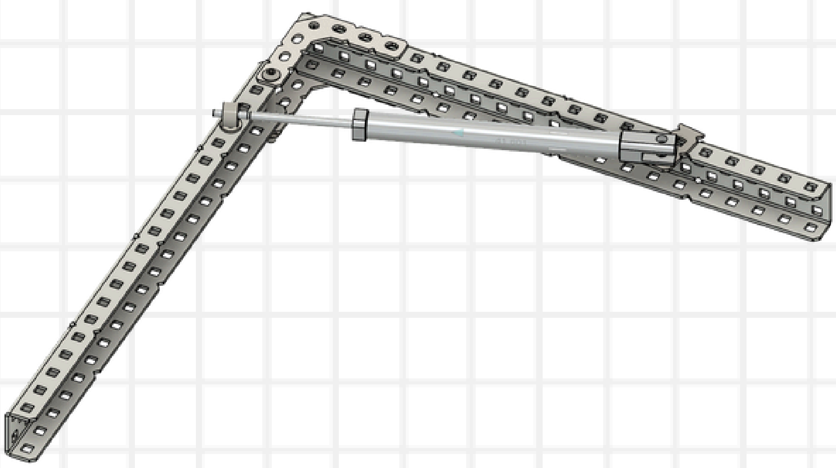


Front View of Extended Wings

Top View of Extended Wings



Top Angled View of Extended Wings



11/11/2023

Shivank

Tournament Analysis

November 25th 2023 the day that we had all been working towards. The day of the VEX Robotics Fort McMurray Regionals tournament. Fun fact, this is the most northern tournament in the world. This tournament had 16 teams coming. As we started the tournament things weren't working out that well. We had many problems.

Catapult

For many of our matches our catapult did not work because the gear had issues connecting to the slip gear because of placement. Another problem was the slip gear itself. The day before when we were thread locking everything we had taken apart the catapult in order to threadlock. During the process of putting the catapult back together we had grabbed the wrong slip gear. This gear was slipped on 2 different sides so the catapult would not extend properly. We had to create a new slip gear at the tournament to solve this problem. For a lot of the matches we had no luck in getting the catapult working.

Intake

The intake was close to perfect and maybe even one of, if not the best intakes in the whole tournament. The only issue with the intake was the chain. The chain kept falling off and in one of our matches our chain got caught up in the drivetrain making us immobile the whole round.

Wings

The wings in this tournamnet worked perfectly. They were strong enough to push multiple triballs at once without any problems. This design was good but for our next robot we want something that is stronger and maybe even locks.

27/11/2023

Shivank

Match	Red Alliance	Blue Alliance	Result
P3	86744T 221Z 62	221X 5760H 110	✗
Q4	86744A 221Z 69	86744W 221W 77	✗
Q8	86744A 221J 122	86744M 221Z 48	✗
Q12	221A 221Z 48	221X 5760A 109	✗
Q16	86744T 86744W 45	221Z 86744F 39	✓
Q18	221Z 5760H 103	50865A 86744F 48	✓
QF4	5760H 221Z 112	221A 86744W 52	✓
SF2	221J 221W 104	5760H 221Z 135	✓
Final	221X 5760A 104	5760H 221Z 92	✗

27/11/2023

Shivank

As you can see we did not have the best start. Our catapult did not work for the first couple games which made us loose them as our alliance did not have a catapult either. This makes us useless after the first couple triballs are put into the net. Once we got a teammate with a good catapult we did very good. The team with the catapult was “5760H”. This team had a great catapult and we had a great intake which gave us an upperhand over the other teams. This proved that for the next tournaments we need a catapult that works well. This is because any team can just push a triball into the net but not many teams can shoot matchloads. Our intake was also one that we wanted to change. This is because when we outake the flexwheels themselves would collide with the top of the net not allowing us to push the triballs in smoothly. We had to outake the triball move it back and push it into the net. This took a lot of time off which we could have been using for other things. The improvement on the wings would be one of the last things that we do. This is because our wings were good and pretty strong after making the change to the single action piston. We decided that we would turn our single action piston to a locking pistson with 2 standoffs which we will explain later. The driveterian is soemthing that we wanted to change immediately, this is becuase the driverterain was very slow. Even though there was little to no friciton. We did not have any speed. The robot was very slow which prevented us from traversing over the field. Another problem was that since all of the wheels were omni and no traction wheels we did not have anything preventing us from getting shot accross the field if we ever get hit from the side. This little to no traction also gave us another problem. This was that the robot could not go over the center pipe which makes us loose a lot of time as we have to go around to the side of the field and then go around to the net.

27/11/2023

Shivank

The Great Rebuild

After our 5 point loss at regionials we were devestated. We had done so well at the touranmetn but we only did good when we were relying on our teammate. We were very keen on making a good catapult while also having a proper intake. This changed our strategy.
Rather than having a mix of both we decided to mainly focus on building a catapult. We decided go fully offensive with a good catapult so we wouldn't have to rely on others.

12/12/2023

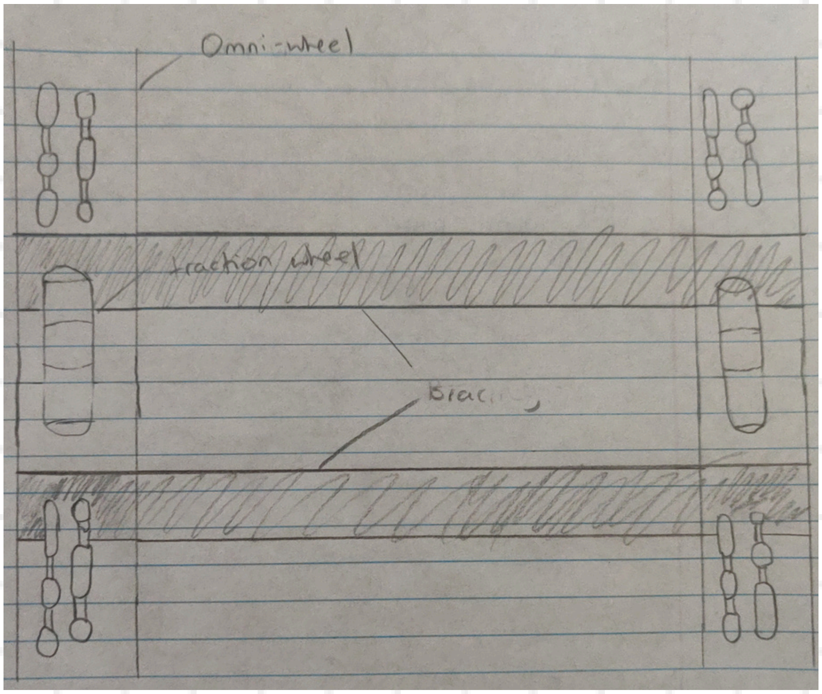
Shivank

Our New Base

When thinking about our new base we wanted something that wouldn't get builled on the court due to little traction while still being able to go over the center pipe. Another thing that we wanted was to make the base have a gear ratio so we could have more speed than last time. On our old base we had a one to one gear ratio making the robot slow. We now need less torque because we wanted atleast one set of traction wheels on our robot. This traction can be a replacement on the extra power genearted by the one to one gear ratio. We started brainstorming again.

1/3 Traction Wheels

This design is one that we thought was a good idea. The idea here is that we would use our old 3 wheels on each side design but replace the center wheel with a traction wheel. This would be better than our old base as we would be able to climb over the center pipe while also not getting pushed when our robot gets hit from the side.



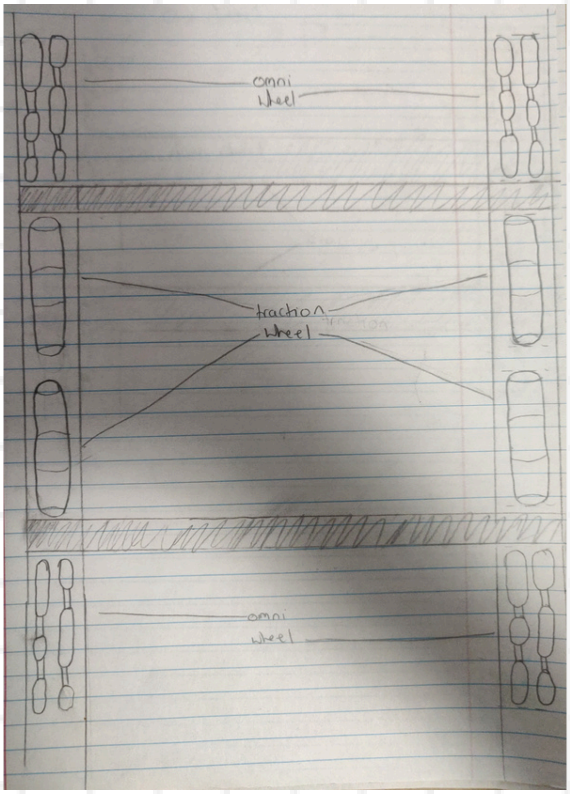
Pros	Cons
• Cannot be pushed • Does not take up much space	• Small base for us to work with

12/12/2023

Shivank

1/2 Traction Wheels

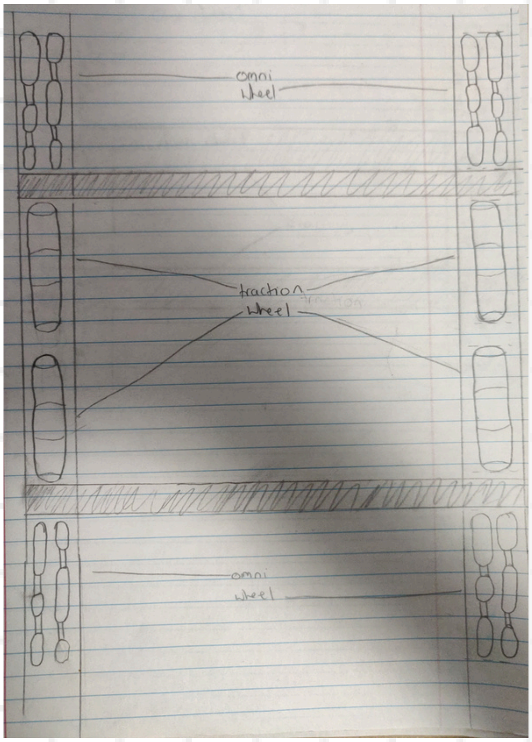
This design was similar to the last one but rather than one set of traction wheels in the middle we would have two traction wheel sets in the middle. This also means that we would have four total sets of wheels. Two sets of omni wheels on the outside with two sets of traction wheels between them. This design would provide us with more space to work with.



Pros	Cons
• Cannot be pushed • Gives us a lot of space to work with	• Harder to build

1/2 Traction Wheels With 6 motors

This design would be the same as the last design but instead of having 4 motors we would have 6 motors total. This would mean that we would only have two motors for catapult and intake. We knew that we could somehow work around that. 6 motors would also make our robot faster and also give us more power.



14/12/2023

Shivank

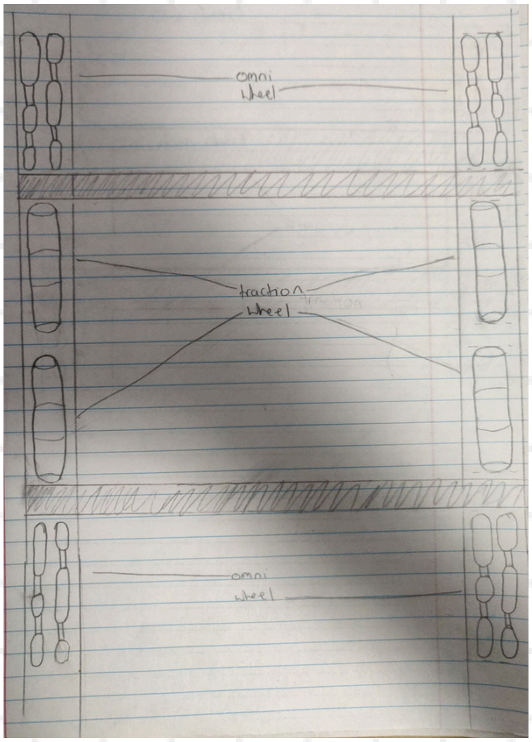
Pros	Cons
• Cannot be pushed • Gives us a lot of space to work with • More speed	• Harder to build

14/12/2023

Shivank

Our New Base

We decided to go with the 1/2 traction with 6 motors. We decided to go with this design as this would give us the most power whiel also giving us a lot of speed. Another thing that this base would be good for is that we would not move if we ever get hit from the side. It would also give us the ability to go over the center pipe reducing the time to go from one side to the other side of the field. We also decided to reuse screw joints to make the base have as little friction as possible.



We had the motor connected to a 36 tooth gear through an axel. This 36 tooth gear was connnected to a 60 tooth gear. The 60 tooth gear was the one with the omni-wheel connected to it which was connected by screw joint. Like our last design this would reduce our friction by a lot. This was for the bottom and top wheels. For our middle traction wheels we had a simialr design but instead we had the gears connected to two traction wheels rather than an omni-wheel which was also by screw joint.

16/12/2023

Shivank

We decided to run blue motors on all of the wheels because we just needed speed and little torque as we had the traction wheels to climb over the center pipe. We decided to run it at full speed so we can get the most power.

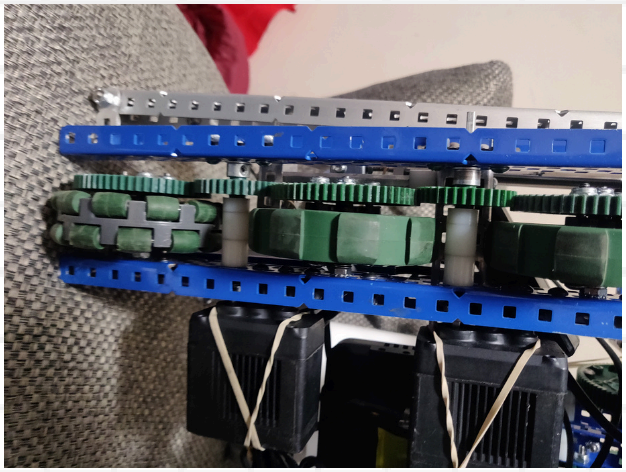
Speed of wheels - RPM of motor X (gear ratio)

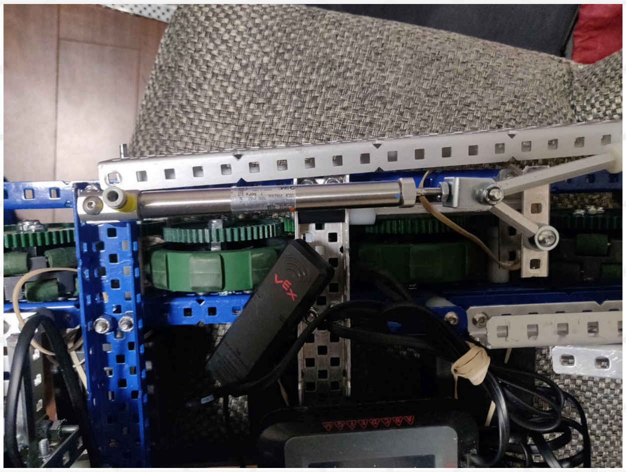
= 600 X(36/60)

= 600 X 0.6

= 360

This means that the wheels are spinning at 360 rpm.





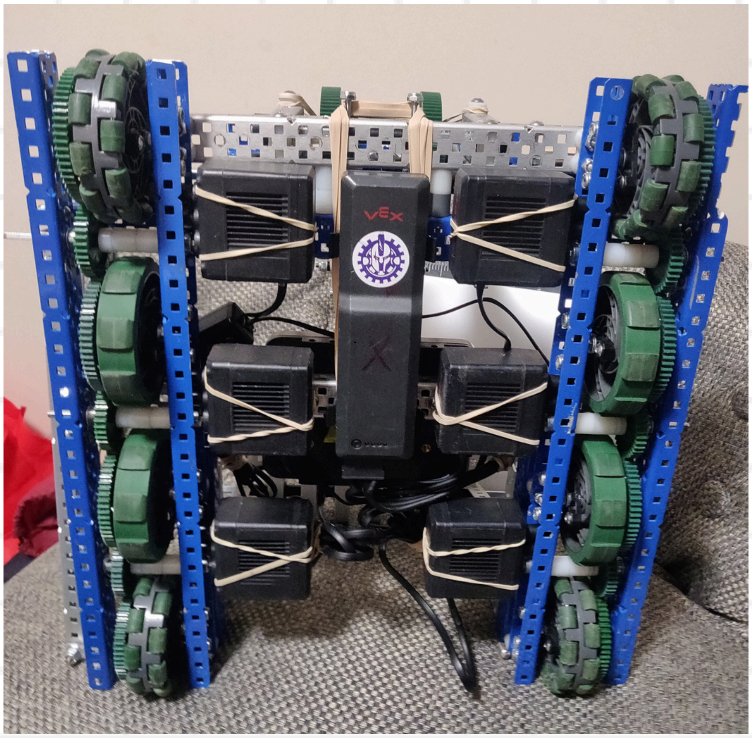
We also connected the motors to the 36 tooth gear. We did this so we would be able to connect the gear between two wheels. This would give us a little bit of extra space when we connected the motor. This is because the motors would be as close as possible giving us extra space in the front and back for our intake and catapult.

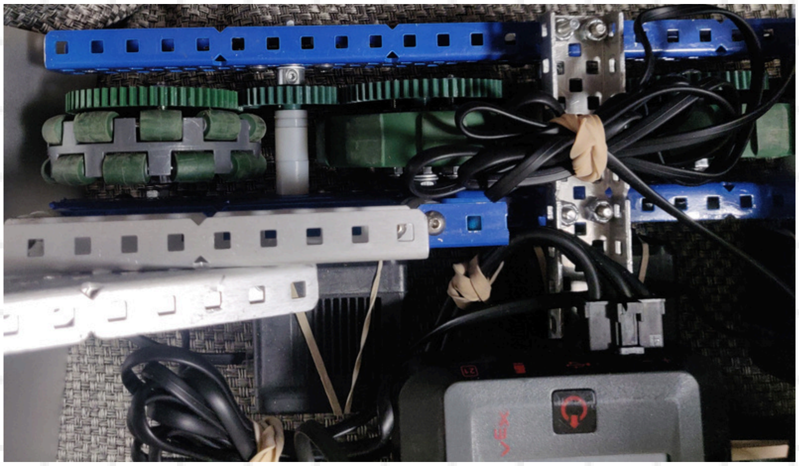
In terms of battery placement we placed it on the bottom of our robot where the two sides of the bases are connected. This would make it so that the battery wouldn't get knocked out if we ever got hit. This also didn't interfere with going over the center pipe so it was a great placement.

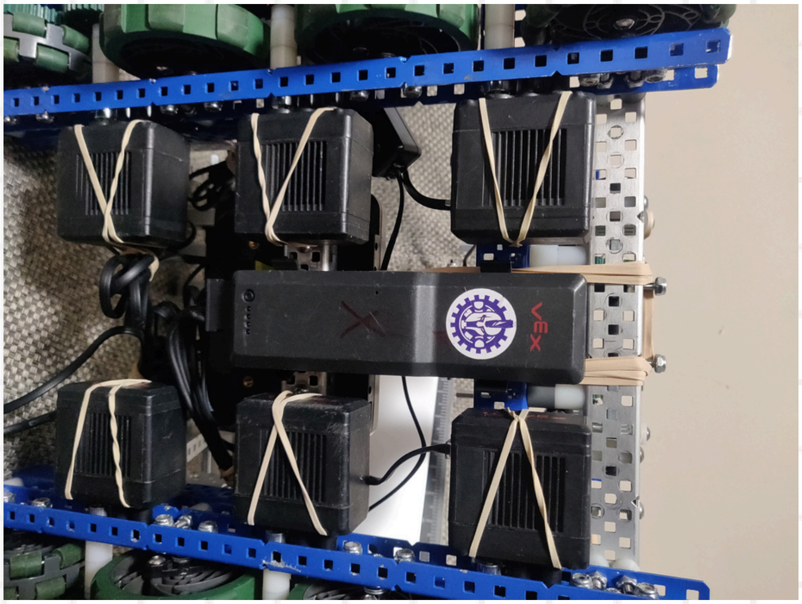
17/12/2023

Shivank

Images







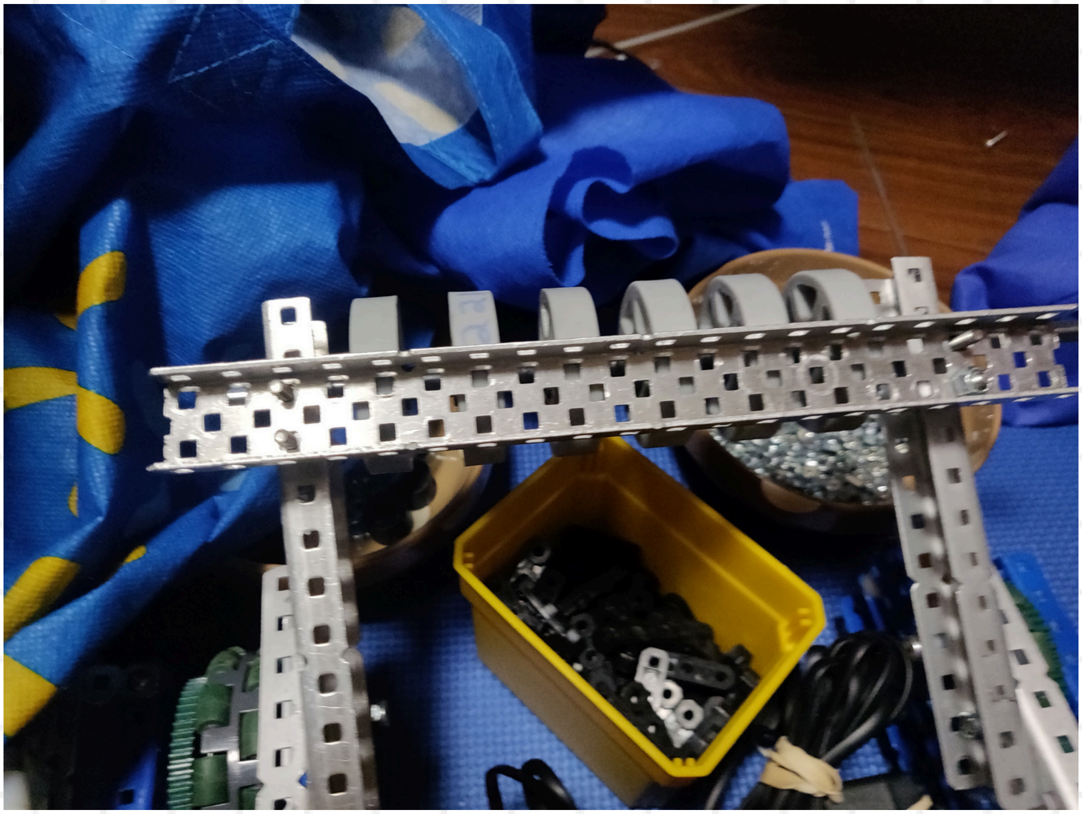
22/12/2023

Shivank

Our New Intake

Even though our last intake was amazing it did take time to put the triball into the net as we had to move back and then push the triball in. This caused us to loose a lot of time so we had to rethink our intake ideas. From our previous brainstorming session we thought that the vertical floating intake would be the best fit.

This intake would have a lot of difficulties to overcome. The first one is that when we hit the net the intake would have to get pushed above the net in order for us to push the triball into the net in one sweep rather than having to move back and push it into the net. We would have to find the perfect height otherwise the triball would not be able to get pushed into the net. We used 6, 30a flexwheels and used a high strength shaft to connect them. The reason we did this was because if we used regular low strength shaft then the axel might bend and cause an issue during the match. Another problem that we had was making

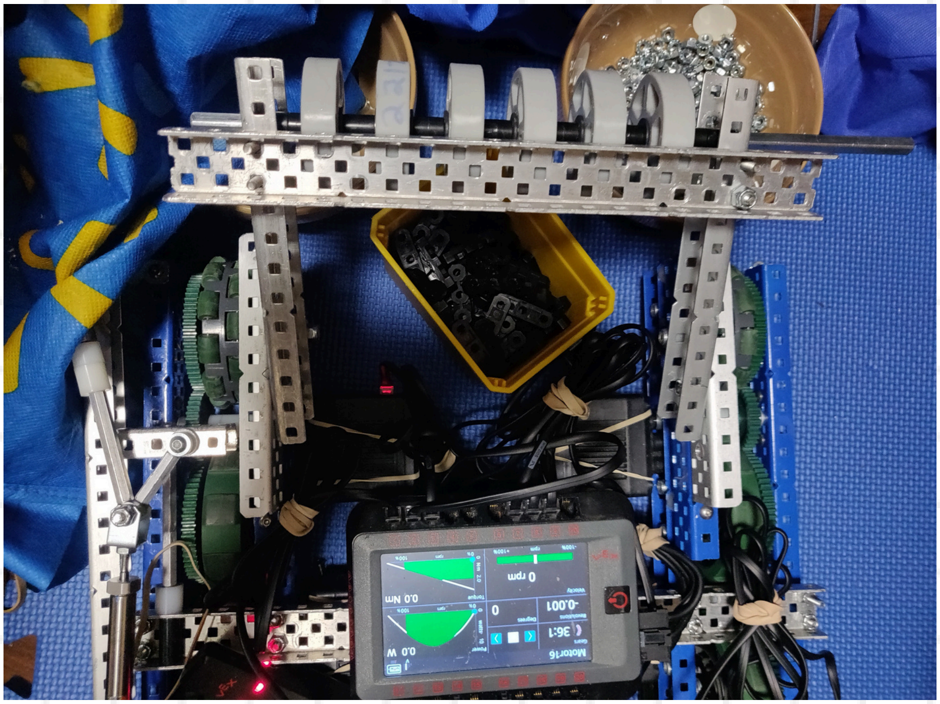


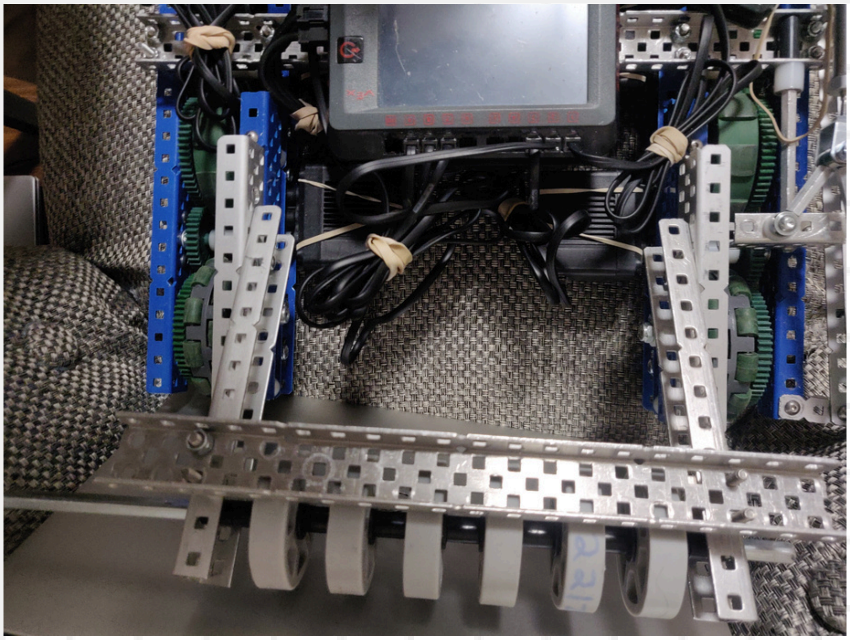
22/12/2023

Shivank

Bracing

For our bracing to attach the intake we decided to use a screw joint at the bottom of the c-channel and connected it to a horizontal immovable c-channel. To prevent it from going all the way down we also had a standoff placed at just at the right hole to prevent it from going all the way down and putting it in its resting position. We also put a c-channel connecting the sides which also gave us a little bit of more support which gave us the peice of mind knowing that it was going to be stable.





30/12/2023

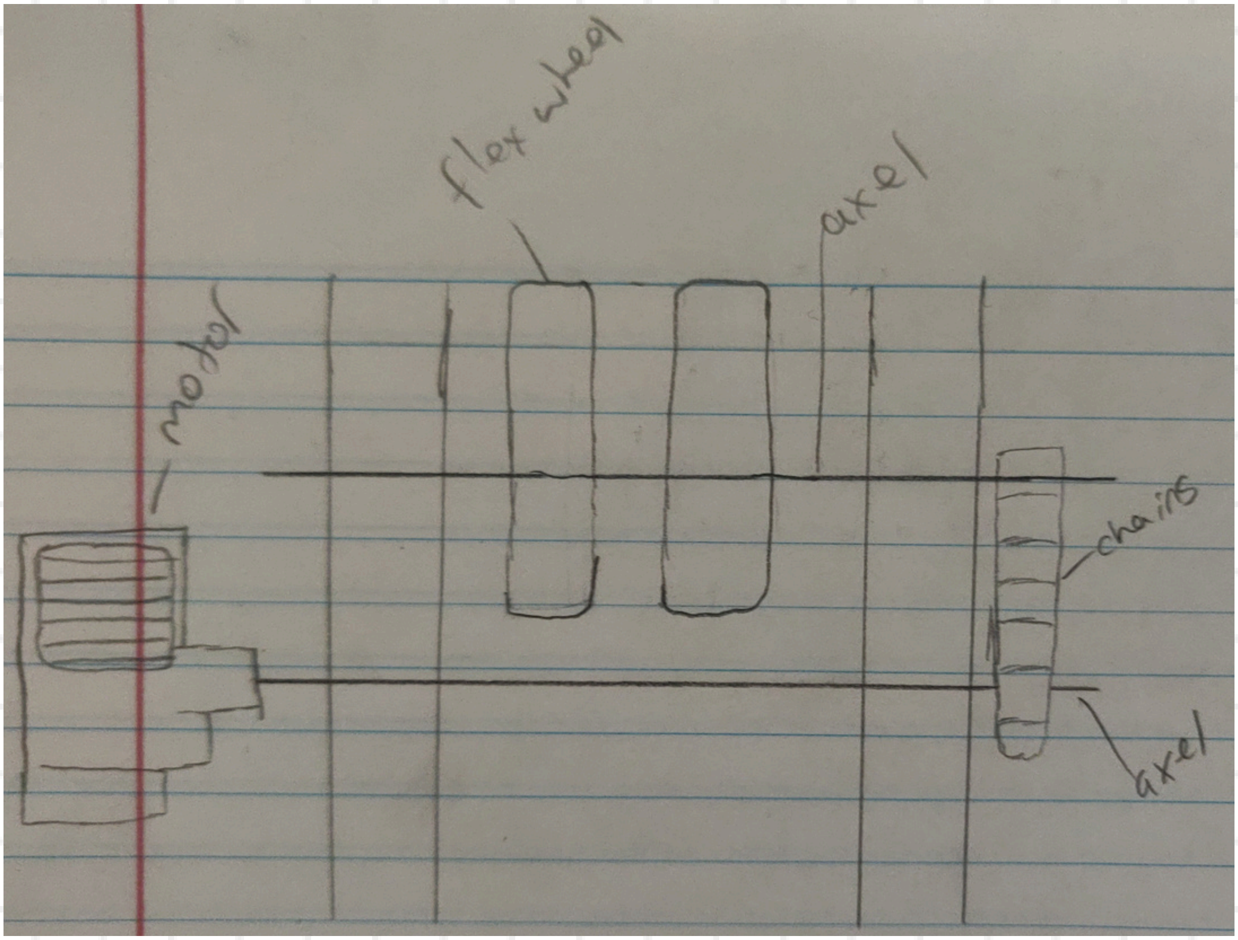
Shivank

Our New Launcher

For our launcher we decided to go with something that would be fast. The catapult would be a good idea but the time it takes for the catapult to go down is a lot which makes us have a disadvantage causing us to potentially loose the game.

If we decided to use horizontally floating flywheel then the launcher might not work as it would have to expand a lot horizontally causing potential error when it comes back. Another thing is that the flywheel would have a lot of rpm drop when we place the triball on it. If we place two triballs fast then the triball might not go far enough.

We decided to go back to the vertical flywheel design as it would be fast and could launch it far. The last one did not work as it was built in less than a week so we know that if we build this design better we could potentially get it working and make it work really well.



2/1/2024

Shivank

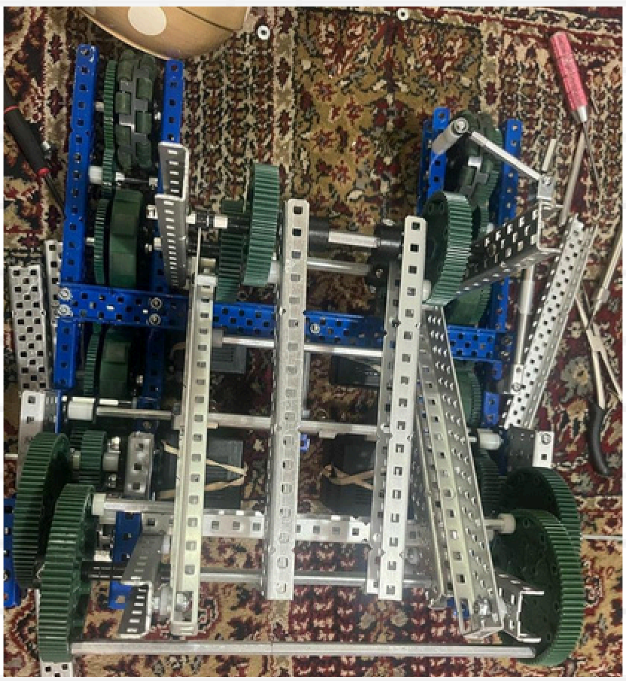
The last design we had one flexwheel and on this design we decided to make it two flywheels this time. This is so that we could have more coverage on the ball. More surface means more speed and reliability. Another thing is this time we will have a better platform to place the triball onto. We also decided to have some sort of bearing weights so that the flywheel does not slow down when the triball is placed onto the flywheel. This causes us to have a better flywheel with little to no rpm drop giving us better grouping on the triballs.

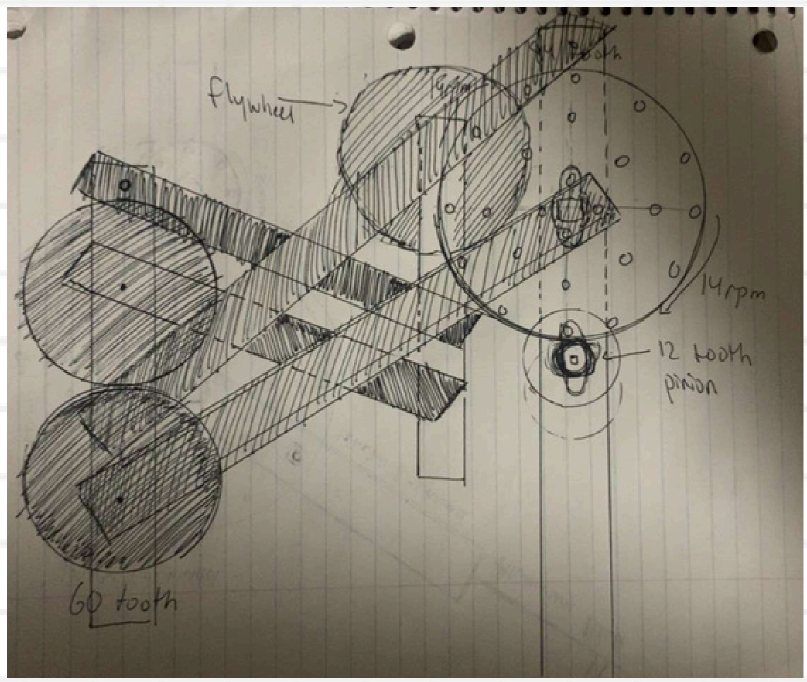
11/1/2024

Shivank

The Second Part of Our Launcher

The flywheel has a very low arch meaning that it wouldn't go over the center pipe and even if it did the triball would likely get deflected by the opposing alliance. This would be very bad for us as a lot of our matchloads could easily be scored by the other team giving them a lot more points. To prevent this we decided that we would build a contraption that would raise up above our robot with the launcher connected to it. This would solve both our problems of not going over the center pipe and getting deflected by the opposing robots.



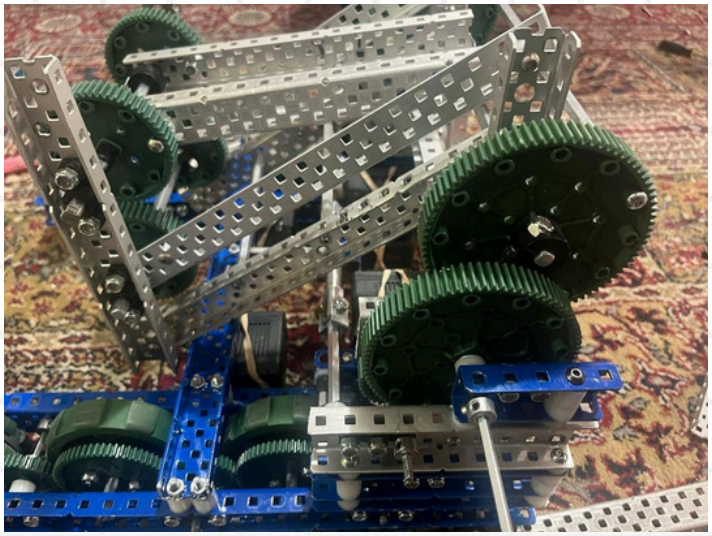


We decided to build a double reverse four bar. This is where there are four bars that actaully lift the catapult. There are two static c-channels that can't move. There is also 2 c-channels that rotate on 2 axis's one below the other. Since it is double there is a second version of this on the inside of the original four bar. This gives us more height which prevents the balls from hitting the other robots. We choose to do a double reverse because a single reverse might not be able to shoot over the other robots.

Shivank

11/1/2024

The math for the motors might not be adding up right now. There are 6 motors on the driverterian and supposed to be 2 motors on the four bar lift. There is one more on the intake and one more on the launcher itself. This means that we need a total of 10 motors when we can only have 8 motors in total. To combat this problem we decided to do a pto system from the back two driveterian motors to the double reverse four bar motors. This would reduce the amount of motors we need to a total of 8 making us leagal in the competition. This also wouldn't make our robot slow as when we have the PTO on when we were shooting triballs. We would not be moving during this time which means that the two motors would not be in use at this time.



18/1/2024

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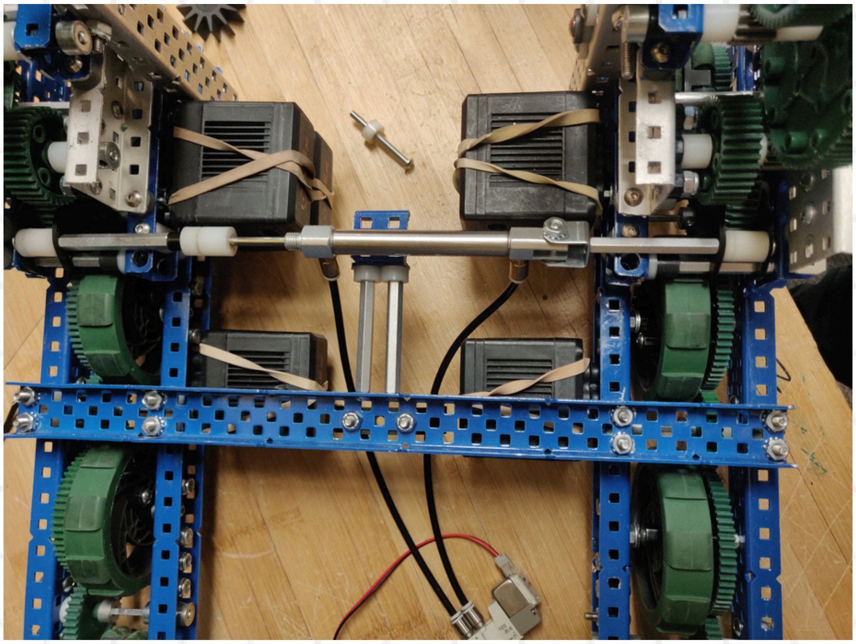
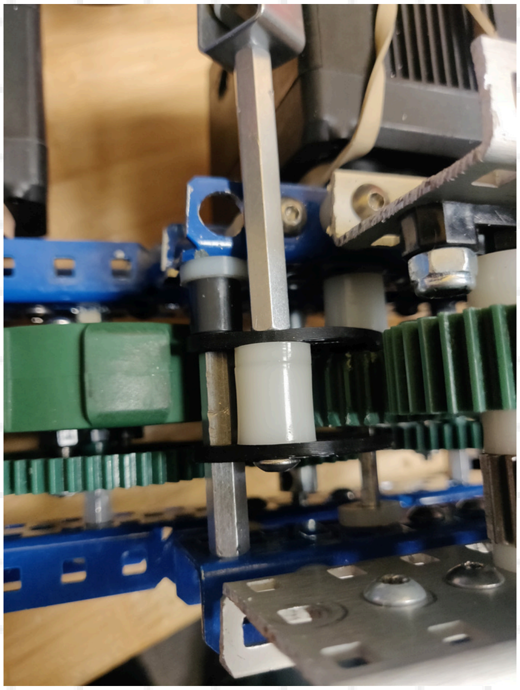
The PTO System

The PTO system enables us to use two motors for two different things. This is because there is a piston that moves two gears from the wheels to the four bar lift. The way that this works is the pto sits in an extended position at rest. When we activate it, the piston pulls back and since it can only move a little bit it pulls the front and back gear in making it connect to the double reverse four bar lift. This is good as we can reduce the amount of motors that we need to a grand total of 8 motors.





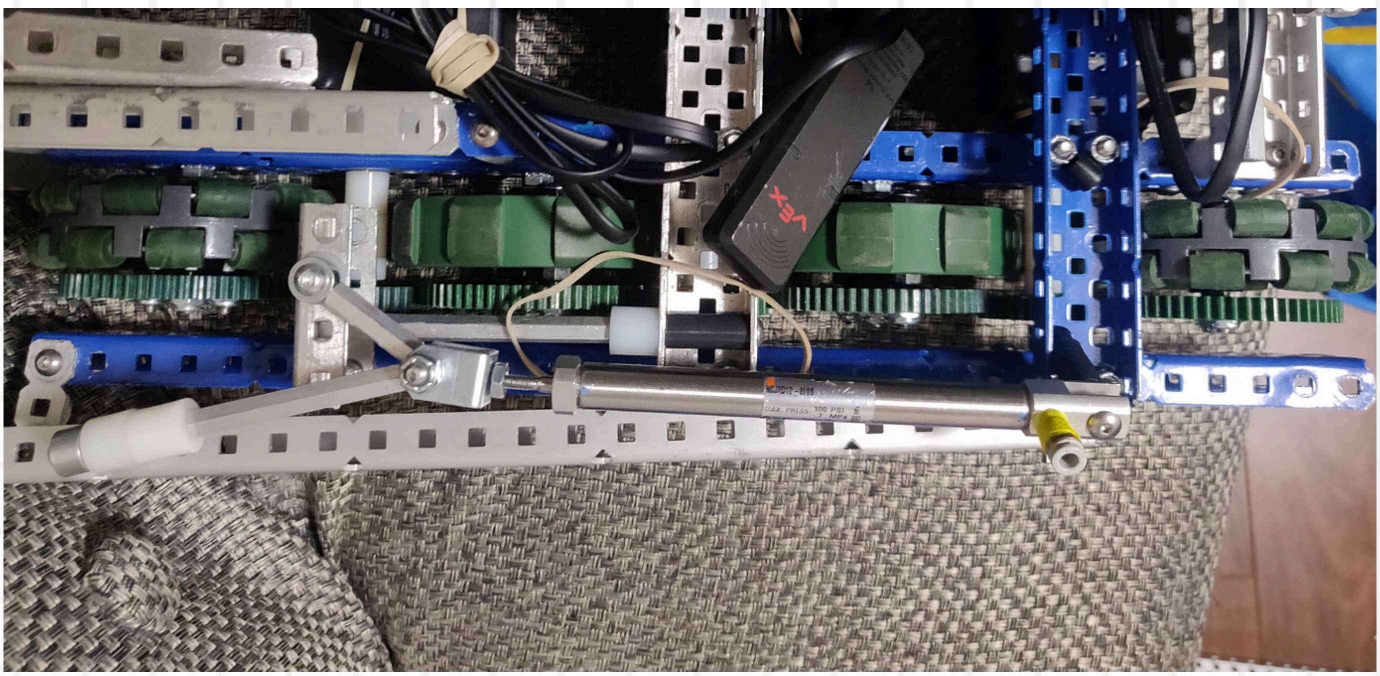
The way that the PTO retracts is that when it extends again. The thing that happens when it extends is that since the piston can't move that much so the front gear would move forward while the piston would get pushed back due to little room. This would also move the gear at the back of the piston back aswell. For this we only used one piston and it is connected by standoffs from the two sides.

18/1/2024

Shivank

Our New Wings

Our last wings worked great but they were direct which made them get pushed back if they hit more than one triball at a time. This made the wings weak if we were pushing many triballs at a time. We decided to rebuild this design to make them locking. There are a couple ways that we could do this. We decided to use the two standoff method. This is where when the piston is extended it forms a diagonal line with a little farther than the center connected to the piston. This means that when the c-channel gets pushed back the force goes horizontal on the piston making it so that the piston doesn’t retract.



One problem that we had was where to put the piston. This is because there is a small elevated c-channel that is connected to the base. This means that to place the wings they had to be elevated. This requires us to use more spacers which isn’t an issue for us but is still an issue. Anoather thing is that we require

18/1/2024

Shivank

Tournament Analysis

Feburary 2-Feb-2024 - 4-Feb-2024 we the days of the signature event Mecha Mayhem. There were 134 teams each and there were two divisions. Praries and rockies. We were part of the rockies team and we had went 6 wins for four losses. We made it to round of 16 and allianced with our sister team 221X. Unfortunately we lost round of 16 match.

Flywheel

Our flywheel worked perfectly. We used it a lot and got all of our triballs out onto the feild quite fast. The only problem was that the wire placement caused the flywheel to not sit right and rather sit at an angle. This also cuased it so that we cannot go under the bar preventing us from bowling. The second part of our flywheel was the double reverse four bar. This is where we had most of the problems. It was a heavy peice of metal. We thought that it would be useful but in reality we only used it a couple times. The first reason that we didn't use it was bbeucase it took a lot of time to come up and put back down. When we had it up and put it back down it offset our center of mass making it so that one tiny push would cause us to tip over. Another reason that it wasn't used much was becuase of our PTO. It was unreliable beucase we needed to shake the robot for the gear to get in place. It was also hard to code making it so that it would not change and if it did it would be connected to our drive. This means that the double reverse four bar went up when we drove forward. And it came down when we drove back. This is not good becuase it would take an even longer time to get it up beucase we would have to do a complex set of moves to get it up. As I said before it was heavy. This meant that our robot was very slow. This also meant that we struggled to go over the center barrier. Overall we had a lot of problems with our double reverse four bar.

2/7/2024

Shivank

Intake

The intake worked as expected. It took in triballs and it went up over the net in order to put the triball into the net. We had one problem though. If we went to fast into a triball. It would just get pushed away. This was quite a bit of a problem but it wasn't too big to be match affecting. Other than that our intake worked perfectly and just as we expected.

Wings

The wings also worked great. They would lock and they were big enough to push in multiple triballs at once.

Base

The base also worked good. Every problem that we had with the base came from the heavy double reverse four bar lift. It was heavy causing our robot to be slow and have a hard time going over the center pipe.

2/7/2024

Shivank

Match	Red Alliance	Blue Alliance	Result
P10	27455E 45519B 51	221Z 886Z 169	✓
Q13	221Z 3141M 95	2088W 2088R 52	✓
Q21	221J 60410A 56	1010T 221Z 119	✓
Q37	1290C 221X 119	3388G 221Z 81	✗
Q56	9409Z 27455C 71	221Z 2088E 77	✓
Q68	221Z 210Z 91	12145B 9409X 59	✓
Q85	3388E 86744W 87	3388K 221Z 78	✗
Q101	1165A 37474A 107	6659E 221Z 82	✗
Q126	210F 221Z 137	20785A 27455E 48	✓
Q143	10012G 221Z 67	45519D 9594J 39	✓
Q168	221Z 50865A 52	3388B 6030J 118	✗

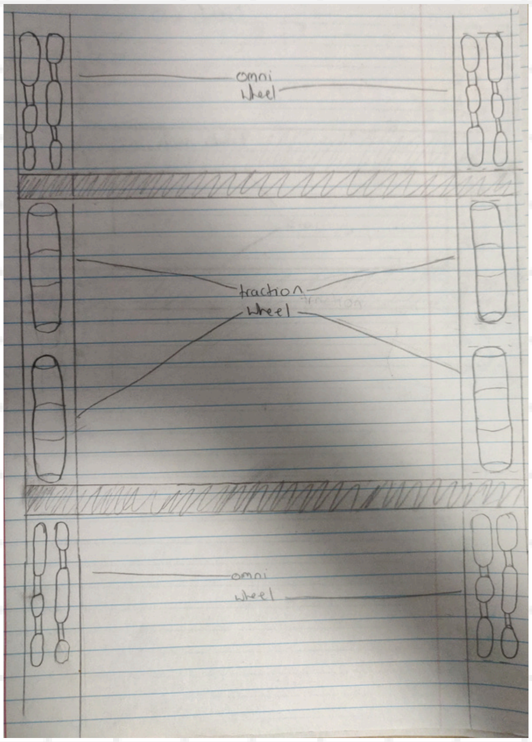
2/17/2024

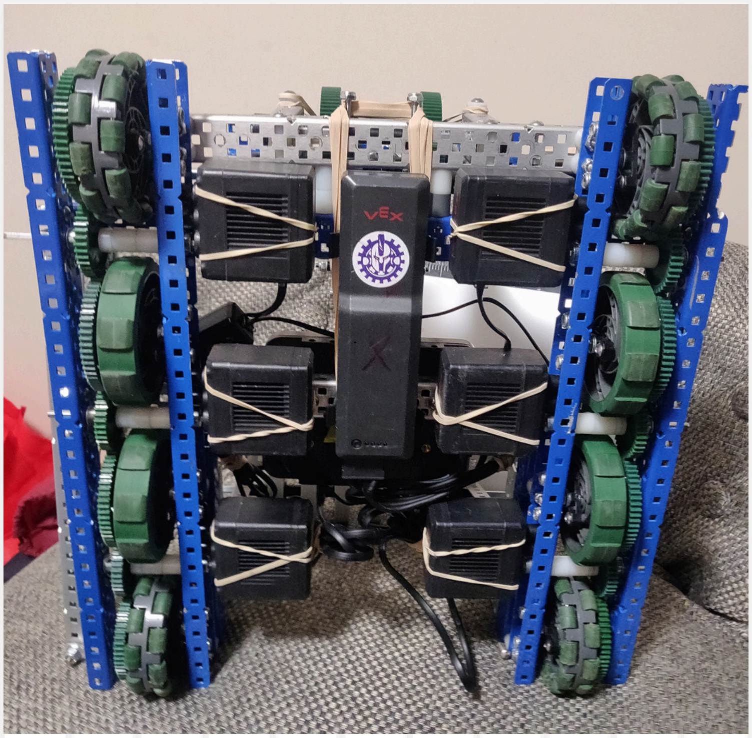
Shivank

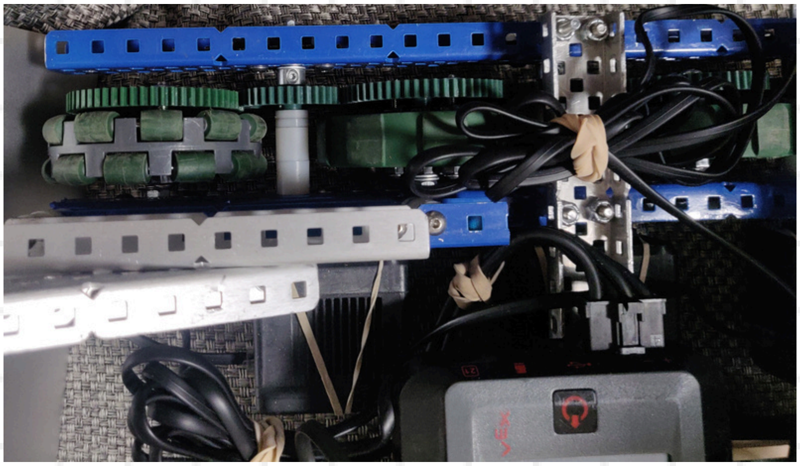
R16-8	82855S 1165A 114	221X 221Z 70	

Our "New" Base

Since the base worked so well at the tournament. The only problem that we had was becuase of the double reverse four bar being so heavy. We decided to keep the base the same since it worked so well. We just changed one thing whihc was the bracing at the end. Instead of a c-channel on the inside of the two sides of the drivetrain we put a long l-channel connecting the outsides of the drivetrains. Other than that minor change we kept the base the same.





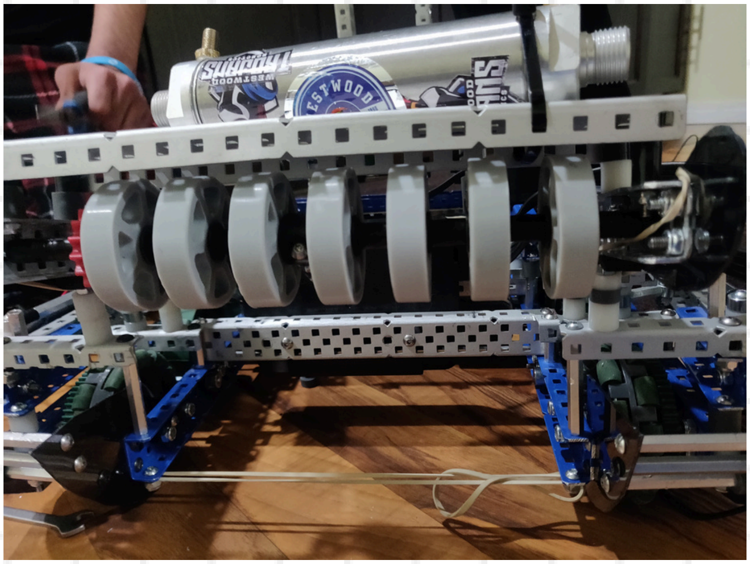


2/19/2024

Shivank

Our New Intake

Our updated intake design closely resembles the previous one: it still takes in the triball and lifts it over the goal for scoring. However, to enhance efficiency, we made significant adjustments. We expanded both the length and width of the intake to accommodate more triballs and to improve intake efficiency during matches. This modification addresses the issue of triballs getting pushed away when approached too quickly with our previous intake design. Furthermore, we replaced the rubber bands used to secure the triball within the robot with latex tubing for better durability and improved grip. Additionally, to facilitate smoother scoring of the triball, we introduced a ram bar in the form of a c-channel, to assist us with scoring the triball with ease. Lastly, we changed our motor placement. Originally we chained the motor and the intake and also used rubber bands to secure gearbox and motor cartridge in place. However, for weight distribution we directly connected the motor to the intake and also used screws instead of rubber bands to secure the motor box preventing it from falling out during a match.



2/19/2024

Shivank

Our Hang

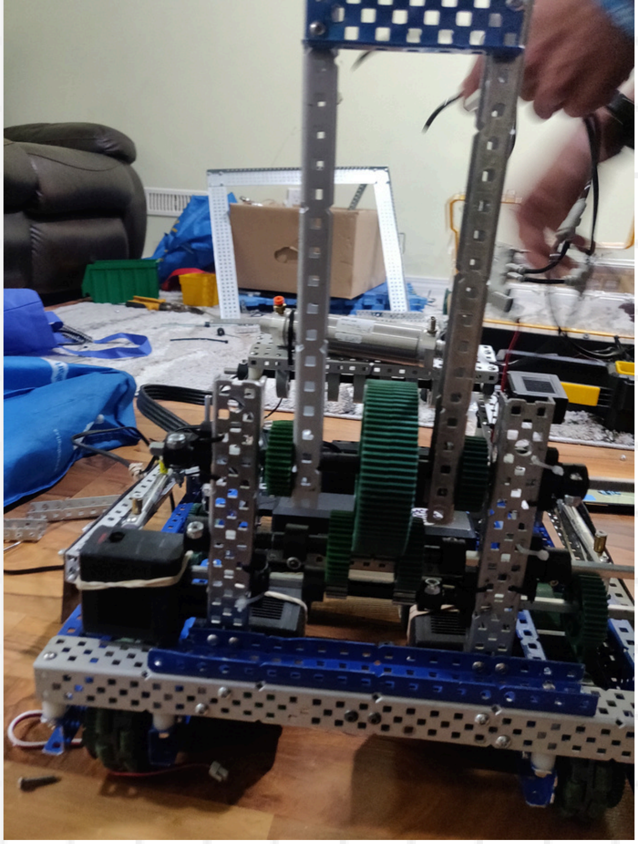
Initially, we opted for a 12-tooth to 36-tooth to 84-tooth gear ratio, driven by a red motor at 100 RPM for our hang mechanism. However, due to the weight of our robot, we needed more torque. Hence, we adjusted the gear ratio to 12-tooth to 36-tooth, and then added another set of 12-tooth and 84-tooth gears, all still powered by the same red motor at 100 RPM. This modification was successful, allowing us to get a B-tier elevation. Subsequently, we encountered issues with our 84-tooth gear snapping from the inside after a certain amount of attempts. To address this, we screwed the 84-tooth gear in with a 72 tooth gear with reinforced steel on the inside, ensuring durability and preventing breakage of the gears.

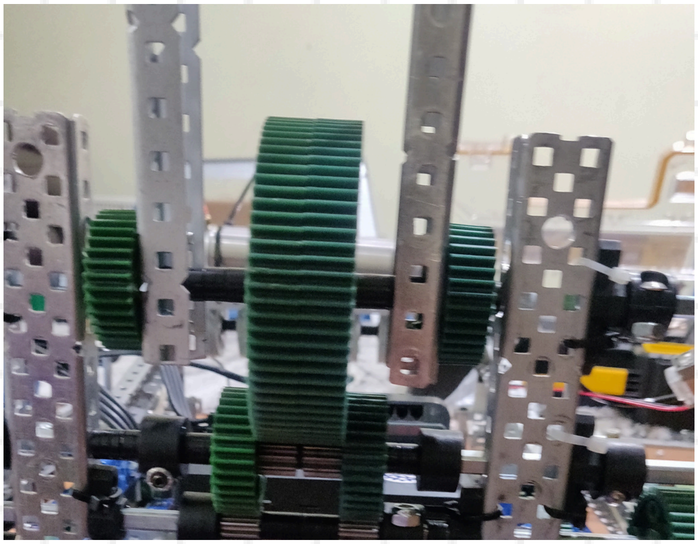
Our hang bar consisted of two 19-hole long C-channels securely fastened onto two 36-tooth gears. Additionally, the hang bar was equipped with four medium-sized standoffs to provide a firm grip on the climbing pipe. Originally we used standoffs to lock onto the latch, but to enhance stability, we replaced it using a high-strength axle running through both channels.

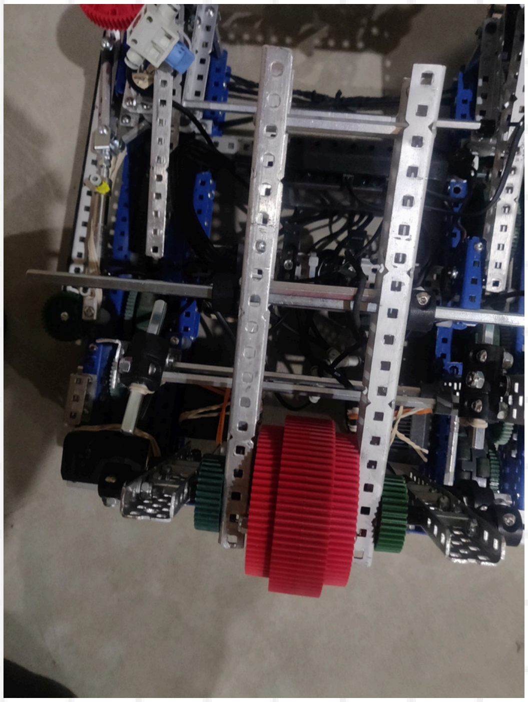
We opted for an alternative method to secure our hang after the match by incorporating two aluminum channels each with a freely spinning high-strength axle and a screw as a stoppage point. These axles were then rubber-banded down, functioning as a latch mechanism. Upon contact between the latch and the hang bar, this mechanism swiftly locked the hang bar in place, avoid the hang from collapsing after the match.

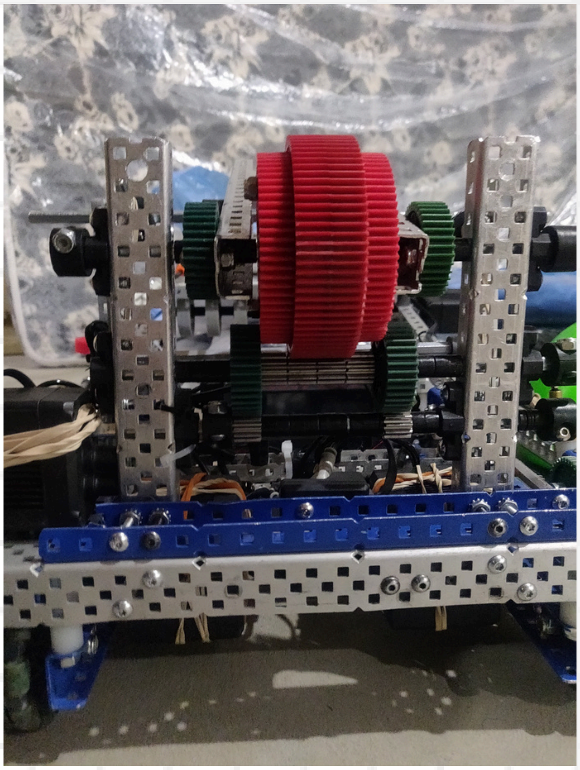
2/22/2024

Shivank









2/22/2024

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